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

NOVEL DIAGNOSTIC TECHNIQUES FOR HEART FAILURE

Focus on Imaging

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2013 ACC/AHA GUIDELINES FOR THE MANAGEMENT OF HEART FAILURE
Recommendations for Imaging

Recommendations	COR	LOE
Patients with suspected, acute, or new-onset HF should undergo a chest x-ray	I	C
A 2-dimensional echocardiogram with Doppler should be performed for initial evaluation of HF	I	C
Repeat measurement of EF is useful in patients with HF who have had a significant change in clinical status or received treatment that might affect cardiac function or for consideration of device therapy	I	C
Noninvasive imaging to detect myocardial ischemia and viability is reasonable in HF and CAD	IIa	C
Viability assessment is reasonable before revascularization in HF patients with CAD	IIa	B (281–285)
Radionuclide ventriculography or MRI can be useful to assess LVEF and volume	IIa	C
MRI is reasonable when assessing myocardial infiltration or scar	IIa	B (286–288)
Routine repeat measurement of LV function assessment should not be performed	III: No Benefit	B (289,290)

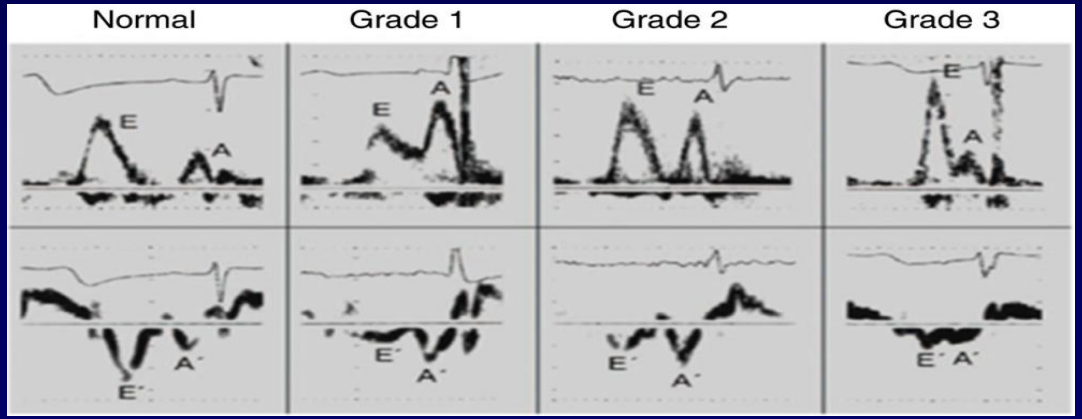
"The most useful diagnostic test in the evaluation of patients with or at risk for HF is a comprehensive 2-D echocardiogram"

Yancy C et al, 2013
JACC 62; e147

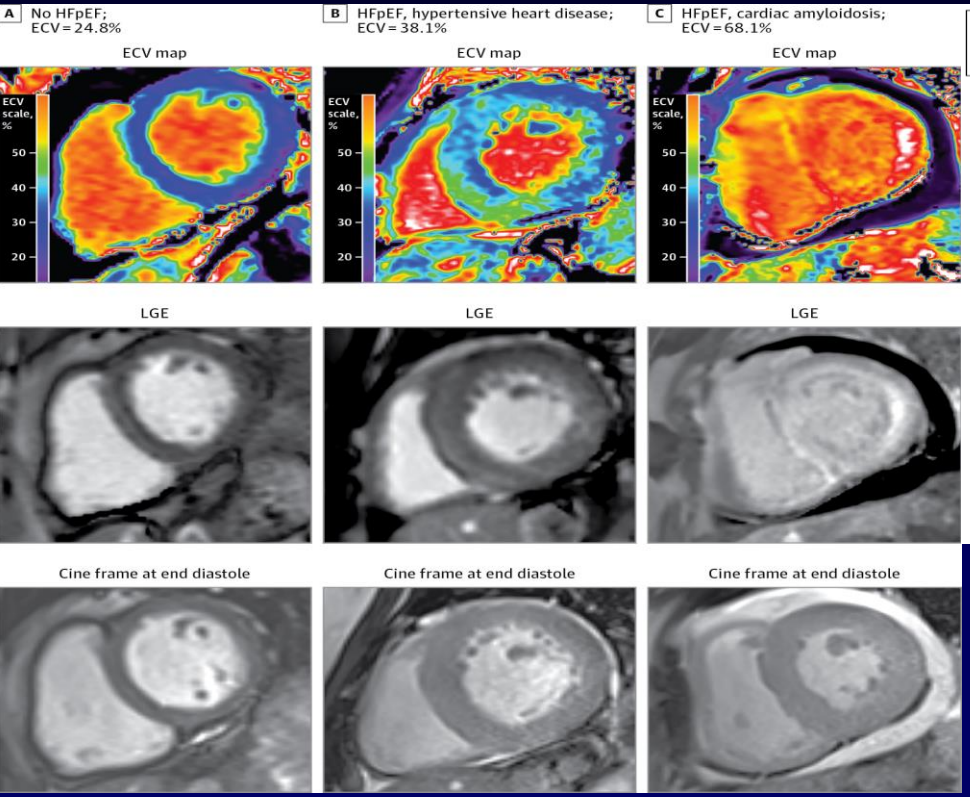
GRADES OF DIASTOLIC DYSFUNCTION
Classification by Echocardiography

