27th ANNUAL SCIENTIFIC CONGRESS
HONG KONG COLLEGE OF CARDIOLOGY
Coronary Ischemia Symposium

ASSESSMENT OF CORONARY PHYSIOLOGY:
Impact on Patient Management

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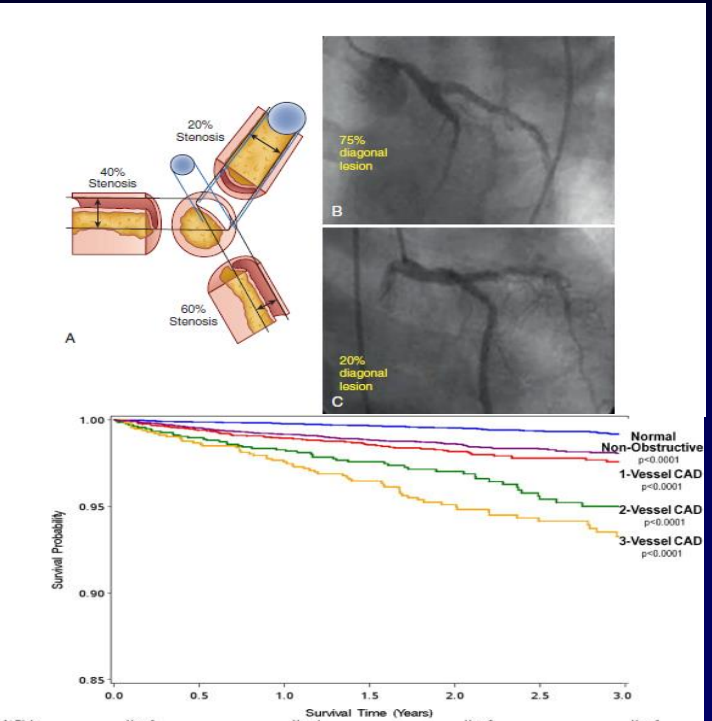
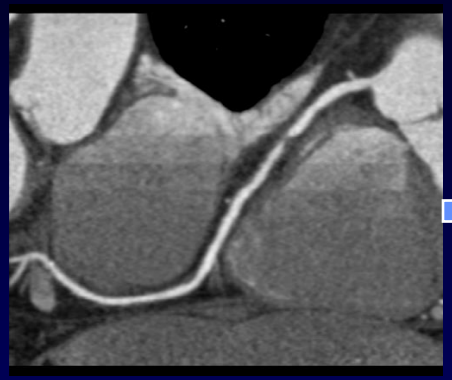
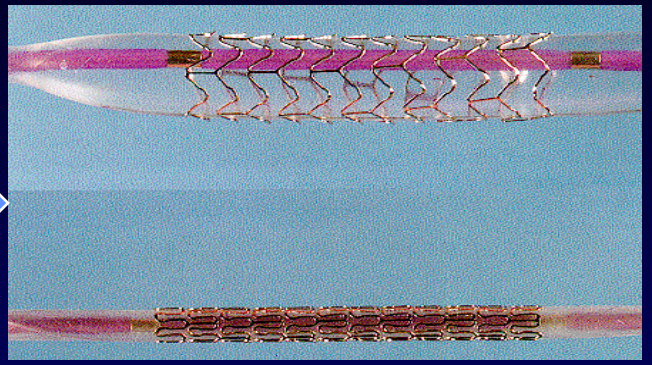
CORONARY ANATOMY



- Angiography may result in both underestimation or overestimation of lesion severity
- Angiographic disease correlates with prognosis, albeit weakly in many cases
- Inconsistent literature regarding the impact of angiographically-guided on “hard” outcomes
- Is coronary angiography alone the best procedure to decide therapy?

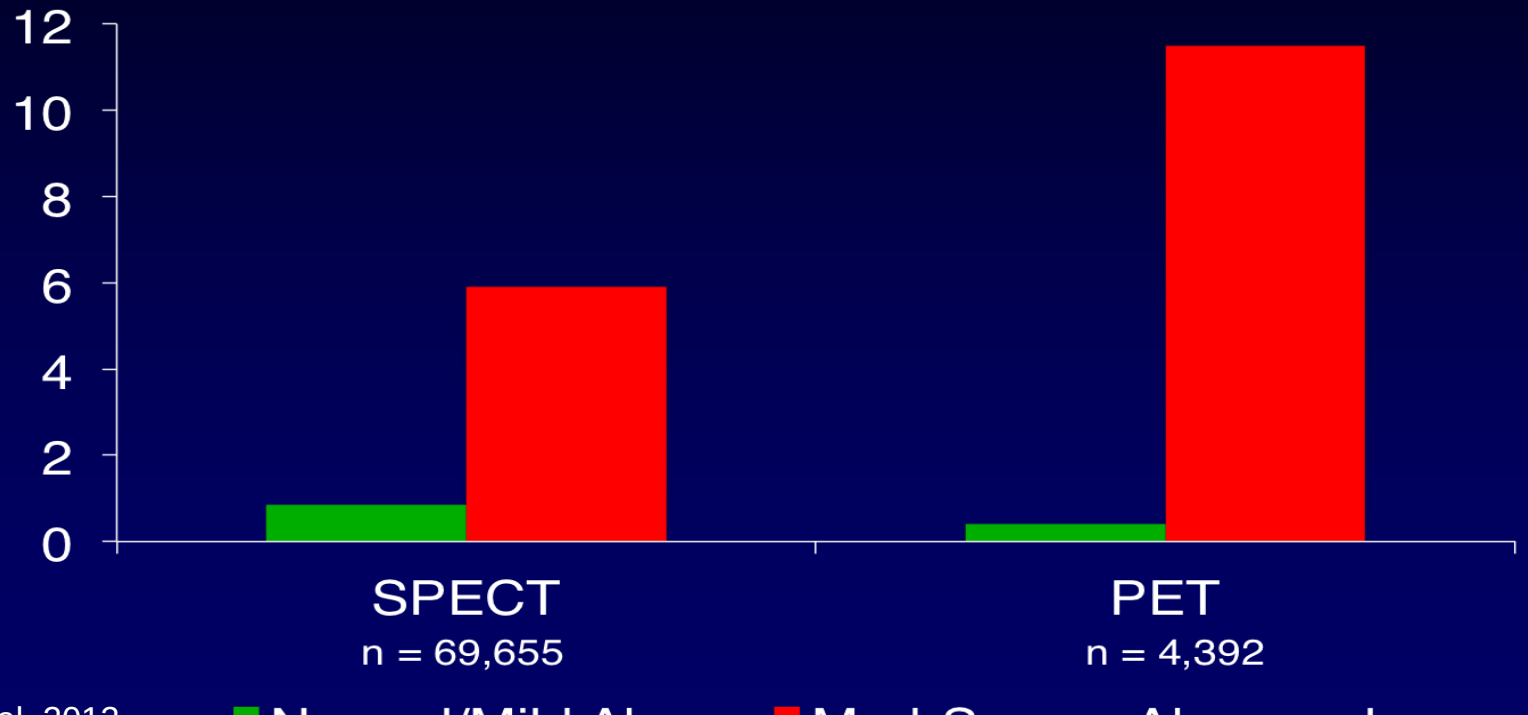
THE OCULO-DILATORY REFLEX?





