Challenges and Current State of the Art Solutions for Diagnosis and Clinical Management of Patients with Heart Disease

Oct 15, 2013
3rd Webinar in a 3 part series on Precision Medicine 2013

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Challenges in Clinical Evaluation of Patients with Suspected Heart Disease

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Disclosures: 1 K23 HL116787-01A1 Award from National Heart, Lung, and Blood Institute; Consultant for CardioDx, Inc.
What’s Changed in the Assessment of CAD Post-COURAGE, BARI-2D, FAME-2, FREEDOM?

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Albany Medical Center, Albany, NY

ACC/CardioSource Webinar Series
October 15, 2013

Dual Goals for Management of Stable Ischemic Heart Disease (SIHD)

Prevent MI and Death (Disease Modification)
Improve “Quantity of Life”

Reduce Ischemia & Relieve Anginal Symptoms
Improve “Quality of Life”

An SIHD Patient Develops Angina with 1.5 mm ST ↓ on Treadmill Exercise at 9.5 Min and Undergoes Cor Angio: What Do You Do?

Is this a benign lesion in a benign condition?
“Conventional Wisdom” Prior to the COURAGE Trial

Treatment Assumptions in CAD Management:

• Symptomatic CAD patients with the triad of chronic angina, objective evidence of ischemia, and significant coronary stenoses at angiography “need” revascularization; the only question is: which procedure—PCI or CABG?

• PCI (based on the positive outcomes in ACS trials) was widely regarded as favorably altering clinical outcomes and improving prognosis—even in stable CAD patients

• PCI is less invasive than CABG surgery and, thus, has become the preferred/default approach to management

Evidence That Coronary Stenoses Could Be Left Alone Without Adverse Events

RITA-2, 1018 patients (504 PTCA, 514 medical management)

• Death

\[ P = \text{NS} \]

• Death or MI

\[ P = \text{NS} \]

• No difference in outcome over median of 7 years

(Henderson, et al. JACC 2003;42:1161)
Stable CAD: PCI vs. Medical Management Pre-COURAGE

Meta-analysis of 11 randomized trials; N = 2,950

<table>
<thead>
<tr>
<th>Event</th>
<th>Favor PCI</th>
<th>Favor Medical Management</th>
</tr>
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<tbody>
<tr>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td></td>
<td>0.68</td>
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<tr>
<td>Cardiac Death or MI</td>
<td></td>
<td>0.28</td>
</tr>
<tr>
<td>Nonfatal MI</td>
<td></td>
<td>0.12</td>
</tr>
<tr>
<td>CABG</td>
<td></td>
<td>0.82</td>
</tr>
<tr>
<td>PCI</td>
<td></td>
<td>0.34</td>
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</tbody>
</table>

Risk ratio (95% CI)

0 1 2


Optimal Medical Therapy with or without PCI for Stable Coronary Disease

- Objective evidence of myocardial ischemia
- Stenosis > 70% in > one proximal coronary artery

- "Optimal Medical Therapy"
- At 5 yrs: 70% had LDL <100 mg/dl; median LDL = 71 mg/dl at 5 yrs
- 65% and 94% had SBP and DBP < 130/85 mmHg, respectively
- 45% of patients with diabetes had Hb A1c <7%
- High adherence to diet, exercise, smoking cessation, and

2287 patients
**Pharmacologic Therapy in SIHD: 2000**

<table>
<thead>
<tr>
<th>Disease-Modifying Therapy</th>
<th>Symptomatic Treatment for Angina/Ischemia Control</th>
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<td>• ACE inhibitors</td>
<td>• Nitrates</td>
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<tr>
<td>• Beta-blockers Post-MI</td>
<td>• Trimetazadine</td>
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**Pharmacologic Rx in SIHD: 2013… An Evolving Target—and Improving**

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<tr>
<td>• ACE inhibitors</td>
<td>• Trimetazadine</td>
</tr>
<tr>
<td>• ARBs</td>
<td>• Ranolazine</td>
</tr>
<tr>
<td>• Beta-blockers Post-MI</td>
<td>• Ivabradine</td>
</tr>
<tr>
<td>• Aldosterone Inhibitors</td>
<td>• Nicorandil</td>
</tr>
</tbody>
</table>
Optimal Medical Therapy
As Used in the COURAGE Trial

Pharmacologic

- Anti-platelet: aspirin; clopidogrel in accordance with established practice standards
- Statin: simvastatin ± ezetimibe or extended-release niacin
- ACE Inhibitor or ARB: lisinopril or losartan
- Beta-blocker: long-acting metoprolol
- Calcium channel blocker: amlodipine
- Nitrate: short-acting nitroglycerine + isosorbide 5-mononitrate

Lifestyle Intervention (Diet, Regular Exercise, Smoking Cessation, etc.)