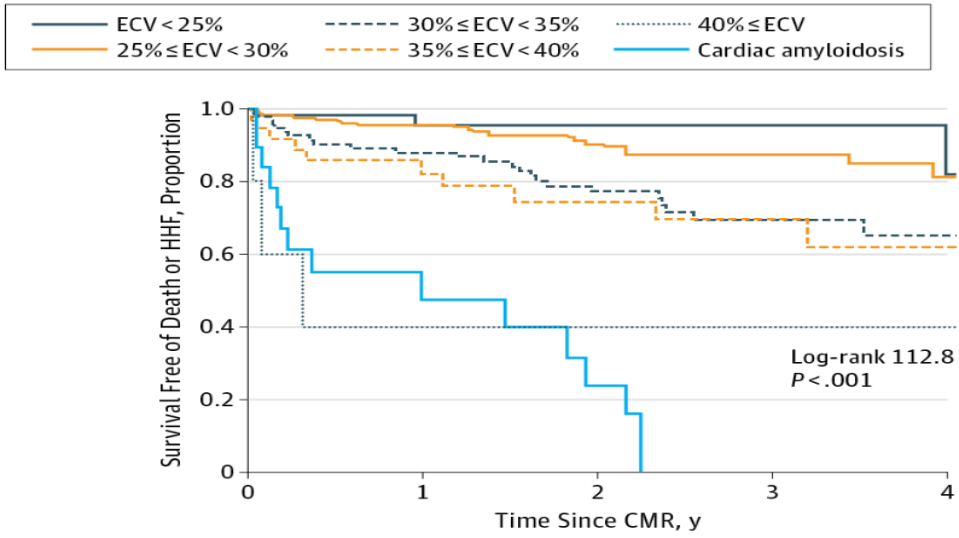
- Relies on annular velocity and LA size
- Mitral inflow and the ratio E/e' allow grade distinction
- PV and mitral inflow during Valsalva are useful

		Grade 1	Grade 2	Grade 3
Normal subjects	Normal/athlete/constriction	Impaired relaxation	Pseudonormal filling	Restrictive filling
Septal e'≥8	Septal e'≥8	Septal e'<8	Septal e'<8	Septal e'<8
Lateral e'≥10	Lateral e'≥10	Lateral e'<10	Lateral e'<10	Lateral e'<10
LA<34 ml/m^2	LA≥34 ml/m^2	LA≥34 ml/m^2	LA≥34 ml/m^2	LA≥34 ml/m^2
		E/A<0.8	E/A 0.8–1.5	E/A≥1.5
		DT>200 ms	DT 160–200 ms	DT<160 ms
		Average E/e'≤8	Average E/e' 9–12	Average E/e'≥13
		Ar-A<0 ms	Ar-A≥30 ms	Ar-A≥30 ms
		Valsalva ΔE/A<0.5	Valsalva ΔE/A≥0.5	Valsalva ΔE/A≥0.5



SEVERITY OF HFpEF AND OUTCOMES
Quantitation of Myocardial Fibrosis by CMR-Derived Extracellular Volume

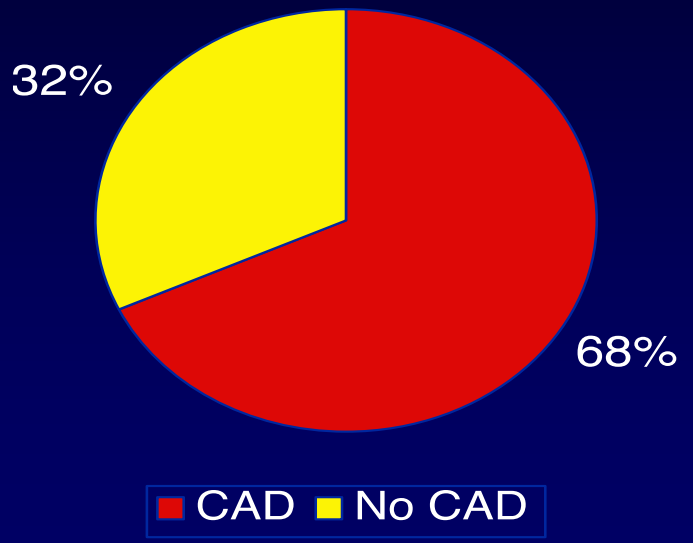




Schelbert EB et al, 2017
JAMA Cardiol 2: 995

PREVALENCE OF CORONARY DISEASE IN MULTICENTER HEART FAILURE TRIALS

	Year	n	CAD
VHEHF-1	1986	642	282
CONSENSUS	1987	253	146
Milrinone	1989	230	115
PROMISE	1991	1088	590
SOLVD-T	1991	2569	1,828
VHEFT-2	1991	804	427
SOLVD-P	1992	4,228	3518
RADIANCE	1993	178	107
Vesnarinone	1993	477	249
CHF-STAT	1995	674	481
Carvedilol	1996	1,094	521
PRAISE	1996	1,153	732
DIG	1997	6,800	4,793
TOTAL		20,190	13,789