ANATOMY IS NOT THE ANSWER!

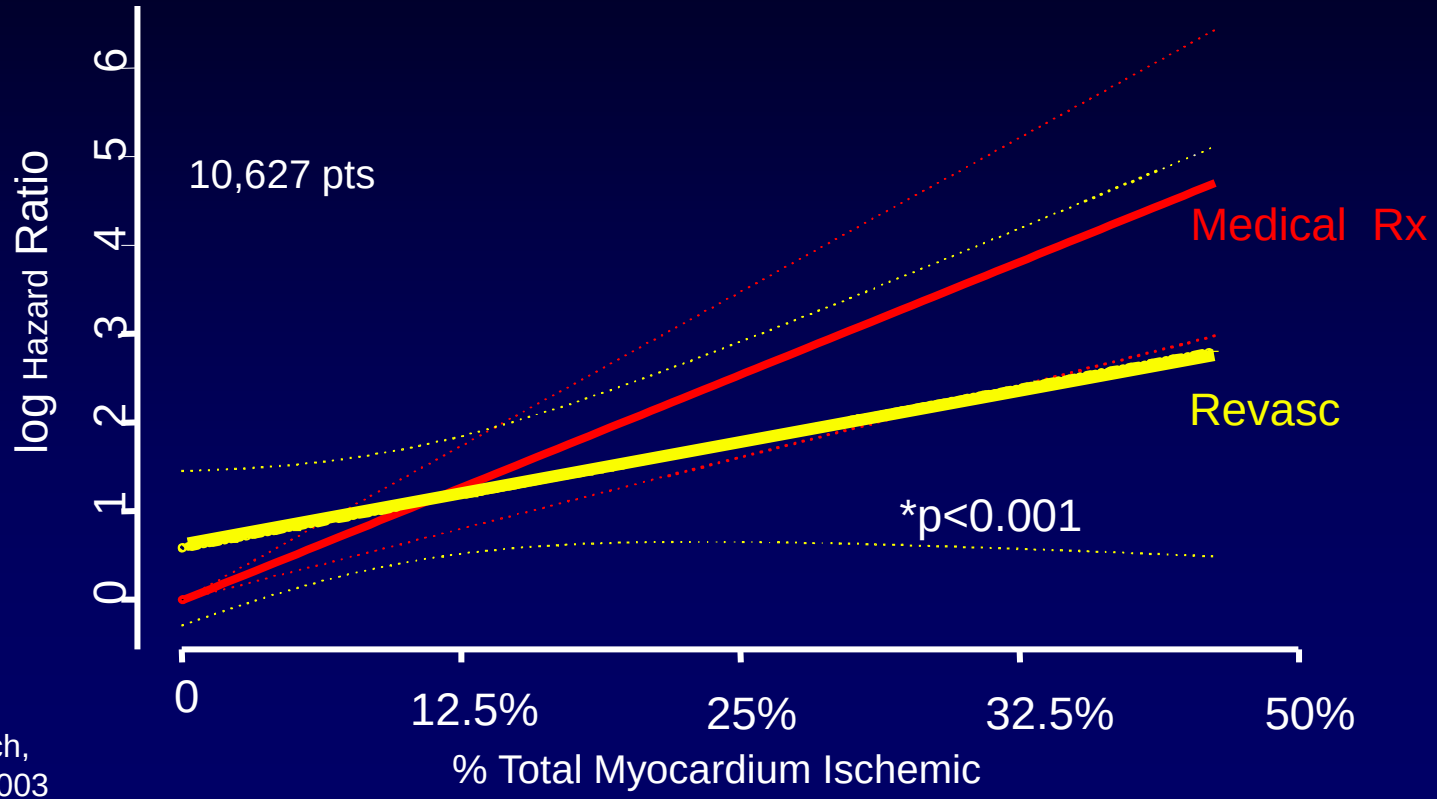
PROGNOSTIC VALUE OF RADIONUCLIDE MYOCARDIAL PERFUSION IMAGING



Shaw L et al, 2012
JNC 1:1026

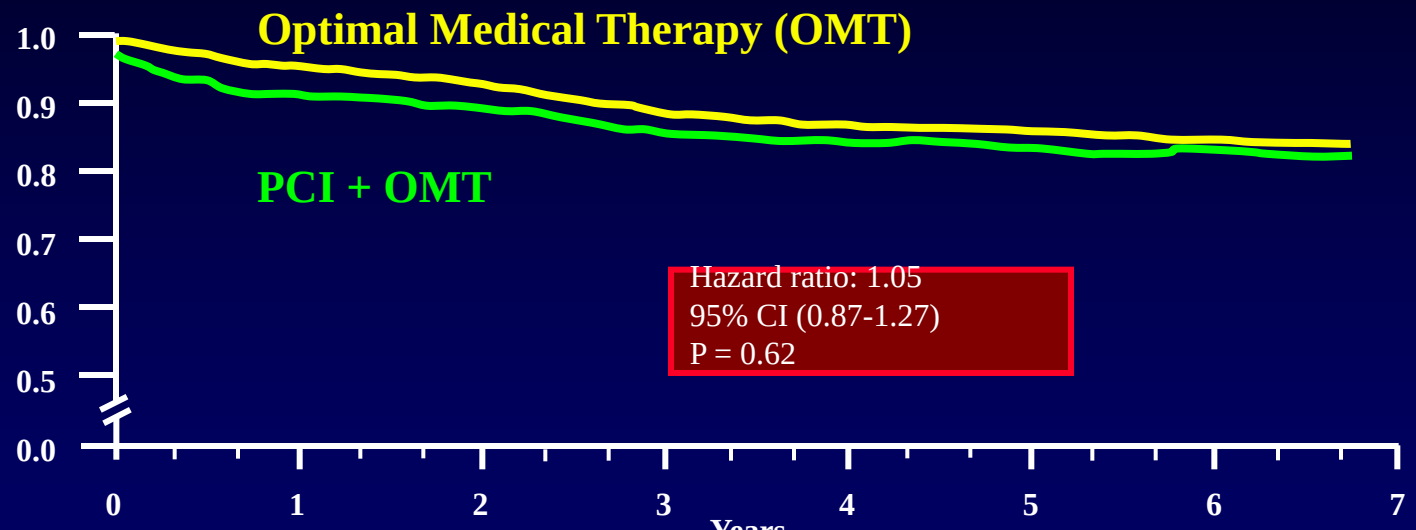
RISK OF CARDIAC DEATH AND INDUCIBLE ISCHEMIA

