Imaging-Guided Myocardial Revascularization in HFrEF

The Role of Imaging Modalities in Optimizing Outcomes

DMSc, Ass.Prof., Yasmin Rustamova, FESC
Vice-President of Azerbaijan Society of Cardiology (2022-2023)
Heart Failure Specialist (Zurich,London)
Cardiac İmaging Specialist
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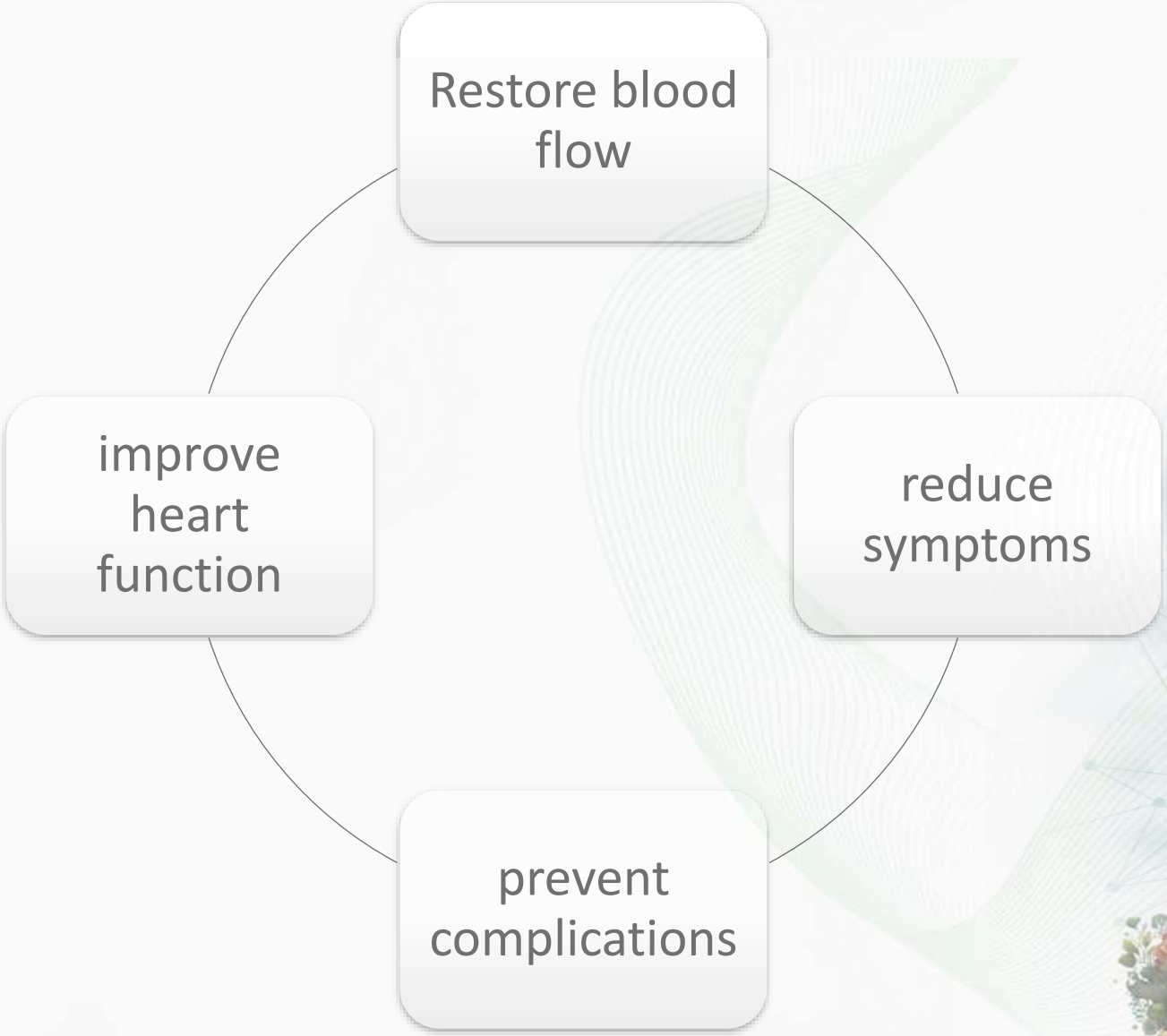
No disclosures

Agenda

- Introduction to Myocardial Revascularization
- Role of Imaging in Revascularization
- Key Imaging Modalities
- Clinical Applications
- Benefits, Challenges, and Future Perspectives

Introduction to Myocardial Revascularization

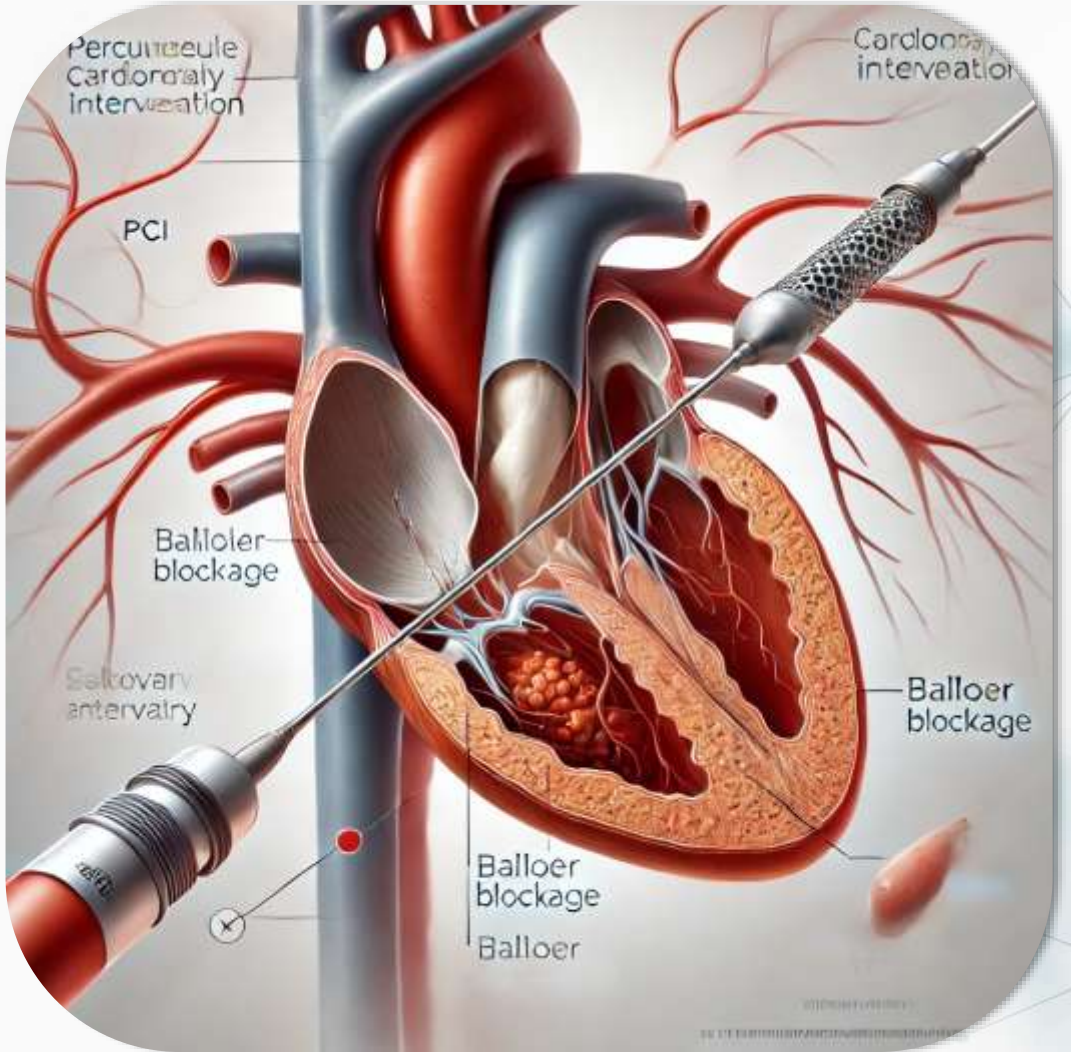
- **The aim** of myocardial revascularization is to minimize ischaemia



