FFR-Guided PCI

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Disclosure Statement of Financial Interest

I, William Fearon, DO NOT have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.

Stanford receives research support from St. Jude Medical.
Why do we need FFR?

- Importance of ischemia
- Limitations of noninvasive testing
- Limitations of angiography
- Limitations of IVUS/OCT
Importance of Ischemia

Nuclear perfusion scans performed in > 5000 patients

COURAGE Nuclear Substudy

Comparison of death/MI in patients with mod-severe pre-treatment ischemia

Shaw et al. Circulation 2008;117:1283
Frequency of Stress Testing to Document Ischemia Prior to Elective Percutaneous Coronary Intervention

Grace A. Lin, MD, MAS
R. Adams Dudley, MD, MBA
F. L. Lucas, PhD
David J. Malenka, MD
Eric Vittinghoff, PhD
Rita F. Redberg, MD, MSc

Context Guidelines call for documenting ischemia in patients with stable coronary artery disease prior to elective percutaneous coronary intervention (PCI).

Objective To determine the frequency and predictors of stress testing prior to elective PCI in a Medicare population.

Design, Setting, and Patients Retrospective, observational cohort study using claims data from a 20% random sample of 2004 Medicare fee-for-service beneficiaries aged 65 years or older who had an elective PCI (N = 23 887).

Main Outcome Measures Percentage of patients who underwent stress testing within 90 days prior to elective PCI; variation in stress testing prior to PCI across 306 hospital referral regions; patient, physician, and hospital characteristics that predicted the appropriate use of stress testing prior to elective PCI.

Results In the United States, 44.5% (n = 10 629) of patients underwent stress testing within the 90 days prior to elective PCI. There was wide regional variation among the hospital referral regions with stress test rates ranging from 22.1% to 70.6% (median, 44.5%; interquartile range, 39.0%-50.9%). Female sex (adjusted odds ratio [AOR], 0.91; 95% confidence interval [CI], 0.86-0.97), age of 85 years or older (AOR, 0.83; 95% CI, 0.72-0.95), a history of congestive heart failure (AOR, 0.85; 95% CI, 0.79-0.92), and prior cardiac catheterization (AOR, 0.45; 95% CI, 0.38-0.54) were associated with a decreased likelihood of prior stress testing. A history of chest pain (AOR, 1.28; 95% CI, 1.09-1.54) and black race (AOR, 1.26; 95% CI, 1.09-1.46) increased the likelihood of stress testing prior to PCI. Patients treated by physicians performing 150 or more PCIs per year were less likely to have stress testing prior to PCI (AOR, 0.84; 95% CI, 0.77-0.93). No hospital characteristics were associated with receipt of stress testing.

Conclusion The majority of Medicare patients with stable coronary artery disease do not have documentation of ischemia by noninvasive testing prior to elective PCI.
# FFR vs. Nuclear Perfusion Scan in MVD

67 patients with angiographic 2 or 3 vessel CAD

<table>
<thead>
<tr>
<th></th>
<th>MPI positive</th>
<th>MPI negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFR &lt; 0.80</td>
<td>38</td>
<td>42</td>
</tr>
<tr>
<td>FFR &gt; 0.80</td>
<td>24</td>
<td>97</td>
</tr>
</tbody>
</table>

FFR vs. Nuclear Perfusion Scan in MVD

67 patients with angiographic 2 or 3 vessel CAD

Limitation of Angiography

Comparison of QCA to FFR in over 3,000 lesions

(-) Ischemia

(+) Ischemia

Courtesy of Bernard De Bruyne, MD, PhD
FFR should not guide ALL PCI!

70 year old man with angina and anterior ischemia
When should we use FFR?

• In patients with coronary narrowings in the 50-90% range and unclear, equivocal or absent noninvasive stress imaging studies.
  
  – Most commonly in patients with multivessel CAD.
Which Lesions Need FFR?

1329 lesions in the FFR-guided arm of the FAME Study

~20%

~35%

Stenosis classification by angiography

Why should FFR Guide PCI?

- Improves outcomes
- Saves money
- PCI of intermediate lesions is not benign
- Medical treatment of hemodynamically insignificant lesions is safe
- FFR-guided PCI can simplify a procedure and may increase PCI volume
Why should FFR Guide PCI?