Role of Post-SPECT Therapy



Hachamovitch, Circulation 2003

SURVIVAL FREE OF DEATH FROM ANY CAUSE AND MYOCARDIAL INFARCTION

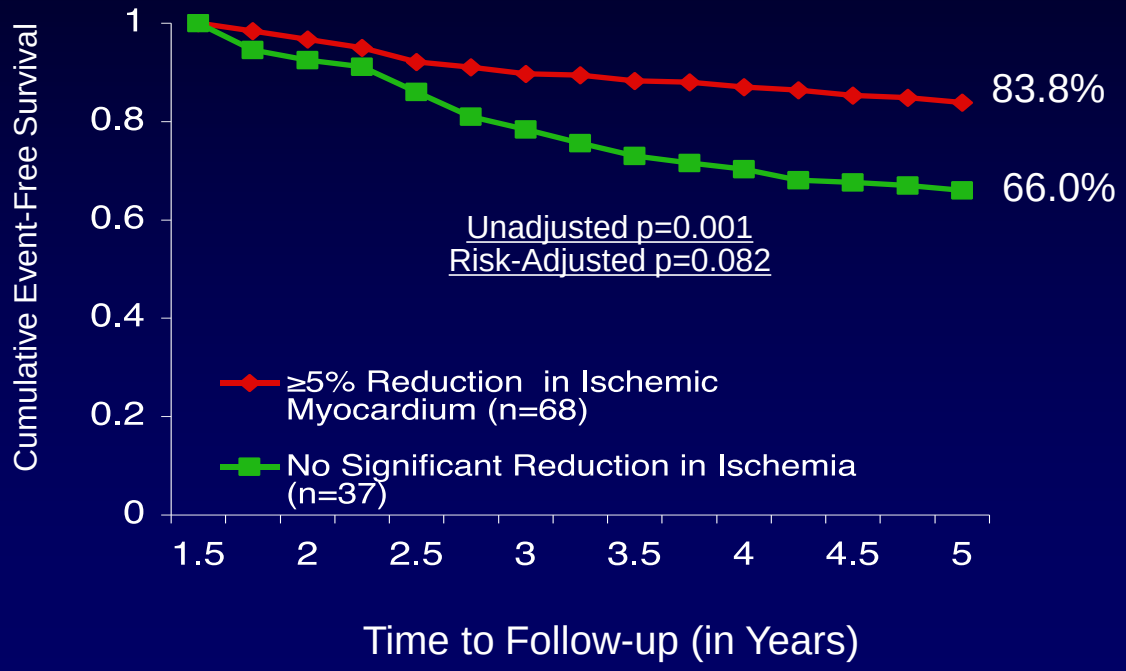


Number at Risk

Medical Therapy	**1138**	**1017**	**959**	**834**	**638**	**408**	**192**	**30**
PCI	**1149**	**1013**	**952**	**833**	**637**	**417**	**200**	**35**

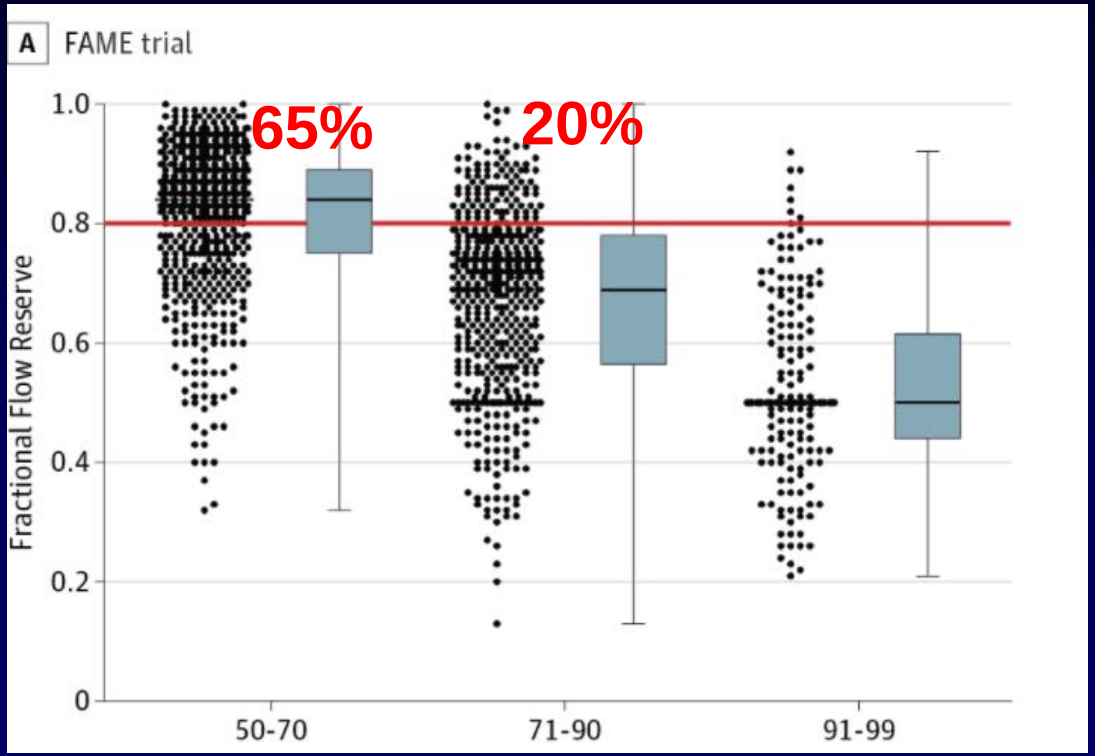
COURAGE (SPECT MPI SUBSTUDY)

Cardiac Event-free Survival In Patients With Moderate-Severe Pre-Rx Ischemia Following PCI + OMT Or OMT (n=105)



Shaw Circulation 2008;117:1283-1291.