Methods

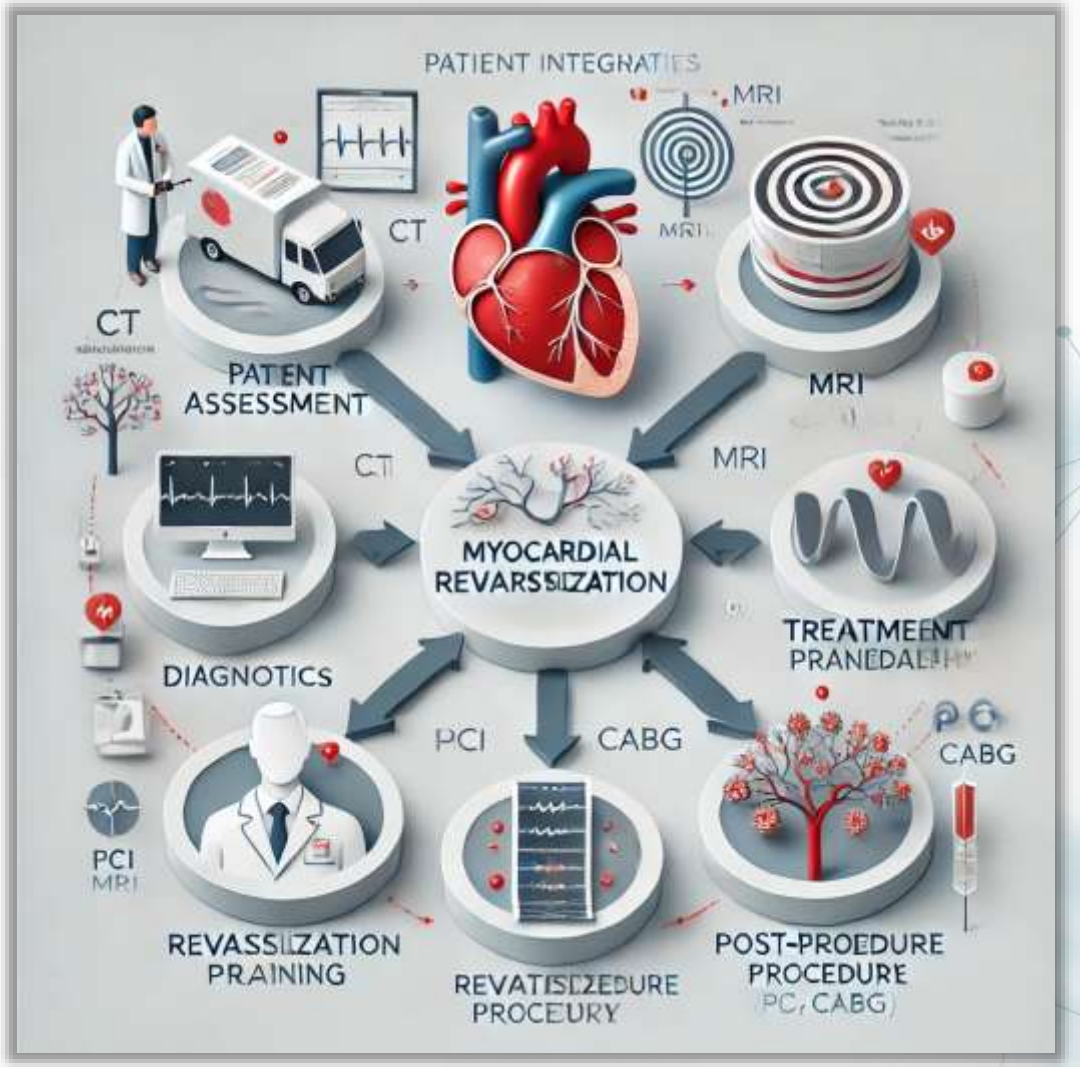
CABG

PCI



Role of Imaging in Revascularization

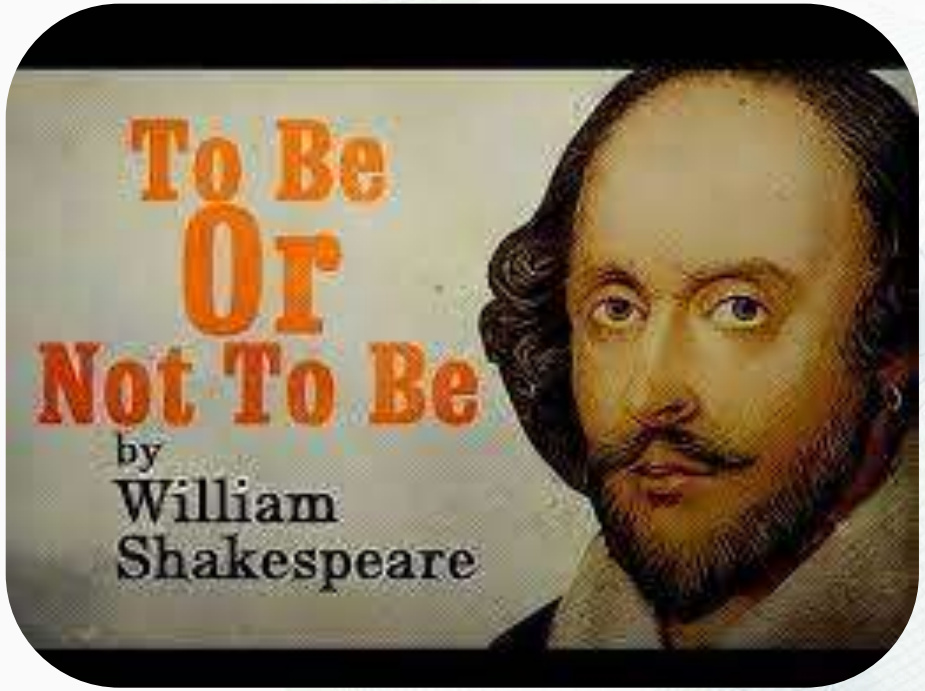
- Assessing coronary artery anatomy
- Identifying viable myocardium
- Guiding revascularization decisions (PCI or CABG)
- Evaluating post-procedure outcomes.



Key Imaging Modalities

Coronary Angiography	• Gold standard for visualizing coronary anatomy. • Used during PCI and CABG planning.
Intravascular Ultrasound (IVUS)	• Cross-sectional views of the vessel. • Detects plaque composition and severity.
Fractional Flow Reserve (FFR)	• Measures pressure differences to assess the functional significance of stenosis.
Cardiac MRI & PET	• Evaluate myocardial viability and perfusion.
CT Coronary Angiography	• Non-invasive approach for coronary assessment.

Revasc or not revasc



ESC European Society of Cardiology

European Heart Journal (2018) 00, 1–96
doi:10.1093/eurheartj/ehy394

ESC/EACTS GUIDELINES

2018 ESC/EACTS Guidelines on myocardial revascularization

The Task Force on myocardial revascularization of the European Society of Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS)

Developed with the special contribution of the European Association for Percutaneous Cardiovascular Interventions (EAPCI)

What the guidelines say?

Recommendations on revascularizations in patients with chronic heart failure and systolic left ventricular dysfunction (ejection fraction ≤35%)

Recommendations	Class[a]	Level[b]
In patients with severe LV systolic dysfunction and coronary artery disease suitable for intervention, myocardial revascularization is recommended.[81,250]	I	B
CABG is recommended as the first revascularization strategy choice in patients with multivessel disease and acceptable surgical risk.[68,81,248,255]	I	B
In patients with one- or two-vessel disease, PCI should be considered as an alternative to CABG when complete revascularization can be achieved.	IIa	C
In patients with three-vessel disease, PCI should be considered based on the evaluation by the Heart Team of the patient's coronary anatomy, the expected completeness of revascularization, diabetes status, and comorbidities.	IIa	C
LV aneurysmectomy during CABG should be considered in patients with NYHA class III/IV, large LV aneurysm, large thrombus formation, or if the aneurysm is the origin of arrhythmias.	IIa	C
Surgical ventricular restoration during CABG may be considered in selected patients treated in centres with expertise.[252–254,256,257]	IIb	B

ESC Guidelines: for Revascularisation & for Heart Failure 2021

Recommendations	Class[a]	Level[b]
CABG should be considered as the first-choice revascularization strategy, in patients suitable for surgery, especially if they have diabetes and for those with multivessel disease.[581,587,588,590]	IIa	B
Coronary revascularization should be considered to relieve persistent symptoms of angina (or an angina-equivalent) in patients with HFrEF, CCS, and coronary anatomy suitable for revascularization, despite OMT including anti-anginal drugs.	IIa	C
In LVAD candidates needing coronary revascularization, CABG should be avoided, if possible.	IIa	C
Coronary revascularization may be considered to improve outcomes in patients with HFrEF, CCS, and coronary anatomy suitable for revascularization, after careful evaluation of the individual risk to benefit ratio, including coronary anatomy (i.e. proximal stenosis >90% of large vessels, stenosis of left main or proximal LAD), comorbidities, life expectancy, and patient's perspectives.	IIb	C
PCI may be considered as an alternative to CABG, based on Heart Team evaluation, considering coronary anatomy, comorbidities, and surgical risk.	IIb	C

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...should be class III/ ...bus for- ...rigin of	IIa	C
...ring CABG ...ients ...52–254, 256, 257].	IIb	B

Class I	Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective.	Is recommended or is indicated
Class II	Conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of the given treatment or procedure.	
Class IIa	Weight of evidence/opinion is in favour of usefulness/efficacy.	Should be considered
Class IIb	Usefulness/efficacy is less well established by evidence/opinion.	May be considered
Class III	Evidence or general agreement that the given treatment or procedure is not useful/effective, and in some cases may be harmful.	Is not recommended

