Assessment Of Myocardial Viability

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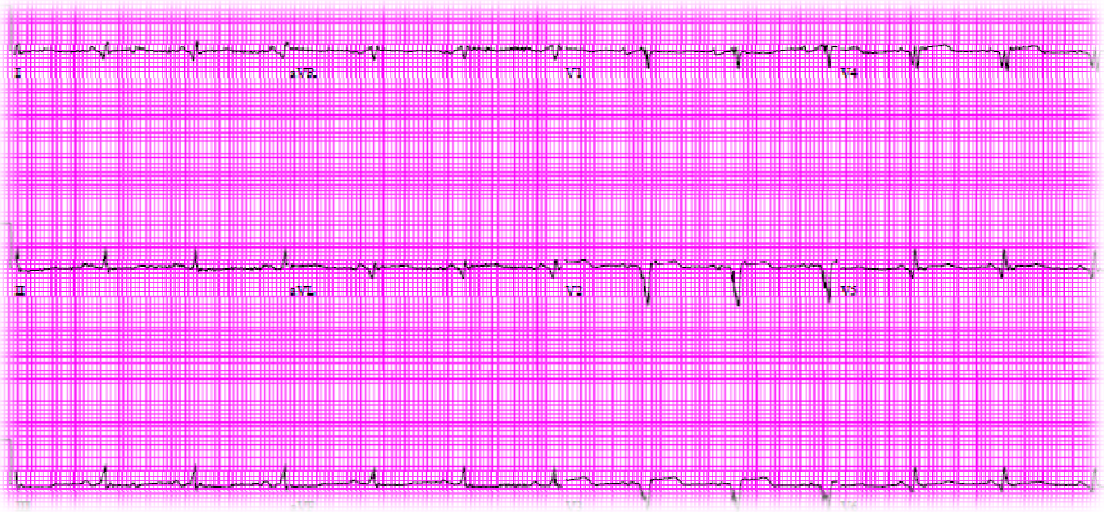
Typical Viability Scenario

- 55 year-old male with severe chest pain; dragged into hospital by wife after 1 day
- Cath: occluded LAD, low BP → balloon pump
- Bedside echo: EF 20%



Management Dilemna

- Balloon pump gradually weaned, but ongoing low-output symptoms
- Bypass surgery (CABG) is being considered to improve blood flow to hypocontractile myocardium

➢CMR ordered to assess viability . . .

Questions We Really Want Answered

- ***Will this patient do better with coronary revascularization?***
  - Relieving symptoms?
  - Do better with an ICD?
  - Experience improved long-term survival?

- ***Will this patient improve (prognosis and therapeutic benefit)?***
  - Improve LV function? Not have worsening LV function?
  - Respond to medical therapy?
  - Do better with an ICD?

Premise for Viability Imaging

- Sick myocardium is substrate for -
  - Heart failure
  - Arrhythmias
  - Cardiovascular death
- If myocardium can be restored to health (i.e. if viable), then outcomes *should* improve

What is myocardial viability?

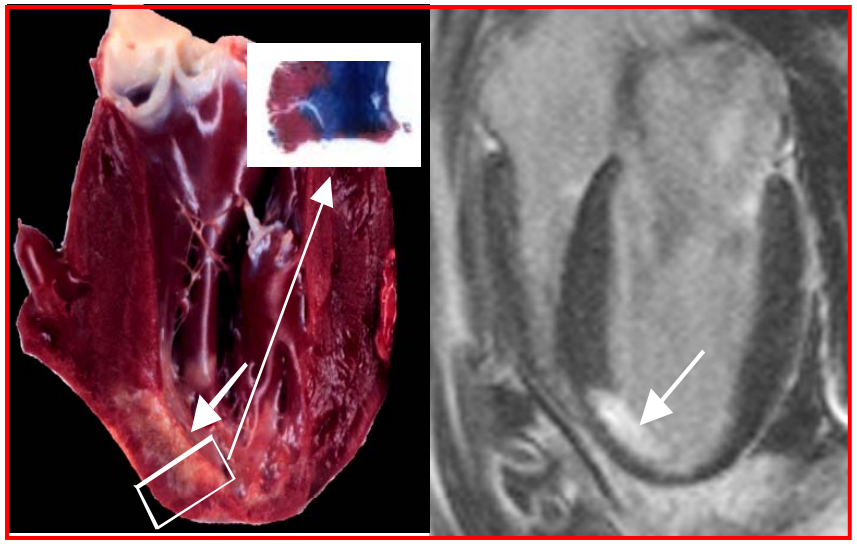
- **Absence of scar**: LGE-CMR
- **Integrity of cell membranes**: LGE-CMR, thallium scintigraphy
- **Metabolic activity**: FDG-PET
- **Demonstration of inotropic reserve**: dobutamine stress echo or CMR

- **Intact generation of high-energy phosphates**: P-MRS
- **Lack of sodium accumulation**: Na-MRS

*Evaluated in STICH Viability study

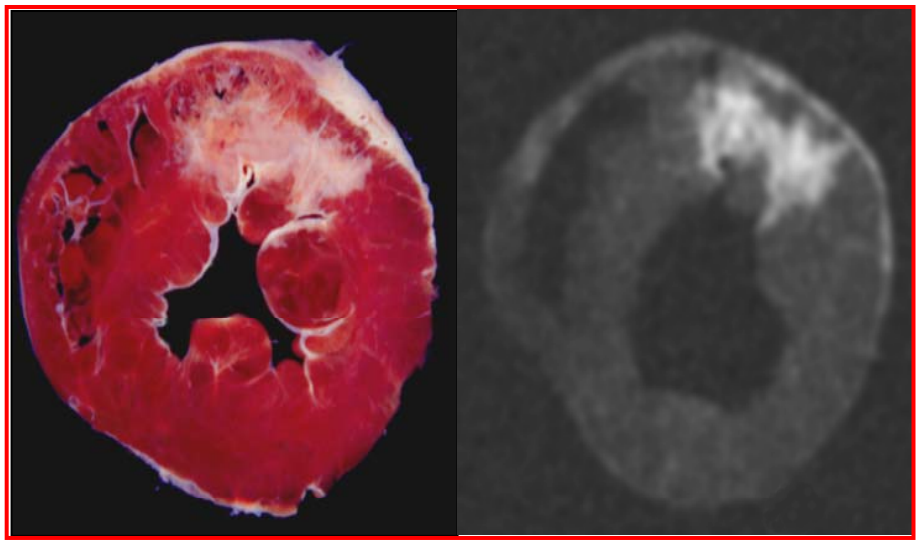
(1) CMR is validated against a pathologic reference standard