ANGIOGRAPHIC LESION SEVERITY VERSUS PHYSIOLOGY



Torino PA et al, 2010
JACC 55: 2816

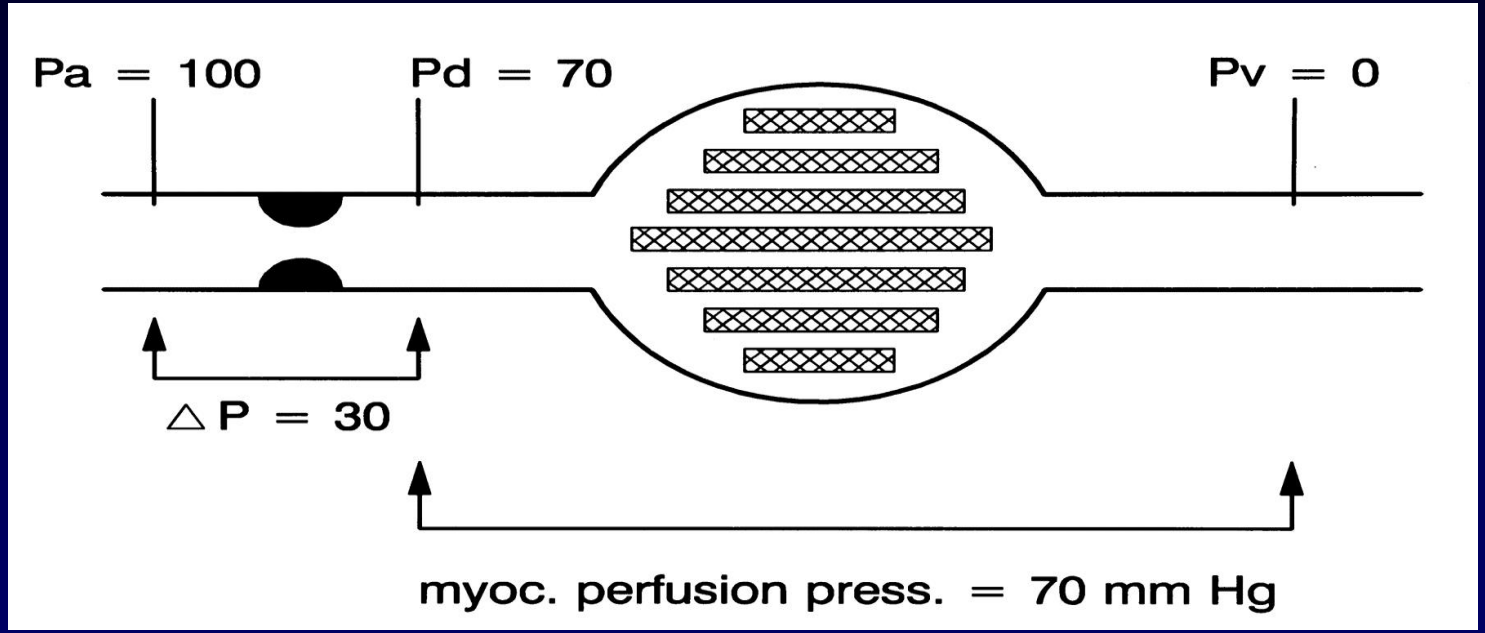
ANATOMY ≠ PHYSIOLOGY
ATHEROSCLEROSIS ≠ ISCHEMIA

“Apples and Oranges”
Paul Cezanne
c. 1899

FLOW RESERVE

- FRACTIONAL FLOW RESERVE (FFR)
  - –Similar to relative coronary flow reserve
  - –Indirect index; uses several assumptions
  - –Assessment of only epicardial stenosis
- ABSOLUTE FLOW RESERVE (CFR)
  - –Impacted by factors impacting on maximal flow: stenosis severity, microcirculation, BP&HR
  - –Reduced with hyperlipidemia, LVH
  - –Related to stenosis dimensions, diffuse atherosclerosis and microvascular dysfunction
- RELATIVE FLOW RESERVE
  - –Regional differences; value reduced with diffuse CAD
  - –Insensitive to hemodynamics
  - –Cornerstone of noninvasive testing

SIMPLIFIED RATIONALE OF FRACTIONAL FLOW RESERVE

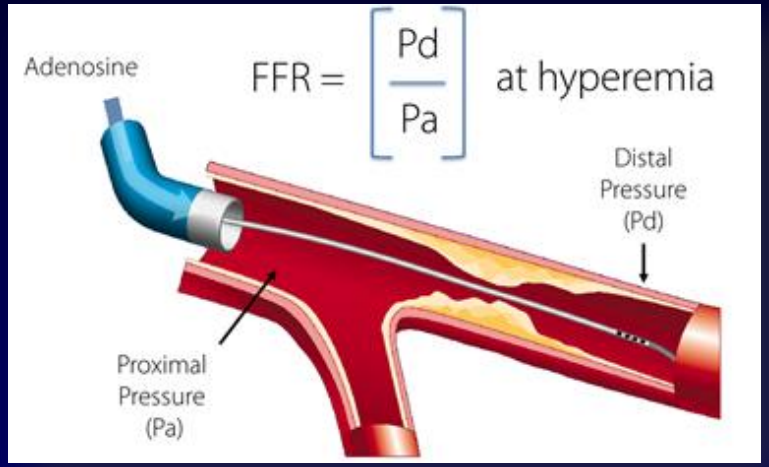


FFR = (Pd – Pv)/(Pa – Pv) = 70 / 100 = 0.7

KEY: PHF, when resistance is minimal

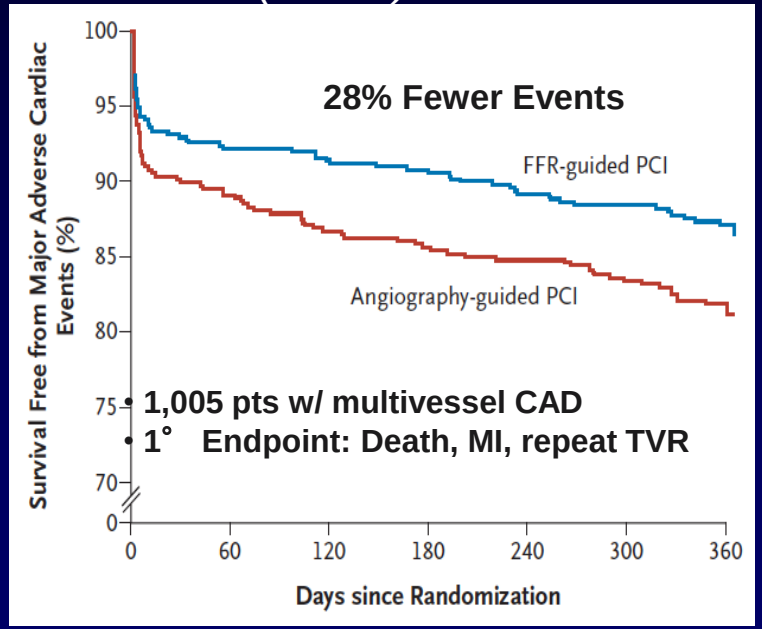
Pijls, N. H.J. et al.1995
Circulation;92:3183-3193

LESION-SPECIFIC ISCHEMIA: FRACTIONAL FLOW RESERVE (FFR)



- FFR = Pressure Differences Across Stenosis
- Lesion-Specific Ischemia: ≤0.80

Fractional Flow Reserve Vs. Angiography for Multivessel Evaluation (FAME) Trial



Pijls JACC 2007;49:2105-2111; Pijls JACC 2010;56:177-184., Tonino NEJM 2009;360:213-24; Pijls JACC 2010;56:177-184.