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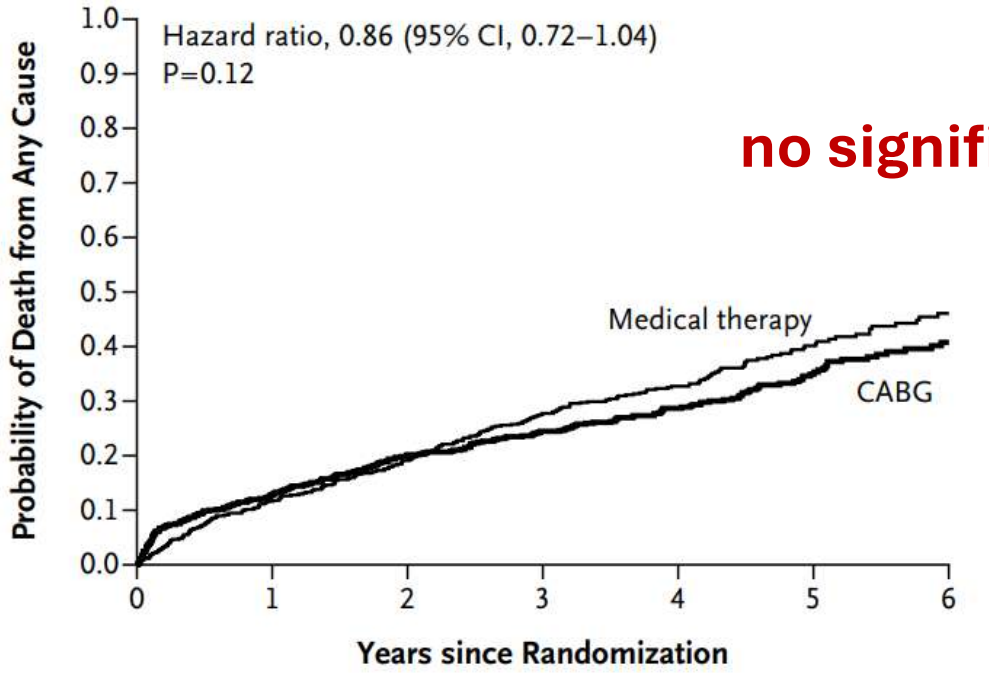
STICH trial

Velazquez et al, NEJM 2011;364:1607-1616

STICH – 2011



No. at Risk							
Medical therapy	602	532	487	435	312	154	80
CABG	610	532	486	459	340	174	91

Figure 1. Kaplan–Meier Curves for the Probability of Death from Any Cause.
CABG denotes coronary-artery bypass grafting.

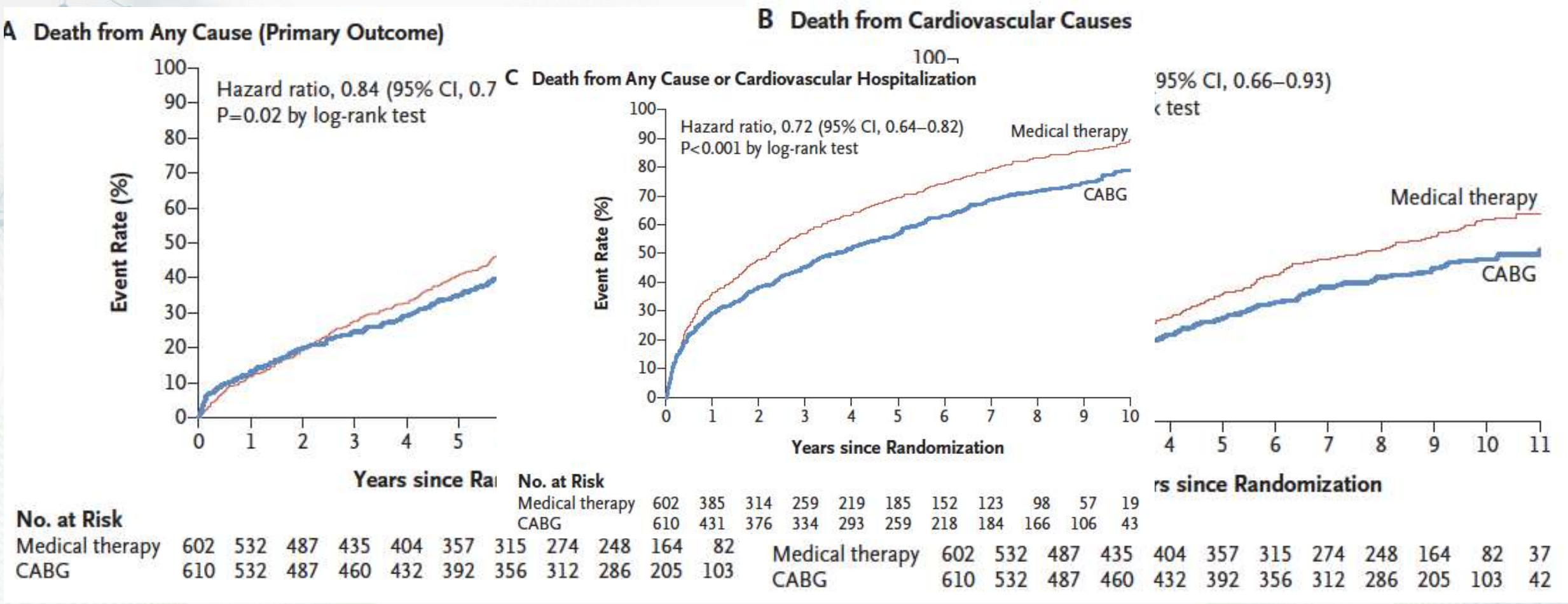
no significant difference

Velazquez et al, NEJM 2011;364:1607-1616

- **STICHES trial**

Velazquez et al. NEJM 2016;374:1511-1520

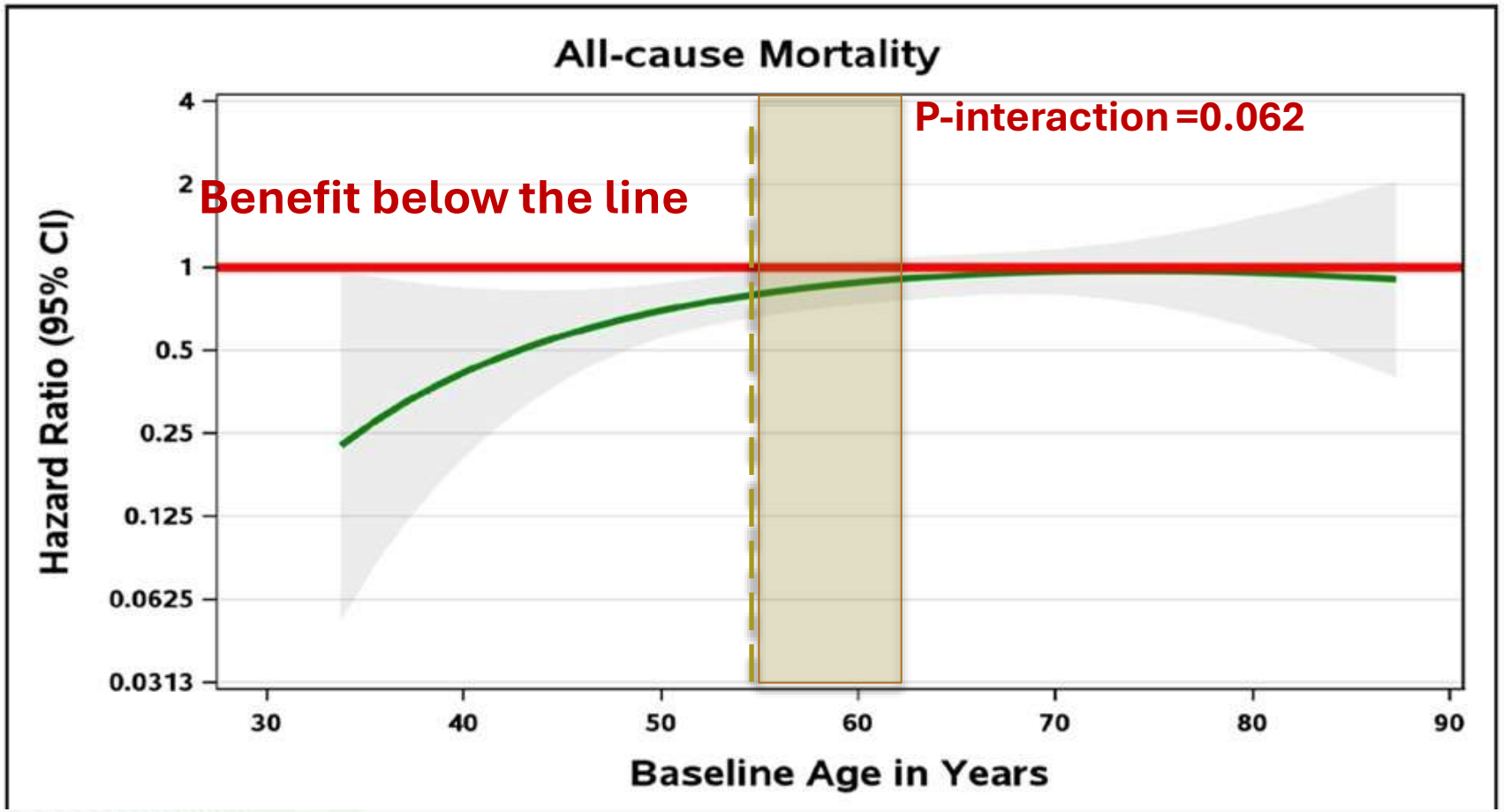
Improvement of Prognosis - STICHES



Velazquez et al. NEJM 2016;374:1511-1520

You must live a long time to benefit from CABG.