2 months



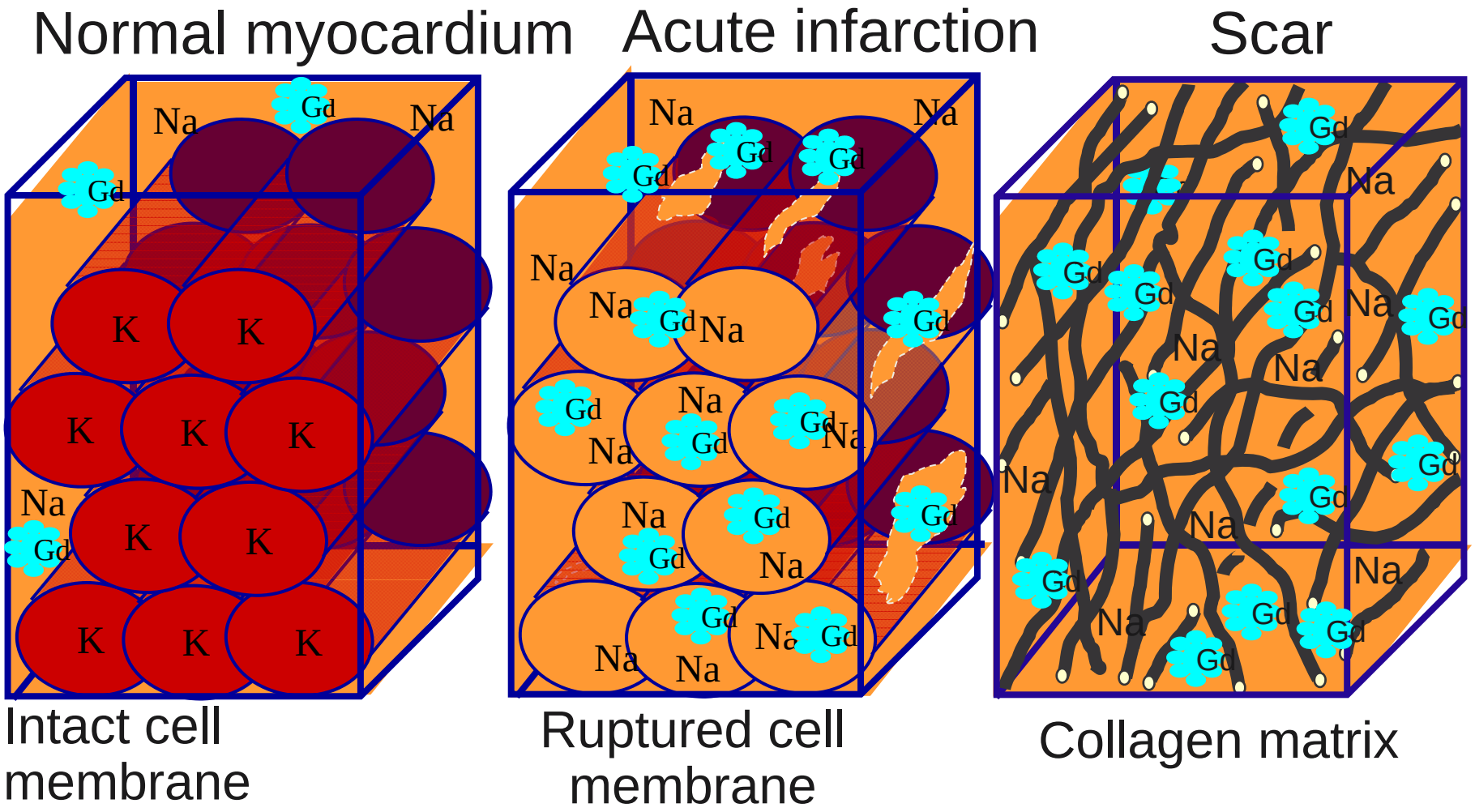
Circulation 1999;100:1992-2002

2 months



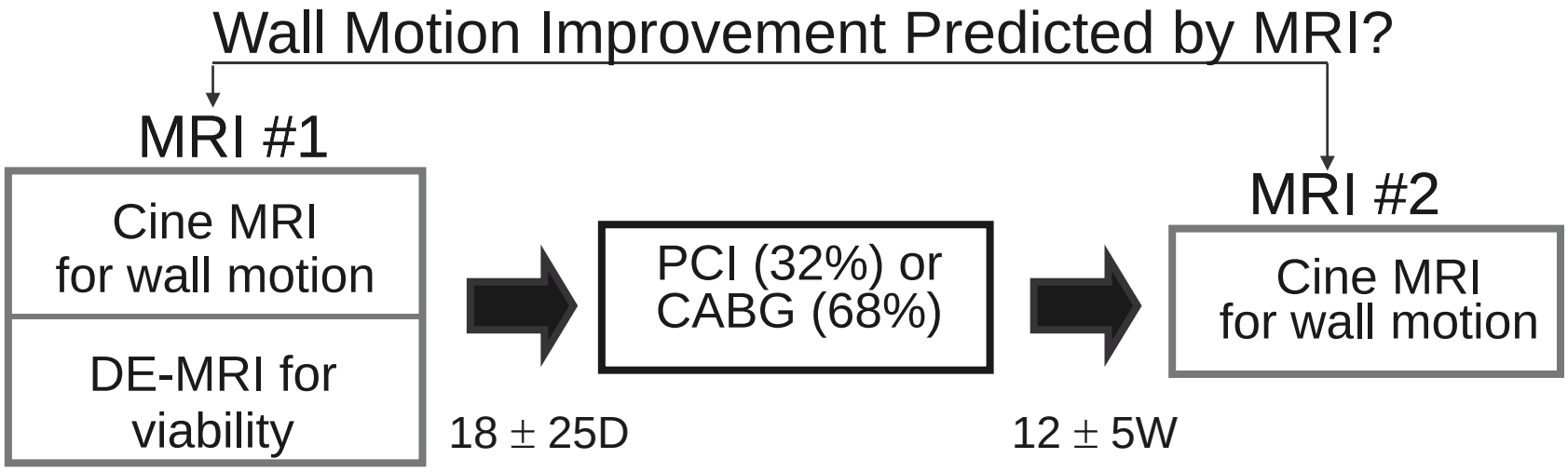
JACC 2000; 36:1985-1991

(2) CMR LGE depicts a logical stepwise pathophysiologic process

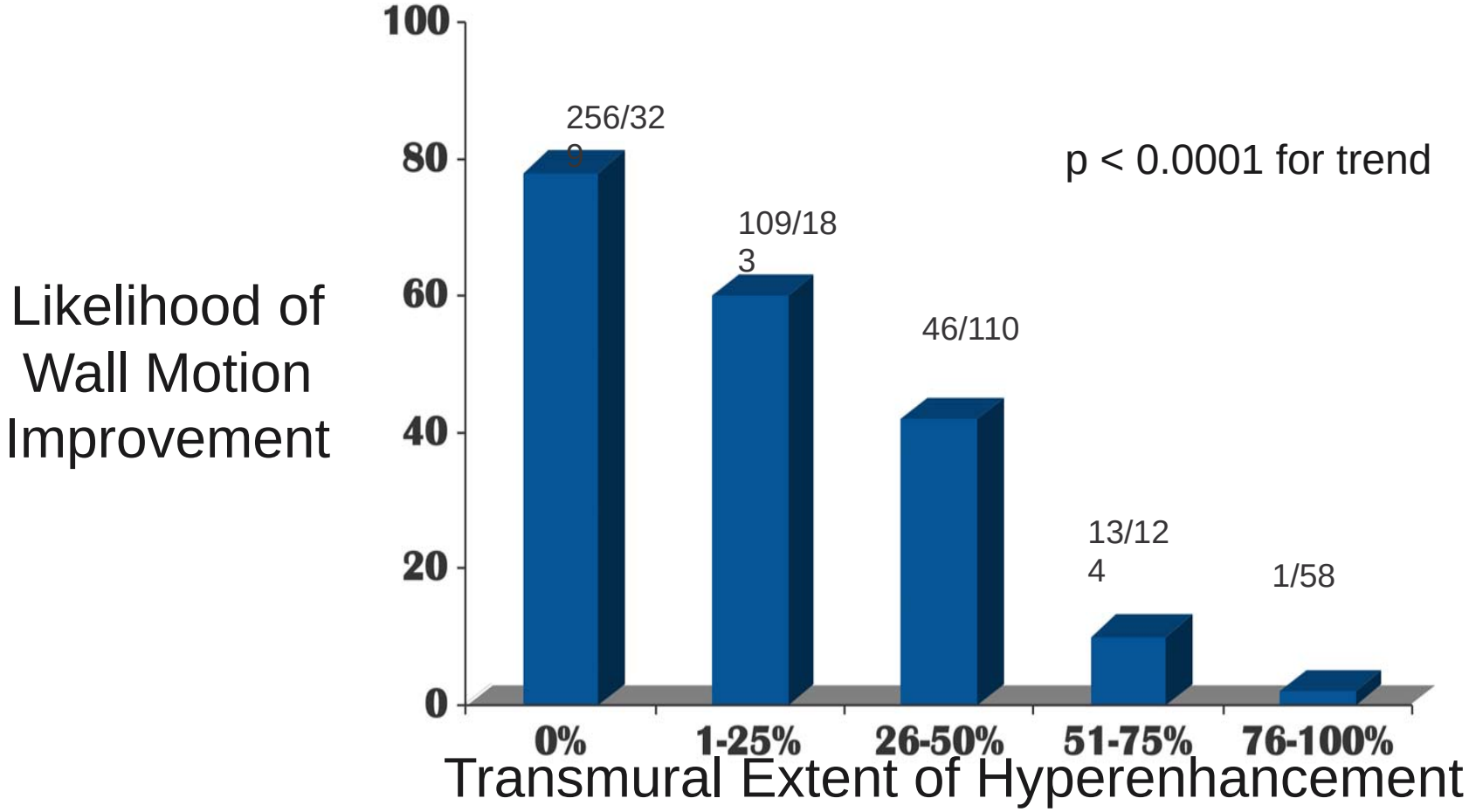


(3) Infarct Transmurality Predicts Revascularization Response

50 pts with LV dysfunction undergoing coronary revascularization (NEJM 2000;343:1445-53)



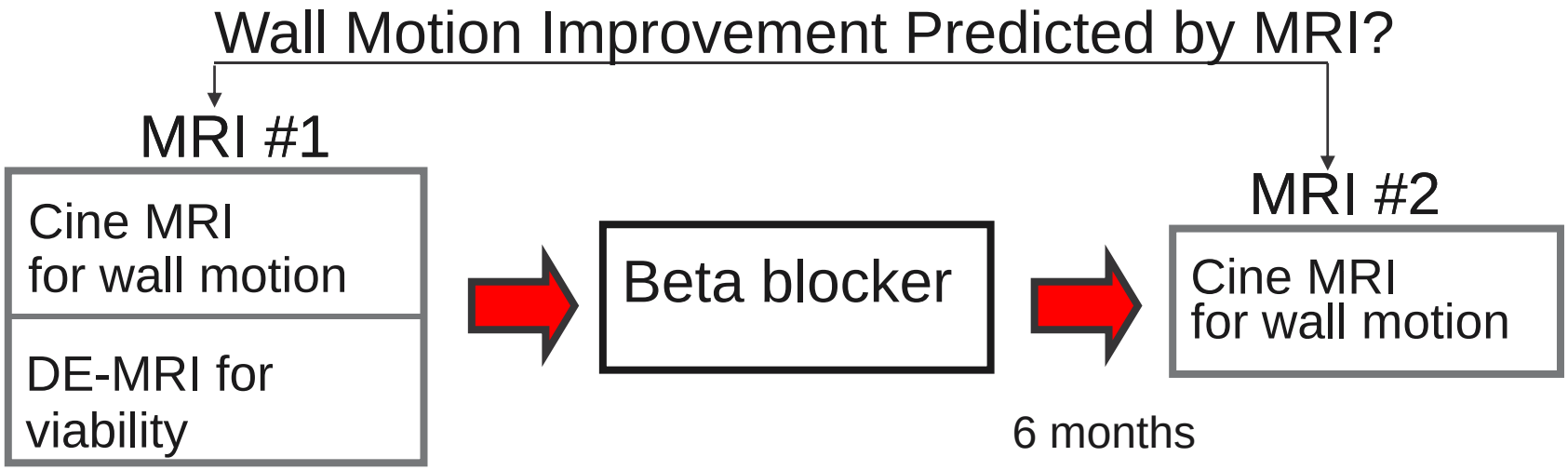
Prediction of Regional & Global Improvement



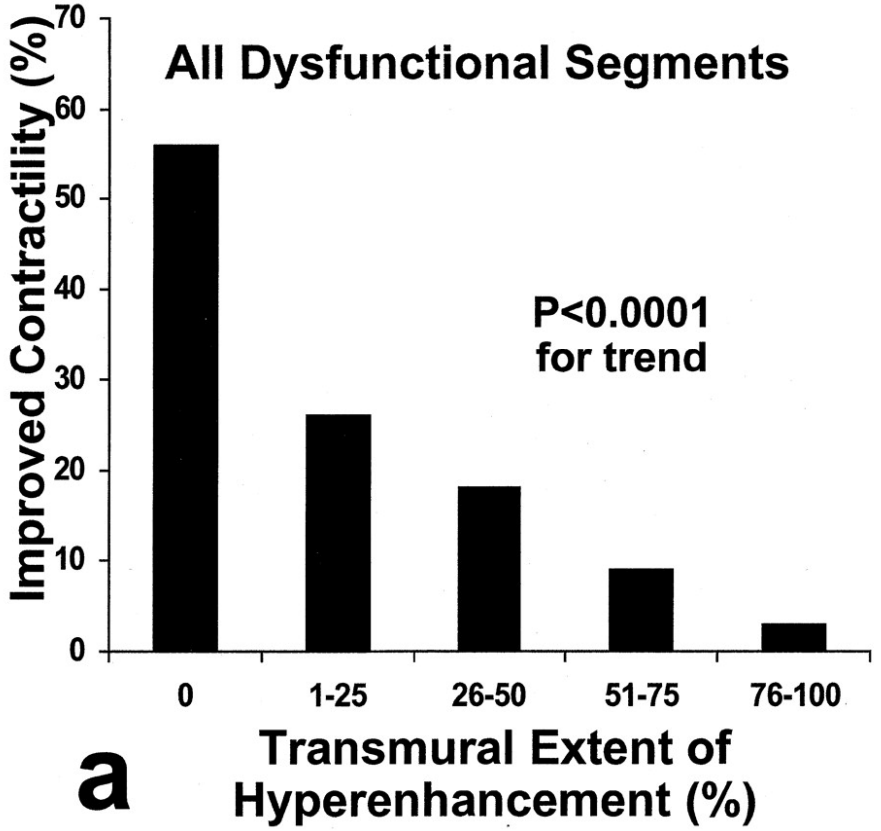
N Eng J Med 2000;343:1445-1453

(4) Infarct Transmurality Predicts Therapeutic Response

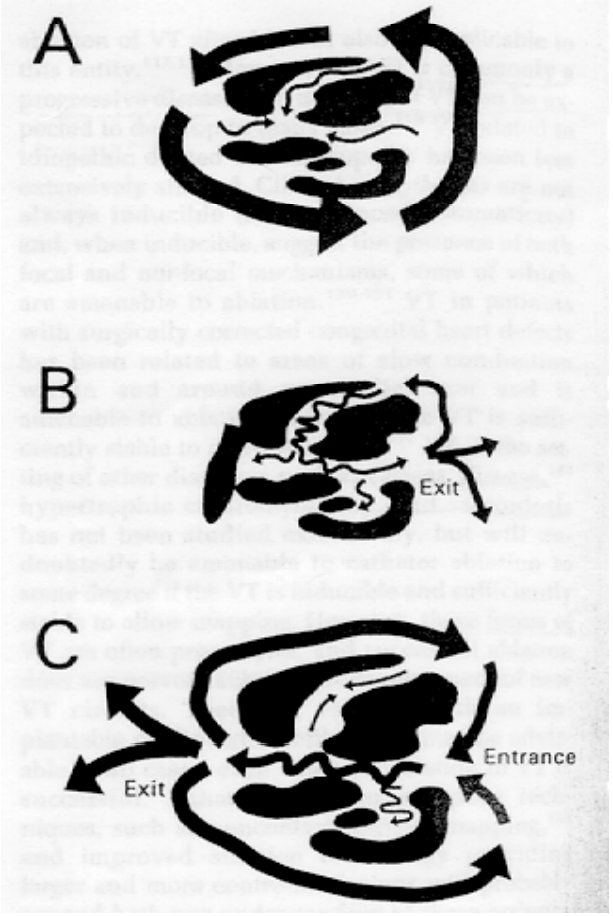
35 pts with LV dysfunction undergoing initiation of beta blocker therapy (62% CAD, NYHA II – III) Circ 2003; 108:1945-53



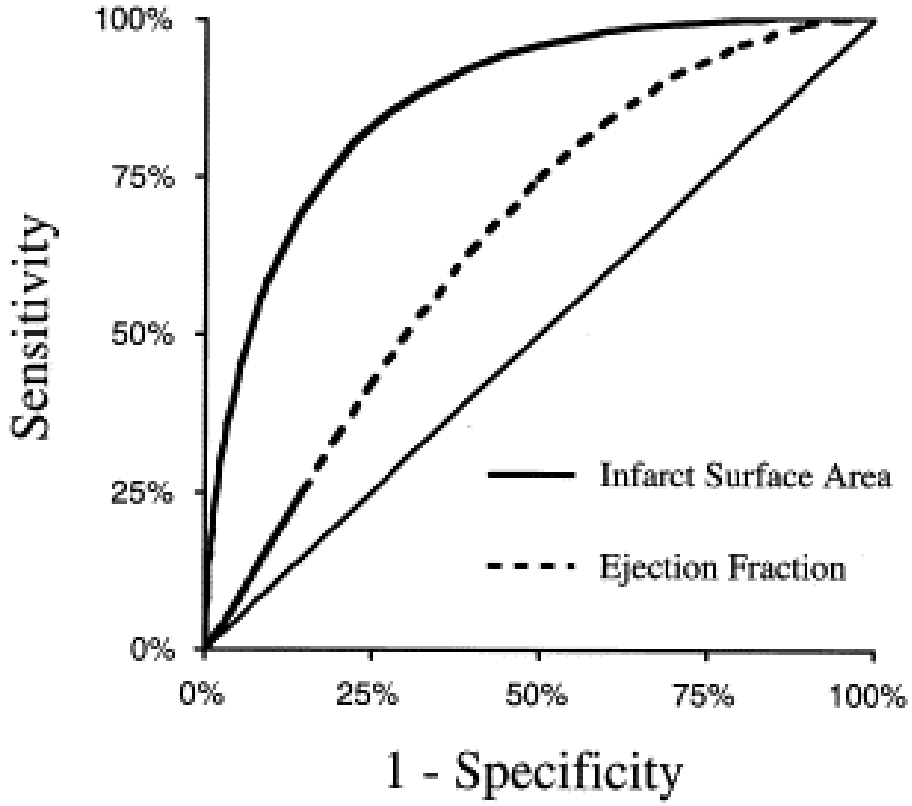
Relation Between Transmural Extent of Scar and Contractile Improvement after Beta-Blocker Therapy



(5) Infarct Surface Area by CMR Better Predicts VT Inducibility than LVEF

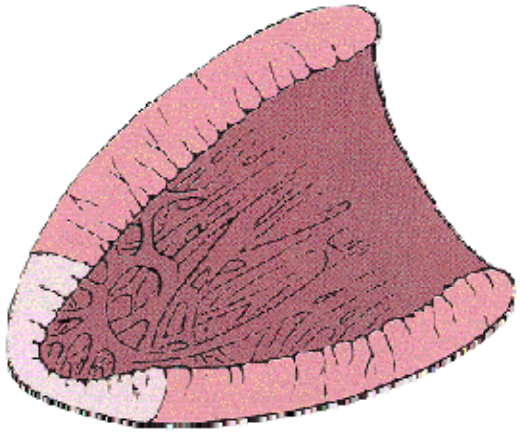


Stevenson WG. JCE 1995.