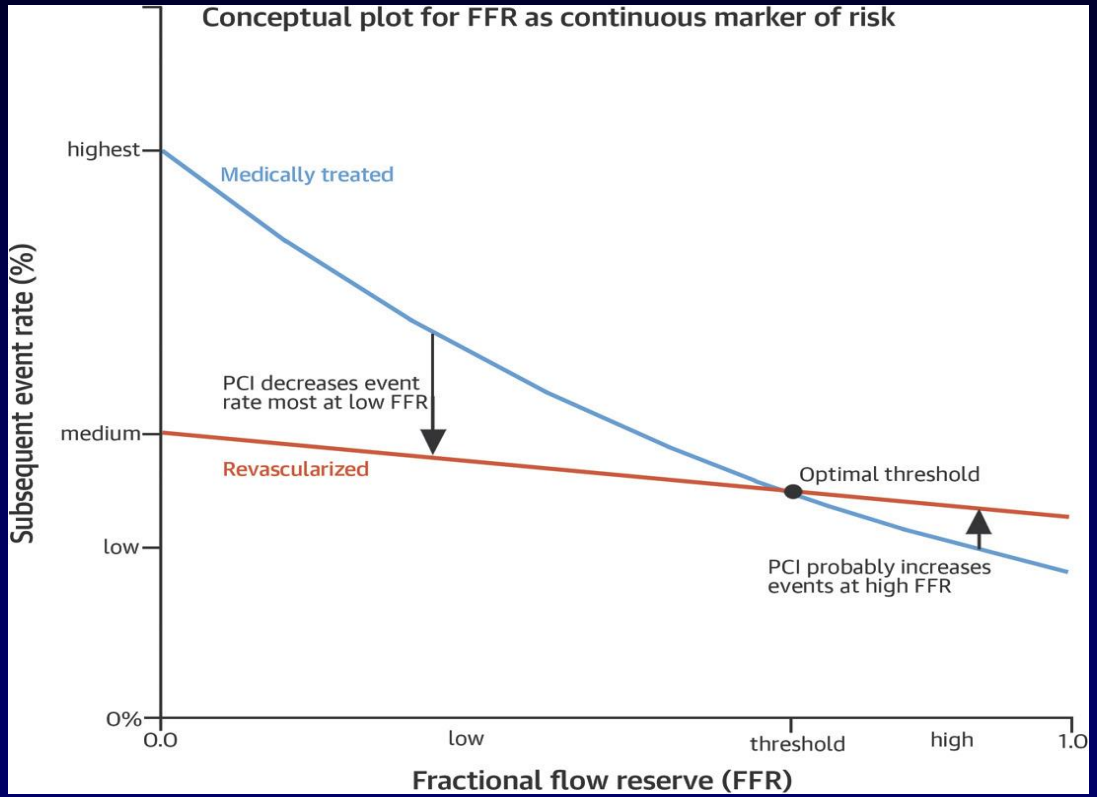
FFR vs. ANGIOGRAPHIC STRATEGY
The FAME, DEFER, and FAME2 Trials

PHYSIOLOGY RULES!

- Discordance between % stenosis and FFR results
  - –>60% of moderate lesions (50-70%): insignificant
- Low event rates if no revascularization performed in absence of abnormal FFR
- PCI did not improve outcome if FFR normal
- Lower event rate when FFR strategy employed, in comparison with angiographic approach

Tonino et al, 2010 JACC 55: 2816
Pijls et al, 2007 JACC 49: 2105
Pijls et al, 2010 JACC 56: 177
De Bruyne et al, NEJM 2012; 367: 991