Georghiade and Bonow
Circulation 1998; 97: 282

EVALUATION FOR ISCHEMIC ETIOLOGY

- Stress echo: Limitations in setting of LV dysfunction
- CMR perfusion: limited data with HF patients
- SPECT: Extensive literature support
- PET: Mostly viability studies
- CCTA: High NPV, but limited recommendations
- ICA: Class I or II recommendation for HF unless not eligible for revascularization
- When renal dysfunction present, avoid potentially nephrotoxic agents when possible

Patel MR et al
JACC 2013; 61: 2207

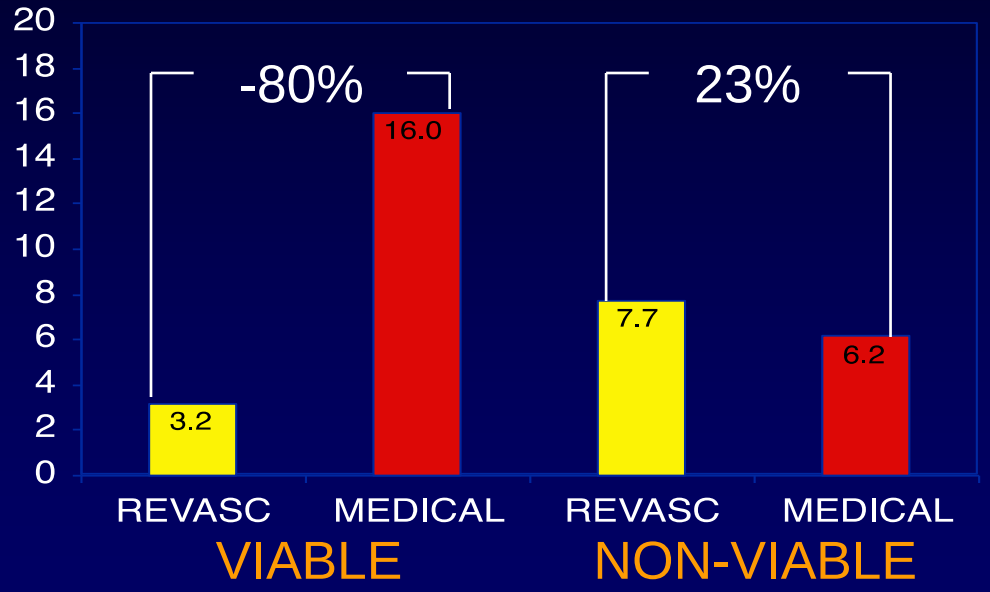
ASSESSMENT OF MYOCARDIAL VIABILITY

Physiologic Basis of Imaging

Characteristic	Imaging Modality	Marker of Viability
Perfusion/intact cell membrane	Thallium-201 SPECT Rb-82 PET Contrast CT Contrast CMR	Tracer activity>50%
Perfusion/intact mitochondria	Tc-99m SPECT	Redistribution >10% Tracer activity >50%
Glucose metabolism	F-18 FDG PET	Increased tracer uptake Perfusion/metabolism mismatch
Free fatty acid metabolism	C-11 fatty acid PET BMIPP SPECT	Tracer activity >50%
Contractile reserve	Dobutamine echo Dobutamine CMR Dobutamine SPECT	Improved contraction
Microvascular integrity	Contrast echo	Hypoenhancement
Scar identification	Contrast CT Contrast CMR	Hyperenhancement

SURVIVAL BASED ON THE PRESENCE OR ABSENCE OF VIABILITY AND TREATMENT WITH MEDICAL THERAPY OR REVASCULARIZATION

- Meta-analysis 24 studies
  - –TI-201
  - –FDG PET
  - –DSE
- 3,088 patients
  - –Follow-up: 25 ± 10 months
  - –LVEF: 23-45% (mean 35%)
- No difference in performance based on technique used



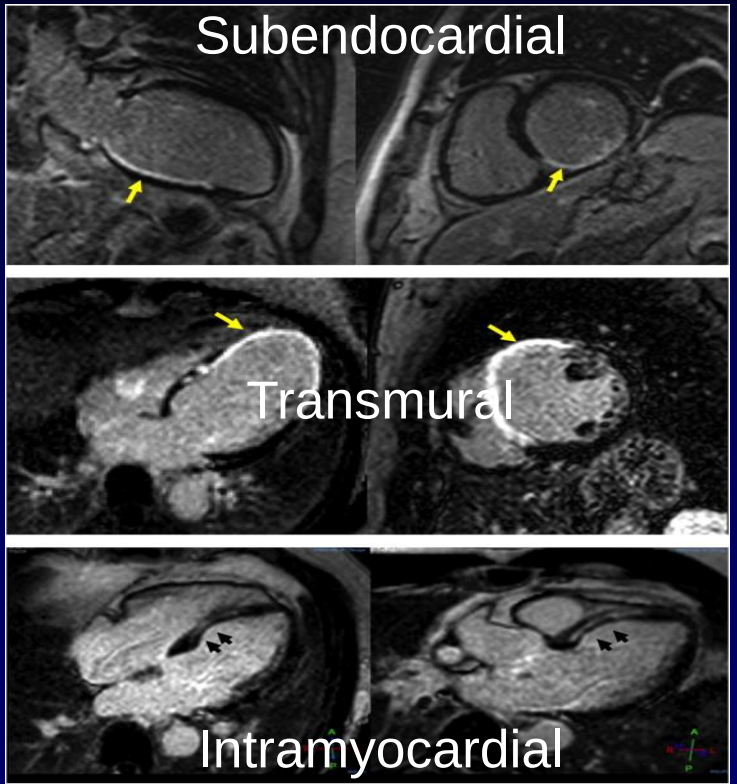
Allman et al, 2002
J Am Coll Cardiol 39: 1151-8