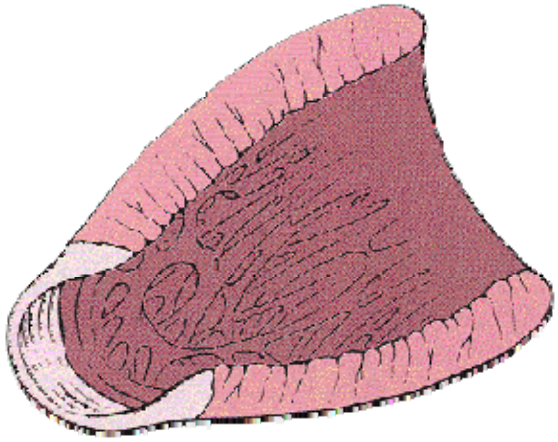


Bello D *et al*. JACC 2005.

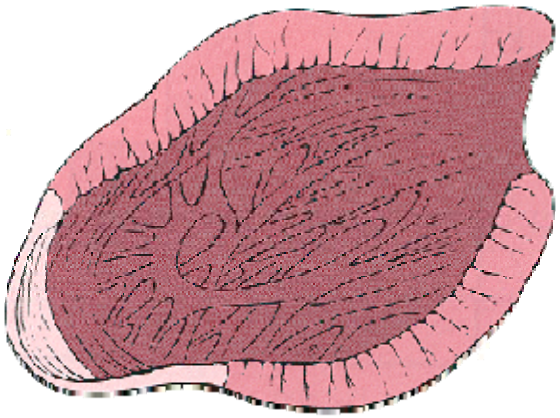
(6) Scar is Substrate for Adverse Post-MI Remodeling



acute MI (hours)



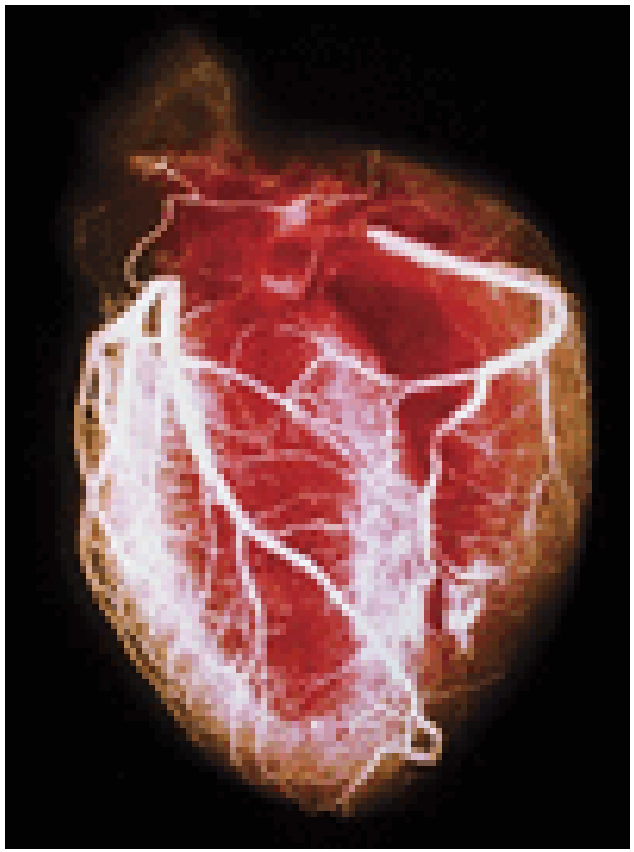
infarct expansion
(hrs to days)

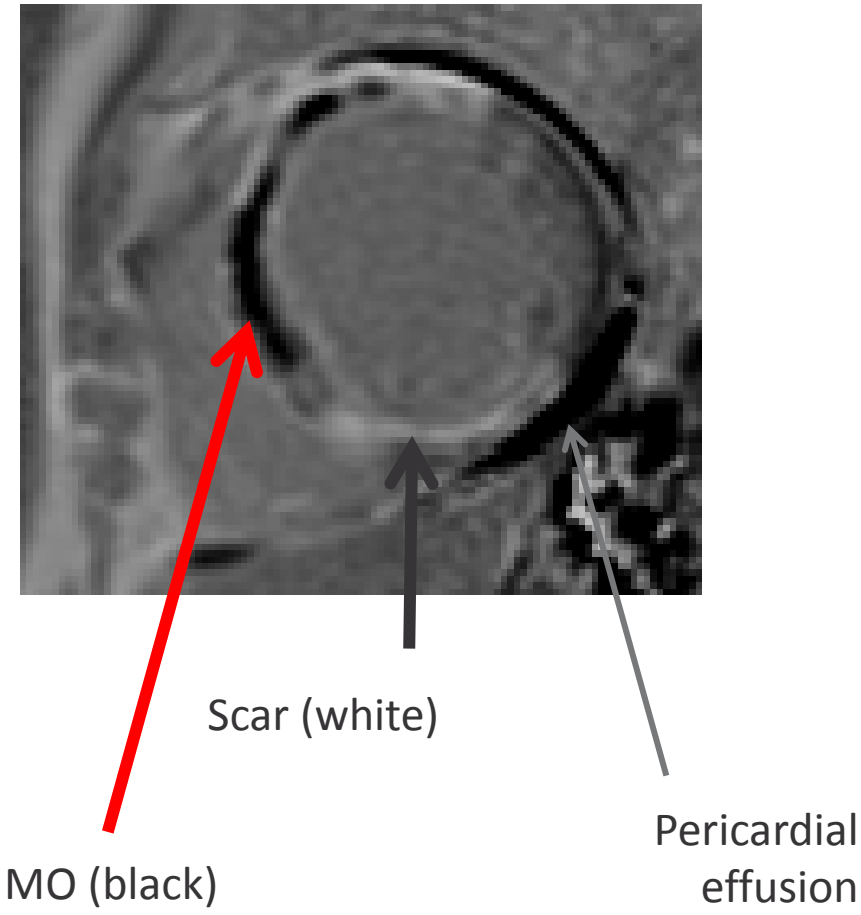


global remodeling
(days to months)

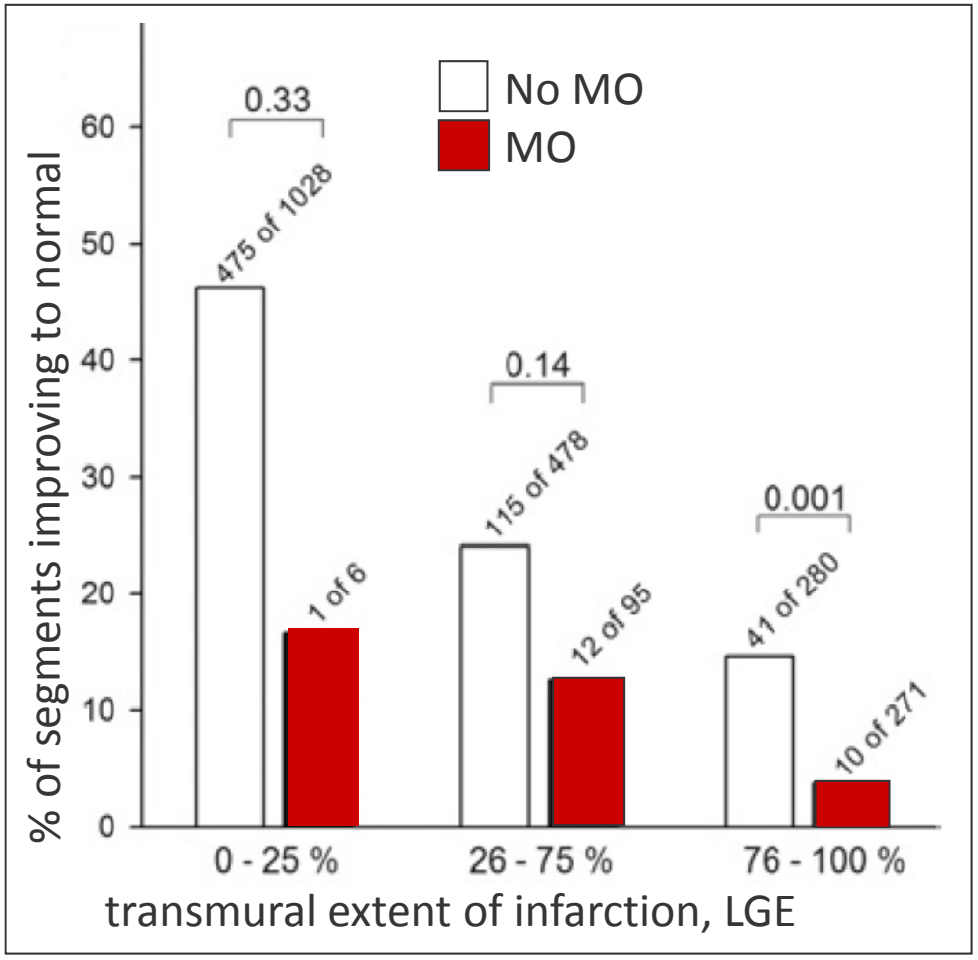
(7) CMR Evaluates Effects on Coronary Microcirculation

- Essential for delivery of substrates/O_2 & washout of metabolites



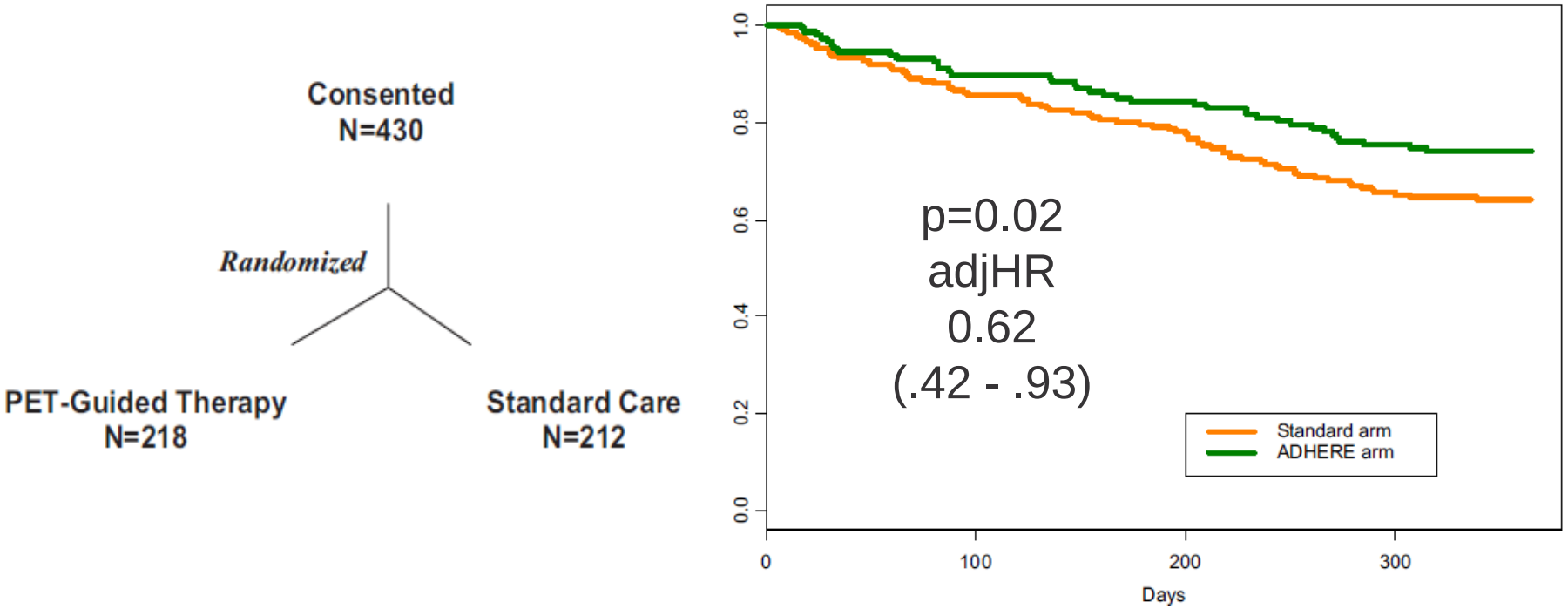


MO and Recovery of Function Post-MI



Nijveldt R *et al*. JACC 2008.

(8) Does Viability Imaging Improve Outcomes?



Significant reduction in cardiac events w/FDG-PET ***if*** management adhered to PET recommendations

Beanlands R *et al.* JACC 2007.

