Viability post STICH trial: How often does play a role?
Aims of Revascularization

Potential benefits:
- Improvement in resting LVEF
- Prevention of ventricular arrhythmias
- Decrease in inducible ischemia
- Decrease in ventricular remodeling
- Decrease in diastolic dysfunction
- Decrease in symptoms of CHF

Improvement symptoms, LV remodeling, prognosis outweighs surgical risk
Viable Myocardium

- Myocardial segments characterized by reduced function at rest but potentially recoverable either spontaneously (stunned myocardium) or with revascularization (hibernating myocardium)

Methods of Detecting Myocardial Viability

- **Metabolic Activity**
  - Fluorodeoxyglucose (FDG)

- **Myocardial Perfusion**
  - PET (Rubidium, NH$_3$)
  - Myocardial Contrast Echo (MCE)

- **Cell Membrane Integrity**
  - Thallium 201
  - Technetium 99

- **Contractile Reserve**
  - Dobutamine Echocardiography
  - MRI
• Thinned, highly echogenic, akinetic segment, <6 mm

SCAR

REST

DOB
Viability criteria

- **PET**: FDG uptake in >2 vascular territories and/or scar<40% of LV (scar<50% FDG uptake)
- **SPECT**: improved perfusion ≥ 20% of the LV
- **LDSE**: improved contractility in 4/16 segments (25% of the LV)
  - opacification grade >0.5 at contrast echo
  - Post systolic shortening at TDI
  - SRI>0.6 l/s DSR >0.25, SR>10 %, DSR>3
  - GLS rest> 5% radial strain>17%
- **MRI**: < 50% hyperenhancement / per segment
Association of QT dispersion with viability

- Low QT at rest = less fibrosis
- Increase of QT = more viable tissue more b-receptors
- More ventricular arrhythmias during infusion

\[ \text{QTd} = \text{dispersion}; \text{combination} = \text{rest QTd} < 65 \text{ ms and/or increase of QTd} > 30%; (\text{+}) = \text{positive}, (\text{-}) = \text{negative.} \]

\[ \begin{array}{ccc}
\text{Sensitivity} & 25/48 (53\%) & 24/48 (51\%) & 32/48 (67\%) \\
\text{Specificity} & 18/27 (67\%) & 23/27 (85\%) & 26/27 (96\%) \\
(\text{+}) \text{ predictive value} & 25/34 (74\%) & 24/28 (86\%) & 32/41 (78\%) \\
(\text{-}) \text{ predictive value} & 18/41 (44\%) & 23/46 (50\%) & 26/49 (53\%) \\
\end{array} \]

Ikonomidis I, Athanasopoulos G et Eur Heart J 2000
Improvement in Regional LV Function After CABG/PTCA (%)

- FDG:MBF Mismatch: 82% (6 studies, 146 patients)
- FDG:MBF Match: 17% (13 studies, 378 patients)
- Uptake: 69% (15 studies, 402 patients)
- No Uptake: 10%
- Contractile Reserve: 83% (15 studies, 402 patients)
- No Reserve: 19%
SPECT vs ECHO ΜΕ ΑΝΑΤΟΜΙΚΑ ΚΡΙΤΗΡΙΑ

✓ Ελάχιστο ποσοστό βιώσιμου ιστού ανά μυοκαρδιακό τμήμα που μπορεί να ανιχνευθεί με το Tl-201 → 43%
  ✓ (μεγαλύτερη ευαισθησία-ψευδώς θετικά)

✓ Ελάχιστο ποσοστό βιώσιμου ιστού ανά μυοκαρδιακό τμήμα που μπορεί να ανιχνευθεί με το DSE → 49%
  ✓ (Μεγαλύτερη ειδικότητα-ψευδώς αρνητικά)

✓ MRI hyperenhancement< 50%

Zamorano et al Am Heart J 2002
Left ventricular ejection fraction, infarct-zone wall-motion score index, end-diastolic volume index, and end-systolic volume index in AMI treated with primary coronary angioplasty.
216 patients (treated with thrombolysis or without reperfusion therapy) with viability (LDSE at 48h)
• to an invasive (PCI) or
• a conservative (ischemia-guided) strategy.

Table 2
Components of primary end points in the viable invasive and viable conservative groups.

<table>
<thead>
<tr>
<th></th>
<th>Invasive (n = 106)</th>
<th>Conservative (n = 110)</th>
<th>p-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite</td>
<td>22 (20.8%)</td>
<td>36 (32.7%)</td>
<td>0.047</td>
</tr>
<tr>
<td>Mortality</td>
<td>9 (8.5%)</td>
<td>9 (8.2%)</td>
<td>0.80</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>8 (7.5%)</td>
<td>12 (10.9%)</td>
<td>0.48</td>
</tr>
<tr>
<td>Unstable angina</td>
<td>5 (4.7%)</td>
<td>15 (13.6%)</td>
<td>0.002</td>
</tr>
</tbody>
</table>

* p-Values calculated with Fisher’s-exact test.
METANALYSIS: IMPROVED PROGNOSIS AFTER REVASCULARISATION IN Viable MYOCARDIUM

- 79.6%

3088 pts

- 65.1%

2217 pts

Response to cardiac resynchronization and contractile reserve

Myocardial viability for decision-making concerning revascularization inpatients with LV dysfunction and CAD: A meta-analysis of non-randomized and randomized studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Total no. of studies/Arms</th>
<th># Events / # Total</th>
<th>RR [95% CI]</th>
<th>Heterogeneity analysis</th>
</tr>
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<tbody>
<tr>
<td>Non-Randomized</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viability (+)</td>
<td>32</td>
<td>103 / 1400</td>
<td>319 / 1163</td>
<td>0.31 [0.25-0.39]</td>
</tr>
<tr>
<td>Viability (-)</td>
<td>25</td>
<td>135 / 650</td>
<td>261 / 1115</td>
<td>0.92 [0.78-1.09]</td>
</tr>
<tr>
<td>Overall</td>
<td>53</td>
<td>238 / 2050</td>
<td>580 / 2278</td>
<td>0.61 [0.53-0.69]</td>
</tr>
<tr>
<td>Randomized</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viability (+)</td>
<td>4</td>
<td>115 / 480</td>
<td>126 / 485</td>
<td>0.91 [0.74-1.12]</td>
</tr>
<tr>
<td>Viability (-)</td>
<td>1</td>
<td>25 / 54</td>
<td>33 / 60</td>
<td>0.84 [0.58-1.22]</td>
</tr>
<tr>
<td>Overall</td>
<td>5</td>
<td>140 / 534</td>
<td>159 / 545</td>
<td>0.89 [0.75-1.07]</td>
</tr>
</tbody>
</table>

PCI/CABG better Medical Tx better

Early (<30 days) vs Delayed Revascularization in Patients With Ischemic Cardiomyopathy and Substantial Viability: Impact on Outcome

Figure 1. Mortality curves of the patients in the two groups; patients with early revascularization had significantly lower mortality as compared with patients with late revascularization. The curves start at the time of surgery. Group I, early revascularization; group II, late revascularization.