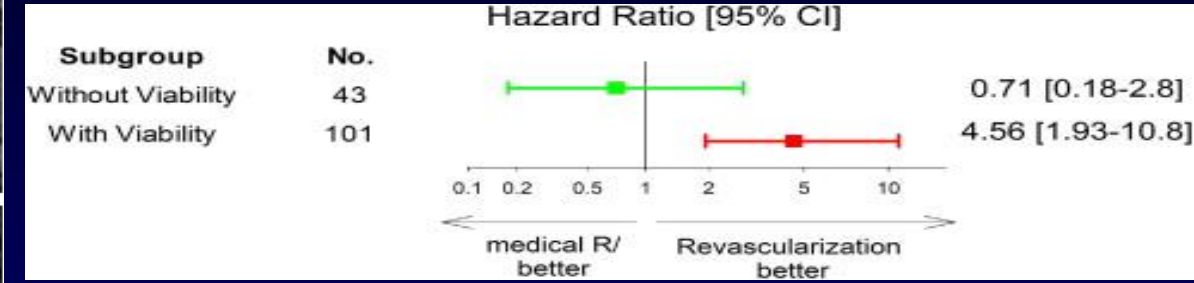
MYOCARDIAL VIABILITY AND MORTALITY
The STICH Trial

Limitations:

- Non-randomized, with likely selection bias
- Extensive crossover to CABG
- Analysis limited to SPECT and dobutamine echo, not PET or cardiac MRI
- Lack of viability data for all patients (subpopulation of STICH)
- Viability testing cohort had more MI's, afib, more prior revascularizations, high use of medical Rx, lower EF's

CMR FOR MYOCARDIAL NECROSIS: LATE GADOLIUM ENHANCEMENT





Risk of 3-year death according to presence or absence of viability and treatment patients with dysfunctional myocardium

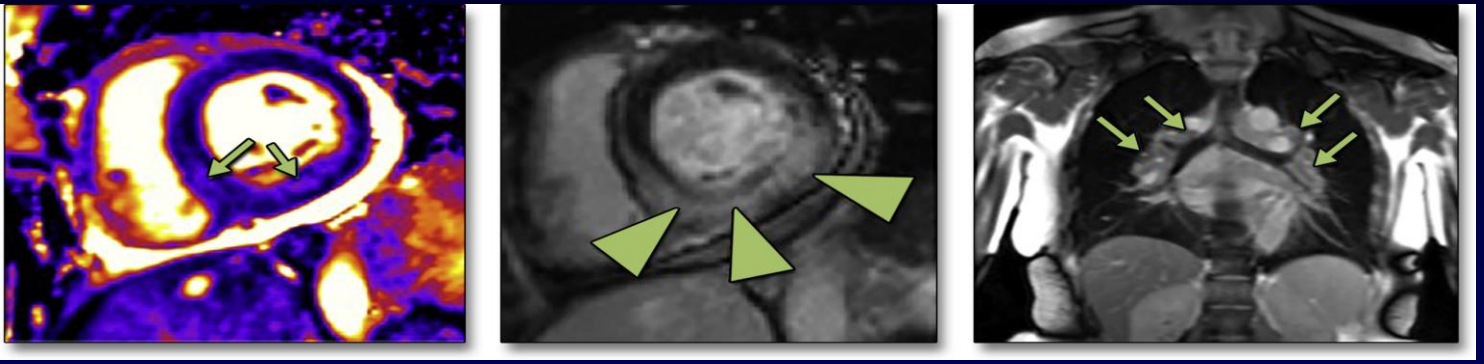
Shah SJ et al, 2011
AHJ 162: 3-15

Gerber BL et al, 2012
JACC 59: 825

CARDIAC SARCOIDOSIS

- Cardiac involvement portends a worse prognosis
- Endomyocardial biopsy has 20-30% sensitivity
- Echo has minimum value in early stages
- Cardiac magnetic resonance
  - –Late gadolium enhancement or increased T2
- Ga-67 useful but low sensitivity; still part of HRS diagnostic criteria.
- F-18 FDG PET (preferred imaging technique)
  - –High sensitivity (89%)
  - –Detection of activated macrophages
  - –Useful in early stages, before perfusion defects of CMR abnormalities
  - –Can tract response to therapy