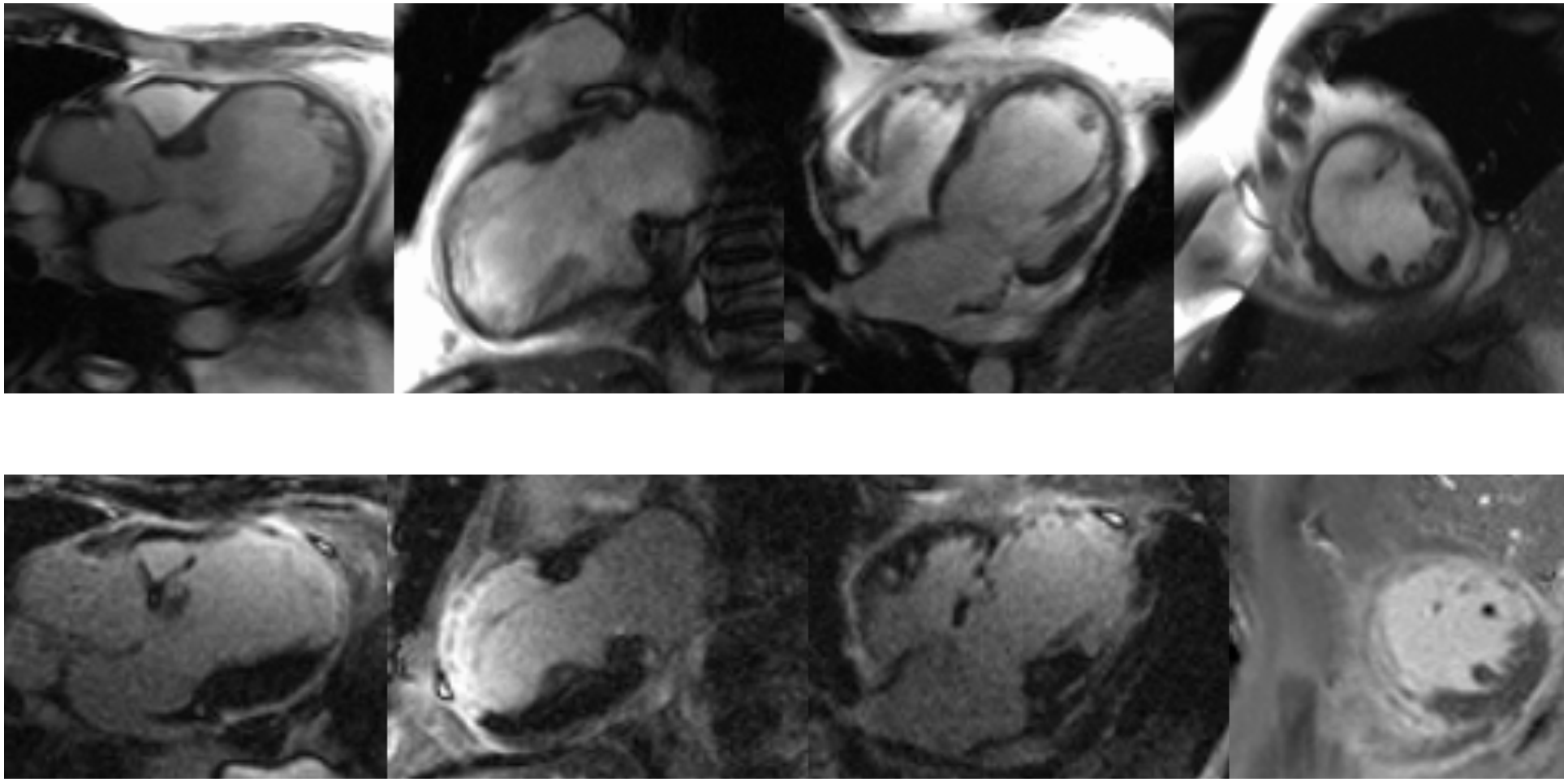
Who Got a Viability Study in STICH?

- Caucasians (82% vs. 54%) [Fewer Asians (5% vs. 30%)]
- Atrial fib / flutter (15% vs. 10%)
- Better Med Tx (higher rates of beta-blocker, ACEI, statin, ASA use)
- No CMR viability data available

Back to Our Patient…

- 55 y/o male with recent MI; occluded LAD
- LGE-CMR ordered for viability assessment

Our Patient…



No viability in LAD territory

→ Left ventricular assist device → transplantation

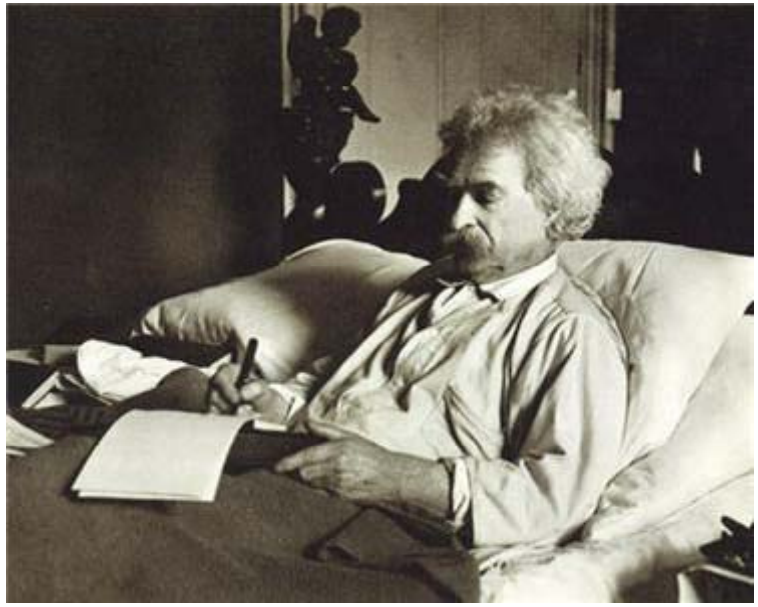
Utility of CMR for Viability Imaging

- Direct relation with pathology
- Accurate imaging of infarct size/ viability
- Predicts functional response to revascularization
- Incremental utility vs. PET/ SPECT
- Targets therapeutic approaches to CM
- Identifies at-risk arrhythmogenic patients
- Examines effects of MI on coronary microcirculation

Thank you.

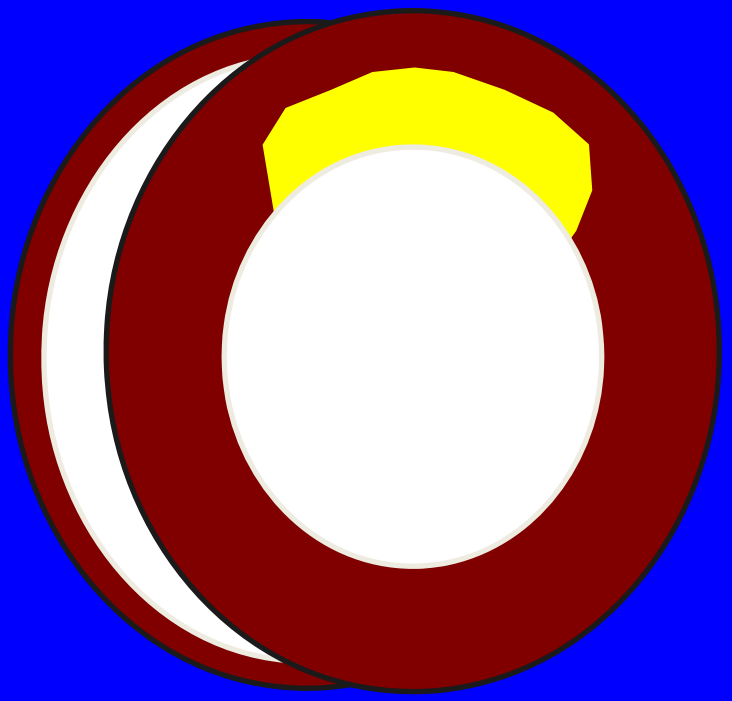
The Reports of Viability Imaging's Death are Greatly Exaggerated…

- Randomization is key
- Multiple modalities need to be compared
- Management decisions based on viability should be standardized



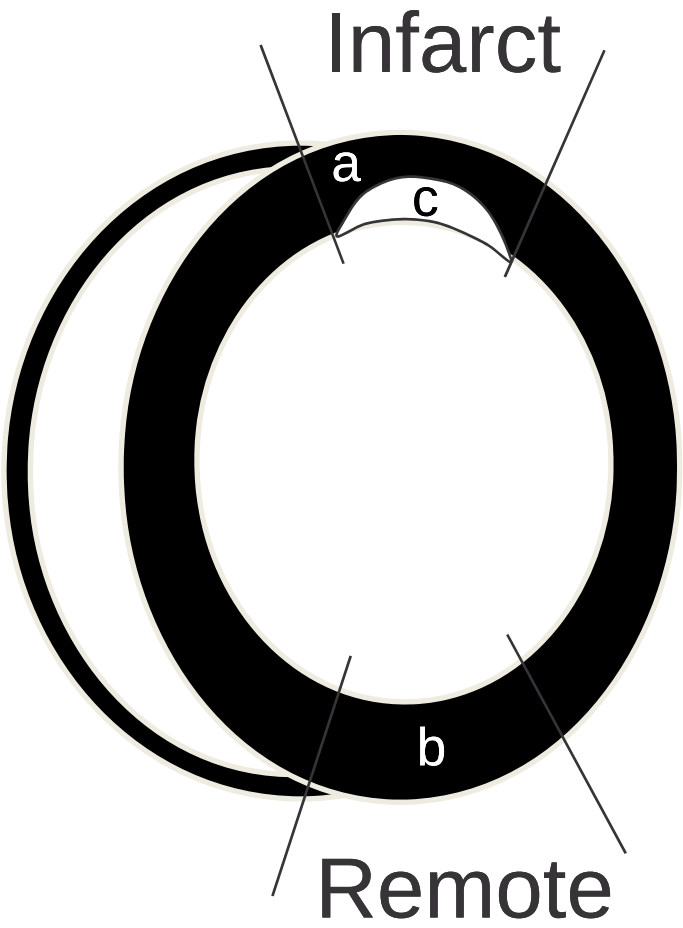
Clinical Definition of Viability

Ideal Imaging Method



QUESTION:
Is the anterior wall viable or not viable?

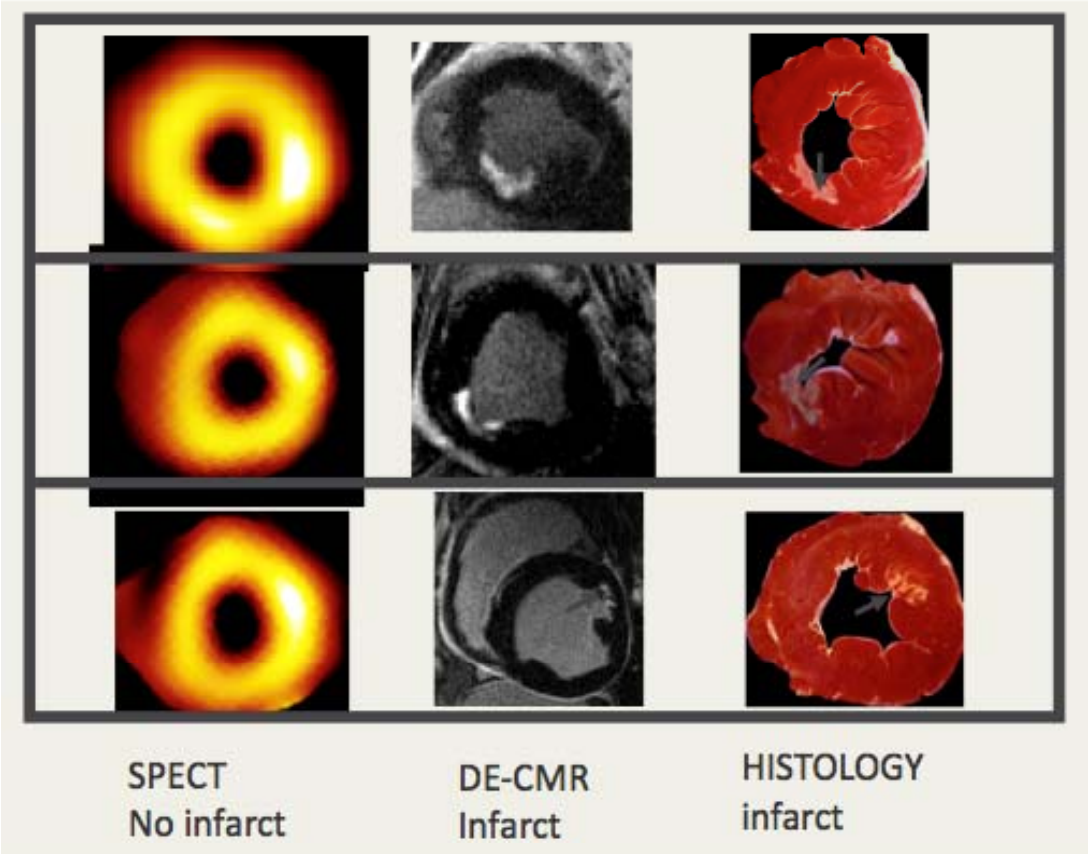
Definition of Viability



MRI: $\frac{a}{a+c}$

SPECT: $\frac{a}{b}$

Limited Spatial Resolution (Partial volume effects)