LDDSE
-4/16 segments
-25%LV

Bax J Circulation. 2003;108[suppl II]:II-39-II-42.)
E. Indications for CABG in Poor LV Function

**Class I**

1. CABG should be performed in patients with poor LV function who have significant left main coronary artery stenosis. *(Level of Evidence: B)*

2. CABG should be performed in patients with poor LV function who have left main equivalent: significant (greater than or equal to 70%) stenosis of the proximal LAD and proximal left circumflex artery. *(Level of Evidence: B)*

3. CABG should be performed in patients with poor LV function who have proximal LAD stenosis with 2- or 3-vessel disease. *(Level of Evidence: B)*

**Class IIa**

1. CABG may be performed in patients with poor LV function with significant viable noncontracting, revascularizable myocardium and without any of the above anatomic patterns. *(Level of Evidence: B)*
Noninvasive imaging to detect myocardial ischemia and viability is reasonable in patients presenting with HF who have known coronary artery disease and no angina unless the patient is not eligible for revascularization of any kind.

(Class IIb, Level of Evidence: B)
Revascularization to Improve Survival: Recommendations

• 2. CABG to improve survival is reasonable in patients with mild-moderate LV systolic dysfunction (EF 35% to 50%) and significant (>70% diameter stenosis) multivessel CAD or proximal LAD coronary artery stenosis, when viable myocardium is present in the region of intended revascularization. 318,352–356

• (Level of Evidence: B)

2011 ACCF/AHA Guideline For CABG Circulation. 2011;124:e652–e735
STICH TRIAL

- 1212 pts with LVEF<35% randomized to medical treatment vs. CABG

### Stratum A

Stratum A included pts eligible for either medical therapy alone or medical therapy plus CABG.

### Stratum B

Stratum B included pts eligible for medical therapy alone, medical therapy plus CABG, or medical therapy plus CABG and surgical ventricular reconstruction.

#### Table

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>No. of Subjects</th>
<th>Hazard Ratio (95% CI)</th>
<th>P Value for Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>All subjects</td>
<td>1212</td>
<td>0.86 (0.72–1.04)</td>
<td>0.41</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥65 yr</td>
<td>396</td>
<td>0.93 (0.70–1.23)</td>
<td></td>
</tr>
<tr>
<td>&lt;65 yr</td>
<td>816</td>
<td>0.80 (0.63–1.01)</td>
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</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1064</td>
<td>0.87 (0.72–1.06)</td>
<td>0.61</td>
</tr>
<tr>
<td>Female</td>
<td>148</td>
<td>0.75 (0.42–1.31)</td>
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<tr>
<td>Race or ethnic group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic, Latino, or nonwhite</td>
<td>421</td>
<td>0.68 (0.49–0.95)</td>
<td>0.09</td>
</tr>
<tr>
<td>White</td>
<td>791</td>
<td>0.96 (0.77–1.19)</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>319</td>
<td>0.95 (0.68–1.33)</td>
<td>0.39</td>
</tr>
<tr>
<td>United States</td>
<td>120</td>
<td>0.81 (0.47–1.40)</td>
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</tr>
<tr>
<td>Canada</td>
<td>123</td>
<td>0.87 (0.48–1.60)</td>
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<tr>
<td>Western Europe</td>
<td>87</td>
<td>1.38 (0.77–2.47)</td>
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<tr>
<td>Other</td>
<td>563</td>
<td>0.73 (0.54–0.97)</td>
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</tr>
<tr>
<td>Current NYHA class</td>
<td></td>
<td></td>
<td>0.83</td>
</tr>
<tr>
<td>I or II</td>
<td>765</td>
<td>0.87 (0.69–1.11)</td>
<td></td>
</tr>
<tr>
<td>III or IV</td>
<td>447</td>
<td>0.84 (0.63–1.12)</td>
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<tr>
<td>LVEF (best available)</td>
<td></td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td>≥27%</td>
<td>612</td>
<td>0.77 (0.60–0.98)</td>
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</tr>
<tr>
<td>&gt;27%</td>
<td>600</td>
<td>0.97 (0.73–1.29)</td>
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<tr>
<td>Subanalysis</td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>A</td>
<td>1061</td>
<td>0.84 (0.72–1.31)</td>
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<tr>
<td>B</td>
<td>151</td>
<td>0.48 (0.28–0.81)</td>
<td></td>
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<tr>
<td>Baseline diabetes</td>
<td></td>
<td></td>
<td>0.56</td>
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<tr>
<td>No</td>
<td>734</td>
<td>0.83 (0.65–1.05)</td>
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<tr>
<td>Yes</td>
<td>478</td>
<td>0.92 (0.70–1.22)</td>
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<td>CCS angina class</td>
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<td></td>
<td>0.30</td>
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<td>0, 1, or II</td>
<td>1154</td>
<td>0.84 (0.70–1.01)</td>
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<tr>
<td>III or IV</td>
<td>58</td>
<td>1.26 (0.57–2.79)</td>
<td></td>
</tr>
<tr>
<td>No. of vessels with ≥50% stenosis</td>
<td></td>
<td></td>
<td>0.23</td>
</tr>
<tr>
<td>1 or 2</td>
<td>478</td>
<td>0.98 (0.73–1.32)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>733</td>
<td>0.79 (0.62–0.99)</td>
<td></td>
</tr>
<tr>
<td>≥50% Stenosis of LM or ≥75% stenosis</td>
<td></td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td>Of PLAD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>373</td>
<td>0.97 (0.69–1.35)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>838</td>
<td>0.82 (0.66–1.02)</td>
<td></td>
</tr>
<tr>
<td>Mitral regurgitation</td>
<td></td>
<td></td>
<td>0.59</td>
</tr>
<tr>
<td>None or trace</td>
<td>435</td>
<td>0.97 (0.69–1.36)</td>
<td></td>
</tr>
<tr>
<td>Mild (≤2+)</td>
<td>554</td>
<td>0.77 (0.59–1.01)</td>
<td></td>
</tr>
<tr>
<td>Moderate or severe (3+ or 4+)</td>
<td>220</td>
<td>0.92 (0.63–1.35)</td>
<td></td>
</tr>
</tbody>
</table>
N=601 of the 1212 pts  
N=114 no viability  
P=0.21 including  
• LVEF  
• LVESV  
• LVEDV, indexes,  
• the RAR score
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).
The characteristics of the overall population in STICH

