Imaging ischemic heart disease: role of SPECT and PET. Focus on Patients with Known CAD

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Academic Medical Center, University of Amsterdam, Amsterdam, Netherlands

International Conference on Integrated Medical Imaging in Cardiovascular Diseases (IMIC 2016)
Disclosure

• Nothing to disclose
Learning objectives

• Discuss the application of appropriate use criteria for SPECT and PET in ischemic heart disease

• Examine new insights in myocardial perfusion imaging: future
Goals

• What is “known” coronary artery disease (CAD):
  – Definition

• What is the evidence for what indication:
  – Ischemia detection vs. prognosis

• Clinical implications:
  – How to use the (imaging) findings
Definition

• Known CAD implies:
  – Already established:
    • Guidelines:
      – Stable Coronary Artery Disease (ESC 2013)
      – Stable Ischemic Heart Disease (ACCF 2012)
  
• Adult patients:
  – with stable known IHD (including angiographically proven, post MI), including recurrent (renewed-onset) chest pain and patients with stable pain syndromes.

ESC Eur Heart J 2013;34:2949–3003
ACCF Circulation 2012;126:e354-e471
Definition

• Stable angina pectoris or other symptoms felt to be related to coronary artery disease (CAD) such as dyspnea;

• Previously symptomatic with known obstructive or non-obstructive CAD, who have become asymptomatic with treatment and need (regular) follow-up.

ESC Eur Heart J 2013;34:2949–3003
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Definition

• Stable angina pectoris or other symptoms felt to be related to coronary artery disease (CAD) such as dyspnea;

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# Main features of SCAD

## Pathogenesis
- Stable anatomical atherosclerotic and/or functional alterations of epicardial vessels and/or microcirculation

## Natural history
- Stable symptomatic or asymptomatic phases which may be interrupted by ACS

## Mechanisms of myocardial ischaemia
- Fixed or dynamic stenoses of epicardial coronary arteries;
- Microvascular dysfunction;
- Focal or diffuse epicardial coronary spasm;
- Overlap of above mechanisms in the same patient and may change over time.
Prognosis

• stable CAD:
  – individual’s prognosis can vary considerably:
    • Reduction of Atherothrombosis for Continued Health (REACH) registry:
      – included very high-risk patients, many with peripheral arterial disease or previous MI and almost 50% with diabetes.
    • Annual mortality rate of 2.9%.

• Annual mortality rate in patients with non-obstructive plaques is 0.63%.

*JAMA 2007;297:1197–1206*
Prognosis

• Therefore important to identify:
  – those patients with a less severe form of disease and a good prognosis (i.e. no unnecessary tests and revascularization procedures).
  – those patients with more severe forms of disease, who may benefit from more aggressive investigation and—potentially—intervention, including revascularization.
## Pre test probability

<table>
<thead>
<tr>
<th>Age</th>
<th>Typical angina</th>
<th>Atypical angina</th>
<th>Non-anginal pain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>30‒39</td>
<td>59</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>40‒49</td>
<td>69</td>
<td>37</td>
<td>38</td>
</tr>
<tr>
<td>50‒59</td>
<td>77</td>
<td>47</td>
<td>49</td>
</tr>
<tr>
<td>60‒69</td>
<td>84</td>
<td>58</td>
<td>59</td>
</tr>
<tr>
<td>70‒79</td>
<td>89</td>
<td>68</td>
<td>69</td>
</tr>
<tr>
<td>&gt;80</td>
<td>93</td>
<td>76</td>
<td>78</td>
</tr>
</tbody>
</table>

- **White:** pre-test probability: <15% ➔ done
- **Blue:** pre-test probability: 15-65% ➔ consider non-invasive testing
- **Light red:** pre-test probability: 66-85% ➔ non-invasive testing
- **Red:** pre-test probability: >85% ➔ non-invasive testing

\[ \text{Genders et al. Eur Heart J 2011;32:1316–1330} \]
Data
Understanding the evidence

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Data derived from multiple randomized clinical trials or meta-analyses.</td>
</tr>
<tr>
<td>B</td>
<td>Data derived from a single randomized clinical trial or large non-randomized studies.</td>
</tr>
<tr>
<td>C</td>
<td>Consensus of opinion of the experts and/or small studies, retrospective studies, registries.</td>
</tr>
</tbody>
</table>
## Understanding the evidence