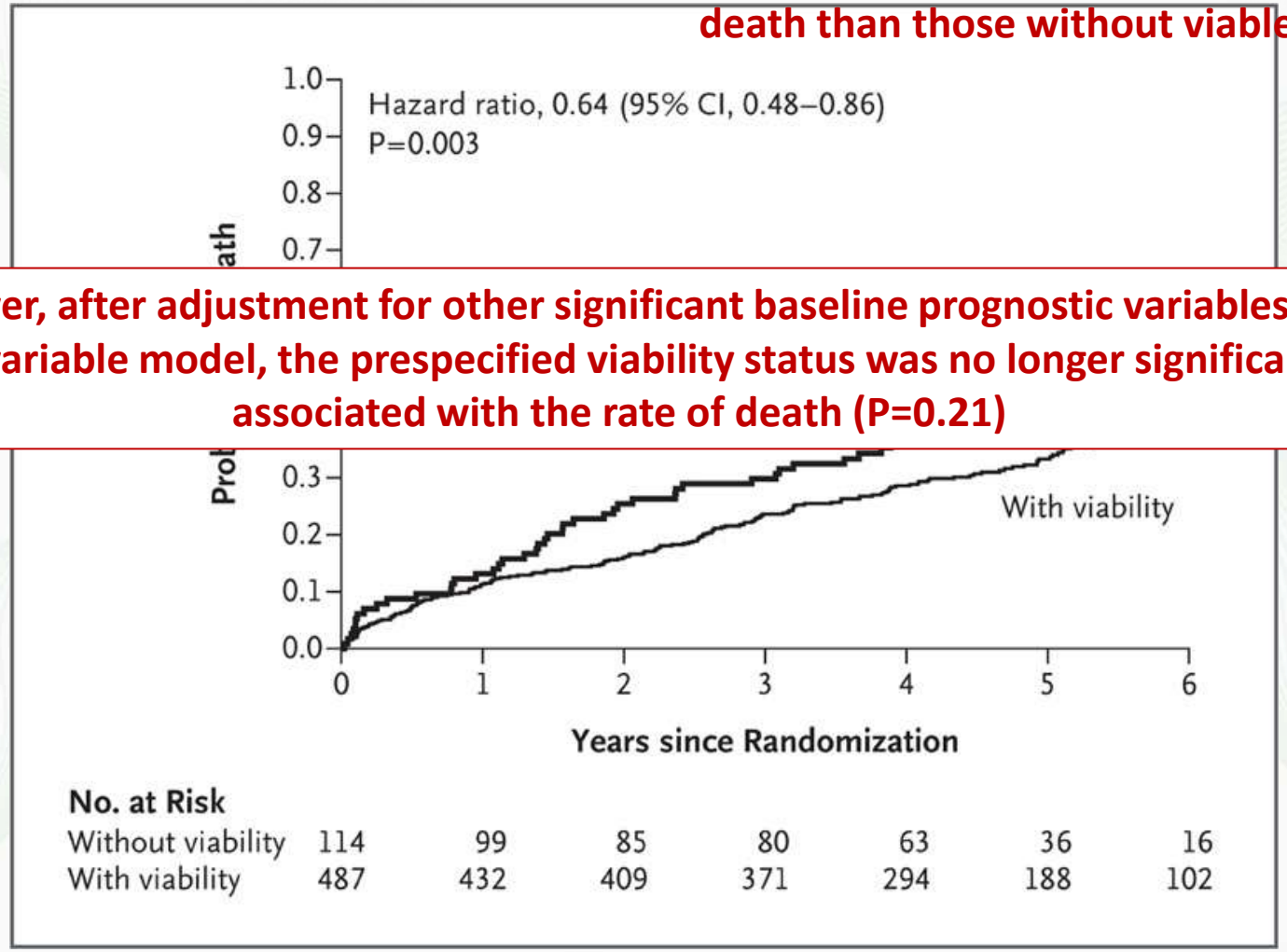
Patients with HFrEF aged >55 years might not.



STICH: Myocardial Viability Sub-study

Kaplan–Meier Analysis of the Probability of Death, According to Myocardial Viability Status

Patients with viable myocardium had lower overall rates of death than those without viable myocardium c



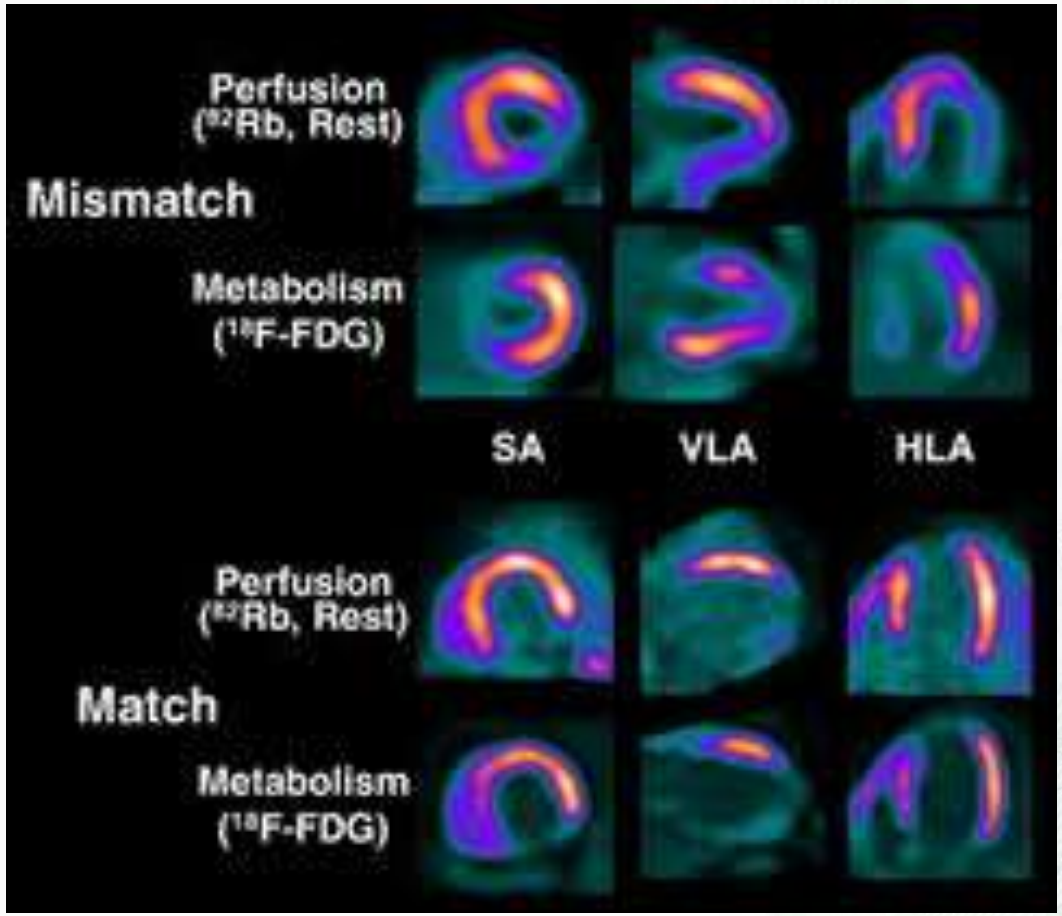
However, after adjustment for other significant baseline prognostic variables in a multivariable model, the prespecified viability status was no longer significantly associated with the rate of death (P=0.21)

Bonow RO et al. N Engl J Med 2011;364:1617-1625.