- less severe angina (<III CCS),
- higher prevalence of single-vessel disease-No LMS disease
- fewer comorbidities
- the requirement for coronary anatomy amenable to revascularization
- the more severe LV function at entry.
- Those with viability test: CABG within 24h
Limitations (1)

- The non-random and non-blinded selection for viability testing of only 601 of the 1212 eligible patients (49.6%)
- 40% of patients enrolled were asymptomatic,
- Viability was defined in a binary fashion (Yes/No)
- No assessment for ischemia.
- Revascularization was not guided by the presence of viable myocardium within specific coronary-artery territories
Limitations (2)

- The study was underpowered in the group with nonviable myocardium
  - 60 pts medical therapy - 54 patients CABG: 114pts

- **81% showed viable myocardium**

- Limitations of SPECT vs. DSE and MRI PET
  - (echo more specific than perfusion techniques: the number of false positive results may have diluted the favourable effect of viability)

- No data on LV remodeling post-CABG

- **10 year recruitment period**: differences in medication (eg use of b-blockers) and surgical techniques
Surgeons perspective

- Viable myocardium does not equate to ischemic myocardium;
  - even normal myocardium is viable but not ischemic.
- The sub-study of STICH trial does not report on whether the viable myocardium was ischemic or not.
- Revascularizing non-ischemic myocardium that is viable will not likely change the event rates.
- Pts LV dysfunction are more likely to have combinations of normal, ischemic and non-viable myocardium
- those with greater LV ESVI and no substantial viability had worse prognosis.
- the effect of CABG relative to medical therapy was not differentially influenced by the combination of these 2 factors.
POST STICH ERA

• The STICH trial should be seen not as a definitive and final answer to the question of viability assessment but rather as a matter of reflection, particularly in the following 2 respects:
  
  • *proper patient selection*
  
  • *proper methods and criteria of assessment of viability*
Methods to define scar: No recovery post CABG
Scar criteria

- **Conventional echocardiography**
  - Wall thickness <6mm
  - Akinetic/hypokinetic with no response at low dose DSE
  - CFR of LAD <1.6
- **Contrast echocardiography**
  - Opacification grade <0.5 (patchy enhancement or opacification of the epicardial layer only)
  - Peak Axb <1.5 dB/s
- **Tissue Doppler Imaging**
  - Flat S’/Absence of post systolic shortening
  - Longitudinal strain <-8.1%
- **Speckle tracking imaging**
  - Radial strain <17%
  - Longitudinal strain<-4.5%
F-18-FDG PET Imaging-Assisted Management of Patients With Severe LV Dysfunction and Suspected CAD: A Randomized, Controlled Trial (PARR-2)

- An “adherence” group
- 1) who underwent PET;
- 2) who had moderate or high amounts of viability and adhered to the PET recommendations by undergoing protocol revascularization;
- 3) who had low amounts of viability so did not undergo protocol revascularization.

156 of 207 (75.4%) adhered to the PET recommendation.

Figure 7: “Survival Curves” (on the Basis of Time to First Occurring Outcome Out of the Composite Event)

The positron emission tomography adherence group versus standard care arm. Mantel-Haenszel (log-rank) Test for differences between 2 survival curves; adjusted hazard ratio = 0.62, 95% CI 0.42 to 0.93, p = 0.019.
ΟΙ ΑΣΘΕΝΕΙΣ ΜΕ CAD + EF < 35 %

ΕΧΟΥΝ ΑΥΞΗΜΕΝΗ ΘΕΙΣΙΜΟΤΗΤΑ

ΕΧΟΥΝ ΑΥΞΗΜΕΝΗ ΧΕΙΡΟΥΡΓΙΚΗ ΘΝΗΤΟΤΗΤΑ
“Patients with >10% of dysfunctional but viable LV myocardium may be more likely to benefit from myocardial revascularization and those with ≤10% less likely to benefit”

European Heart Journal (2012) 33, 1787–1847
European Heart Journal (2016) 37, 2129–2200
<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Classa</th>
<th>Levelb</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABG is recommended for patients with significant LM stenosis and LM equivalent with proximal stenosis of both LAD and LCx arteries.</td>
<td>I</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>CABG is recommended for patients with significant LAD artery stenosis and multivessel disease to reduce death and hospitalization for cardiovascular causes.</td>
<td>I</td>
<td>B</td>
<td>112,288</td>
</tr>
<tr>
<td>LV aneurysmectomy during CABG should be considered in patients with a large LV aneurysm, if there is a risk of rupture, large thrombus formation or the aneurysm is the origin of arrhythmias.</td>
<td>IIa</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Myocardial revascularization should be considered in the presence of viable myocardium.</td>
<td>IIa</td>
<td>B</td>
<td>55</td>
</tr>
<tr>
<td>CABG with surgical ventricular restoration may be considered in patients with scarred LAD territory, especially if a post-operative LVESV index &lt;70 mL/m² can be predictably achieved.</td>
<td>IIb</td>
<td>B</td>
<td>291–295</td>
</tr>
<tr>
<td>PCI may be considered if anatomy is suitable, in the presence of viable myocardium, and surgery is not indicated.</td>
<td>IIb</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