USE OF CARDIAC MAGNETIC RESONANCE IN CARDIAC SARCOIDOSIS

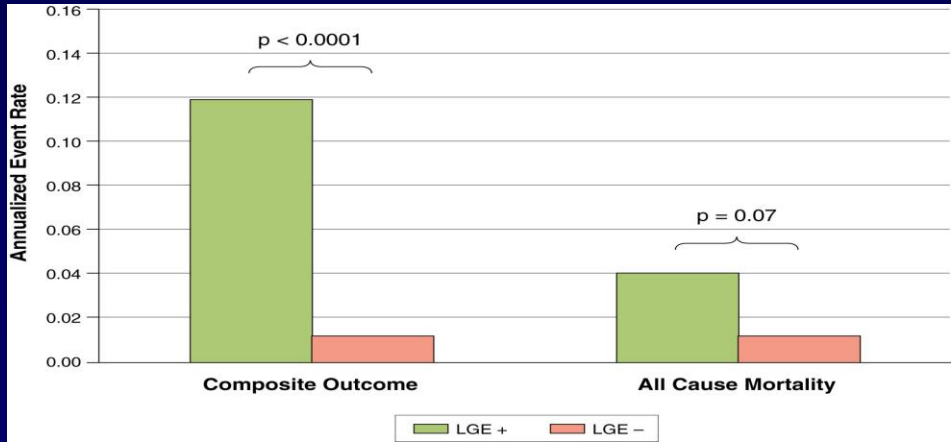


Kadkhodayan A, 2016
JACC Img; 9: 603

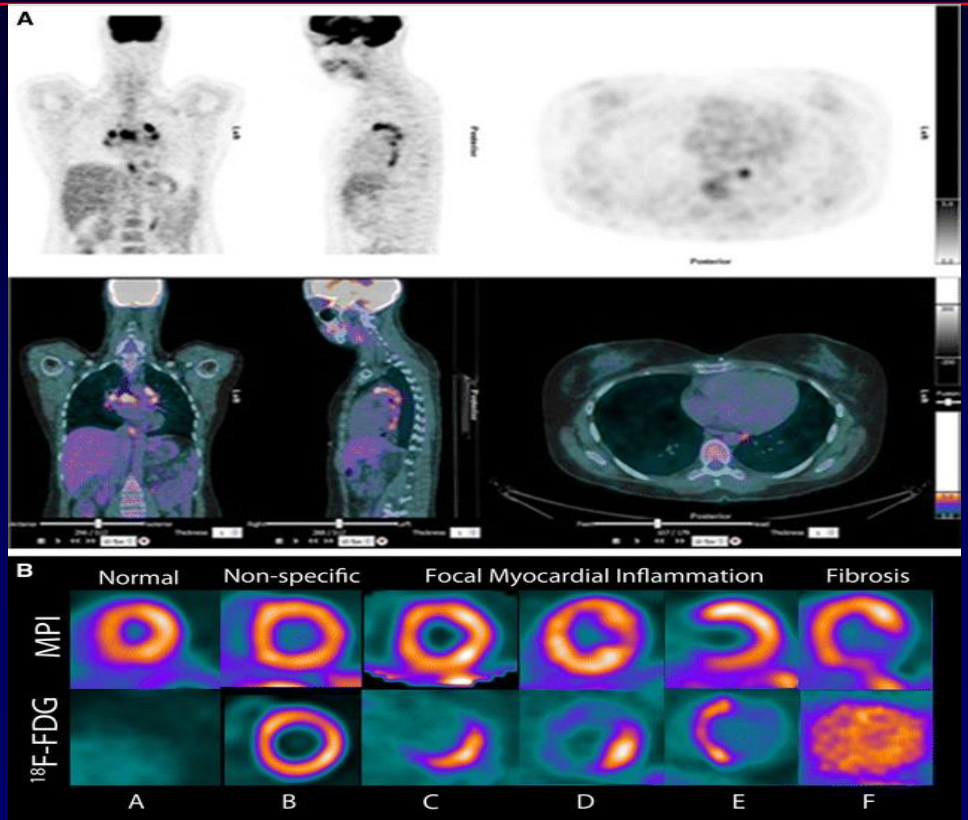
T2 LGE

CMR may be preferred test for serial imaging

Coleman GC et al, 2017
JACC Img 10: 411

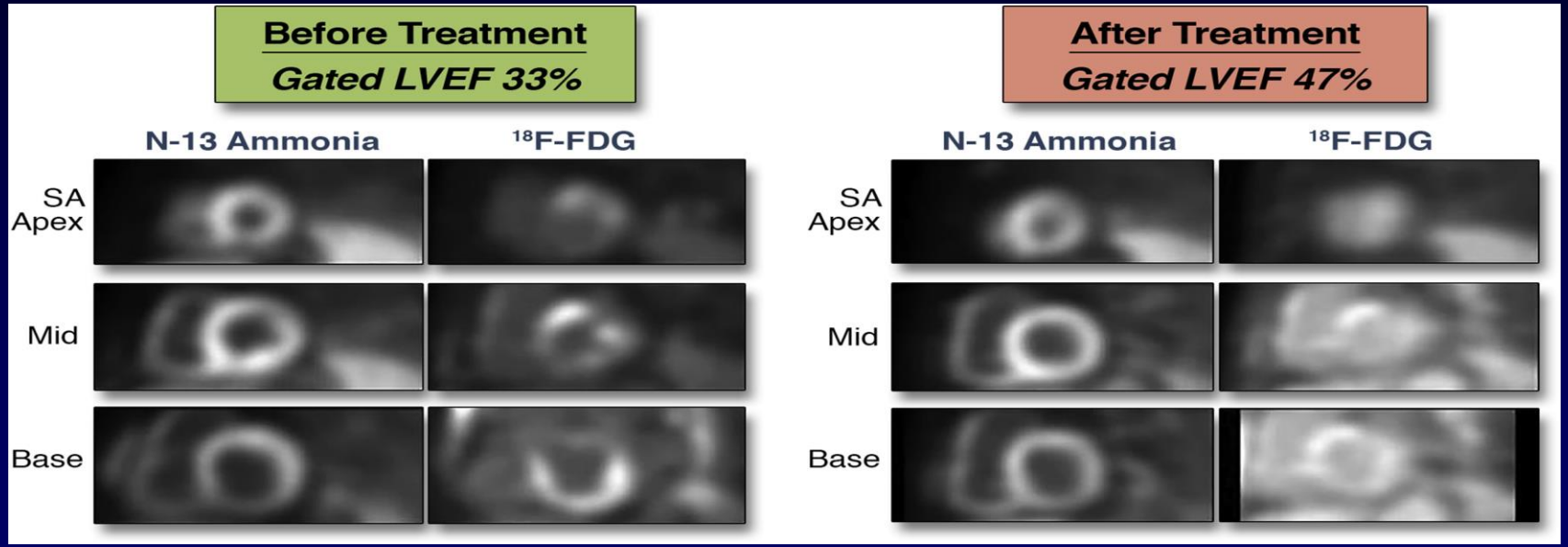


SARCOIDOSIS: PET



Slart RHJA et al
JNC 2018; 25: 298

PET IMAGES OF WOMAN WITH CARDIAC SARCOIDOSIS

