Stress echo, infarction, reperfusion injury and viability

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Chest pain of recent onset

Assessment and diagnosis of recent onset chest pain or discomfort of suspected cardiac origin

This guidance partially updates NICE technology appraisal guidance 73 (published November 2003)
Probability - angina

Table 1 Percentage of people estimated to have coronary artery disease according to typicality of symptoms, age, sex and risk factors

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Non-anginal chest pain</th>
<th>Atypical angina</th>
<th>Typical angina</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>35</td>
<td>3</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>45</td>
<td>9</td>
<td>47</td>
<td>2</td>
</tr>
<tr>
<td>55</td>
<td>23</td>
<td>59</td>
<td>4</td>
</tr>
<tr>
<td>65</td>
<td>49</td>
<td>69</td>
<td>9</td>
</tr>
</tbody>
</table>

For men older than 70 with atypical or typical symptoms, assume an estimate > 90%.
For women older than 70, assume an estimate of 61–90% EXCEPT women at high risk AND with typical symptoms where a risk of > 90% should be assumed.

Values are per cent of people at each mid-decade age with significant coronary artery disease (CAD)\(^1\).
Hi = High risk = diabetes, smoking and hyperlipidaemia (total cholesterol > 6.47 mmol/litre).
Lo = Low risk = none of these three.
The shaded area represents people with symptoms of non-anginal chest pain, who would not be investigated for stable angina routinely.

Note:
These results are likely to overestimate CAD in primary care populations.
If there are resting ECG ST-T changes or Q waves, the likelihood of CAD is higher in each cell of the table.

1.3.3 Making a diagnosis based on clinical assessment

1.3.3.1 Anginal pain is:
- constricting discomfort in the front of the chest, or in the neck, shoulders, jaw, or arms
- precipitated by physical exertion
- relieved by rest or GTN within about 5 minutes.

Use clinical assessment and the typicality of anginal pain features listed below to estimate the likelihood of CAD (see table 1):

- Three of the features above are defined as typical angina.
- Two of the three features above are defined as atypical angina.
- One or none of the features above are defined as non-anginal chest pain.
Guidelines – stable angina

Diagnostic testing for people in whom stable angina cannot be diagnosed or excluded by clinical assessment alone:

Likelihood: 61-90%
angiography

Likelihood: 30-60%
non-invasive functional imaging for myocardial ischemia

Likelihood: 10-29%
CT calcium score

Non-invasive functional imaging for myocardial ischaemia:

Myokard perfusjons scintigrafi med single photon emisjon computed tomography (MPS med SPECT)

Stress echocardiography

Perfusion MR with stress or stress MR

NICE 2010
SPECT
single photon emission computed tomography
Perfusion MR with stress

Baseline

RV contrast uptake

LV contrast uptake

Myocardial contrast uptake

Stress-Perfusion

Rest-Perfusion
Coronary calcium

Zero

Moderate

Extensive
Typical breast pain
(50 yo – m)
At rest
At peak stress
40ug/min/kg - Dobutamin
Angiography:

- **75% RCA stenosis**
Angiography:

- 75% prox LAD stenosis
Typical breast pain (50 yo – m)
Rest - At peak stress
Strain-Rate Imaging During Dobutamine Stress Echocardiography Provides Objective Evidence of Inducible Ischemia

Jens-Uwe Voigt, MD; Bert Exner; Kristin Schmiedehausen, MD; Cord Huchzemeyer, Cord Huchzemeyer, MD; Udo Reitbach, MD; Uwe Nixdorf, MD, FESC; Günther Platsch, MD; Torsten Kuwert, MD, Werner G. Daniel, MD, FESC, Frank A. Flourkampf, MD, FESC

(Circulation. 2003;107:2120-2126.)

a) echo / scintigraphy

b) strain rate [s⁻¹]

c) strain [%]

d) ECG
Aypical breast pain
65 yo - m
Aypical breast pain
65 yo - m
Atypical breast pain
65 yo - m

LAD 90% prox stenosis, RCA OK
Atypical breast pain
65 yo - m

LAD 90% prox stenosis, RCA OK
Advices – Stress Echo

• **Ischemia**

• **Stress echo**
  • Use if the likelihood of ischemia is moderate
  • Wall motion score index
    • Hypokinesia / akinesia / dyskinesia
  • Wall motion score index

• Novel techniques: Strain echocardiography
  • Use as support / in addition
  • Look for post systolic shortening (PSS)
  • You need GOOD image quality!!
Extension of myocardial infarction

TTC-staining

Helle-Valle et al, AHA 2006
Circumferential strain

Helle-Valle et al, AHA 2006
Thin wall / dyskinesia
Thin wall / dyskinesia
End-diastolic wall thickness vs Dobutamine stress echo

EDWT (cm)