- If <50% of counts of remote region → Fixed (Infarct) by SPECT

- If <50% myocardium involved → No Infarct by SPECT

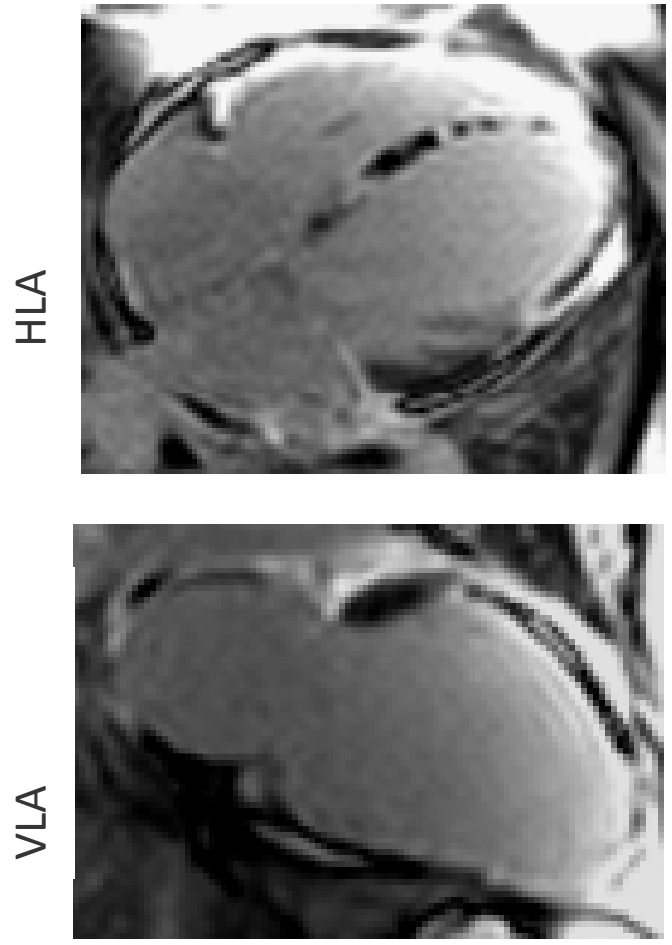
Lancet 2003; 361:374 - 9

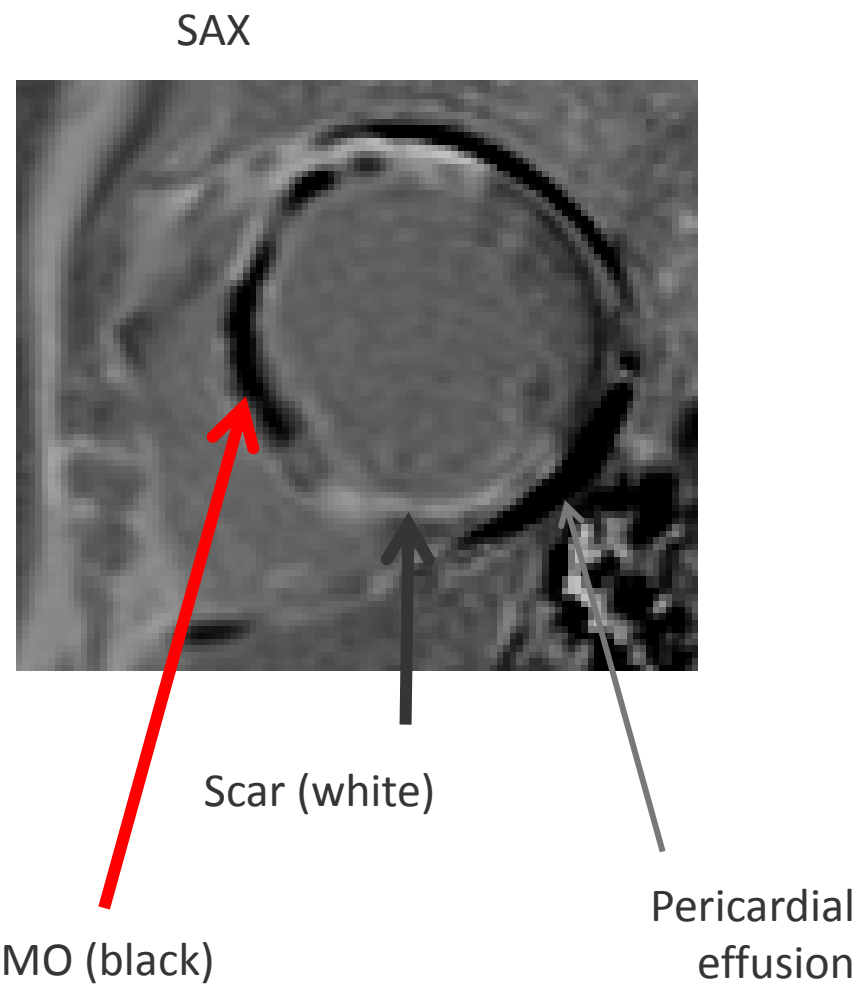
Infarct Morphology is Importan

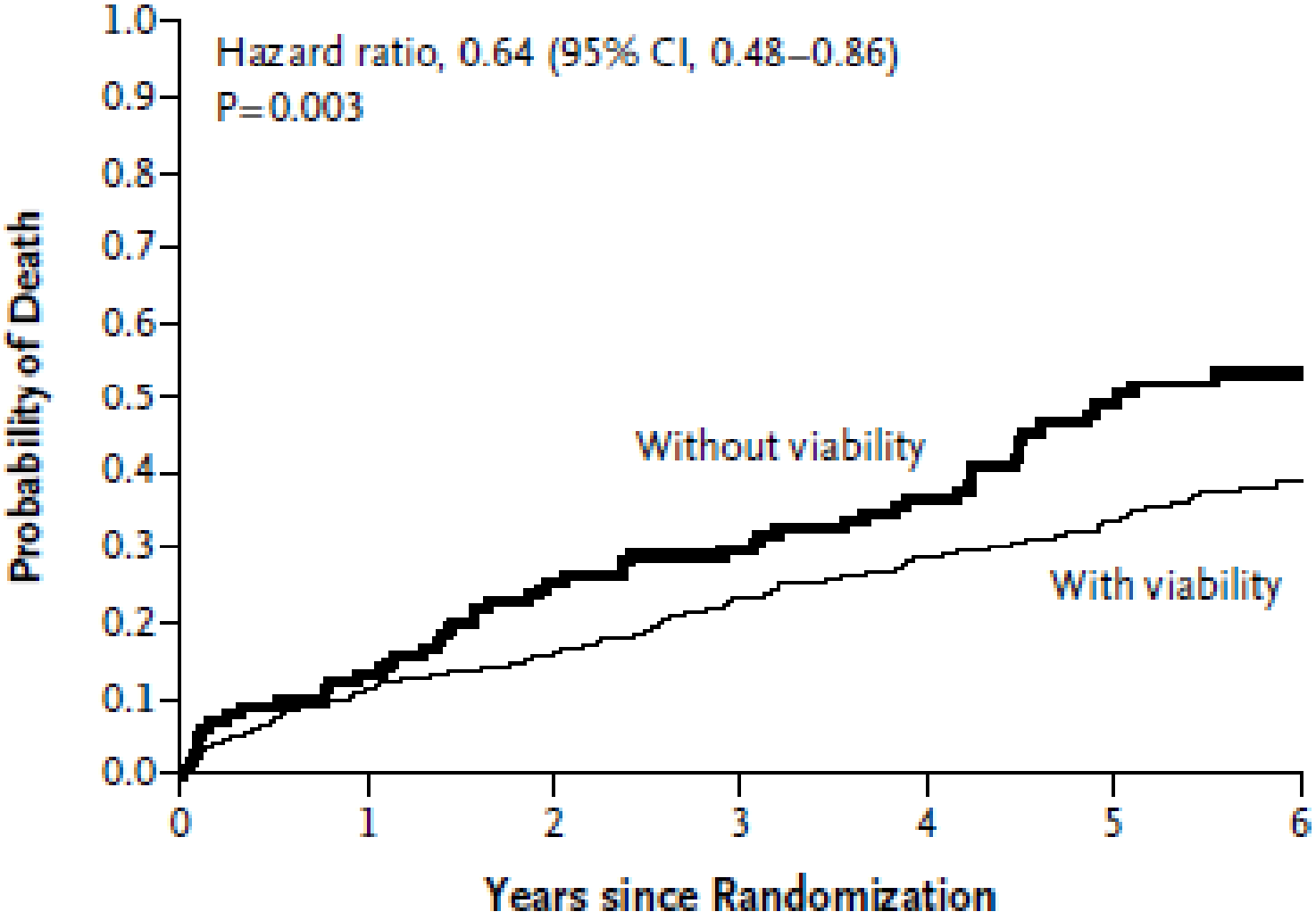
- Transmural extent of infarct predicts functional response

- DE-MRI is uniquely capable of imaging transmural extent of infarct

Microvascular Obstruction by LGE-CMR







You're worse off without viability

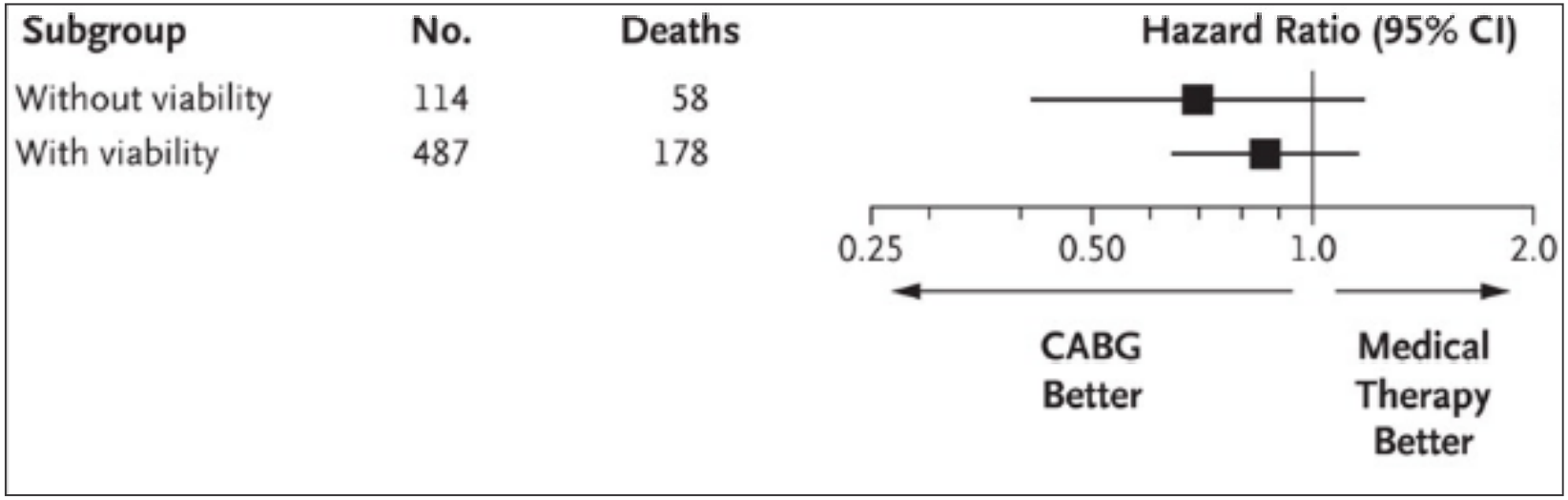
Case: 46 y/o Caucasian Man

- **Chest pain**: Atypical chest pain prompted CT angiogram at OSH
  - Reported to have left main dissection
  - High-grade stenosis in LAD
  - Other coronaries reported as “moderate”
  - Now CP-free

- Self-refers to 2 cardiologists for 2nd and 3rd opinion
  - Coronary CT angiogram re-reviewed

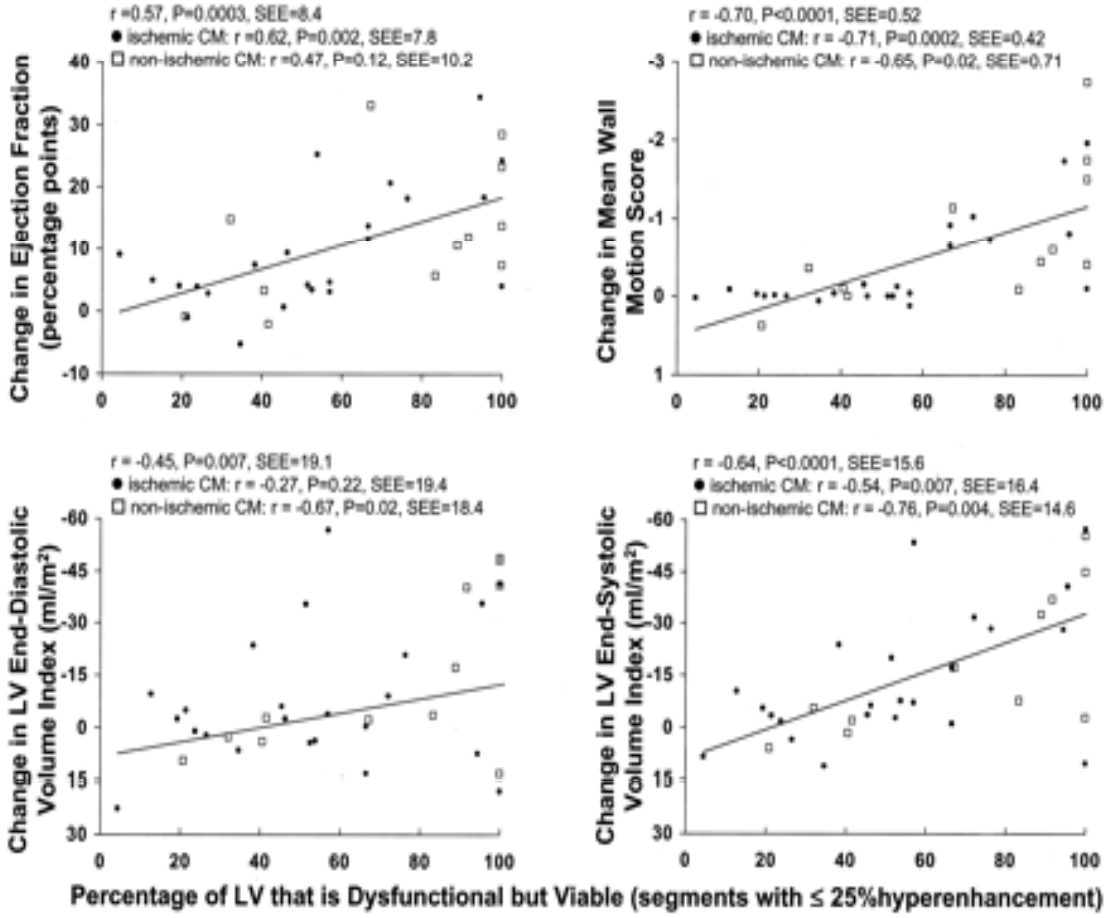
STICH-Viability Trial

- 1,212 patients underwent physician-directed viability testing with SPECT or dobutamine echo
- 601 with usable test results