Dobumatin Stress-Echo / SPECT

CMR

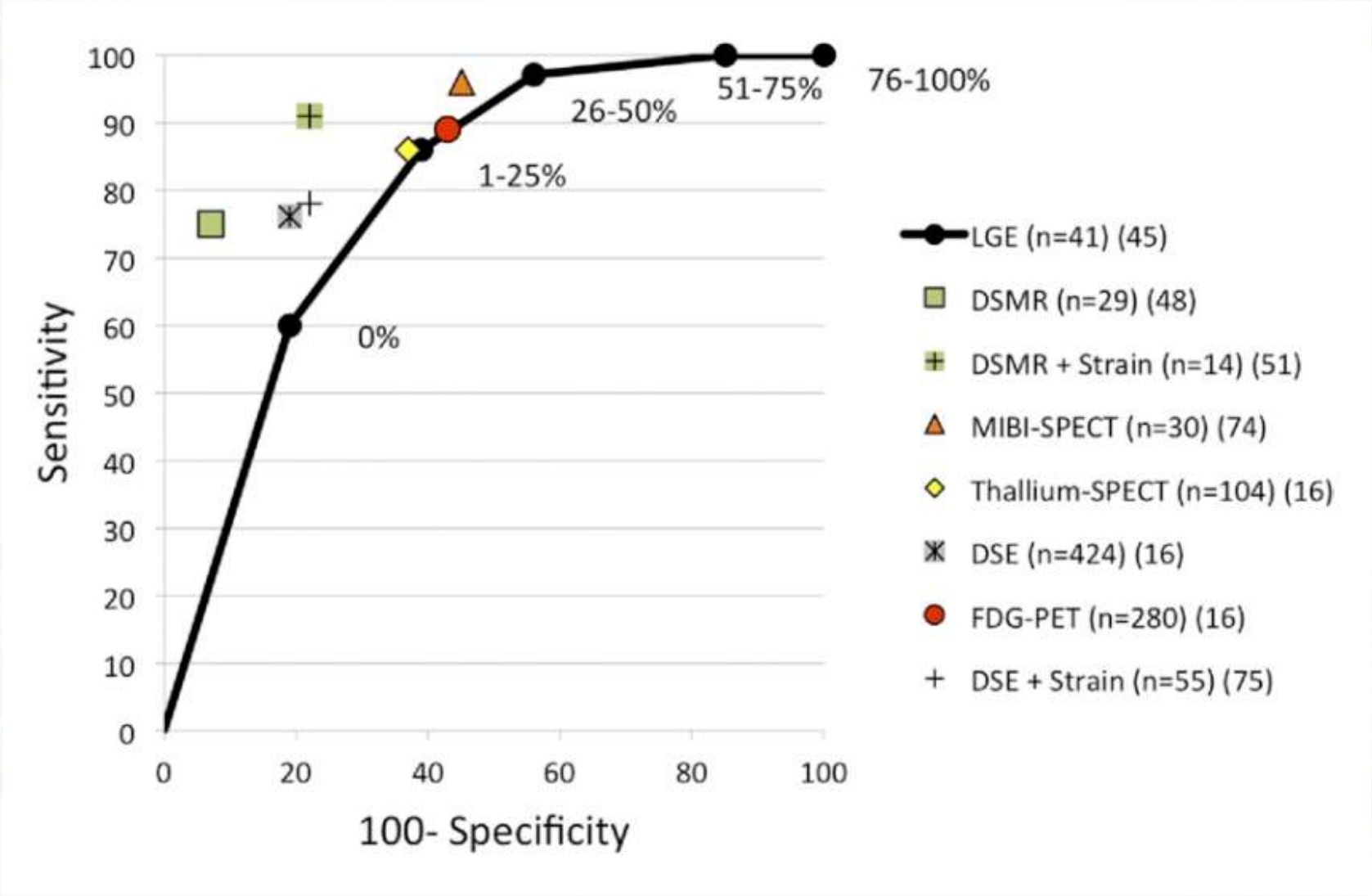
PET


Perfusion
(82Rb, Rest)
Mismatch
Metabolism
(18F-FDG)
SA
VLA
HLA
Perfusion
(82Rb, Rest)
Match
Metabolism
(18F-FDG)

Comparison for Myocardial Viability

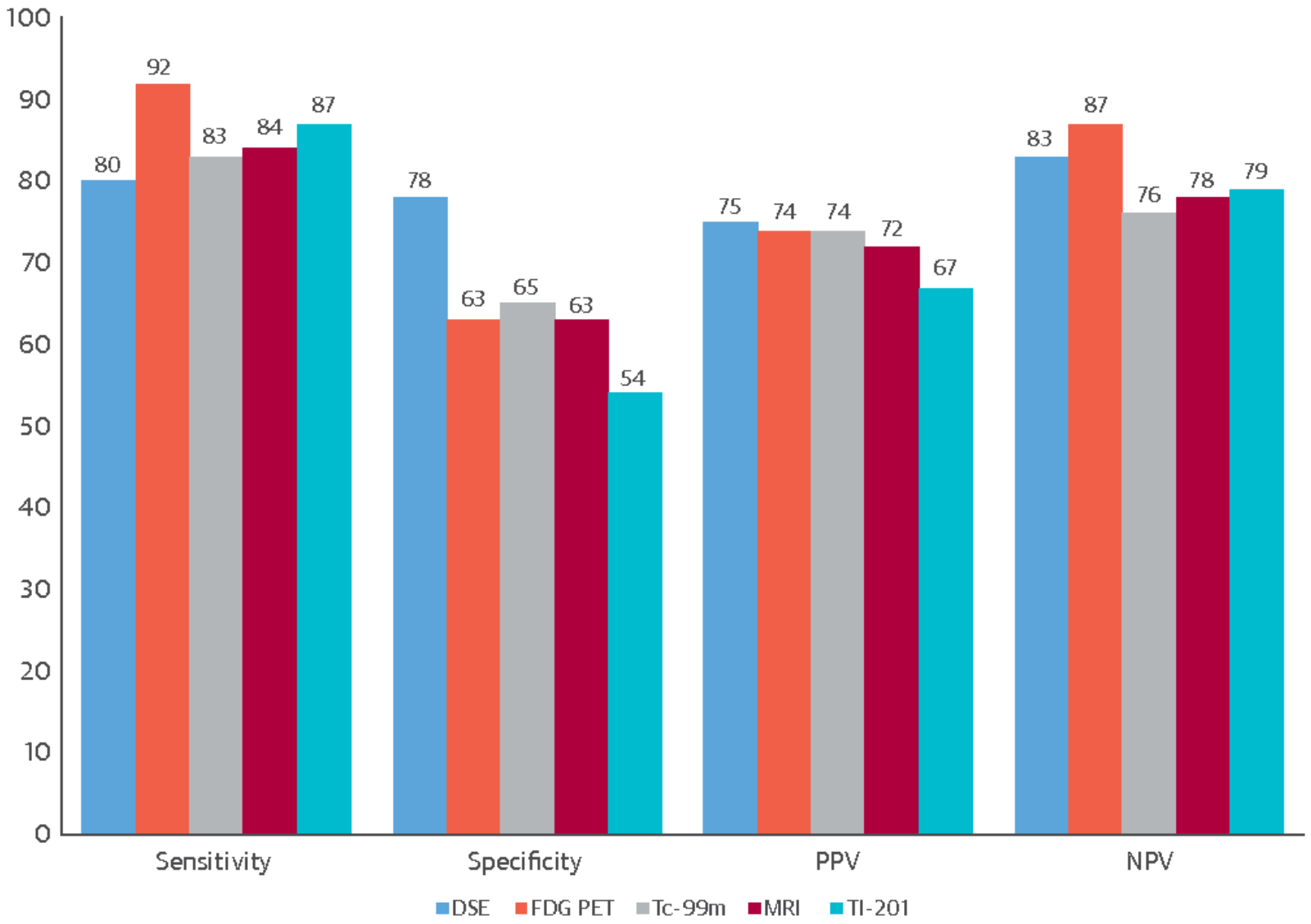
Modality	Sensitivity	Specificity	Key Strength	Main Limitation
DSE	Moderate	High	Contractile reserve assessment	Operator dependency, poor in bad windows
SPECT	High	Moderate	Perfusion and viability, widely available	Limited resolution, radiation
PET	Very High	Very High	Gold standard for metabolic viability	Cost, availability
Cardiac MRI (LGE)	Very High	Very High	Accurate scar quantification	Cost, contrast contraindications
CT Perfusion	Moderate	Moderate	Combined coronary and perfusion data	Emerging, radiation exposure

Diagnostic significance of different methods in the assessment of dysfunctional myocardium