CABG = coronary artery bypass grafting; LAD = left anterior descending; LCx = left circumflex; LM = left main; LVESV = left ventricular end-systolic volume; PCI = percutaneous coronary intervention; SVR = surgical ventricular reconstruction.

aClass of recommendation.
bLevel of evidence.
cReferences.
DSE: 3-Chamber

PATIENT 2VESSEL CAD Bisphasic response
Baseline

Peak DSE

LDSE

Peak dose

Post PCI

Peak dose
ηρεμία
Multidimensional contractile reserve predicts adverse outcome in patients with severe systolic heart failure: a 4-year follow-up study

Ioannis A. Paraskevaidis¹, Ignatios Ikonomidou¹*, Panagiotis Simitsis, John Parissis, Vasilios Stasinos, George Makavos, and John Lekakis

A
Overall Kaplan-Meier Curves

Survival

Time (months)

Mean
95% CI

B
Kaplan-Meier Curves by GLS at rest

Survival

Time (months)

Log Rank p=0.003

GLS < -8.0%
GLS > -8.0%

C
Kaplan-Meier Curves by RS at rest

Survival

Time (months)

Log Rank p<0.001

RS <15.31%
RS >15.31%

D
Kaplan-Meier Curves by ΔGLS(%) 

Survival

Time (months)

Log Rank p<0.001

ΔGLS(%) <19.0%
ΔGLS(%) >19.0%
ΙΝΟΤΡΟΠΗ ΕΦΕΔΡΕΙΑ

-ΒΕΛΤΙΩΣΗ ΜΕΤΑ ΛΕΒΟΣΙΜΕΝΔΑΝΗ

“Take home”

- Among pts with severe LV systolic dysfunction and reasonable surgical targets who are not at excessive surgical risk, the consequences of no intervention may outweigh the risks of intervention, even if testing fails to detect viability.

- Pts with moderate or greater surgical risks and less than ideal surgical targets need viability testing to help physician’s decision making

_Bach et al JACC 2003_
Ευχαριστώ για την προσοχή σας
Scar criteria

- **Conventional echocardiography**
  - Wall thickness <6mm
  - Akinetic/hypokinetic with no response at low dose DSE
  - CFR of LAD <1.6
- **Contrast echocardiography**
  - Opacification grade <0.5 (patchy enhancement or opacification of the epicardial layer only)
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- **Tissue Doppler Imaging**
  - Flat S’/Absence of post systolic shortening
  - Longitudinal strain <-8.1%
- **Speckle tracking imaging**
  - Radial strain <17%
  - Longitudinal strain<-4.5%
“Take home”

• Η ανίχνευση βιώσιμου μυοκαρδίου με ηχωκαρδιογράφημα είναι ένδειξη καλής προγνωσής μόνο μετά από επαναγγείωση.

• Η ανίχνευση βιώσιμου μυοκαρδίου με ηχωκαρδιογράφημα είναι εξαιρετικά δυσμενής χωρίς επαναγγείωση
## Risk of surgery

<table>
<thead>
<tr>
<th>Patient-related factors</th>
<th>Cardiac-related factors</th>
<th>Operation-related factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) 82</td>
<td>Unstable angina (\text{\textsuperscript{6}})</td>
<td>Emergency (\text{\textsuperscript{3}})</td>
</tr>
<tr>
<td>Gender Female</td>
<td>LV function</td>
<td>Other than isolated CABG</td>
</tr>
<tr>
<td>Chronic pulmonary disease (\text{\textsuperscript{1}}) Yes</td>
<td>Recent MI (\text{\textsuperscript{7}})</td>
<td>Surgery on thoracic aorta</td>
</tr>
<tr>
<td>Extracardiac arteriopathy (\text{\textsuperscript{2}}) No</td>
<td>Pulmonary hypertension (\text{\textsuperscript{8}})</td>
<td>Post infarct septal rupture</td>
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<tr>
<td>Neurological dysfunction (\text{\textsuperscript{3}}) No</td>
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<td></td>
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<tr>
<td>Previous Cardiac Surgery No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine &gt; 200 (\mu\text{mol} / \text{L}) No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active endocarditis (\text{\textsuperscript{4}}) No</td>
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</tr>
<tr>
<td>Critical preoperative state (\text{\textsuperscript{5}}) No</td>
<td></td>
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</tbody>
</table>

Logistic \(\text{\textbf{EuroSCORE}}\) 25.79%
The World Post STICH: Is This a “Game Changer?” A Surgeon’s Perspective — Revascularization Is Still the Treatment of Choice

Ramesh Dagubati, Pradeep Arumugam, T. Bruce Ferguson Jr

Available online 19 March 2013

Abstract

The Surgical Treatment for Ischemic Heart Failure (STICH) trial addressed the broader role of surgical revascularization in patients with heart failure due to reduced LV systolic function $EF \leq 35\%$ and less severe CAD. The primary outcome (all-cause death) was not reduced by CABG. CABG did, however, reduce the secondary outcomes of cardiovascular death (RRR 16\%) and death from any cause or cardiovascular hospitalization (RRR 26\%).

However, 40\% of patients enrolled were asymptomatic, and only 49\% of patients underwent careful functional evaluation pre-randomization. Moreover, this assessment was for viability, and not ischemia. Careful scrutiny of these trial results illustrates important emerging trends in revascularization, namely the functional as well as anatomic assessment of patients prior to intervention with CABG, and the benefits of CABG in these patients.

These STICH findings illustrate the importance of these evaluations in all candidates for revascularization in ischemic heart disease; the results of the trial in terms of the efficacy of CABG need to be interpreted in this light.

Abbreviations and Acronyms

CABG, coronary artery bypass grafting; CAD, coronary artery disease; CSA, chronic stable angina; EF, ejection fraction; FFR, fractional flow reserve; LV, left ventricle; MI, myocardial infarction; PCI, percutaneous cardiovascular intervention; SYNTAX, Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery; STICH, Surgical Treatment for Ischemic Heart Failure
POST STICH

• Alternatives??
DSE Predicts Viability in CAD and CHF

F-18-FDG PET Imaging-Assisted Management of Patients With Severe LV Dysfunction and Suspected CAD
A Randomized, Controlled Trial (PARR-2)

- An “adherence” group
- 1) who underwent PET;
- 2) who had moderate or high amounts of viability and adhered to the PET recommendations by undergoing protocol revascularization;
- 3) who had low amounts of viability so did not undergo protocol revascularization.