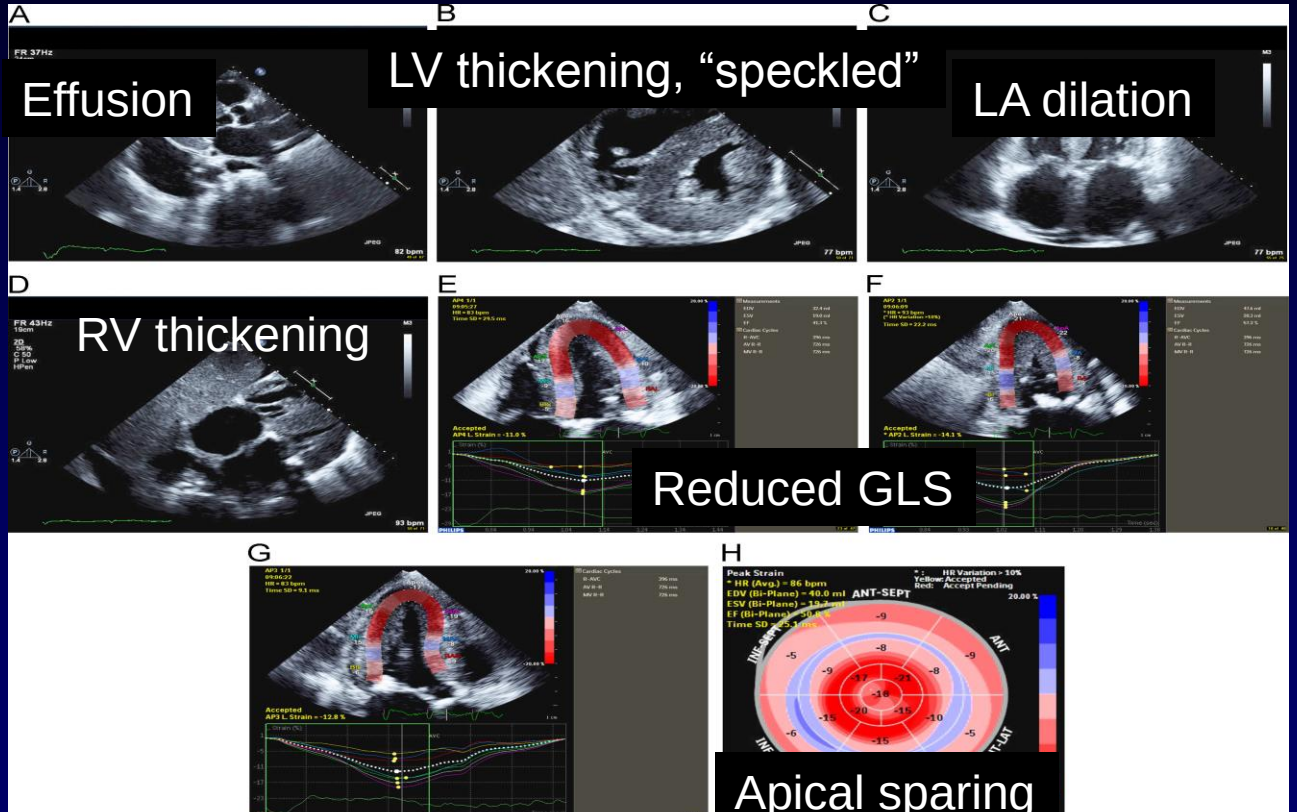


Kadkhodayan A, 2016
JACC Img; 9: 603

CARDIAC AMYLOIDOSIS

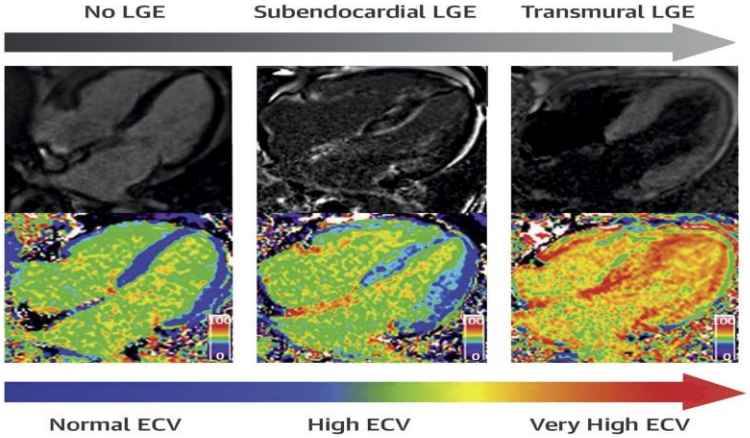
- Restrictive cardiomyopathy
- Systemic process
- Should be suspected in setting of heart failure with increased wall thickness and noon-dilated LV
- Types of amyloidosis
  - –AL (AKA primary)
  - –ATTRwt [(transthyretin wild type) AKA senile]
  - –ATTRm [(transthyretin mutant type) AKA hereditary]