RELATIONSHIP BETWEEN FRACTIONAL FLOW RESERVE AND OUTCOME

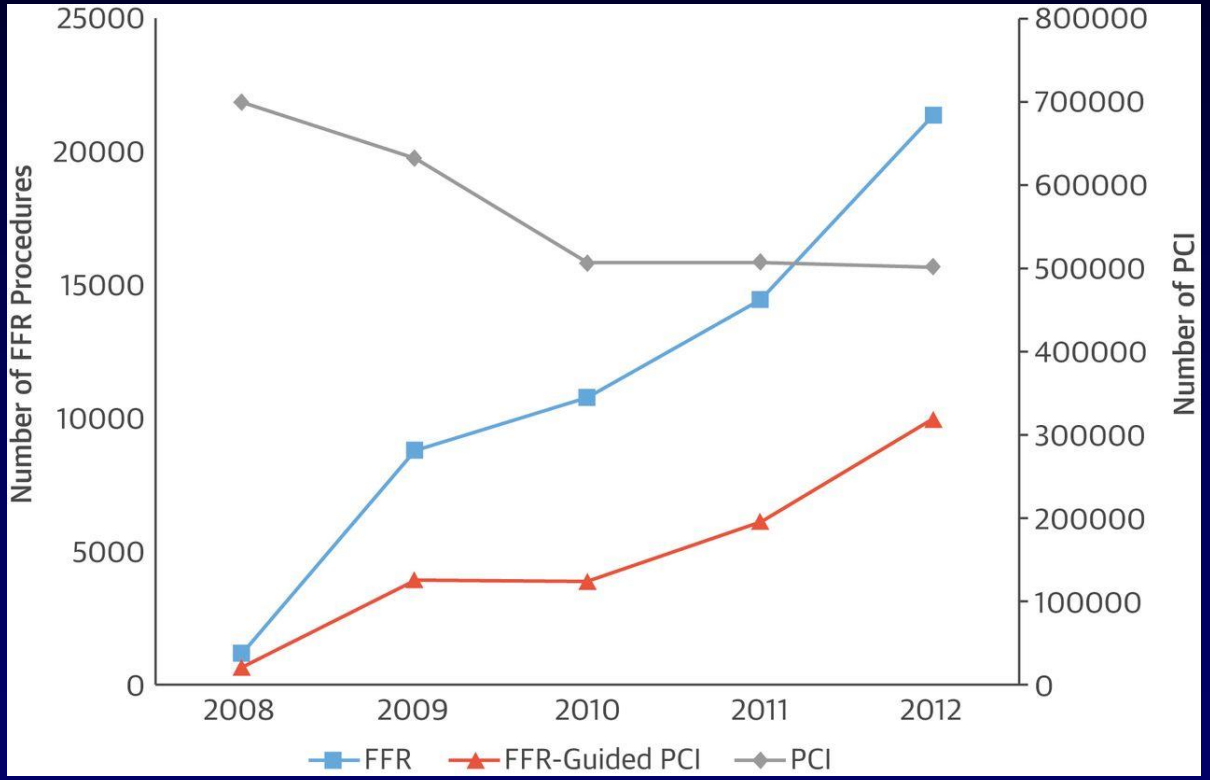


Johnson NP et al
JACC 2014; 64: 1641

GUIDELINES FOR THE USE OF FFR

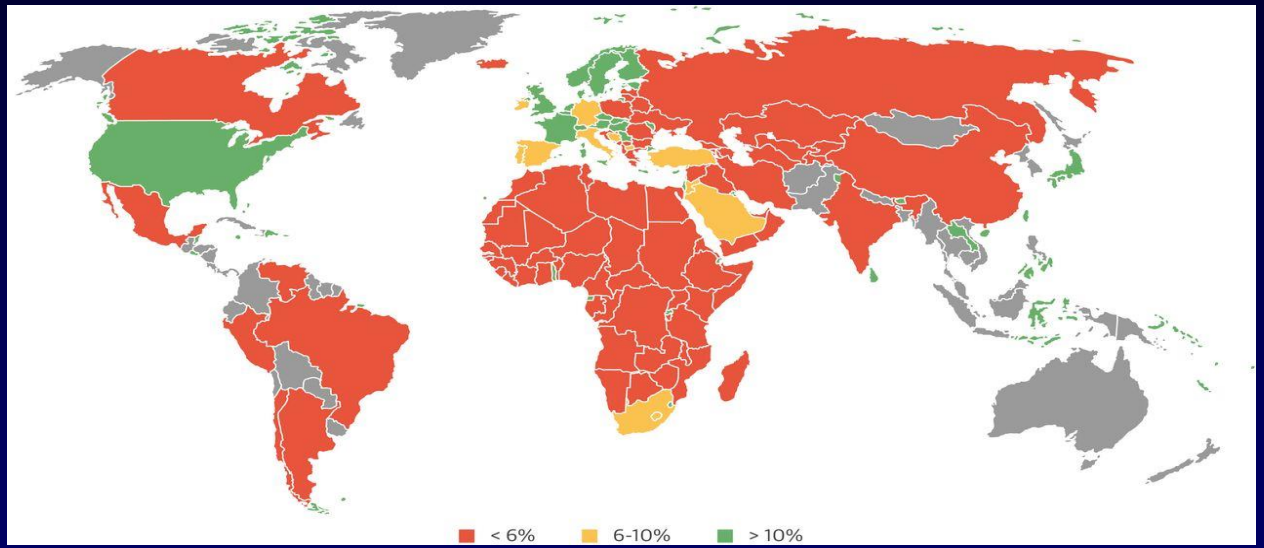
Publication	Recommendations
2011 ACCF/AHA/SCAI Guideline	Class IIa: angiographic intermediate coronary lesions (50-70%); For recommendations about revascularization
Expert consensus statement on FFR	In SIHD when **noninvasive imaging is unavailable, nondiagnostic, or discordant**, FFR should be used to assess functional significance of intermediate-severe coronary stenosis (50-90%)
2014 ESC/EACTS	Class I; FFR is indicated for moderate stenosis. Defer revascularization if FFR >0.80
2013 ACC Appropriate use criteria for SIHD	Advocate for expanded use of intracoronary physiological testing
2017 ACC Appropriate use criteria for PCI	**If no stress test or results are indeterminant**, FFR can be used to determine appropriateness of revascularization

U.S. TRENDS IN UTILIZATION OF FFR, FFR-GUIDED PCI, AND PCI FROM 2008 TO 2012



Naga V. et al., 2016
JACC;67:732-733

GLOBAL ADOPTION OF CORONARY PHYSIOLOGY TO GUIDE REVASCULARIZATION DECISION MAKING IN 2016

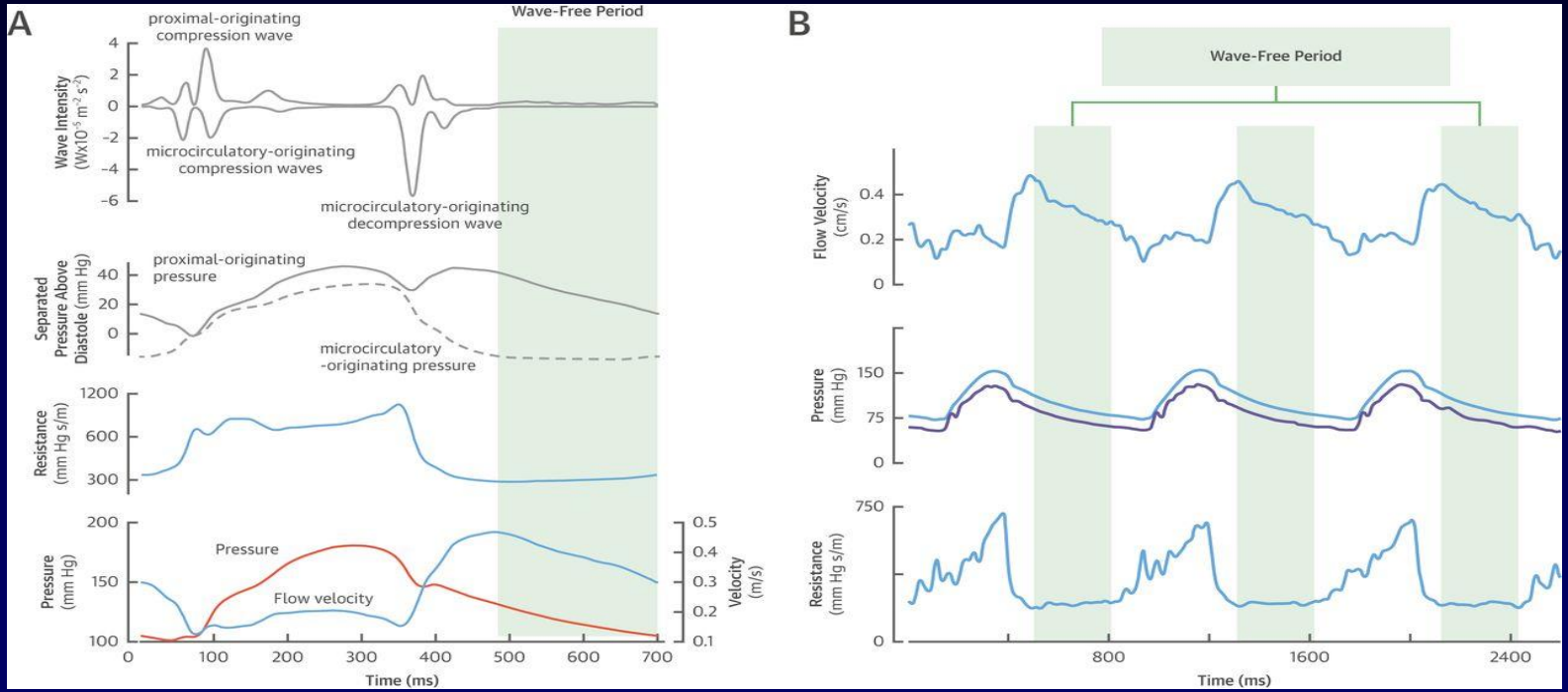


Reasons for low adoption

- Unavailable
- Time consuming
- Expensive
- Contraindications
- Adverse reactions