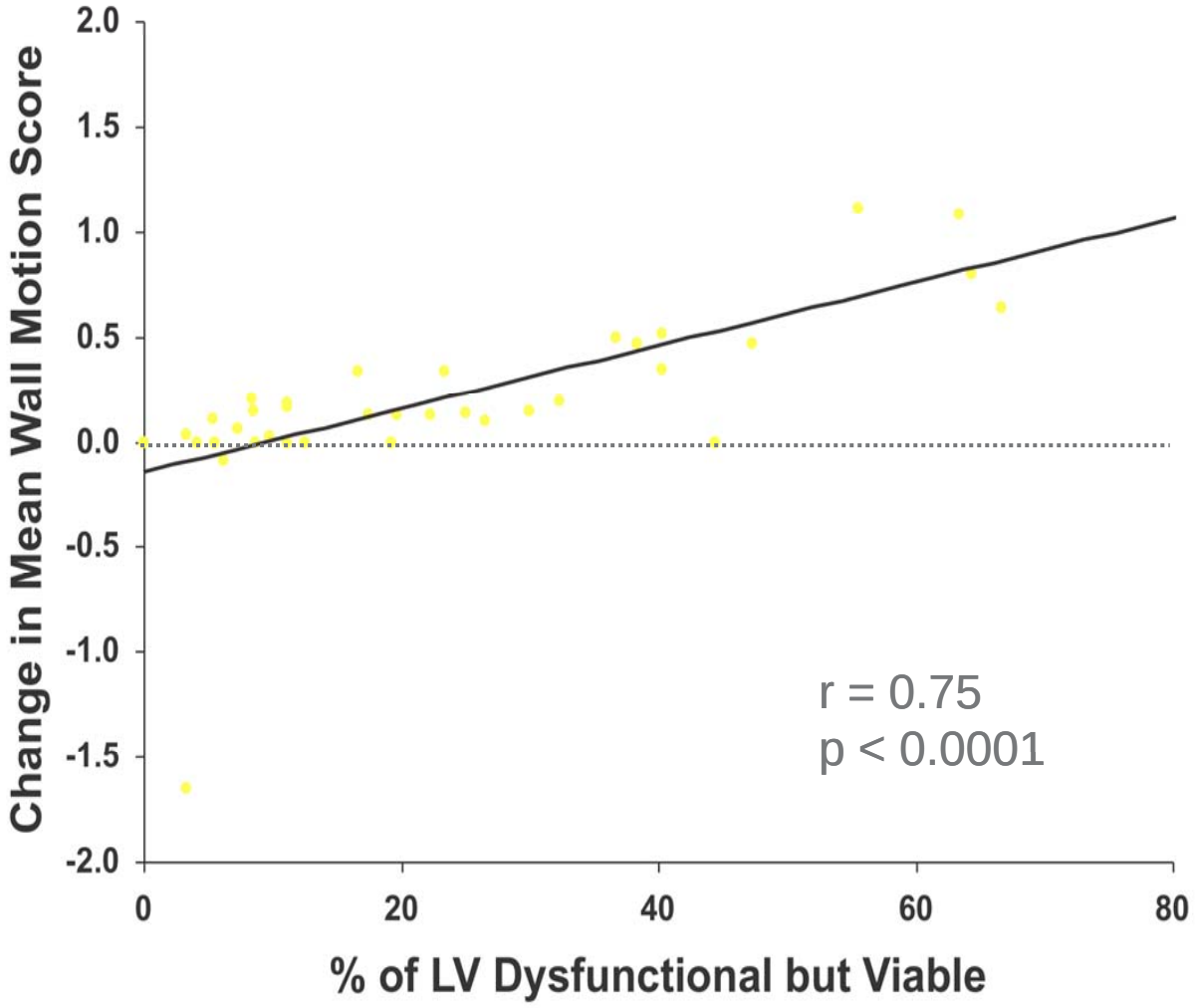


Bonow RO *et al.* NEJM 2011.

Relation Between Transmural Extent of Scar and Contractile Improvement after Beta-Blocker Therapy



Prediction of Global Improvement

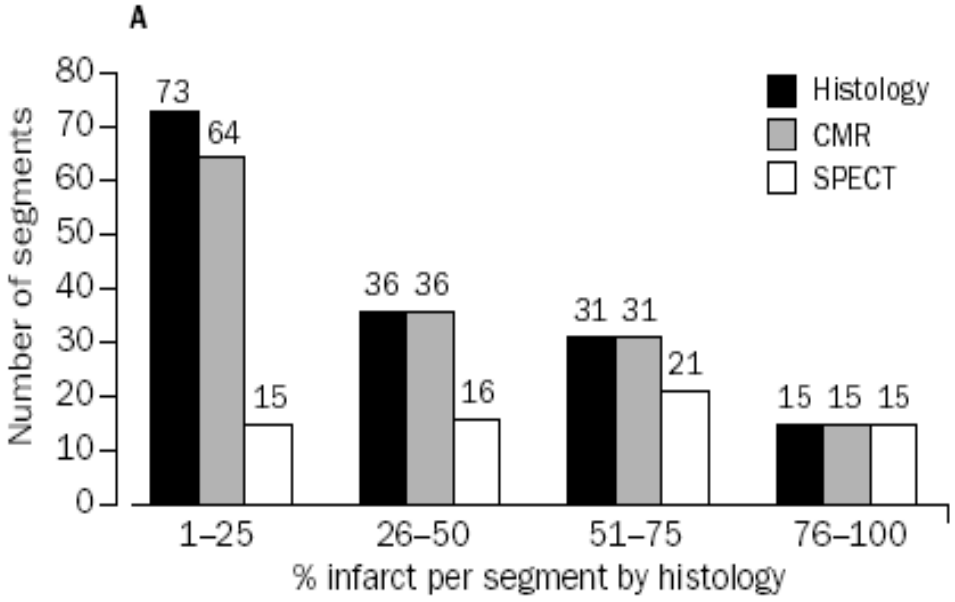


N Engl J Med
2000;343:1445-1453

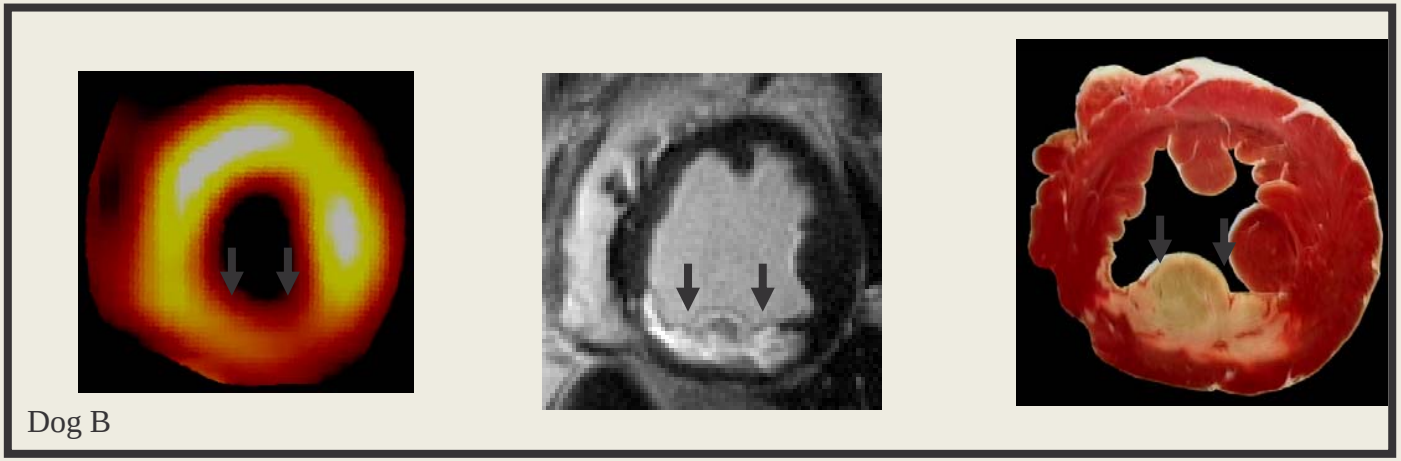
Contrast-enhanced MRI and routine single photon emission computed tomography (SPECT) perfusion imaging for detection of subendocardial myocardial infarcts: an imaging study