- Applied to Both Arms by Protocol and Case-Managed

What Can Be Achieved with OMT in SIHD:
COURAGE Primary Endpoint
Survival Free of Death or MI

- Randomization to PCI + OMT vs OMT
- Intensive, Guideline-driven Medical Therapy & Lifestyle Intervention In Both Groups

### Are COURAGE Trial Patients Generalizable to Contemporary Clinical Practice?

- Significant clinical co-morbidity: 67% HTN; 34% DM; 71% dyslipidemic; 29% smokers; 39% prior MI
- Significant angina at baseline in 88% (12% had “silent ischemia”); 58% were CCS Class II or III
- Significant ischemia at baseline in 95% of pts: 5% had UA and no ischemia testing (but with 80% cor. angio. stenosis); 10% had ischemic ECG changes at rest; 85% had inducible ischemia (57% ETT and 43% stress MPI, of whom 67% had multiple reversible ischemic defects)
- 69% of patients had multivessel CAD with at least a 70% proximal visual stenosis in one or more epicardial coronary arteries

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### COURAGE Patient Randomized to OMT Alone

![Image of coronary angiogram]
COURAGE Patient Randomized to OMT Alone

Need for Subsequent Revascularization: 7 Years of F/U*

<table>
<thead>
<tr>
<th></th>
<th>PCI + OMT</th>
<th>OMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Need for Revascularization</td>
<td>21%</td>
<td>33%</td>
</tr>
<tr>
<td>Subsequent CABG</td>
<td>N=77</td>
<td>N=81</td>
</tr>
<tr>
<td>Median Time to Revascularization†</td>
<td>10 months; 10.5%</td>
<td>10.8 months; 16.5%</td>
</tr>
</tbody>
</table>

• *Median 4.6 years of follow-up
• †Median time to Repeat or 1st Revascularization
• After ~ 11 mo, the avg. X-over from OMT to PCI was 2.8%/yr over yrs 1-7
Review of Evidence: Impact of Revascularization on Angina Relief and Quality of Life (QOL) and the Unmet Need of Persistent or Recurrent Angina Post-PCI

Freedom from Angina: CASS vs. COURAGE

Need to treat 17 patients with PCI+OMT for 1 patient to have significantly greater angina relief than OMT alone.

The greatest symptom improvement was in the worst third, with no improvement in the best third (P<0.001 for the interaction).


COURAGE Nuclear Substudy: Unadjusted and Risk-Adjusted Outcomes for Reduction in Ischemic Myocardium
Does PCI Reduce Clinical Events?

COURAGE: Death/MI rates PCI vs. OMT in Pts with Moderate-to-Severe Ischemia at Baseline, with or without a 2nd scan during Follow-Up

- Site read Moderate-to-Severe Ischemia
  - Death or MI (N=407)

- Core Lab read Moderate-to-Severe Ischemia
  - Death or MI (N=189)

- PCI vs. OMT
  - 24% vs. 21%
  - HR 1.19
  - 95% CI 0.65-2.18


COURAGE Nuclear Substudy

- Patient randomized to medical treatment only

- Stress Rest Stress Rest
- Apex
- Mid Base

Before treatment
After optimal anti-ischemic medical therapy

Circulation 2008; 117:1283-1291
COURAGE Trial: 
Summary

- PCI added to OMT did not reduce risk of death, MI, or other major CV events as compared with OMT alone
  - 21.1% of patients in the PCI group required additional revascularization versus 32.6% of patients in the optimal therapy group (HR: 0.60; P<0.001)—but over 7 years!
- Findings reinforce existing clinical practice guidelines
  - OMT and aggressive management of multiple treatment targets without initial PCI can be implemented safely in the majority of patients with chronic stable angina, even those with objective evidence of ischemia and significant multivessel CAD

A Randomized Trial of Therapies for Type 2 Diabetes and Coronary Artery Disease

The BARI 2D Study Group

BARI 2D Study: Medical Therapy Versus Revascularization

Primary Outcome (All-Cause Death)