Gotberg M et al, 2017
JACC 70: 1379

WAVE-FREE PERIOD OF DIASTOLE AND ASSOCIATED HEMODYNAMICS



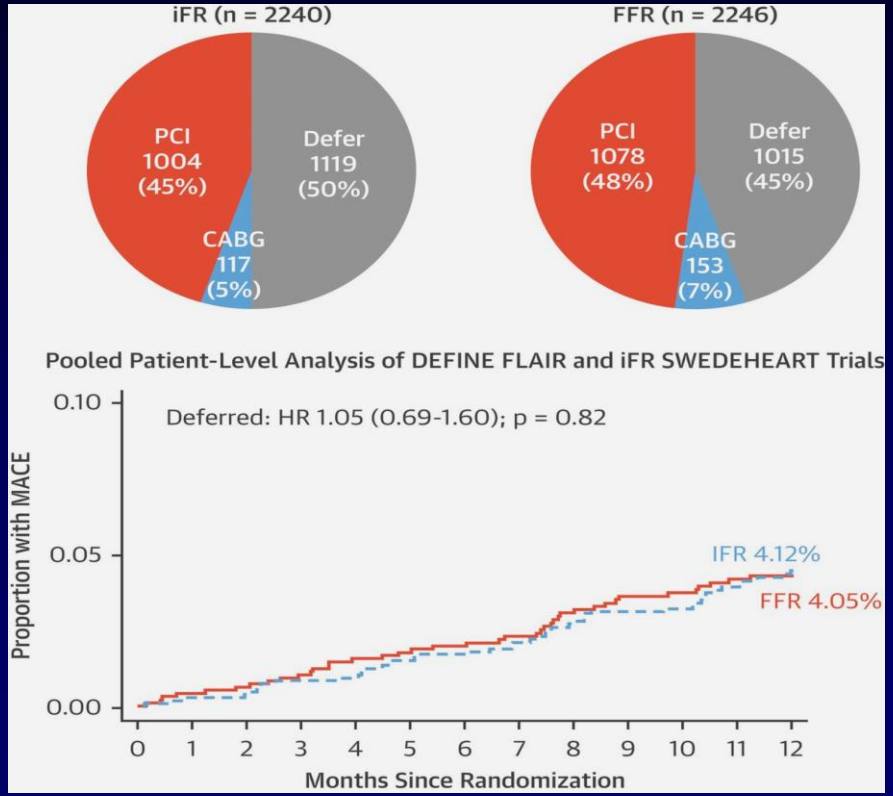
Gotberg M et al, 2017
JACC 70: 1379

INVASIVE TOOLS TO ASSESS PHYSIOLOGY
A Guide for Coronary Revascularization

FFR	iFR
Lengthy procedure	Hyperemia independent
Adenosine cost	Excellent signal-to-noise ratio
Availability of adenosine	More rapid procedure
Inability to assess serial lesions	Assess serial lesions
Frequent patient discomfort	Infrequent side effects

Gotberg M et al, 2017
JACC 70: 1379

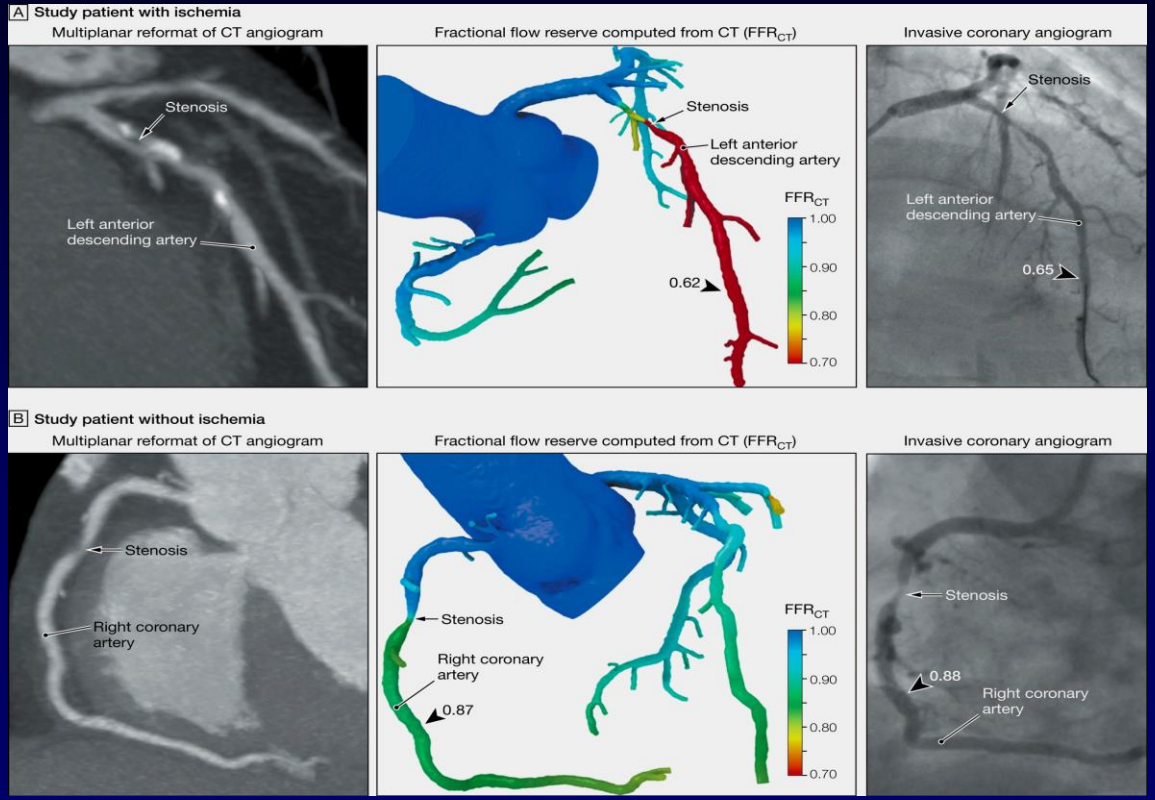
DEFERRAL OF REVASCULARIZATION ACCORDING TO iFR AND FFR
DEFINE FLAIR and iFR SWEDEHEART



- Single cutoff for iFR (0.98)
- Individual studies both revealed non-inferiority
- iFR avoid adenosine
  - –Procedural time
  - –Costs
  - –Patient side effects
- Deferral of revascularization more common with iFR than with FFR
- iFR: The new standard?