<table>
<thead>
<tr>
<th>Contractile reserve</th>
<th>No contractile reserve</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.86±0.20</td>
<td>0.64±0.25</td>
</tr>
</tbody>
</table>

*P<0.001

Cwajg: JACC, 2000
Non-viable
Viabel
Myocardial viability
Dobutamine stress echo

Courtesy of PA Pellikka
STICH
Surgical Treatment for Ischemic Heart Failure

Coronary-Artery Bypass Surgery in Patients with Left Ventricular Dysfunction

Eric J. Velazquez, M.D., Kerry L. Lee, Ph.D., Marek A. Deja, M.D., Ph.D.,
Anil Jain, M.D., George Sopko, M.D., M.P.H., Andrey Marchenko, M.D., Ph.D.
Imtiaz S. Ali, M.D., Gerald Pohost, M.D., Sinisa Gradinac, M.D., Ph.D.,
William T. Abraham, M.D., Michael Yii, M.S., F.R.C.S., F.R.A.C.S.,
Dorairaj Prabhakaran, M.D., D.M., Hanna Szwed, M.D., Paolo Ferrazzi, M.D.,
Mark C. Petrie, M.D., Christopher M. O'Conor, M.D.,
Pradit Panchavinnin, M.D., Lilin She, Ph.D., Robert O. Bonow, M.D.,
Gena Roush Rankin, M.P.H., R.D., Robert H. Jones, M.D.,
and Jean-Lucien Rouleau, M.D., for the STICH Investigators*
• 1212 patients
• July 2002 – 2007
• non blinded – randomised
• 127 hospitals – 26 countries
• EF<=35%
• Medicine (n=602) / medicine+CABG (n=610)

• 601 tested for viability: Stess echo / SPECT
  • Viable = 487 / non-viable = 114
• Death: 178 (37%) / 58 (51%)
Figure 1. Kaplan–Meier Analysis of the Probability of Death According to Myocardial Viability Status.
The comparison that is shown has not been adjusted for other prognostic baseline variables. After adjustment for such variables on multivariable analysis, the between-group difference was not significant (P=0.21).

Figure 2. Kaplan–Meier Analysis of the Probability of Death According to Myocardial Viability Status and Treatment.
At 5 years in the intention-to-treat analysis, the rates of death for patients without myocardial viability were 41.5% in the group assigned to undergo coronary-artery bypass grafting (CABG) and 55.8% in the group assigned to receive medical therapy (Panel A). Among patients with myocardial viability, the respective rates were 31.2% and 35.4% (Panel B). There was no significant interaction between viability status and treatment assignment with respect to mortality (P=0.53) (Panel C).
Figure 2. Typical Contrast-Enhanced Images Obtained by MRI in a Short-Axis View (Upper Panels) and a Long-Axis View (Lower Panels) in Three Patients. Hyperenhancement is present (arrows) in various coronary-perfusion territories — the left anterior descending coronary artery, the left circumflex artery, and the right coronary artery — with a range of transmural involvement.
Figure 4. Relation between the Transmural Extent of Hyperenhancement before Revascularization and the Likelihood of Increased Contractility after Revascularization.

Data are shown for all 804 dysfunctional segments and separately for the 462 segments with at least severe hypokinesia and the 160 segments with akinesia or dyskinesia before revascularization. For all three analyses, there was an inverse relation between the transmural extent of hyperenhancement and the likelihood of improvement in contractility.
Infarct size by MR and survival

Wu et al. Circ 1998

Møller et al. AHJ 2006
Infarct and remodeling

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Multivariate linear regression models of the relation between scar characteristics and left ventricular (LV) volumes and function (n = 52)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>End-diastolic Volume Index (ml/m²)</td>
</tr>
<tr>
<td></td>
<td>$R^2 = 0.81$, p &lt; 0.0001</td>
</tr>
<tr>
<td>Scar size (g/m²)</td>
<td>0.70</td>
</tr>
<tr>
<td>Nonviable LV mass (g/m²)</td>
<td>0.35</td>
</tr>
<tr>
<td>Transmurality (%)</td>
<td>$-0.12$</td>
</tr>
<tr>
<td>Localization</td>
<td>0.06</td>
</tr>
<tr>
<td>Ischemia</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Effect of Left Ventricular Scar Size, Location, and Transmurality on Left Ventricular Remodeling With Healed Myocardial Infarction

Stein Örn, MD, MD[®][x], Cord Manchenke, MD, MD, Inder S. Anand, MD, PhD[®][x], Lain Squire, MD, MD[®][x], Eike Nagel, MD, PhD[®][x], Thor Edvardsen, MD, PhD[®][x], and Kenneth Dickstein, MD, PhD[®][x]
Summary – Viability

- Viability
  - Thin walls / dyskinesia
  - Low dose dobutamine stress ekko (LD DSE)

- Preferred modality:
  - Contrast MR and visual assessment of wall motion