PCI

CABG

Survival (%)

Follow-Up (Years)

Medical therapy
Revascularization

Survival (%)

Follow-Up (Years)

Medical therapy
Revascularization

BARI 2D Study: Medical Therapy Versus Revascularization

Principal Secondary Endpoint (Death, MI, or Stroke)

- PCI
  - Medical therapy: 78.9%
  - Revascularization: 77.0%
  - *P* = 0.15

- CABG
  - Medical therapy: 77.6%
  - Revascularization: 69.5%
  - *P* = 0.01


BARI 2D Study: Summary

- In patients with type 2 diabetes and stable ischemic cardiovascular disease, there were no significant difference in the rates of death and major cardiovascular events between
  - Patients undergoing prompt revascularization and those undergoing medical therapy
  - Strategies of insulin sensitization and insulin provision


FAME 2: FFR-Guided PCI versus Medical Therapy in Stable Coronary Disease

Urgent Revascularization

HR 0.13 (0.06-0.30)  
\( p<0.001 \)


Which Is More Enduring — FAME or COURAGE?  
Williams B. Boden, M.D.
**FAME 2: FFR-Guided PCI versus Medical Therapy in Stable CAD**

On recommendation of the DMC, recruitment was halted on after inclusion of 1220 patients (± 54% of planned Pts)

**Primary Outcomes**

All-Cause Death, MI, Unplanned Hosp w/ Urgent Revasc

- PCI+MT vs. MT: HR 0.32 (0.19-0.53); p<0.001

**No Difference in All-Cause Death or MI**

- Cumulative incidence (%)
  - Months after randomization


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**FAME 2: FFR-Guided PCI versus Medical Therapy in Stable CAD**

**Patients with Angina Class II to IV**

<table>
<thead>
<tr>
<th>Time</th>
<th>PCI+MT</th>
<th>MT</th>
<th>Registry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>![Graph]</td>
<td>![Graph]</td>
<td>![Graph]</td>
</tr>
<tr>
<td>30 days</td>
<td>![Graph]</td>
<td>![Graph]</td>
<td>![Graph]</td>
</tr>
<tr>
<td>6 months</td>
<td>![Graph]</td>
<td>![Graph]</td>
<td>![Graph]</td>
</tr>
<tr>
<td>12 months</td>
<td>![Graph]</td>
<td>![Graph]</td>
<td>![Graph]</td>
</tr>
</tbody>
</table>

- P<0.001
- P=0.002
- P=0.002
- P=0.073

Analysis of 61 Randomized Trials in Non-Acute CAD 25,388 Patients


Outcomes in Combined Direct and Indirect Analysis of 61 Randomized Trials in Non-Acute CAD, HR (95% CI) n=25,388 patients

<table>
<thead>
<tr>
<th></th>
<th>PTCA vs medical therapy</th>
<th>Bare-metal stent vs medical</th>
<th>DES vs medical therapy</th>
<th>Bare-metal stent vs PTCA</th>
<th>DES vs PTCA</th>
<th>DES vs bare-metal stent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>0.91</td>
<td>0.90</td>
<td>0.96</td>
<td>0.99</td>
<td>1.05</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>0.70–1.18</td>
<td>0.70–1.16</td>
<td>0.60–1.52</td>
<td>0.76–1.30</td>
<td>0.66–1.69</td>
<td>0.71–1.58</td>
</tr>
<tr>
<td>MI</td>
<td>1.23</td>
<td>1.24</td>
<td>1.15</td>
<td>1.01</td>
<td>0.94</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>0.89–1.70</td>
<td>0.88–1.75</td>
<td>0.73–1.82</td>
<td>0.83–1.23</td>
<td>0.65–1.35</td>
<td>0.68–1.26</td>
</tr>
</tbody>
</table>

Debate continues to exist surrounding coronary artery stenting versus medical therapy for stable CAD. A meta-analysis of RCTs in which stents were used in >50% of patients in the PCI group was conducted and published in 2012. Eight trials, 7229 patients, event rates for stent implantation and medical therapy:

- Death: 8.9% and 9.1% (OR, 0.98; 95% CI, 0.84-1.16)
- Nonfatal MI: 8.9% and 8.1% (OR, 1.12; 95% CI, 0.93-1.34)
- Unplanned revascularization: 21.4% and 30.7% (OR, 0.78; 95% CI, 0.57-1.06)