ECHOCARDIOGRAPHY FOR CARDIAC AMYLOIDOSIS

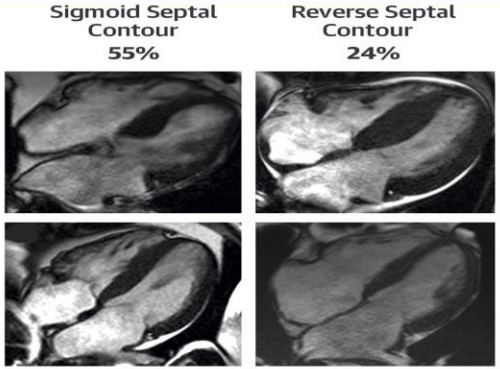


Siddiqi and Rudberg
Trends in CV Med , 2017

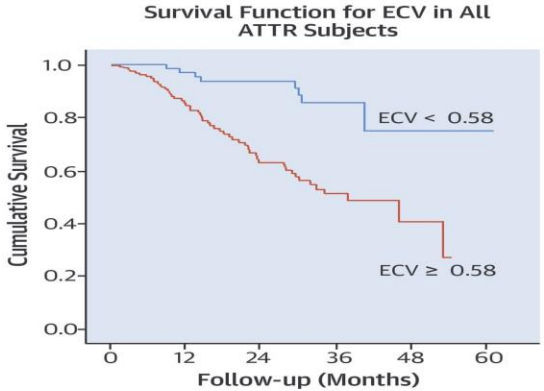
Relationship Between LGE and ECV



Asymmetric Hypertrophy

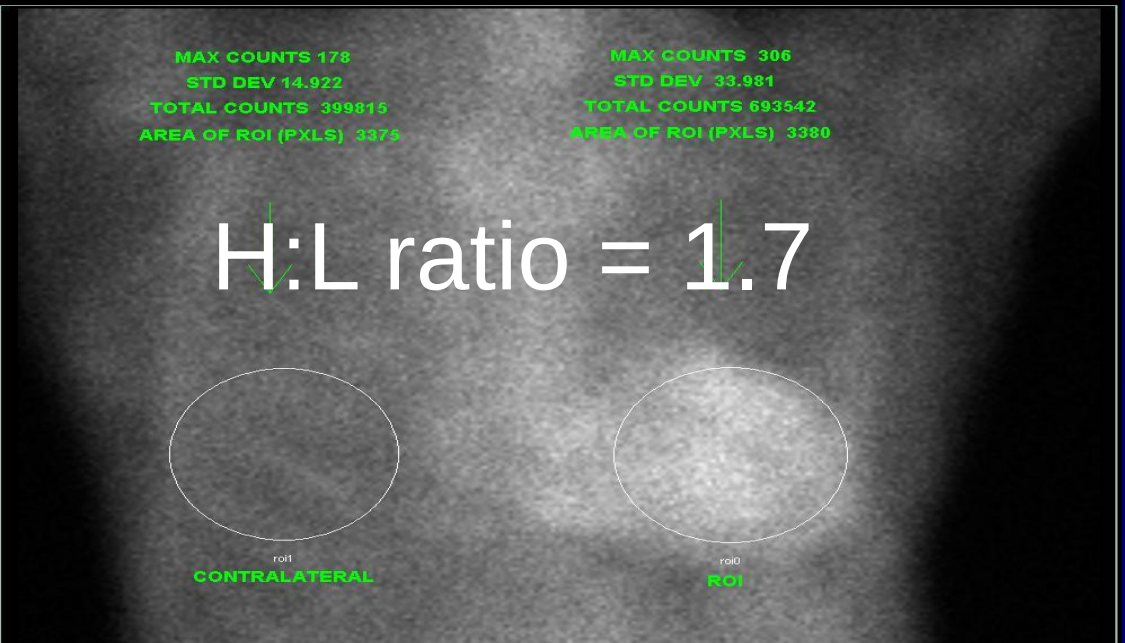


Prognosis



Martinez-Naharro, A. et al. J Am Coll Cardiol. 2017;70(4):466–77.