<table>
<thead>
<tr>
<th>Classes of recommendations</th>
<th>Definition</th>
<th>Suggested wording to use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class I</strong></td>
<td>Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective.</td>
<td>Is recommended/is indicated</td>
</tr>
<tr>
<td><strong>Class II</strong></td>
<td>Conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of the given treatment or procedure.</td>
<td></td>
</tr>
<tr>
<td><strong>Class IIa</strong></td>
<td>Weight of evidence/opinion is in favour of usefulness/efficacy.</td>
<td>Should be considered</td>
</tr>
<tr>
<td><strong>Class IIb</strong></td>
<td>Usefulness/efficacy is less well established by evidence/opinion.</td>
<td>May be considered</td>
</tr>
<tr>
<td><strong>Class III</strong></td>
<td>Evidence or general agreement that the given treatment or procedure is not useful/effective, and in some cases may be harmful.</td>
<td>Is not recommended</td>
</tr>
</tbody>
</table>
Understanding the evidence

• An appropriate imaging study:
  – expected incremental information in combination with clinical judgment:
  – exceeds the expected negative consequences by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.

ACCF etc. JACC 2009;53:2201-29
Understanding the evidence

– Score 7–9:
  • Appropriate (test is generally acceptable and is a reasonable approach for the indication).

– Score 4–6:
  • Uncertain (test may be generally acceptable and may be a reasonable approach for the indication).

– Score 1–3:
  • Inappropriate (test is not generally acceptable and is not a reasonable approach for the indication).
Understanding the evidence

– Score 7–9:
  • Appropriate (test is generally acceptable and is a reasonable approach for the indication).

– Score 4–6:
  • Uncertain (test may be generally acceptable and may be a reasonable approach for the indication).

– Score 1–3:
  • Inappropriate (test is not generally acceptable and is not a reasonable approach for the indication).

ACCF etc. JACC 2009;53:2201-29

Known CAD: Nuclear Cardiology
IMIC 2016
### Appropriate use criteria

<table>
<thead>
<tr>
<th>Indication</th>
<th>Description</th>
<th>Score</th>
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<tbody>
<tr>
<td><strong>Risk Assessment With Prior Test Results and/or Known Chronic Stable CAD Prior Noninvasive Evaluation</strong></td>
<td>• Equivocal, borderline, or discordant stress testing where obstructive CAD remains a concern</td>
<td>A (8)</td>
</tr>
<tr>
<td><strong>Risk Assessment With Prior Test Results and/or Known Chronic Stable CAD New or Worsening Symptoms</strong></td>
<td>• Abnormal coronary angiography OR abnormal prior stress imaging study</td>
<td>A (9)</td>
</tr>
<tr>
<td><strong>Risk Assessment With Prior Test Results and/or Known Chronic Stable CAD Coronary Angiography (Invasive or Noninvasive)</strong></td>
<td>• Coronary stenosis or anatomic abnormality of uncertain significance • Evaluation of ischaemic equivalent</td>
<td>A (9)</td>
</tr>
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*A (8)* and *A (9)* refer to the grading system used in the ACCF et al. JACC 2009;53:2201-29.
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<td><strong>Risk Assessment: Postrevascularization</strong></td>
<td>•Evaluation of ischaemic equivalent</td>
<td>A (8)</td>
</tr>
<tr>
<td>(PCI or CABG) †Symptomatic</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Risk Assessment: Postrevascularization</strong></td>
<td>•Incomplete revascularization</td>
<td>A (7)</td>
</tr>
<tr>
<td>(PCI or CABG) †Asymptomatic</td>
<td>•Additional revascularization feasible</td>
<td>A (7)</td>
</tr>
<tr>
<td></td>
<td>•Greater than or equal to 5 years after CABG</td>
<td></td>
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<tr>
<td><strong>Risk Assessment: Within 3 Months of an ACS STEMI</strong></td>
<td>• Hemodynamically stable, no recurrent chest pain symptoms or no signs of HF&lt;br&gt;• To evaluate for inducible ischaemia&lt;br&gt;• No prior coronary angiography</td>
<td>A (8)</td>
</tr>
<tr>
<td><strong>Risk Assessment: Within 3 Months of an ACS UA/NSTEMI</strong></td>
<td>• Hemodynamically stable, no recurrent chest pain symptoms or no signs of HF&lt;br&gt;• To evaluate for inducible ischaemia&lt;br&gt;• No prior coronary angiography</td>
<td>A (9)</td>
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*ACCF etc. JACC 2009;53:2201-29*
# Appropriate use criteria