2011 ACCF/AHA/SCAI PCI Guidelines

- “The findings from individual studies and systematic reviews of PCI vs. medical therapy in SIHD patients can be summarized as follows:
  - PCI reduces the incidence of angina
  - PCI has not been demonstrated to improve survival in stable patients
  - PCI may increase the short-term risk of MI
  - PCI does not lower the long-term risk of MI”

Why The Evidence Supports OMT as an Appropriate Initial Approach to SIHD Management

- 16 RCTs in 8,820 patients (including COURAGE, BARI-2D, & FAME-2) show no difference in death, MI, stroke, or other “hard” CV events between PCI and OMT
- Aggressive medical therapy & lifestyle intervention without initial PCI can be implemented safely in the majority of SIHD patients—1/3 of whom may require a symptom-driven procedure over 7 years of F/U, but 2/3 of whom may not require even a first revascularization. This approach incurs no penalty with respect to death, MI, ACS, or need for CABG
- Whether greater PCI benefit exists in those with more extensive ischemia remains ambiguous/unsettled, and is currently under prospective study (ISCHEMIA Trial)

ISCHEMIA

Stable Patients
Moderate or Severe Ischemia

Blinded CCTA

Core lab anatomy eligible?

no

Late screen failure

yes

RANDOMIZE

INVASIVE Strategy
OMT³ + Cath +
Optimal Revascularization

CONSERVATIVE Strategy
OMT³ alone
Cath reserved for OMT failures

Average 4 Years of Follow-up
Primary Endpoint: Composite of CV Death and MI

¹CCTA will be performed in all patients with eGFR ≥60 mL/min
²Exclude patients with LM disease or no obstructive disease
³OMT=Optimal medical therapy
Challenges in Clinical Evaluation of Patients with Suspected Heart Disease

Joseph A. Ladapo, MD, PhD
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Epidemiology of CAD and Healthcare Utilization

Public health challenge
- 15.4 million adults in the US live with CAD
- 6.4% of adults overall; 7.9% of men and 5.1% of women
- One American has a myocardial infarction (MI) every 44 seconds

Healthcare costs
- CAD costs $195.2 billion in direct and indirect costs annually (2009)
- In 2006, Medicare spent $11.7 billion on inpatient care for CAD
- By 2030, medical costs for CAD (real 2010$) projected to increase ≈100%

Ambulatory and hospital care
- Over 14 million ambulatory visits annually with CAD as primary diagnosis
- 1.3 million hospital admissions with CAD listed as the first diagnosis
- 954,000 percutaneous coronary interventions (PCIs), 397,000 cardiac bypass surgeries, 1.03 million diagnostic cardiac catheterizations
Physicians Routinely Manage Patients with Suspected or Diagnosed CAD

- 4M Stable, Symptomatic Patients Suggestive of Coronary Disease Annually

Diagnostic Tests:
- Clinical Factors
- EKG Treadmill

Stress Echo:
- Nuclear Imaging
- CT Angiography

Often Repeat Testing

Invasive Angiography

- Obstructive CAD is not found in ~60% patients

~$4.5B annual expenditures

Source: Mudrick et al, AHJ 2012; Claims data from United Healthcare

What Test Do We Choose During Our Initial Evaluation of Newly Presenting Patients?

Noninvasive Cardiac Stress Test

- Stress MPI: 54%
- Stress ECHO: 21%
- Exercise Treadmill: 25%

Source: Mudrick et al, AHU 2012; Claims data from United Healthcare
Utilization of Cardiac Imaging Stress Tests Has Grown Tremendously…

Medicare population
- Between 1993 and 2001, nearly 300% increase in use of imaging stress tests (stress echocardiography, ECHO; myocardial perfusion imaging, MPI)
  - Rose from 29 to 82 per 1,000 beneficiaries
- Rate of non-imaging stress tests fell modestly

But Slowed Recently (Though Still Growing Overall)

- Between 2000 and 2007, cardiac imaging grew by over 50% among Medicare beneficiaries
- Driven almost entirely by stress MPI
- Medicare spent $1.1 billion on MPI in 2007 alone
- Overall spending on cardiovascular imaging, including public and private payors, is approximately $17 billion annually
Challenges to Clinical Care: Diagnostic Uncertainty