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FAME Study: One Year Outcomes

Over 1,000 patients with MVD undergoing PCI and randomized to FFR or angiographic guidance alone

- **Angio-Guided**
- **FFR-Guided**

<table>
<thead>
<tr>
<th>Event</th>
<th>Angio-Guided</th>
<th>FFR-Guided</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>~40% ↓</td>
<td>~30% ↓</td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td>~35% ↓</td>
<td>~35% ↓</td>
<td>p=0.04</td>
</tr>
<tr>
<td>Repeat Revasc</td>
<td>~30% ↓</td>
<td>~30% ↓</td>
<td></td>
</tr>
<tr>
<td>Death/MI</td>
<td>~35% ↓</td>
<td>~35% ↓</td>
<td>p=0.02</td>
</tr>
<tr>
<td>MACE</td>
<td>~30% ↓</td>
<td>13.2% ↓</td>
<td></td>
</tr>
</tbody>
</table>

FAME Study: Two Year Outcomes

Survival Free from Major Adverse Cardiac Events

Days since Randomization

730 days
4.5%

J Am Coll Cardiol 2010;56:177-184
FAME: 1 Year Economic Evaluation

FFR Guidance Improves outcomes

**ICER of 50,000 $ / QALY**

**1 Year Costs**
- Angio ~ $16,700 / patient
- FFR ~ $14,300 / patient

**Increm. Cost [$]**
-5000, -4000, -3000, -2000, -1000, 0, 1000, 2000, 3000, 4000

**Increm. QALY**

Angio Less Costly  
FFR Less Costly

Angio Better  
FFR Better

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- FFR-guided PCI can simplify a procedure and may increase PCI volume
Stanford

Should we perform PCI in all intermediate lesions?

Drug-Eluting Stents in the Treatment of Intermediate Lesions
Pooled Analysis From Four Randomized Trials

Jeffrey W. Moses, MD, FACC,* Gregg W. Stone, MD, FACC,* Eugenia Nikolsky, MD, PhD, FACC,* Gary S. Mintz, MD, FACC,* George Dangas, MD, PhD, FACC,* Ebberhard Grube, MD,† Stephen G. Ellis, MD, FACC,‡ Alexandra J. Lansky, MD, FACC,* Giora Weisz, MD,* Martin Fahy, MSc,* Yingbo Na, MSc,* Mary E. Russell, MD, FACC,§ Dennis Donohoe, MD,|| Martin B. Leon, MD, FACC,* Roxana Mehran, MD, FACC*

New York, New York; Siegburg, Germany; Cleveland, Ohio; Natick, Massachusetts; and Warren, New Jersey

92 lesions with QCA < 50% stenosis treated with DES

What is the Expected MACE in DES-Treated Intermediate Lesions?

1 year events in 92 intermediate lesions treated with DES

<table>
<thead>
<tr>
<th>Event</th>
<th>Count (Rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac death, n (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Myocardial infarction, n (%)</td>
<td>3 (3.4)</td>
</tr>
<tr>
<td>Q-wave</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Non-Q-wave</td>
<td>3 (3.4)</td>
</tr>
<tr>
<td>Stent thrombosis, n (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Target lesion revascularization, n (%)</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>Target vessel revascularization, n (%)</td>
<td>3 (3.4)</td>
</tr>
<tr>
<td>Composite adverse cardiac events, n (%)*</td>
<td>5 (5.6)</td>
</tr>
</tbody>
</table>

1 Year Cardiac Death and MI rate of 3.4%

5 Year Cardiac Death / MI in DEFER study

181 patients with intermediate lesions and FFR ≥0.75 randomized to PCI or deferral

2 Year Outcome of Deferred Lesions in FAME

513 Deferred Lesions in 509 FFR-Guided Patients

2 Years

31 Myocardial Infarctions

9 Late Myocardial Infarctions

1 Myocardial Infarction due to an Originally Deferred Lesion

22 Peri-procedural

8 Due to a New Lesion or Stent-Related

Only 1/513 or 0.2% of deferred lesions resulted in a late myocardial infarction
Why should FFR Guide PCI?

- Improves outcomes
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- PCI of intermediate lesions is not benign
- Medical treatment of hemodynamically insignificant lesions is safe
- FFR-guided PCI can simplify a procedure and may increase PCI volume
Recent Case: “Mr. H.”

- 79 year old retired physicist with angina
- Risk factors include HTN and dyslipidemia
- Stress echo revealed anteroseptal and apical ischemia
- Referred for coronary angiography on September 10th, 2010…
How should we handle this case?