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| Assessment of Viability/Ischemia Ischemic Cardiomyopathy / Assessment of Viability | • Known severe LV dysfunction  
• Patient eligible for revascularization                                        | A (9) |
Use of AUC

N=5928

- Multivariate analysis for inappropriateness:
  - Asymptomatic OR: 22.5 (95%CI:15.2–33.2)

“known” CAD:
- The second most frequent inappropriate indication was the performance of SPECT imaging ≤2 years after PCI in an asymptomatic patient (23.8%).

Hendel et al. JACC 2010;55:156-62
Use of AUC

An objective automated computer algorithm calculated appropriateness

Period 1: baseline.
Period 2: after availability of “on-demand” reports.
Period 3: after delivery of specific site and aggregate reports.

Hendel et al. JACC 2010;55:156-62
Use of AUC

An objective automated computer algorithm calculated appropriateness

The single site with substantial change in the rate of inappropriate test use:

Initiated discussions to educate physicians on compliance with the AUC.

Period 1: baseline.
Period 2: after availability of “on-demand” reports.
Period 3: after delivery of specific site and aggregate reports.

Hendel et al. JACC 2010;55:156-62
Testing asymptomatic patients at risk for SCAD

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<thead>
<tr>
<th>Recommendation</th>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>In low- or intermediate-risk (based on SCORE) asymptomatic adults stress imaging tests are not indicated for further CV risk assessment.</td>
<td>III</td>
<td>C</td>
</tr>
</tbody>
</table>

*ESC Eur Heart J* 2013;34:2949-3003
## ESC and AFFC guideline

<table>
<thead>
<tr>
<th>Risk</th>
<th>Ischaemia imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High risk</strong> (annual mortality rate &gt;3%)</td>
<td>Area of ischaemia &gt;10% (≥ 2/17 segments)</td>
</tr>
<tr>
<td><strong>Intermediate risk</strong> (annual mortality rate 1-3%)</td>
<td>Area of ischaemia between 1 to 10%</td>
</tr>
<tr>
<td><strong>Low risk</strong> (annual mortality rate &lt;1%)</td>
<td>No ischaemia</td>
</tr>
</tbody>
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**Known CAD: Nuclear Cardiology**

*IMIC 2016*

*ACCF Circulation* 2012;126:e354-e471

*ESC Eur Heart J* 2013;34:2949-3003
Risk stratification using ischaemia testing ESC

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Class</th>
<th>Level</th>
</tr>
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<tbody>
<tr>
<td>Risk stratification using preferably stress imaging is recommended in patients with SCAD after significant change in symptom level.</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Stress imaging is recommended for risk stratification in patients with known SCAD and a deterioration in symptoms if the site and extent of ischaemia would influence clinical decision making</td>
<td>I</td>
<td>B</td>
</tr>
</tbody>
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*ESC Eur Heart J 2013;34:2949-3003*
Risk stratification using ischaemia testing ACCF

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<td>Either exercise or pharmacological stress with imaging is recommended for risk assessment in patients with SCAD who are being considered for revascularization of known coronary stenosis of unclear physiological significance.</td>
<td>I</td>
<td>B</td>
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# Re-assessment in patients with SCAD ESC

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<th>Level</th>
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</thead>
<tbody>
<tr>
<td>An exercise ECG or stress imaging if appropriate is recommended in the presence of recurrent or new symptoms once instability has been ruled out.</td>
<td>I</td>
<td>C</td>
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*ESC Eur Heart J 2013;34:2949-3003*
Re-assessment in patients with SCAD ACCF

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<tr>
<td>Stress imaging with nuclear MPI or echocardiography is recommended in patients with known SCAD who have new or worsening symptoms not consistent with unstable angina.</td>
<td>I</td>
<td>B</td>
</tr>
</tbody>
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ACCF Circulation 2012;126:e354-e471