Uncertainty About How to Interpret Diagnostic Test Results is Common

- Bayes' theorem defines how pretest disease risk and diagnostic test performance can be used to guide interpretation of test results

\[ P(A | B) = \frac{P(B | A)P(A)}{P(B)} \]
Referral Bias Influences Diagnostic Accuracy and Test Interpretation

Referral bias

- Sometimes called “verification bias” or “workup bias”
- Occurs because higher-risk patients are preferentially referred to cardiac catheterization
- Bayesian methods needed to adjust diagnostic test performance for referral

Most studies do not account for referral

- Studies of stress test performance do not adjust for this phenomenon so estimates of sensitivity and specificity biased

Biases clinical decision-making

- Because it biases test performance, it may also bias clinical decision-making

Cardiac Catheterization Referral Rates After Normal Exercise ECHO or MPI Results

Referral rates are low after a normal study
- Range of ~1% to 5% generally

Homogenous
- Geographic location and patient characteristics vary but little variation in referral rates

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Cardiac Catheterization Referral Rates After Abnormal Exercise ECHO or MPI Results

Referral rates higher after an abnormal test
- Range of ~20% to 75% generally

Heterogeneity
- Significant variation in referral rates

Presented at American Heart Association Quality of Care and Outcomes Research (AHA QCOR) 2012, Baltimore, MD and Society for Medical Decision Making, Phoenix, AZ

Observed vs. True Diagnostic Performance of Exercise ECHO

True performance = observed performance after adjustment for referral
Observed vs. True Diagnostic Performance of Exercise MPI

Challenges to Clinical Care: Unnecessary Testing
Unnecessary Testing is Common

Our Threshold for Testing Patients is Falling

- 39,515 patients undergoing stress MPI between 1991-2009 at Cedars Sinai
- Incidence of abnormal scans fell from 41% to 9%
- Incidence of ischemic scans fell from 30% to 5%
- Only 3% of patients who did not have typical angina and could exercise had an abnormal scan

Rozanski, JACC 2013

Challenges to Clinical Care: Unnecessary Procedures
Cardiac Catheterization Frequently Performed Needlessly

- 398,978 patients in American College of Cardiology (ACC) National Cardiovascular Data Registry (NCDR)
- Noninvasive cardiac testing performed in 84% of patients prior to catheterization
- Only 1 in 3 patients were found to have obstructive coronary disease
- No coronary artery disease was reported in 39% of patients

Unnecessary Procedures are Common

Challenges to Clinical Care: Unnecessary Radiation
Unnecessary Radiation Exposure is a Growing Problem

Potential harms related to radiation exposure are poorly understood
- Stress MPI accounts for 22% of cumulative effective radiation from medical sources
- One MPI = 1,000 chest x-rays = 10-15 mSv
- Persons at risk for repeated radiation exposure, such as healthcare workers and the nuclear industry, typically restricted to max 100 mSv every 5 years

Columbia University Medical Center
- 1,097 consecutive patients, 8-10 years of follow-up
- Multiple MPIs performed in 424 patients (39%)
- Median cumulative effective dose from MPI was 29 mSv
- Median cumulative effective dose from medical sources was 64 mSv

Medicare population
- Between 1993-2001, 34% of enrollees underwent repeat testing

US nonelderly population
- Among patients undergoing cardiac imaging, mean cumulative dose 16.4 mSv (1.5-190 mSv)
- MPI accounted for 74% of cumulative dose
Improving Quality of Care: Reducing Unnecessary Testing

**Appropriateness guidelines**
- Greater physician awareness of appropriate use criteria
- ACC and United Healthcare registry: 34% of stress MPIs inappropriate or of uncertain appropriateness

### Insurer policies and regulation
- Prior authorization by radiology benefits managers
- Reductions in reimbursement
- Medicare released national coverage decision requesting more evidence for coronary CT angiography (CTCA)

### Patient education
- Informed decision-making
- Shared decision-making
- Concerns about radiation exposure risks (but does it reduce utilization?)