Schuster A. et al. J Am Coll Cardiol 2012;59:359–70

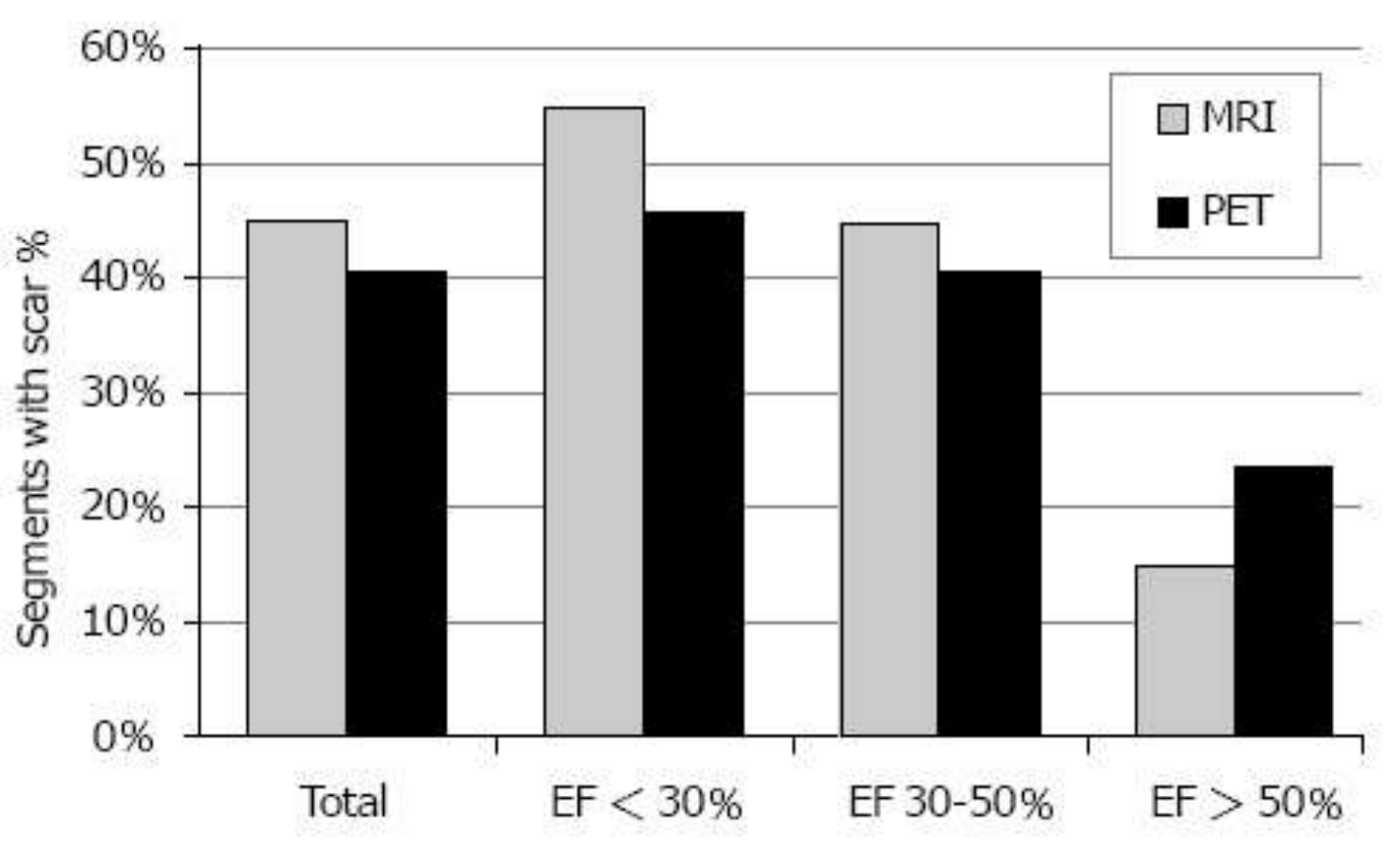
FIGURE 3 Range of Sensitivity, Specificity, PPV, and NPV of Currently Available Viability Testing Modalities

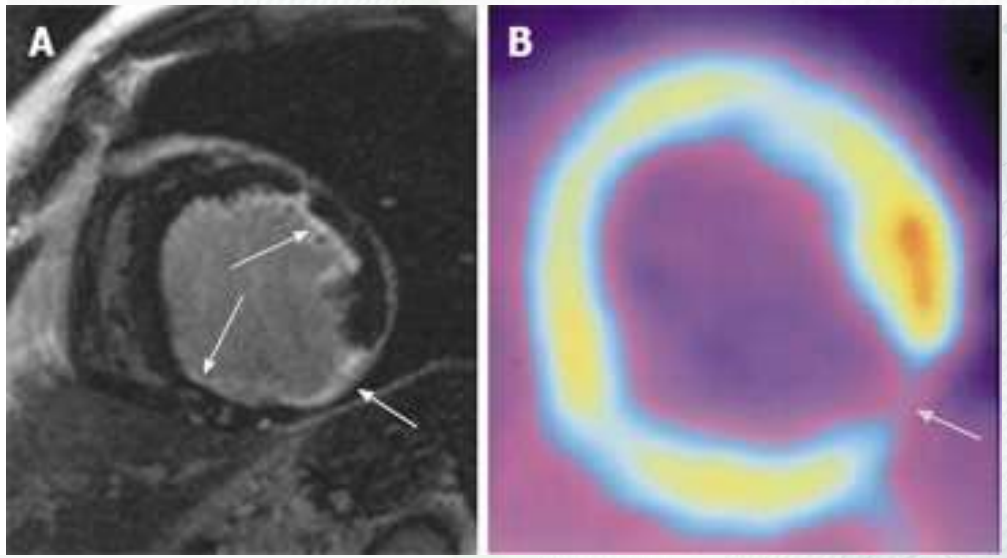


^{18}F-fluorodeoxyglucose positron emission tomography (FDG-PET) imaging offers the greatest sensitivity, with comparable specificity to other