Known CAD: Nuclear Cardiology
IMIC 2016
Management based risk assessment

Confirmed diagnosis SCAD

- Low risk
- Intermediate event risk
- High event risk

- OMT and consider CAG
- CAG (+ PCI option) + OMT

Trial of OMT

- Yes: Continue OMT
- No: Symptoms improved

Symptoms improved

- Yes: Intensify medical treatment
- No: Symptoms improved

Known CAD: Nuclear Cardiology
IMIC 2016
# Revascularization of SCAD in patients OMT ESC

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>To improve prognosis</th>
<th>To improve symptoms persistent on OMT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class</td>
<td>Level</td>
</tr>
<tr>
<td>Proven large area of ischaemia (&gt;10% LV)</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Dyspnoea/cardiac heart failure with &gt;10% ischaemia/viability supplied by stenosis &gt;50%</td>
<td>IIb</td>
<td>B</td>
</tr>
<tr>
<td>No limiting symptoms with OMT in vessel other than left main or proximal LAD or single remaining vessel or vessel subtending area of ischaemia &lt;10% of myocardium or with FFR ≥0.80.</td>
<td>III</td>
<td>A</td>
</tr>
</tbody>
</table>

*ESC Eur Heart J 2013;34:2949-3003*
# Risk stratification using ischaemia testing ACCF

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**Of interest**

A request to perform either a) more than 1 stress imaging study or b) a stress imaging study and a CCTA at the same time is not recommended for risk assessment in patients with SCAD.

III     C
Revascularization of SCAD in patients OMT

Significant CAD + ischaemia (>10% myocardium) + OMT

Revascularization possible

Anatomical factors
Clinical factors
Technical factors
Local factors

CABG    hybrid    PCI

Revascularization not possible

Failure

Refractory angina

Stem cell therapy?
Spinal cord stimulation?
Etc.
Myocardial perfusion

- **♂ 79 year**
- **history:**
  - 1988 inferior MI
  - 2000 atypical AP, medical treatment
  - 2013 change of cardiologist
- **RF:**
  - Hypertension, DM, smoking
- **Co-morbidity: arthritis**
- **EGG:**

Known CAD: Nuclear Cardiology
IMIC 2016
Myocardial perfusion

ECG at rest

Known CAD: Nuclear Cardiology
IMIC 2016
Myocardial perfusion

ECG after Adenosine
Nuclear Cardiology

myocardial perfusion
Myocardial perfusion

Stress  Rest

EF = 36%

EF = 38%

Known CAD: Nuclear Cardiology
IMIC 2016
Myocardial perfusion

RCA

LAD

Known CAD: Nuclear Cardiology
IMIC 2016
Myocardial perfusion

- 79 year
- History:
  - 1988 inferior MI
  - 2000 atypical AP, medical treatment
  - 2013 change of cardiologist
- MPS:
  - Ischemia
- CAG:
  - 2 vessel disease and successful PCI of RCA and LAD
- 3 months later recurrence of angina!
Myocardial perfusion
Myocardial perfusion

Stress

Rest

EF = 53%

Known CAD: Nuclear Cardiology
IMIC 2016
Myocardial perfusion

RCA Post-PCI

LAD Post-PCI

Known CAD: Nuclear Cardiology
IMIC 2016
Known SCAD and normal MPI

N= 266,
CAD: previous myocardial infarction and/or previous coronary revascularization
Normal MPI during stress and at rest (<2 segments)
Median follow-up of 12 years (range 8 to 21 years)

The annualized cardiac mortality rate was 0.9%

*Ottenhof et al. J Nucl Cardiol 2013;20:748–54*
## Appropriate use criteria

<table>
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<tr>
<th>Indication</th>
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<th>Score</th>
</tr>
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</table>
| Risk Assessment with Prior Test Results and/or Known Chronic Stable CAD Asymptomatic Prior Coronary Calcium Agatston Score | • High CHD risk  
• Agatston score between 100 and 400  
• Agatston score greater than 400 | A (7)  |
Conclusions

• Role of MPI in patients with known SCAD is well validated:
  – Adequate representation in guidelines

• Adherence to guidelines or appropriate use criteria is essential:
  – Adequate patient care
  – Trainable!
Myocardial perfusion

Quality is essential!
Therefore, important to realize that:

Prevent GIGO!

Garbage In, Garbage Out!
Call for abstracts & clinical cases
Deadline 21 Nov 2016
JOIN US IN VIENNA, AUSTRIA!