THE LANCET • Vol 361 • February 1, 2003 • www.thelancet.com

- 5 dogs with CMR and SPECT prior to sacrifice
- Pathology infarct verification



Lancet 2003; 361:374 - 9

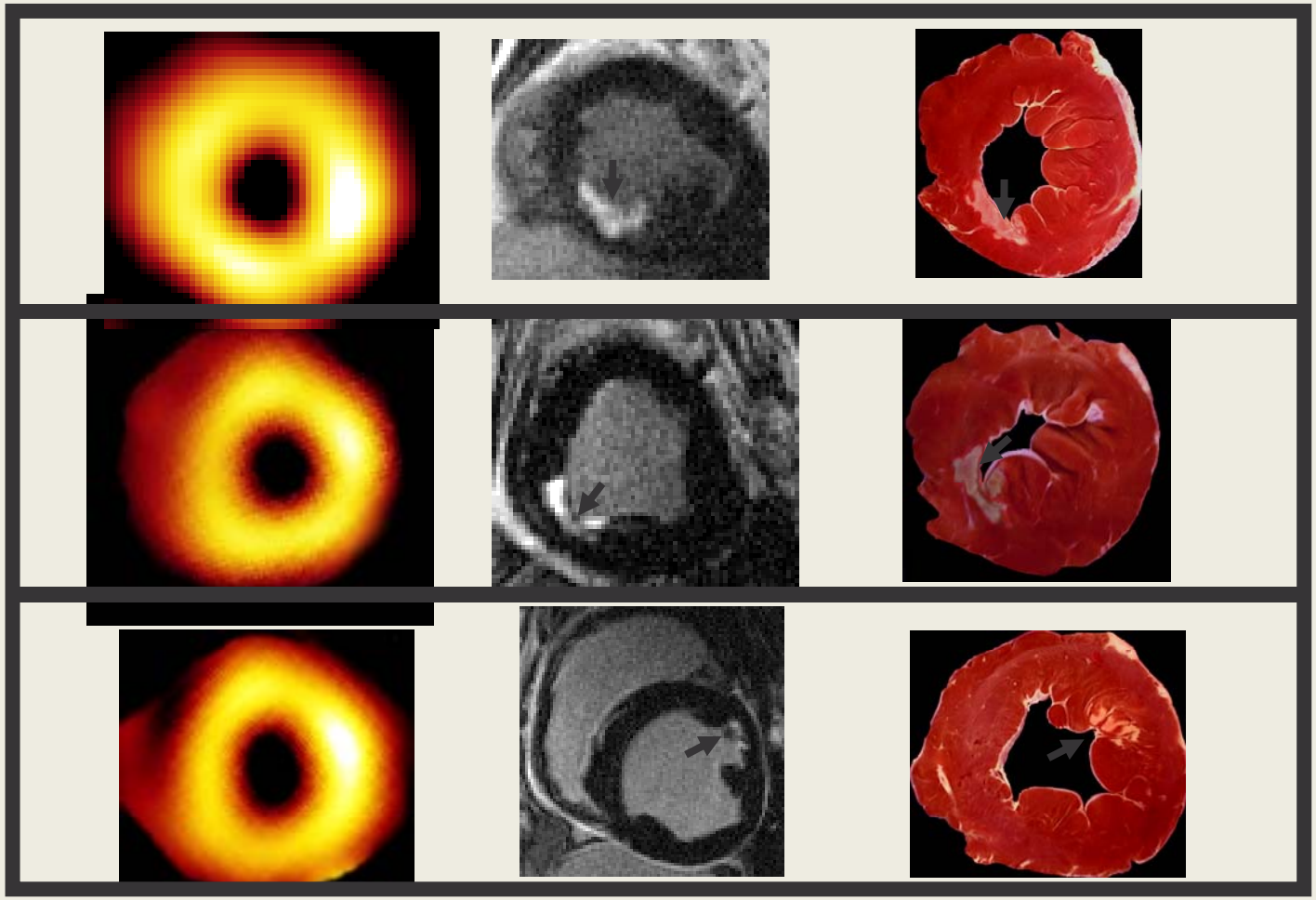


SPECT
infarct

DE-CMR
infarct

HISTOLOGY
infarct

Lancet 2003;361:374-79

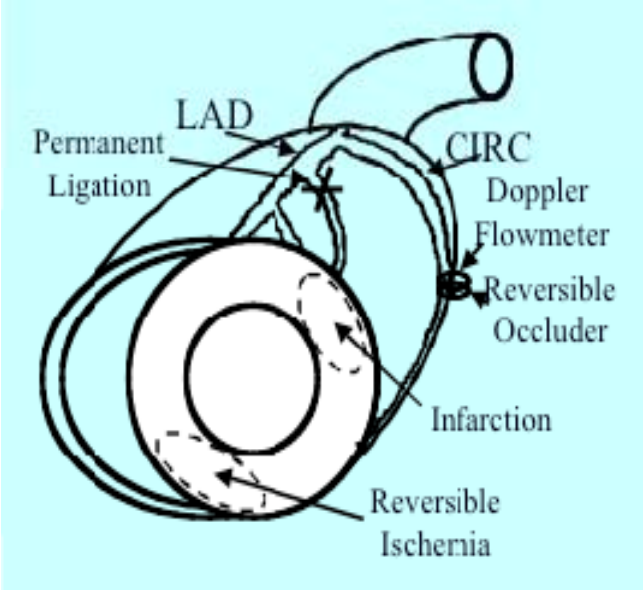


SPECT
No infarct

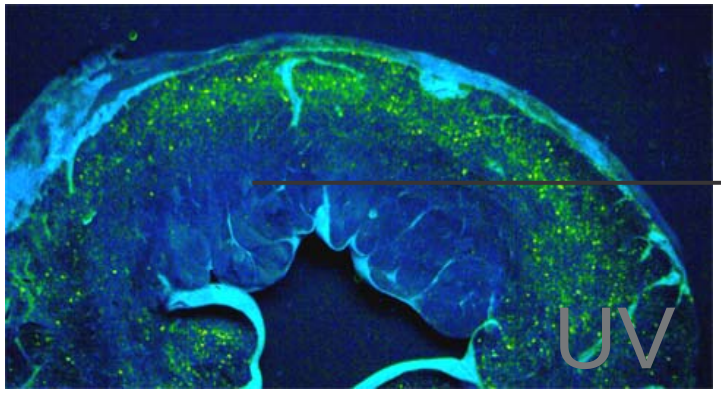
DE-CMR
Infarct

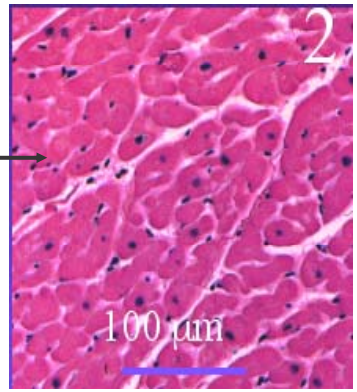
HISTOLOGY
infarct

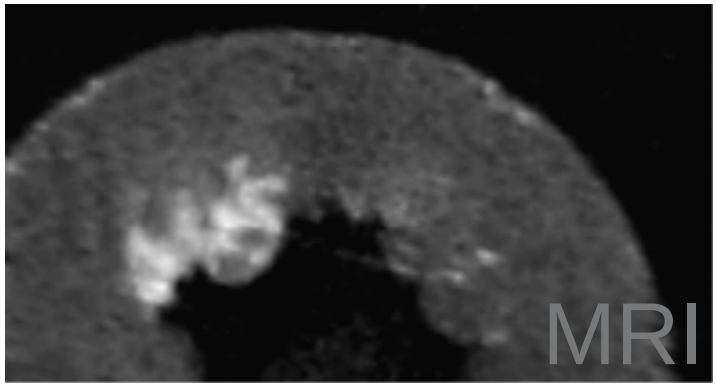
Myocyte Necrosis = Hyperenhancement



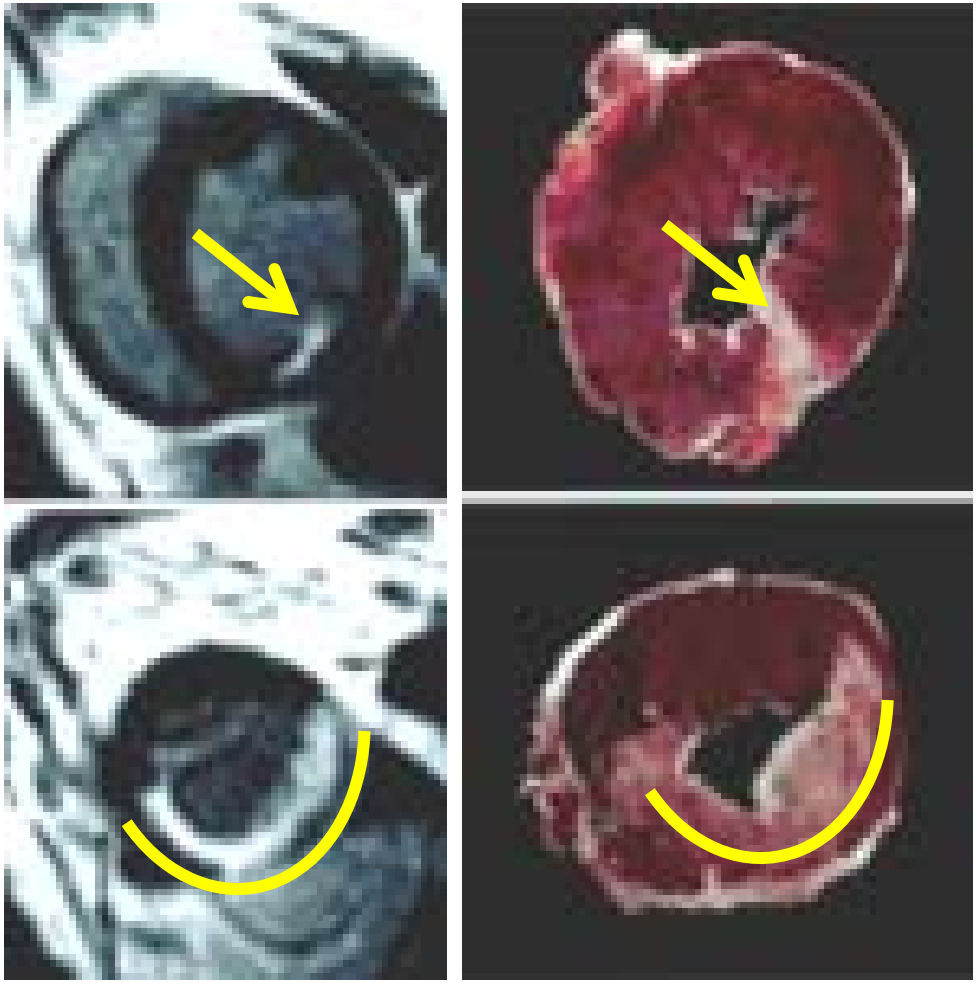
JACC 2000; 36:1985 - 91







Late Gadolinium Enhancement (LGE)

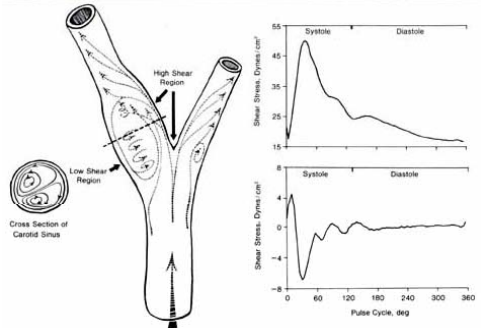


Kim RJ *et al.* Circ 1999.

Thank you.

(4) Understanding of Atherosclerotic Adaptive Mechanisms, 1980s to Present

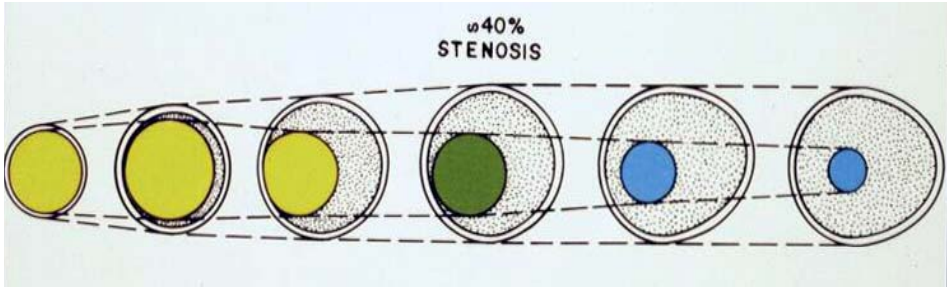
- Plaque localization
- Artery wall adaptive responses
- Shear stress regulation of artery size
- Atherosclerotic plaque evolution
- Autoregulation



Circ Res 53:502-514, 1983

COMPENSATORY ENLARGEMENT OF HUMAN ATHEROSCLEROTIC CORONARY ARTERIES

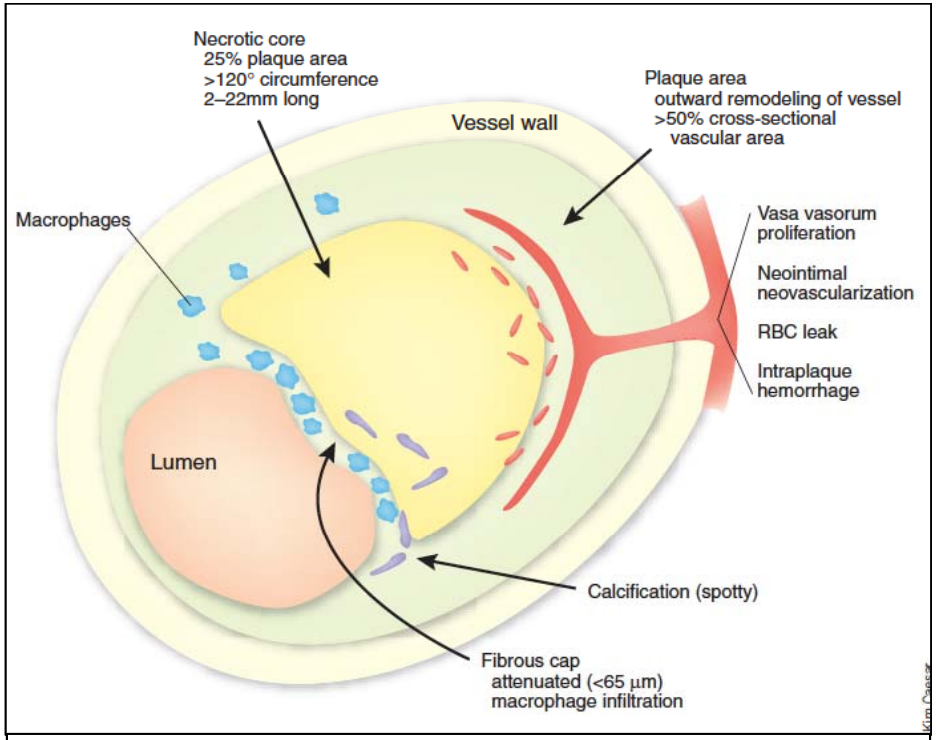
SEYMOUR GLAGOV, M.D., ELLIOT WEISENBERG, B.A., CHRISTOPHER K. ZARINS, M.D., REGINA STANKUNAVICIUS, M.P.H., AND GEORGE J. KOLETTIS, B.A.