Anavekar N et al. J Am Coll Cardiol 2016;67:2874–87

PET vs MRI



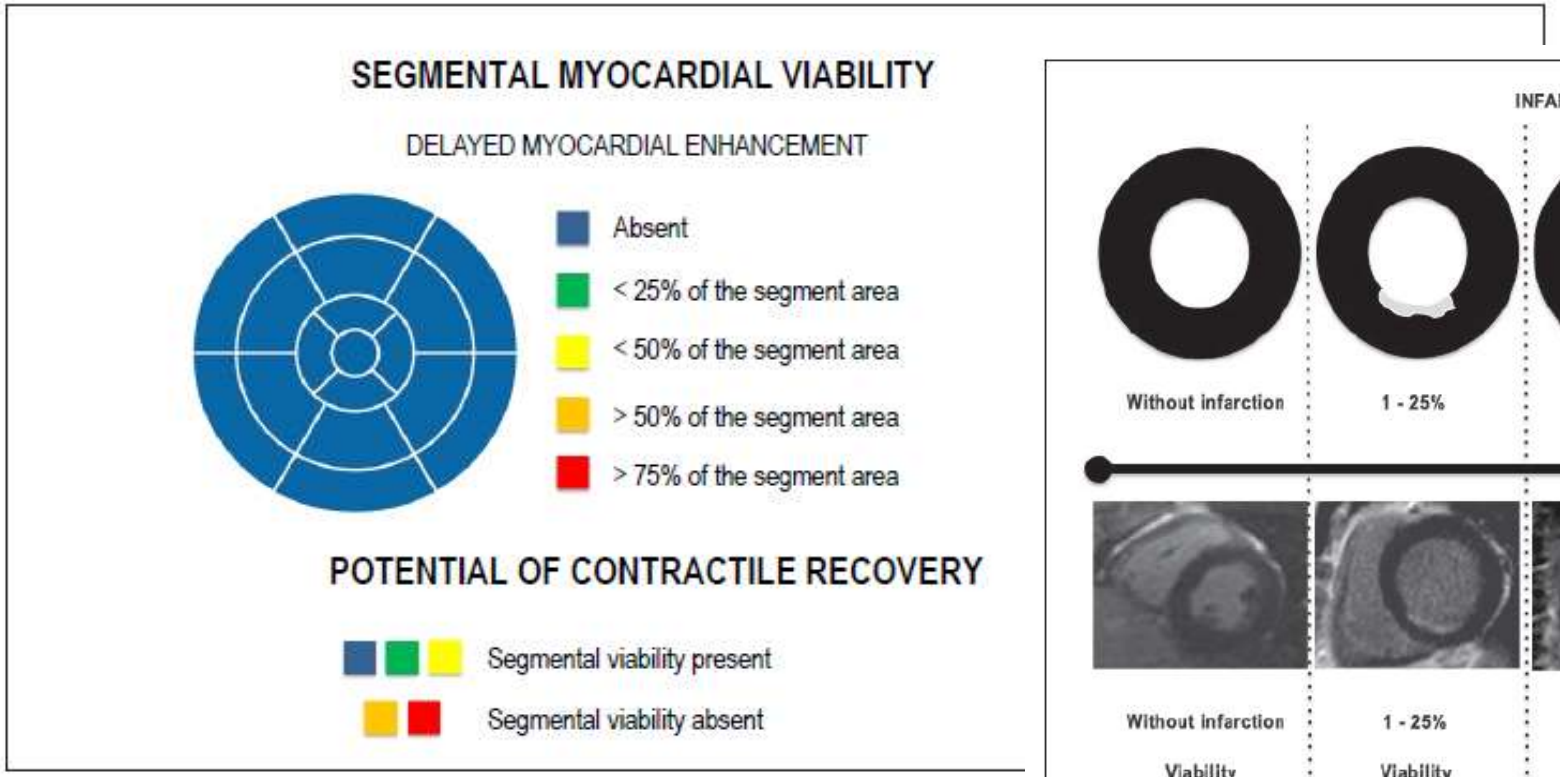


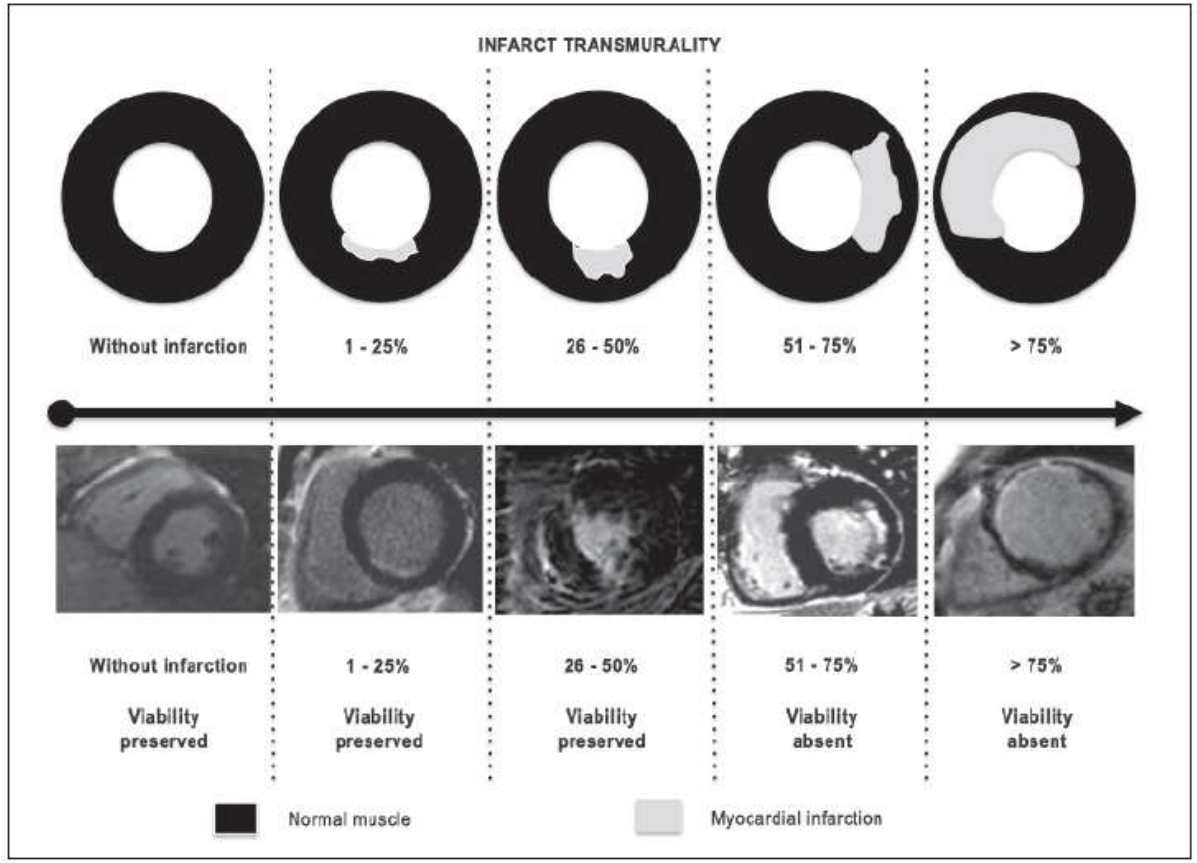
Accuracy of myocardial **viability** imaging by **cardiac** MRI and **PET** depending on left ventricular function.
Hunold P, Jakob H, Erbel R, Barkhausen J, Heilmaier C.
World J Cardiol. 2018 Sep 26;10(9):110-118. doi: 10.4330/wjc.v10.i9.110.

Myocardial Viability on Cardiac Magnetic Resonance

Ana Luiza Mansur Souto,[1] Rafael Mansur Souto,[2] Isabella Cristina Resende Teixeira,[3] Marcelo Souto Nacif[1,2,3]

Universidade Federal Fluminense;[1] Centro de Imagem Complexo Hospitalar de Niterói;[2] Niterói, RJ; Unidade de Radiologia Clínica - Hospital Vivalle – Rede D´Or - São Luiz,[3] São José dos Campo, SP – Brazil





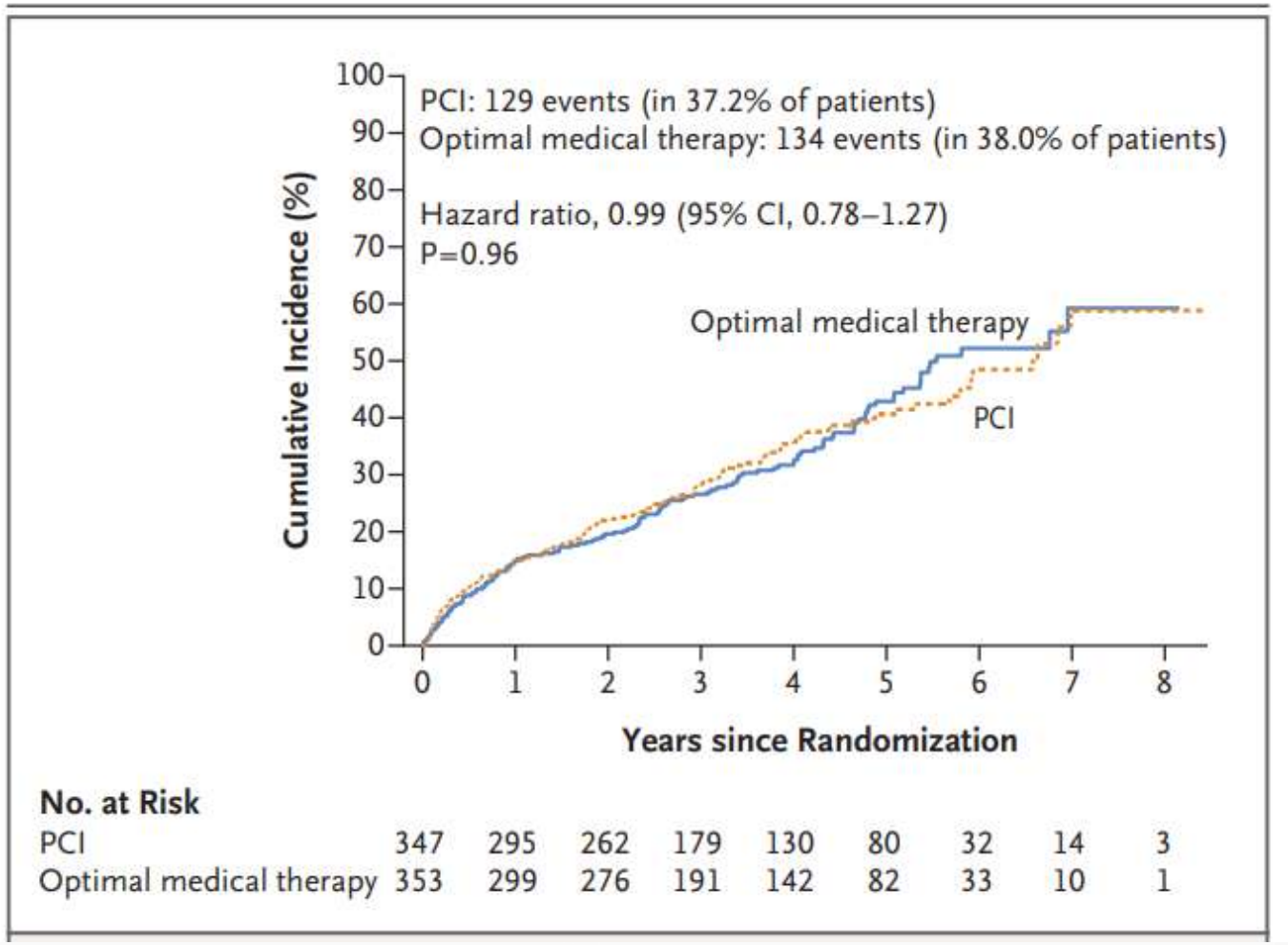
Arq Bras Cardiol. 2017 May; 108(5): 458–469.

Revasc for Ischemic ventricular dysfunction (REVIVED trial)

REVIVED
REVASCULARISATION FOR ISCHAEMIC VENTRICULAR DYSFUNCTION

Primary Endpoint

Death from Any Cause or Hospitalization for Heart Failure



129 Events (37.2%)

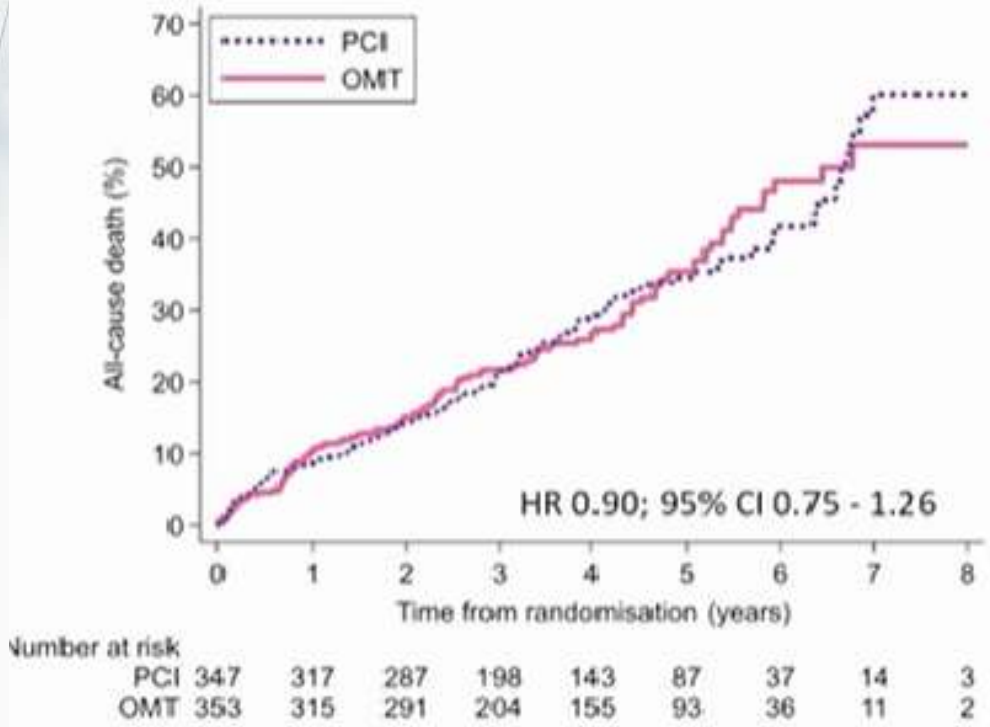
134 Events (38.0%)