156 of 207 (75.4%) adhered to the PET recommendation.

Figure 7 “Survival Curves” (on the Basis of Time to First Occurring Outcome Out of the Composite Event)

The positron emission tomography adherence group versus standard care arm. Mantel-Haenszel (log-rank) Test for differences between 2 survival curves; adjusted hazard ratio = 0.62, 95% CI 0.42 to 0.93, p = 0.019.

Comparative Prediction of Cardiac Events by Wall Motion, Wall Motion Plus Coronary Flow Reserve, or Myocardial Perfusion Analysis: A Multicenter Study of Contrast Stress Echocardiography.

<table>
<thead>
<tr>
<th>Summary Table for Model Comparison</th>
<th>p Value for Harrell C-Index Difference</th>
<th>p Value for Likelihood Ratio Test</th>
<th>NRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical parameters only model (Model 1) vs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical data + WMA</td>
<td>0.148</td>
<td>0.012</td>
<td>0.810</td>
</tr>
<tr>
<td>Clinical data + WMA/CFR-LAD &lt;2</td>
<td>0.037</td>
<td>&lt;0.001</td>
<td>0.001</td>
</tr>
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<td>Clinical data + MPD</td>
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</tr>
<tr>
<td>Clinical parameters + WMA (Model 2) vs.</td>
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<tr>
<td>Clinical data + WMA/CFR-LAD &lt;2</td>
<td>0.242</td>
<td>Not feasible</td>
<td>0.001</td>
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<tr>
<td><strong>Clinical data + WMA + MPD</strong></td>
<td><strong>0.004</strong></td>
<td><strong>&lt;0.001</strong></td>
<td><strong>&lt;0.001</strong></td>
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<tr>
<td>Clinical data + MPD</td>
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<td>Clinical parameters + WMA/CFR-LAD (Model 3) vs.</td>
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<tr>
<td>Clinical data + WMA/CFR-LAD &gt;2 + MPD</td>
<td>0.012</td>
<td>&lt;0.001</td>
<td>0.025</td>
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<td>Clinical parameters + MPD (Model 4) vs.</td>
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<td>Clinical data + MPD + WMA/CFR-LAD &lt;2</td>
<td>0.766</td>
<td>0.059</td>
<td>0.542</td>
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Risk reclassification is also shown, based on NRI. Bold values are statistically significant.
NRI = net reclassification improvement; other abbreviations as in Table 1.

718 patients for 16 months
ANTERIOR MI Primary PCI

Pre PCI

Immediately after

Effects of post conditioning

30 days after

Ikonomidis I, Paraskevaidis J, Iliodromitis E Heart 2010
Myocardial Deformation Imaging Based on Ultrasonic Pixel Tracking to Identify Reversible Myocardial Dysfunction

Michael Becker, MD,* Alexandra Lenzen, MD,* Christina Ocklenburg, MSc,† Katharina Stempel,* Harald Kühl, MD,* Miria Neizel, MD,* Markus Katoh, MD,‡ Rafael Kramann,* Joachim Wildberger, MD,‡ Malte Kelm, MD,* Rainer Hoffmann, MD*
Aachen, Germany

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Βιώσιμο

Μη Βιώσιμο
MRI

STIR

Gadolinium
Methods to define scar: No recovery post CABG
Longitudinal and Circumferential Strain Rate is related with LV Remodeling, and Prognosis after AMI during 20-month f/up: VALIANT Investigators

J Am Coll Cardiol 2010;56:1812–22
<table>
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<th>Indication</th>
<th>Appropriate use score (1–9)</th>
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<tr>
<td>Ischemic Cardiomyopathy/Assessment of Viability With Stress Echocardiography</td>
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<tr>
<td>176. Known moderate or severe LV dysfunction</td>
<td>A (8)</td>
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<tr>
<td>176. Patient eligible for revascularization</td>
<td></td>
</tr>
<tr>
<td>176. Use of dobutamine stress only</td>
<td></td>
</tr>
</tbody>
</table>

A indicates appropriate; I, inappropriate; U, uncertain.
Ευχαριστώ για την προσοχή σας
CENTRAL ILLUSTRATION  Revascularization in Patients With Severe LV Dysfunction: Prognosis of Patients With LV Dysfunction and CAD

Myocardial viability imaging

- Viable myocardium:
  The muscular wall of the heart, does not contract normally at rest but has the potential to recover its function

- Positron emission tomography (PET)
  Assess myocardial perfusion and metabolism

- Single-photon emission computed tomography (SPECT)
  Estimate resting perfusion, stress-induced ischemia, scarring and cardiac function

- Echocardiography
  Assess cardiac size, shape, wall thickness and wall motion

- Cardiac MRI
  Assess myocardial scarring as evidence of nonviable tissue

Does patient have viable myocardium?

- Revascularization improves outcomes, cardiac function and functional class
  Mortality increases with OMT alone

- Revascularization does not predict better outcomes than optimal medical therapy (OMT) alone
  Patients with severe LV dysfunction benefit most from revascularization; a high peri-procedural risk must be balanced against late mortality benefit.

Table 2 Components of primary end points

<table>
<thead>
<tr>
<th></th>
<th>Invasive (n = 106)</th>
<th>Conservative (n = 110)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite</td>
<td>8 (7.5%)</td>
<td>19 (17.3%)</td>
<td>0.04</td>
</tr>
<tr>
<td>Mortality</td>
<td>2 (1.9%)</td>
<td>3 (2.7%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Acute MI</td>
<td>2 (1.9%)</td>
<td>2 (1.8%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Unstable Angina</td>
<td>4 (3.7%)</td>
<td>19 (12.7%)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

* P-values calculated with Fisher-exact test.
CABG in Acute MII

- Class III: HARM
- 1. Emergency CABG should not be performed in patients with persistent angina and a small area of viable myocardium who are stable hemodynamically.
  (Level of Evidence: C)
- 2. Emergency CABG should not be performed in patients with no reflow (successful epicardial reperfusion with unsuccessful microvascular reperfusion).
  (Level of Evidence: C)

CAD, previous MI, HF

ECHO Global and segmental function

SCAR?
1. Thinned, highly echogenic, akinetic segment
2. Viability test - Novel techniques

Yes → Med
No → Graftable or plastable vessel?