Recently published European guidelines for revascularization

<table>
<thead>
<tr>
<th>Subset of CAD by anatomy</th>
<th>Favours CABG</th>
<th>Favours PCI</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1VD or 2VD - non-proximal LAD</td>
<td>Iib C</td>
<td>I C</td>
<td>—</td>
</tr>
<tr>
<td>1VD or 2VD - proximal LAD</td>
<td>I A</td>
<td>Ila B</td>
<td>30, 31, 50, 51</td>
</tr>
<tr>
<td>3VD simple lesions, full functional revascularization achievable with PCI, SYNTAX score &lt;22</td>
<td>I A</td>
<td>Ila B</td>
<td>4, 30–37, 53</td>
</tr>
<tr>
<td>3VD complex lesions, incomplete revascularization achievable with PCI, SYNTAX score &gt;22</td>
<td>I A</td>
<td>III A</td>
<td>4, 30–37, 53</td>
</tr>
<tr>
<td>Left main (isolated or 1VD, ostium/shaft)</td>
<td>I A</td>
<td>Ila B</td>
<td>4, 54</td>
</tr>
<tr>
<td>Left main (isolated or 1VD, distal bifurcation)</td>
<td>I A</td>
<td>Iib B</td>
<td>4, 54</td>
</tr>
<tr>
<td>Left main + 2VD or 3VD, SYNTAX score ≤32</td>
<td>I A</td>
<td>Iib B</td>
<td>4, 54</td>
</tr>
<tr>
<td>Left main + 2VD or 3VD, SYNTAX score ≥33</td>
<td>I A</td>
<td>III B</td>
<td>4, 54</td>
</tr>
</tbody>
</table>

Calculated SYNTAX score = 25.5

PCI vs. CABG Outcomes Based on Syntax Score

Worse outcomes with PCI vs CABG with higher SYNTAX score

PCI vs. CABG Outcomes Based on Syntax Score

Similar outcomes with PCI vs CABG with lower SYNTAX score

FFR of RCA = 0.91
How should we handle this case?

Recently published European guidelines for revascularization

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<td>IVD or 2VD - non-proximal LAD</td>
<td>Iib-C</td>
<td>LC</td>
<td>—</td>
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Recalculated SYNTAX score after \( FFR = 18.5 \)

Sept. 19th, 2010:

Dr. Fearon....this is from New Mexico. Yesterday we were walking around on the base of the Santa Fe ski area at over 10,300 feet. Not too strenuous but then not too much air there. Feeling great and just wanted to tell you and say thanks...Bill
Anatomic vs. Functional CAD

Patients with angiographically 3VD (N=115), proportions per number of diseased vessels after assessment by FFR

Angiographic 3 Vessel Disease

Tonino et al., JACC 2010;55:2816-21
Change in SYNTAX score after FFR

SYNTAX score in roughly 500 FAME patients before and after FFR

CW Nam, MD (preliminary data)
Impact of FFR on SYNTAX Score

Prognostic value of SYNTAX score improves after incorporating FFR

CW Nam, MD (preliminary data)
1. FFR can be useful to determine if PCI is warranted, particularly if the noninvasive test is absent or equivocal. It is reasonable to use FFR for assessing the need for PCI of intermediate lesions (IIa)

2. FFR is not warranted to assess an angiographically significant stenosis if there is angina present and an unequivocally positive stress test in a concordant vascular distribution (III)
**2010 European PCI Guidelines**

*FFR Receives IA Recommendation*

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**Table 33** Recommendations for specific percutaneous coronary intervention devices and pharmacotherapy

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Class</th>
<th>Level</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFR-guided PCI is recommended for detection of ischaemia-related lesion(s) when objective evidence of vessel-related ischaemia is not available.</td>
<td>I</td>
<td>A</td>
<td>15, 28</td>
</tr>
<tr>
<td>DES&lt;sup&gt;d&lt;/sup&gt; are recommended for reduction of restenosis/re-occlusion, if no contraindication to extended DAPT.</td>
<td>I</td>
<td>A</td>
<td>45, 46, 55, 215</td>
</tr>
</tbody>
</table>

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**Table 1** Classes of recommendations

<table>
<thead>
<tr>
<th>Classes of recommendations</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective.</td>
</tr>
<tr>
<td>Class II</td>
<td>Conflicting evidence and/or a</td>
</tr>
</tbody>
</table>

**Table 2** Levels of evidence

<table>
<thead>
<tr>
<th>Level of evidence A</th>
<th>Data derived from multiple randomized clinical trials or meta-analyses.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of evidence B</td>
<td>Data derived from a single randomized clinical trial or large non-randomized studies.</td>
</tr>
</tbody>
</table>

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Should FFR Guide PCI?

• Yes, in most cases, FFR will:
  – Simplify your procedure
  – Save money
  – And most importantly, improve your patient’s outcome!