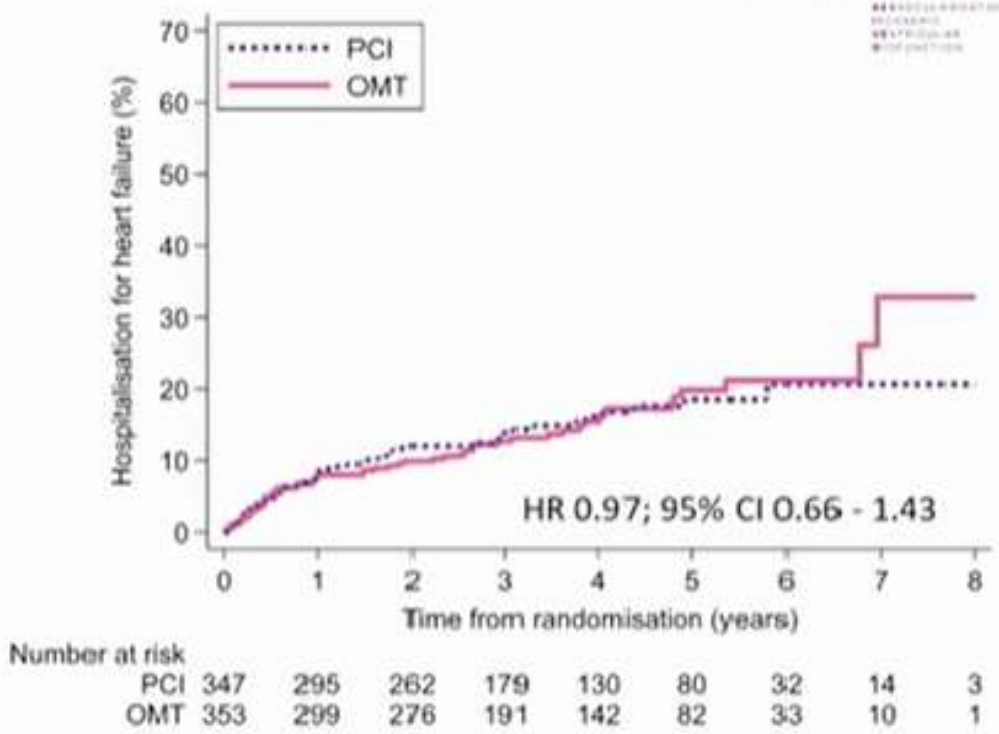
Hazard Ratio 0.99
95% CI 0.78 - 1.27
p=0.96

Perera et al. N Engl J Med. 2022;387:1351-1360

REVIVED : RCT on PCI versus OMT in CHF

Components of primary endpoint



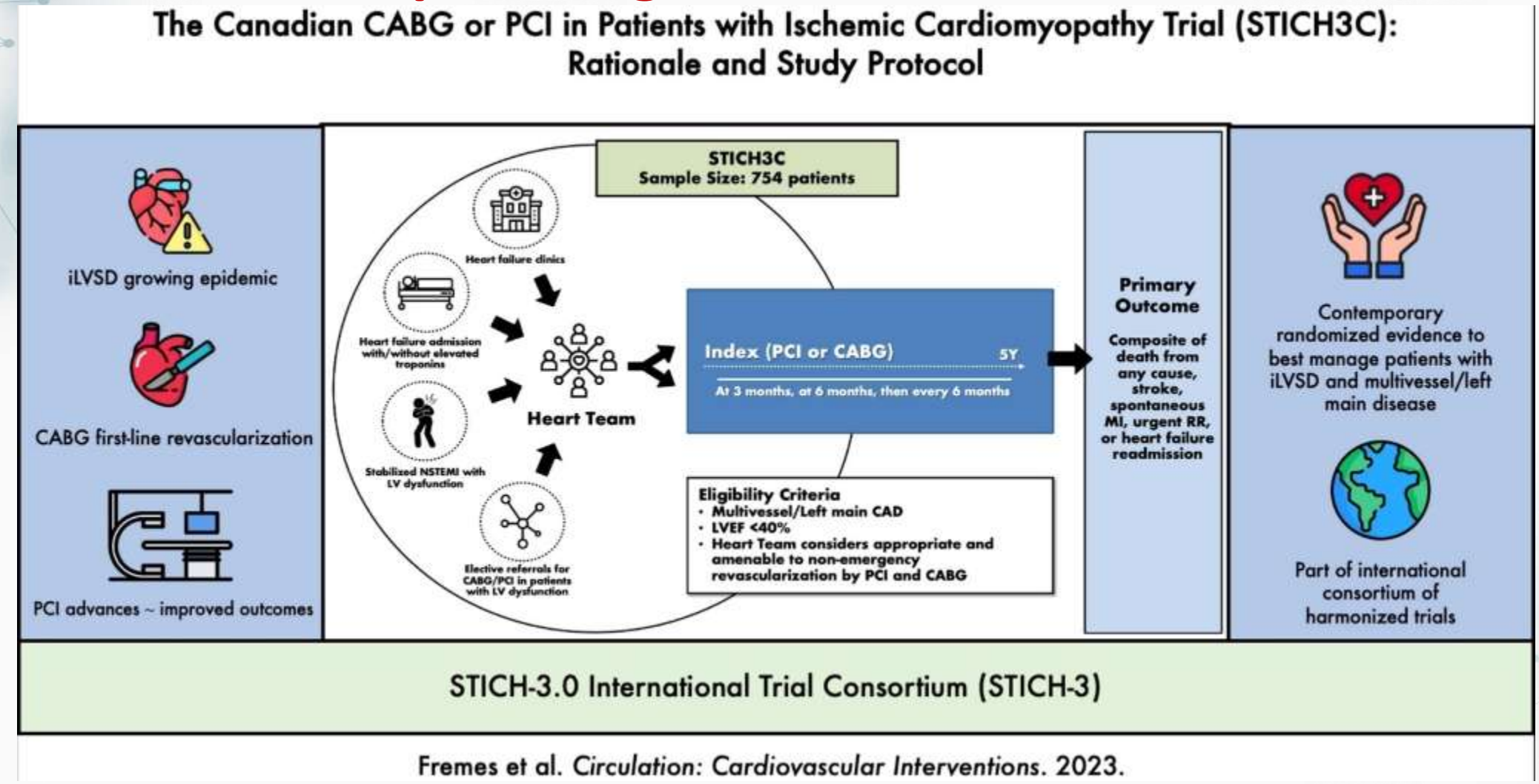


Perera et al. N Engl J Med. 2022;387:1351-1360

ed comparison of the
trategy of PCI plus op-
is compared with strat-
therapy alone, among
ventricular systolic dys-
nary artery disease, and
cardium. The incidence
e or hospitalization for
y outcome) did not dif-
n the trial groups. An
PCI was observed with
but the between-group
r time owing to the pro-
scores in the optimal-
ardiac function appeared
ups over the course of
e was not affected by

function that was incremental to the improvement with optimal medical therapy alone. These findings challenge the paradigm of myocardial hibernation, which is classically defined according to improvement in left ventricular volumes and function after revascularization. Our observations mirror those in the STICH trial, in which revascularization by CABG did not affect left ventricular function, a finding that was consistent across the whole trial cohort, including the subgroup who underwent discretionary viability testing.[16] We have not yet determined the concordance between the coronary arteries revascularized by PCI and the viable myocardial segments; hence, we cannot determine whether viability tests predict changes in segmental contractile function after medical therapy or revascularization or whether such changes are linked to clinical outcomes.[17]

Upcoming RCTs – STICH-3



Fremes et al. Circ Interv 2023;16:e012527

Clinical Applications

- **Pre-Procedure Planning**
- Selecting the revascularization strategy (PCI vs CABG).
- Identifying areas of ischemia or myocardial viability.

- **During Procedure**
- Guiding stent placement (OCT/IVUS).
- Assessing results of angioplasty or bypass.

- **Post-Procedure**
- Monitoring restenosis or complications.

Benefits and Limitations of Imaging-Guided Revascularization

- Precision in diagnosis and treatment.
- Improved procedural success rates.
- Reduced complications and restenosis.
- Enhanced patient outcomes and quality of life.

- Cost of advanced imaging modalities.
- Need for specialized training.
- Limited accessibility in some regions.
- Risk of complications with invasive imaging techniques.

Future Perspectives

- ✓ Integration of AI in imaging analysis.
- ✓ Emerging modalities (e.g., hybrid imaging).
- ✓ Personalized treatment plans using multimodality imaging.

Conclusions

- No good evidence that revascularization ~~(anatomical)~~ of chronic 'stable' coronary artery disease improves outcome whether or not
  - LVEF is Reduced
  - Myocardial viability / ischaemia
  - Diagnosis of Heart Failure
- Most patients with heart failure
  - Are aged >70 years
  - Patients with heart failure are at high risk – bad things happen to them

Future

Imaging-guided Functional revascularization