Yes → CABG or PTCA
No → No
Scar criteria

- **Conventional echocardiography**
  - Wall thickness <6mm
  - Akinetic/hypokinetic with no response at low dose DSE
  - CFR of LAD <1.6

- **Contrast echocardiography**
  - Opacification grade <0.5 (patchy enhancement or opacification of the epicardial layer only)
  - Peak Axb <1.5 dB/s

- **Tissue Doppler Imaging**
  - Flat S’/Absence of post systolic shortening
  - Longitudinal strain <-8.1%

- **Speckle tracking imaging**
  - Radial strain <17%
  - Longitudinal strain <-4.5%
ΔΙΑΚΟΠΗ ΑΛΚΟΟΛ
ΦΑΡΜΑΚΕΥΤΙΚΗ ΑΓΩΓΗ
ΤΙΜΕΣ LGS < -5% ΑΝΤΙΣΤΟΙΧΟΥΝ ΣΕ ΟΥΛΗ (>75% ΙΝΩΣΗ ΣΕ MRI)
ΙΝΟΤΡΟΠΗ ΕΦΕΔΡΕΙΑ

-ΒΕΛΤΙΩΣΗ ΜΕΤΑ ΛΕΒΟΣΙΜΕΝΔΑΝΗ

indicates that, in the absence of angina, CABG may be considered, with the intent of improving survival in patients with ischemic heart disease with severe LV systolic dysfunction (EF <35%) whether or not viable myocardium is present (class IIb, level of evidence B).
Stress echocardiography

• Infusion of the "stress" agent, either a direct inotrope or a vasodilator, causes previously dysfunctional but viable myocardium to resume contractile function. This is referred to as stress-induced contractile reserve.

• Sensitivity of 84% and a specificity of 81% with this technique

Relationship of Echocardiographic Views and Normal Coronary Artery Circulation
• Χρόνος ημίσειας ζωής 2min
• Steady state 10 min
• υπό β αναστολέα απαραίτητα 20γ-30γ
• Αυξάνεται η συσταλτικότητα χωρίς να αυξάνεται η καρδιακή συχνότητα και η ΑΠ
Πλεονεκτήματα

• Αποτελεί τον ιδανικό διεγέρτη στην Ηχωκαρδιογραφία κόπωσης
• η ιδανική θέση εξέτασης του ασθενή,
• μπορεί να συνδυασθεί η εκτίμηση βιωσιμότητας με την εκτίμηση της ισχαιμίας ενώ
• αποφεύγεται ο υπεραερισμός
• Μικρό ποσοστό παρενεργειών
Characteristic Responses of Dysfunctional Myocardium to Dobutamine

Biphasic Response

Worsening of Function

Sustained Response

No Change
ΔΙΑΓΝΩΣΤΙΚΗ ΠΡΟΣΠΕΛΑΣΗ II

<table>
<thead>
<tr>
<th>Φυσιολογικό</th>
<th>Βελτίωση</th>
<th>Βελτίωση</th>
<th>normal</th>
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<tr>
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<td>Βελτίωση</td>
<td>Επιδείνωση</td>
<td>ischemia</td>
</tr>
<tr>
<td>Υποκινητικό/ακινητικό</td>
<td>Βελτίωση</td>
<td>Επιδείνωση</td>
<td>hibernating</td>
</tr>
<tr>
<td>Υποκινητικό/ακινητικό</td>
<td>Βελτίωση</td>
<td>Βελτίωση</td>
<td>Stunning vs sub.scar</td>
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<tr>
<td>Υποκινητικό/ακινητικό</td>
<td>Όχι μεταβολή</td>
<td>Όχι μεταβολή</td>
<td>scar</td>
</tr>
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<td>ischemia</td>
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</table>
Determinants of the Contractile Response of Viable Myocardium

- Severity of coronary stenosis
- Coronary reserve
- Extent of collateral circulation
- Cellular degeneration
- Metabolism
- Tethering

VIABILITY INTERROGATION

- **Chronic dysfunction**
  = ischemic responses
  biphasic responses
  *both indicative for viability/recovery*

- = **sustained improvement**
  => *fixed dysfunction*

Alfridi JACC 1996
INTERROGATION FOR VIABILITY

• **Low dose dobutamine**
  – sensitivity is high in both mildly and severely hypokinetic segments
  – (96% vs 89%)
• **but:** In mildly hypokinetic segments
  – low specificity (39% vs 78%)
  
  *Cornel Am J Card 1997*

• **Due to:**
  • 1  **mixture of subendocardial scar/normal myocardium**
  • 2.  **Tethering by adjacent akinetic segments**=>**irreversible hypokinesia**

  **Thus in mildly hypokinetic segments**
  =>**combination of low/high dose dobutamine**
Association of QT dispersion with viability

<table>
<thead>
<tr>
<th></th>
<th>Resting QTd &lt;65 ms</th>
<th>Increase of QTd &gt;30%</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>25/48 (53%)</td>
<td>24/48 (51%)</td>
<td>32/48 (67%)</td>
</tr>
<tr>
<td>Specificity</td>
<td>18/27 (67%)</td>
<td>23/27 (85%)</td>
<td>26/27 (96%)</td>
</tr>
<tr>
<td>(+) predictive value</td>
<td>25/34 (74%)</td>
<td>24/28 (86%)</td>
<td>32/41 (78%)</td>
</tr>
<tr>
<td>(−) predictive value</td>
<td>18/41 (44%)</td>
<td>23/46 (50%)</td>
<td>26/49 (53%)</td>
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QTd = dispersion; combination = rest QTd <65 ms and/or increase of QTd >30%; (+) = positive, (−) = negative.