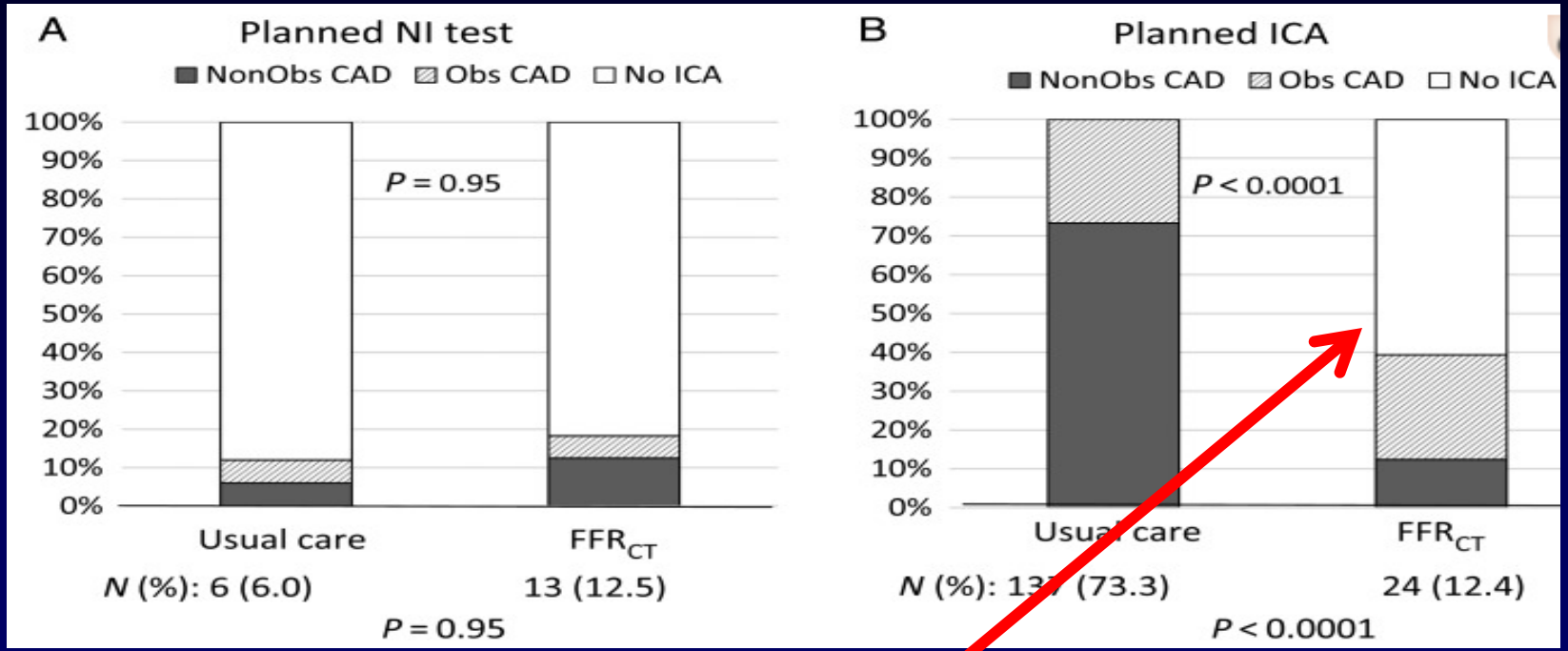
Gotberg M et al, 2017
JACC 70: 1379

ASSESSMENT OF FFR FROM CT ANGIOGRAPHY
The DeFACTO Study (n=288)



Min JK et al, 2012
JAMA 308: 1237

INVASIVE CATHETERIZATION AND PRESENCE OF OBSTRUCTIVE DISEASE BASED ON STRATEGY
The PLATFORM Trial



No MACE if ICA deferred based on FFR_{CT}

Douglas PS et al
E Heart J 2015; 36: 3559

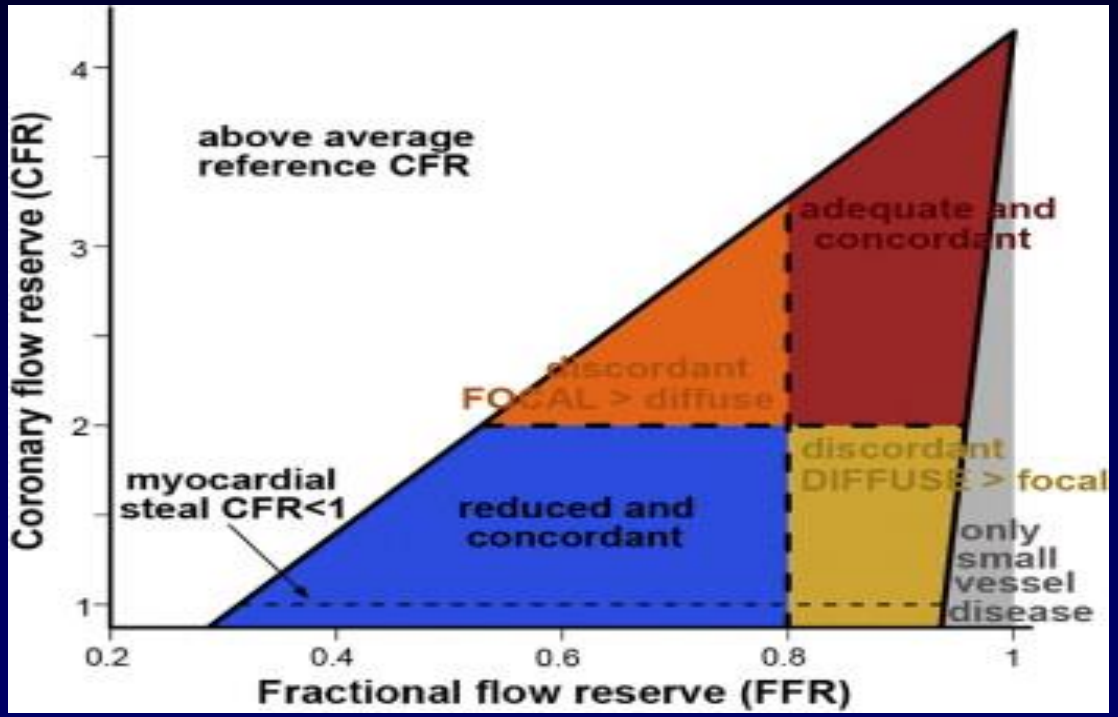
NON-INVASIVE TESTING COMPARED WITH FFR
A Meta-Analysis

Test	Sens	Spec	NLR	AUC	Q-stat
SPECT	74%	79%	0.39	0.82	0.75
Echo	69%	84%	0.42	0.83	0.75
CMR	89%	87%	0.14	0.94	0.88
PET	84%	87%	0.14	0.93	0.87
CT	88%	80%	0.12	0.93	0.87

- CMR, CT and PET-r/o significant CAD and may serve as gatekeeper to cath lab
- CMR is test of choice
- BUT….Does FFR = functional testing?

Takx RAP et al, 2015
Circulation CV Img; 8: e002666

RELATIONSHIP BETWEEN CFR AND FFR



- CFR and FFR, even when discordance, reflect coronary physiology, not methodologic differences
- Discordance explained by relative contribution of focal, diffuse, and small-vessel disease.

CONCLUSIONS

- Echocardiography, SPECT, PET, CCTA, CMR, and ICA have substantial prognostic value
- COURAGE nuclear substudy and other image-guided trials support use on non-invasive testing to guide revascularization
- FFR-directed PCI leads to improved outcomes based on FAME, DEFER and FAME 2 trials
- iFR assessment may be preferable
- Non-invasive evaluation of FFR appears
- Determination of CFR provides assessment of more than just stenosis physiology, but ischemia at tissue level
- Increasing evidence for PET-CFR to predict outcomes and plan strategy
- FFR≠CFR, as different physiologic entities; use CFR to detect ischemia and FFR to determine candidacy for intervention?
- Guidelines support physiology-guided revascularization