**Improving Quality of Care: Comparative Effectiveness Research**

**Comparative effectiveness research (CER)**
- Because tests vary in diagnostic accuracy, initial test choices may influence outcomes, independent of regional/physician care patterns and patients' risk factors
- Large data set analyses and clinical trials

### Stress MPI vs. ECHO (unpublished data)
- 11,794 patients underwent stress testing and were followed for 12 months
- Mean age 53 yrs, 62% male
- Risk of major adverse cardiovascular events lower after stress ECHO (aOR 0.6, p<0.001) compared to MPI

### Stress MPI vs. ECHO vs. CTCA
- 282,830 Medicare patients undergoing stress testing and followed for 6 months
- Mean age 74 yrs, 46% men
- Risk of acute MI lower after stress ECHO (aOR 0.8, p<0.03) and CTCA (aOR 0.6, p<0.04) compared to MPI

Ladapo et al, in development; Shreibati, JAMA 2011
Improving Quality of Care: Clinical Decision Analysis

**Clinical decision analysis**
- Integrates mathematical modeling, uncertainty, and patient preferences to identify optimal care strategies
- Informs health policy and clinical practice

**Patient preferences**
- Impact of false positive tests
- Preferences over medical management vs. invasive management of CAD
- Radiation concerns

No models of patient care have integrated (1) patients’ preferences about false positives and (2) accurate measures of diagnostic accuracy (referral-adjusted)

Clinical Outcomes and Cost-Effectiveness of Coronary Computed Tomography Angiography in the Evaluation of Patients With Chest Pain

Ladapo, JACC 2009

Improving Quality of Care: Optimizing Diagnostic Accuracy

Research on diagnostic accuracy of stress testing that accounts for referral patterns to cardiac catheterization is needed
- Our meta-analysis of referral rates from 1980-2012 is currently under review

**Coronary CT angiography**
- High-resolution visualization of coronary anatomy
- Limitation: Ischemic heart disease occurs in absence of coronary stenosis

**Corus CAD, a blood-based gene expression test for diagnosing obstructive CAD**
- First clinically validated gene expression test for assessing obstructive CAD (>50% stenosis in a major coronary artery)
- Algorithm based on the peripheral blood gene expression of 23 genes, gender and age
- Targeted application is as a first line rule-out test, prior to additional stress testing or cardiac catheterization
- Nondiabetic patients only
Theoretical Framework for Blood-based Gene Expression Test for CAD

Changes in gene expression have been observed in diseased arterial wall samples

Gene expression in circulating cells reflects presence of CAD

Peripheral blood gene expression signatures correlate with inflammatory and immune-mediated disorders

Inflammation plays an established role in atherosclerotic development

Methods and Results

Objective

• Validate Corus CAD in symptomatic patients referred for myocardial perfusion imaging (MPI)

Implications

• Corus CAD outperforms stress MPI, the most widely used cardiac imaging study for CAD diagnosis

• But we know that patients with normal stress MPI or ECHO have excellent prognosis (NPV for MI and cardiac death ~98-99% over three years)

• How does Corus compare?

Methods and Results

• Prospective multi-center study of 537 undergoing GES, MPI, and either ICA or CT-angiography (CTA)

• ROC curve area for GES was 0.79 compared to site/core-lab AUCs for MPI were 0.59 and 0.63

• At 6 months, 27/28 patients with adverse cardiovascular events had GES >15

COMPASS Trial Design

COMPASS (Coronary Obstruction Detection by Molecular Personalized Gene Expression)

- Primary Endpoint: Corus® CAD performance by ROC analysis
- Steering Committee: Greg Thomas, MD, MPH, John McPherson, MD, Alexandra Lansky, MD, Szilard Voros, MD
- 19 U.S. sites, 431 patients in final cohort

Potential New Paradigm of Care Based on COMPASS Results

- Score ≤ 15: No further cardiac testing
- Score > 15: MPI
  - Negative MPI: No further cardiac testing
  - Positive MPI: Invasive Coronary Angiography
- Cardiology
  - MPI: Revascularization, Medical therapy
- GES Test
  - Primary Care: No further cardiac testing
Does Better Testing Mean Better Care?

Achieving Quality in Cardiovascular Imaging
Proceedings From the American College of Cardiology–Duke University Medical Center Think Tank on Quality in Cardiovascular Imaging
Developed in Collaboration With the Cardiovascular Imaging Collaborative Quality Work Group, American College of Radiology, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Coalition of Cardiovascular Organizations, Heart Failure Society of America, Heart Rhythm Society, Intersocietal Accreditation Commission, Society of Cardiac and Thoracic Imaging, Society for Cardiovascular Magnetic Resonance, and Society for Vascular Medicine and Biology

Douglas et al JACC 2006;48:2141-2151

Thank you!

joseph.ladapo@nyumc.org
Questions?