- Low QT at rest = less fibrosis
- Increase of QT = more viable tissue more b-receptors
- More ventricular arrhythmias during infusion

Ikonomidis et Eur Heart J 2000
DSE Predicts Viability in CAD and CHF

In STICH sustain improvement was considered as marker of viability

Clinical Relevance of Viability in CAD and CHF

- 318 patients with CAD and LVEF ≤ 35%
- Viability defined as 4 or more dobutamine-responsive segments
  Decision to revascularize made by physician, not randomized
- Follow up for 18 ± 10 months

# Clinical Relevance of Viability in CAD and CHF

<table>
<thead>
<tr>
<th>Group</th>
<th>(n)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>85</td>
<td>Viable, Revascularized</td>
</tr>
<tr>
<td>Group II</td>
<td>119</td>
<td>Viable, Not Revascularized</td>
</tr>
<tr>
<td>Group III</td>
<td>30</td>
<td>Not Viable, Revascularized</td>
</tr>
<tr>
<td>Group IV</td>
<td>84</td>
<td>Not Viable, Not Revascularized</td>
</tr>
</tbody>
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Clinical Relevance of Viability in CAD and CHF

Adjusted for:
- age
- LV function,
- severity of CAD

✓ Ελάχιστο ποσοστό βιώσιμου ιστού ανά μυοκαρδιακό τμήμα που μπορεί να ανιχνευθεί με το Tl-201 → 43%
✓ Ελάχιστο ποσοστό βιώσιμου ιστού ανά μυοκαρδιακό τμήμα που μπορεί να ανιχνευθεί με το DSE → 49%
✓ MRI hyperenhancement< 50%

Zamorano et al Am Heart J 2002
Novel echo techniques
# Myocardial Deformation Imaging Based on Ultrasonic Pixel Tracking to Identify Reversible Myocardial Dysfunction

Michael Becker, MD,* Alexandra Lenzen, MD,* Christina Ocklenburg, MSc,† Katharina Stempel,* Harald Kühl, MD,* Miria Neizel, MD,* Markus Katoh, MD,‡ Rafael Kramann,* Joachim Wildberger, MD,‡ Malte Kelm, MD,* Rainer Hoffmann, MD*

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Μη Βιώσιμο
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CAD, previous MI, HF

ECHO Global and segmental function

SCAR? (Thinned, highly echogenic, akinetic segment)

Yes

No

Graftable or plastable vessel?

Yes

CABG or PTCA

No

Med
ΟΙ ΑΣΘΕΝΕΙΣ ΜΕ CAD + EF < 35 %

ΕΧΟΥΝ ΑΥΞΗΜΕΝΗ ΘΝΗΣΙΜΟΤΗΤΑ

ΕΧΟΥΝ ΑΥΞΗΜΕΝΗ ΧΕΙΡΟΥΡΓΙΚΗ ΘΝΗΤΟΤΗΤΑ
"Take home"

• Η ανίχνευση βιώσιμου μυοκαρδίου με ηχωκαρδιογράφημα είναι ένδειξη καλής προγνωσης μόνο μετά από επαναγγείωση.
• Η ανίχνευση βιώσιμου μυοκαρδίου με ηχωκαρδιογράφημα είναι εξαιρετικά δυσμενής χωρίς επαναγγείωση
“Take home”

- Among pts with severe LV systolic dysfunction and reasonable surgical targets who are not at excessive surgical risk, the consequences of no intervention may outweigh the risks of intervention, even if testing fails to detect viability.

- Pts with moderate or greater surgical risks and less than ideal surgical targets need viability testing to help physician’s decision making.

Bach et al JACC 2003
Ευχαριστώ για την προσοχή σας
Ηρεμία
Δοβουταμίνη
A CFVR >1.6 in the infarct-related artery predicts recovery of regional left ventricular function.

Composite score for prediction of recovery

Viability score = (1.7 x WMS) - (1.8 x low-dose Db SR) - (1.7 x SR increment)
CAD, previous MI, HF

ECHO Global and segmental function

SCAR? (Thinned, highly echogenic, akinetic segment)

Yes
Viability test
Novel techniques

No
Graftable or plastable vessel?

No
CABG or PTCA

Yes
Early (<30 days) vs Delayed Revascularization in Patients With Ischemic Cardiomyopathy and Substantial Viability: Impact on Outcome

Figure 1. Mortality curves of the patients in the two groups; patients with early revascularization had significantly lower mortality as compared with patients with late revascularization. The curves start at the time of surgery. Group I, early revascularization; group II, late revascularization.

LDDSE
-4/16 segments
-25%LV
Predictors of Late Functional Recovery in AMI after PCI

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCE (0.5-1)</td>
<td>96%</td>
<td>18%</td>
<td>41%</td>
<td>89%</td>
<td>47%</td>
</tr>
<tr>
<td>MCE (1)</td>
<td>67%</td>
<td>49%</td>
<td>44%</td>
<td>71%</td>
<td>56%</td>
</tr>
<tr>
<td>DE</td>
<td>89%</td>
<td>91%</td>
<td>86%</td>
<td>93%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Contrast echocardiography
Independent predictor of recovery
DSE

• <15% of myocardial segments demonstrating either no change or sustained improvement with low- and high-dose DSE had functional recovery with revascularization,

• 72% of segments with a biphasic response recovered function

• In STICH sustain improvement was considered as marker of viability

Rizzello V, Heart 2006; 92:239–44.
Limitations of overall trial
Crossover in 17% of patients assigned to medical therapy and 9% of patients assigned to CABG
Randomization of a very small proportion of eligible patients
Average of only 2 patients per site per year at 127 sites in 26 countries over 5 years
Outcome of the large number of patients screened but not randomized not reported
Lack of randomization in viability substudy
Optional viability testing performed at clinician's discretion
Only about one-half of eligible patients from the main trial
Significant differences in baseline characteristics between those with versus those without viability testing
Nonsignificant trend toward higher rates of CABG among patients with viability testing on the day of randomization or on the following day than among those who had testing before randomization
Acceptable viability tests do not have highest sensitivity or negative predictive value for identifying viable myocardium
Binary classification of viability with controversial thresholds for extent and uptake
Stress-induced ischemia not consistently addressed by viability testing
Revascularization not guided by the presence of viable myocardium
Small sample size of the group with nonviable myocardium
Table 1: Limitations of the STICH Viability Substudy

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CABG = coronary artery bypass graft; STICH = Surgical Treatment for Ischemic Heart Failure.
Association of QT dispersion with viability

- Low QT at rest = less fibrosis
- Increase of QT = more viable tissue more β-receptors
- More ventricular arrhythmias during infusion