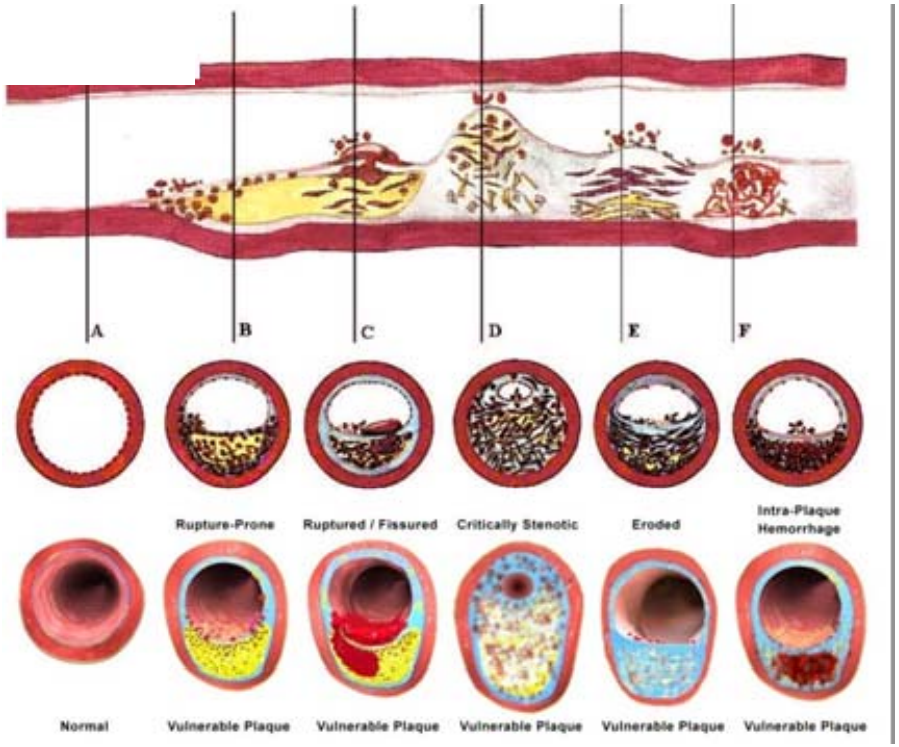
NEJM 1987

"Function Follows Form" Relationships

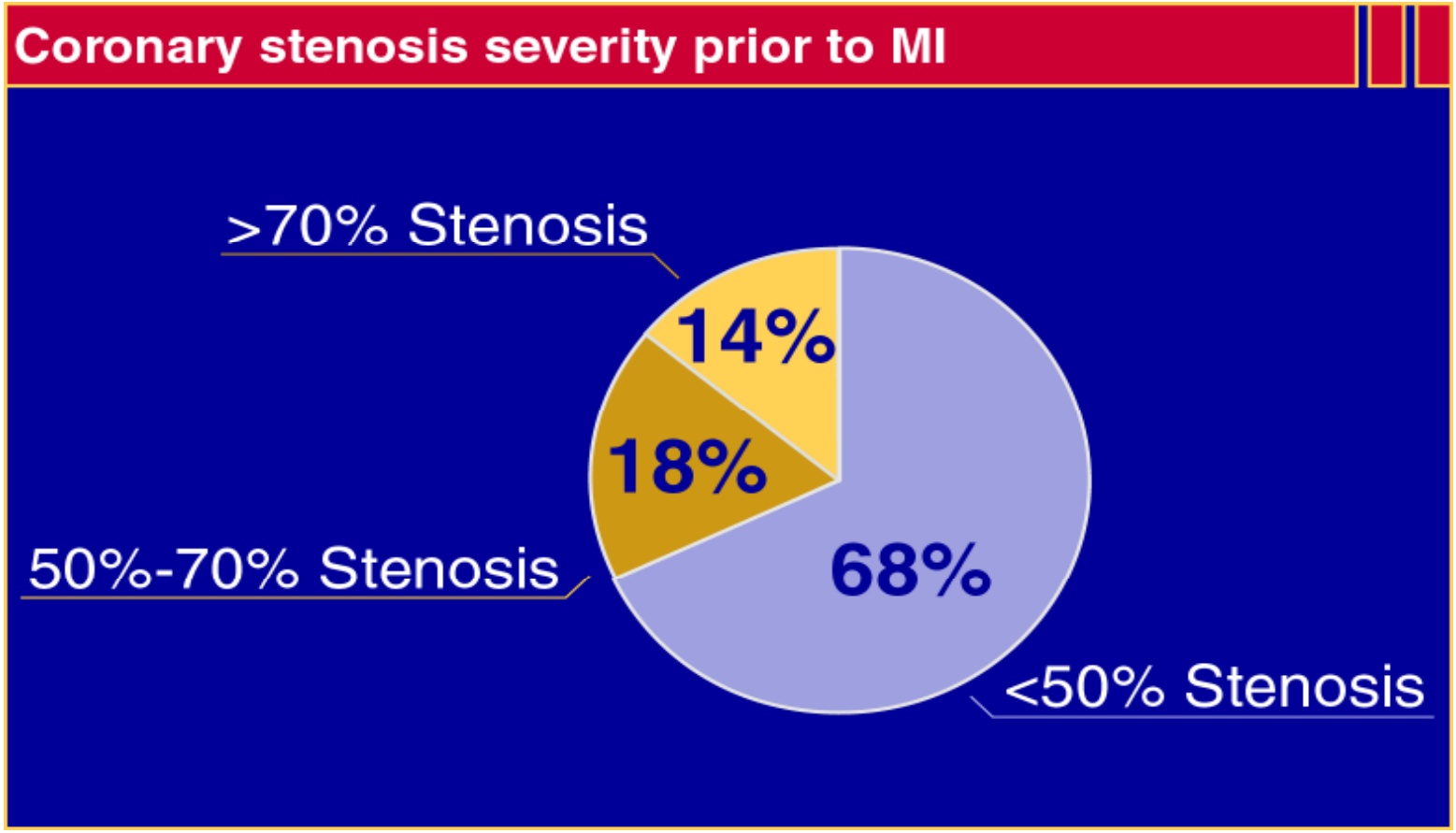
Vulnerable Plaque



Prototype high-risk plaque at risk of rupture.
(Narula and Strauss. Nature Medicine 2007.)



Most Myocardial Infarctions Are Caused by Low-Grade Stenoses

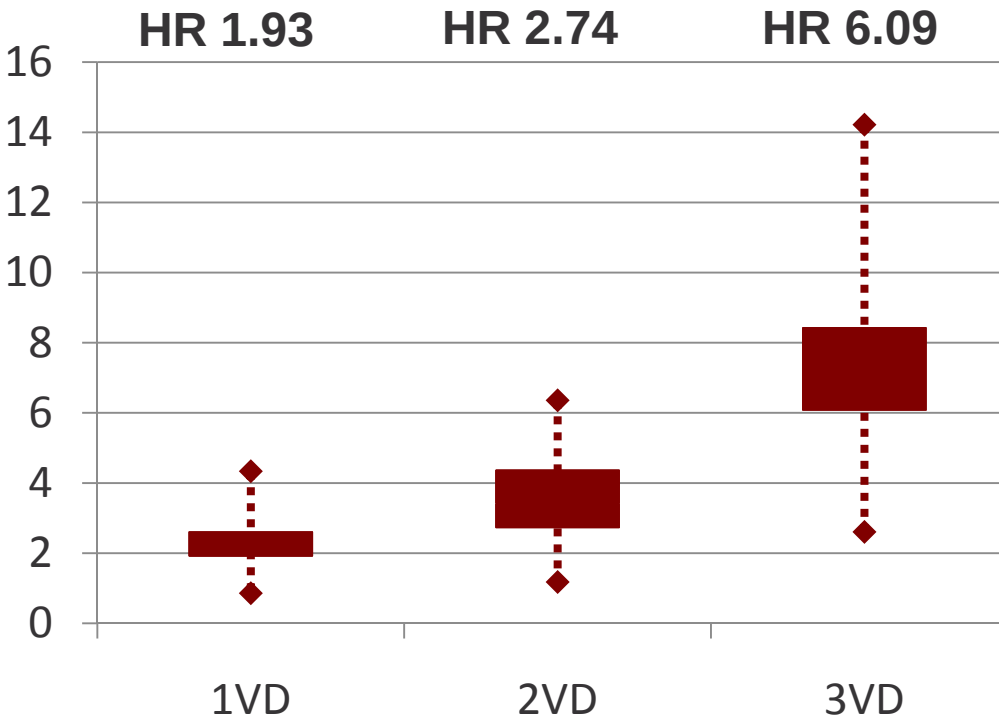


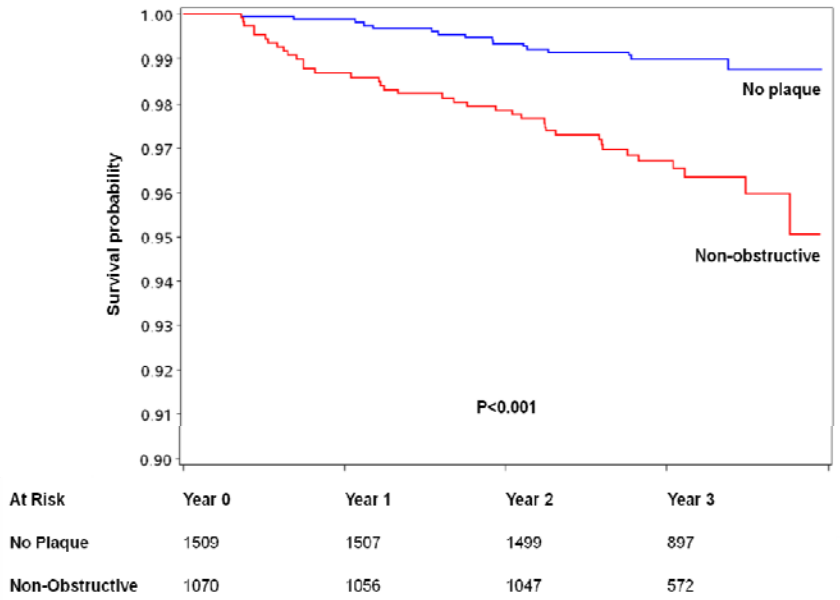
- In >50% of victims, the first symptom of asymptomatic atherosclerosis is sudden cardiac death or acute MI

Source: Pooled data from 4 studies: Ambrose et al, 1988; Little et al, 1988; Nobuyoshi et al, 1991; and Giroud et al, 1992. (Adapted from Falk et al.)

Mild Plaques Cause Adverse Events

2,583 patients undergoing CCTA with ≤50% stenosis followed for 3.1 years





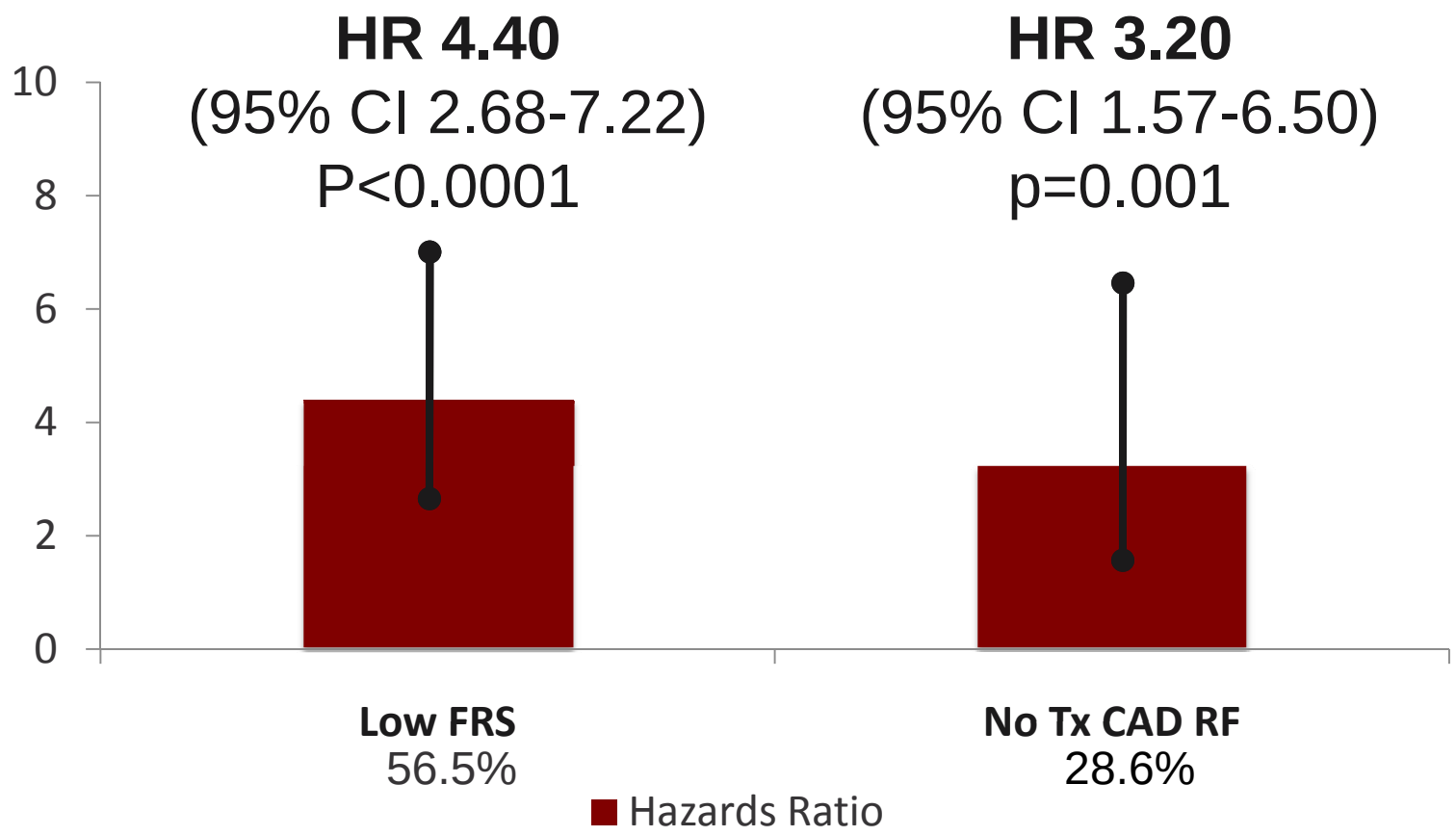
At Risk	Year 0	Year 1	Year 2	Year 3
No Plaque	1509	1507	1499	897
Non-Obstructive	1070	1056	1047	572

- >6-fold higher mortality for patients with 3-vessel mild CAD

Source: Lin et al., J Am Coll Cardiol 2011

Where do we go from here?

Increased hazards for ACM evident for those with low FRS and no medically modifiable risk factors



Medically Modifiable CAD RF = diabetes, dyslipidemia, hypertension

Source: Min et al. ACC 2011 Scientific Sessions 2011; Chow et al. AHA 2011