*Ikonomidis et Eur Heart J 2000*

<table>
<thead>
<tr>
<th></th>
<th>Resting QTd &lt;65 ms</th>
<th>Increase of QTd &gt;30%</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>25/48 (53%)</td>
<td>24/48 (51%)</td>
<td>32/48 (67%)</td>
</tr>
<tr>
<td>Specificity</td>
<td>18/27 (67%)</td>
<td>23/27 (85%)</td>
<td>26/27 (96%)</td>
</tr>
<tr>
<td>(+) predictive value</td>
<td>25/34 (74%)</td>
<td>24/28 (86%)</td>
<td>32/41 (78%)</td>
</tr>
<tr>
<td>(−) predictive value</td>
<td>18/41 (44%)</td>
<td>23/46 (50%)</td>
<td>26/49 (53%)</td>
</tr>
</tbody>
</table>

QTd = dispersion; combination = rest QTd <65 ms and/or increase of QTd >30%; (+) = positive, (−) = negative.
Response to cardiac resynchronization and contractile reserve

Incremental Value of Strain Rate Analysis as an Adjunct to Wall-Motion Scoring for Assessment of Myocardial Viability by Dobutamine Echocardiography

A Follow-Up Study After Revascularization

Lizelle Hanekom, MD; Carly Jenkins, BS; Leanne Jeffries, BS; Colin Case, MD; Julie Mundy, MD; Carmel Hawley, MD; Thomas H. Marwick, MD, PhD
Το επίμηκες strain (-4%) είναι ο δείκτης απουσίας βιωσιμότητας μετά OEM

*Migrino R Am J Cardiol 2009;104:1023–1029*
Annual death rate in patients with ischemic cardiomyopathy in 24 prognostic studies

-79.6%

Criterion for revascularization
Viability > 4 viable segments

Allman et.al. JACC 2002
Clinical significance

- Acute MI LV remodelling
- Ischemic cardiomyopathy
  Recovery post intervention
- Response to synchronisation therapy
Φυσιολογικό  

Φυσιολογικό

Υποκινητικό/ακινητικό

Υποκινητικό/ακινητικό

Υποκινητικό/ακινητικό

Υποκινητικό/ακινητικό

Οχι μεταβολή

normal

ischemia

hibernating

Stunning vs sub.scar

scar

ischemia
Revascularization to Improve Survival: Recommendations

- Class IIa
- 1. CABG to improve survival is reasonable in patients with significant (>70% diameter) stenoses in 2 major coronary arteries with severe or extensive myocardial ischemia (e.g., high-risk criteria on stress testing, abnormal intracoronary hemodynamic evaluation, or >20% perfusion defect by myocardial perfusion stress imaging) or target vessels supplying a large area of viable myocardium. (Level of Evidence: B)

2011 ACCF/AHA Guideline For CABG Circulation. 2011;124:e652–e735
Response to cardiac resynchronization and contractile reserve

Viability criteria

- **PET:** FDG uptake in >2 vascular territories and/or scar<40% of LV (scar<50% FDG uptake )
- **SPECT:** improved perfusion ≥20% of the LV
- **LDSE:** improved contractility in 4/16 segments (25% of the LV)
  - opacification grade >0,5 at contrast echo
  - Post systolic shortening at TDI
  - SRI>0.6 l/s DSR >0.25, SR>10 %, DSR>3
  - GLS rest> 5% radial strain>17%
- **MRI:** < 50% hyperenhancement /per segment
SPECT vs ECHO ΜΕ ΑΝΑΤΟΜΙΚΑ ΚΡΙΤΗΡΙΑ

✓ Ελάχιστο ποσοστό βιώσιμου ιστού ανά μυοκαρδιακό τμήμα που μπορεί να ανιχνευθεί με το Tl-201 → 43%
✓ (μεγαλύτερη ευαισθησία-ψευδώς θετικά)
✓ Ελάχιστο ποσοστό βιώσιμου ιστού ανά μυοκαρδιακό τμήμα που μπορεί να ανιχνευθεί με το DSE → 49%
✓ (Μεγαλύτερη ειδικότητα-ψευδώς αρνητικά)
✓ MRI hyperenhancement< 50%

Zamorano et al Am Heart J 2002
### DSE vs Other Techniques for Viability in CAD and CHF

<table>
<thead>
<tr>
<th></th>
<th>No. of Pts</th>
<th>Sens (%)</th>
<th>95% CI</th>
<th>99% CI</th>
<th>Spec (%)</th>
<th>95% CI</th>
<th>99% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc-99m MIBI</td>
<td>207</td>
<td>83</td>
<td>78–87</td>
<td>77–89</td>
<td>69</td>
<td>63–74</td>
<td>61–76</td>
</tr>
<tr>
<td>LDDE</td>
<td>448</td>
<td>84</td>
<td>82–86</td>
<td>81–87</td>
<td>81</td>
<td>79–84</td>
<td>79–84</td>
</tr>
<tr>
<td>Tl-201 reinjection</td>
<td>209</td>
<td>86</td>
<td>83–89</td>
<td>82–90</td>
<td>47</td>
<td>43–51</td>
<td>42–52</td>
</tr>
<tr>
<td>F-18 FDG PET</td>
<td>332</td>
<td>88</td>
<td>84–91</td>
<td>83–92</td>
<td>73</td>
<td>69–77</td>
<td>69–77</td>
</tr>
<tr>
<td>Tl-201 rest-redistribution</td>
<td>145</td>
<td>90</td>
<td>87–93</td>
<td>86–94</td>
<td>54</td>
<td>49–60</td>
<td>48–61</td>
</tr>
</tbody>
</table>

CI = confidence interval; F-18 FDG = fluorine-18 fluorodeoxyglucose; LDDE = low dose dobutamine echocardiography; Tc-99m MIBI = technetium-99m sestamibi; Tl-201 = thallium-201; other abbreviations as in .

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Viability definition

- classify patients in a binary fashion as
  - either having
  - or not having substantial myocardial viability.

- **For SPECT:** those with $\geq 11/17$ viable segments on the basis of relative tracer activity.

- **For DSE:** those with $\geq 5$ segments with abnormal resting systolic function but manifesting contractile reserve during dobutamine administration.