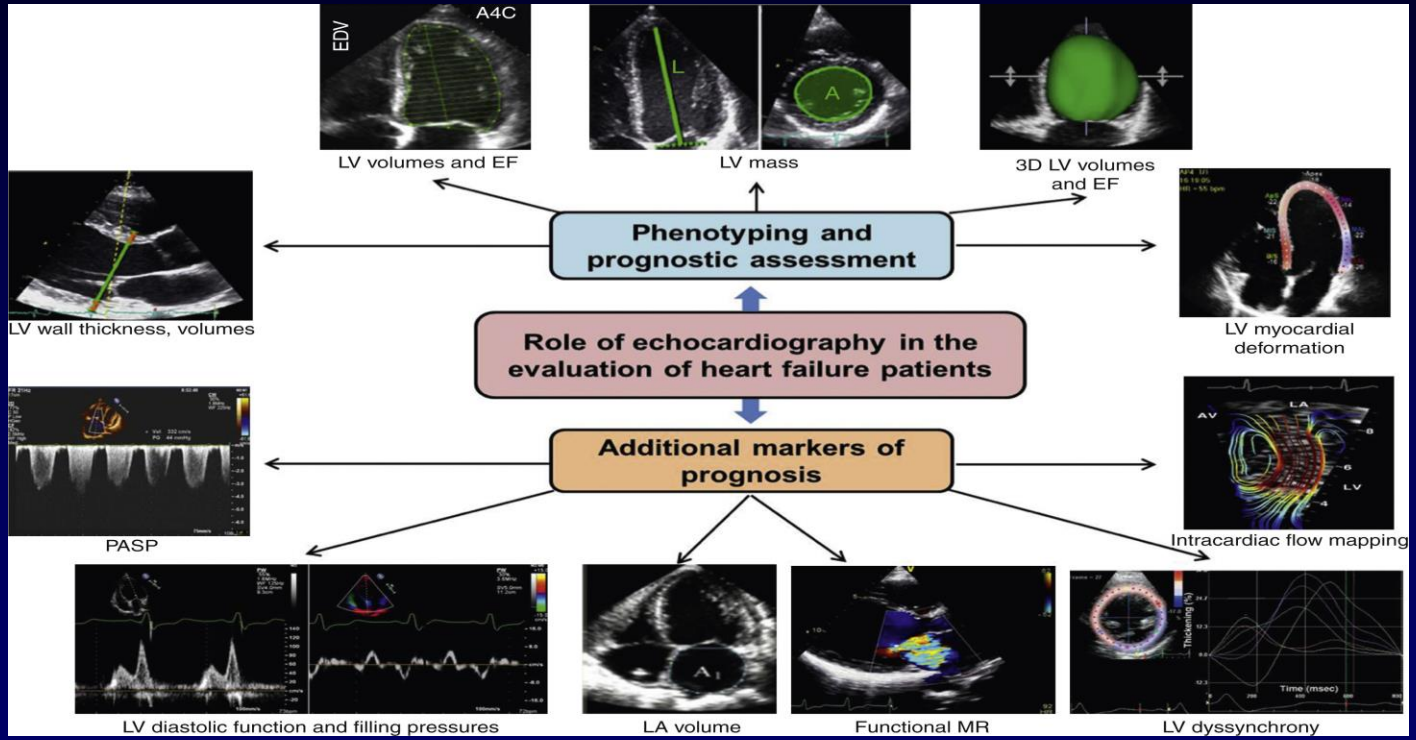
DETECTION AND RISK ASSESSMENT OF ATTR WITH Tc-99m PYROPHOSPHATE IMAGING



- Multicenter trial (n=229)
- High accuracy for detection of ATTR
- Sensitivity=91%
- Specificity=92%
- Worse survival if H:L>1.6

Castano A et al, 2016
JAMA Cardiol 1:880

THE ROLE OF ECHOCARDIOGRAPHY IN HEART FAILURE

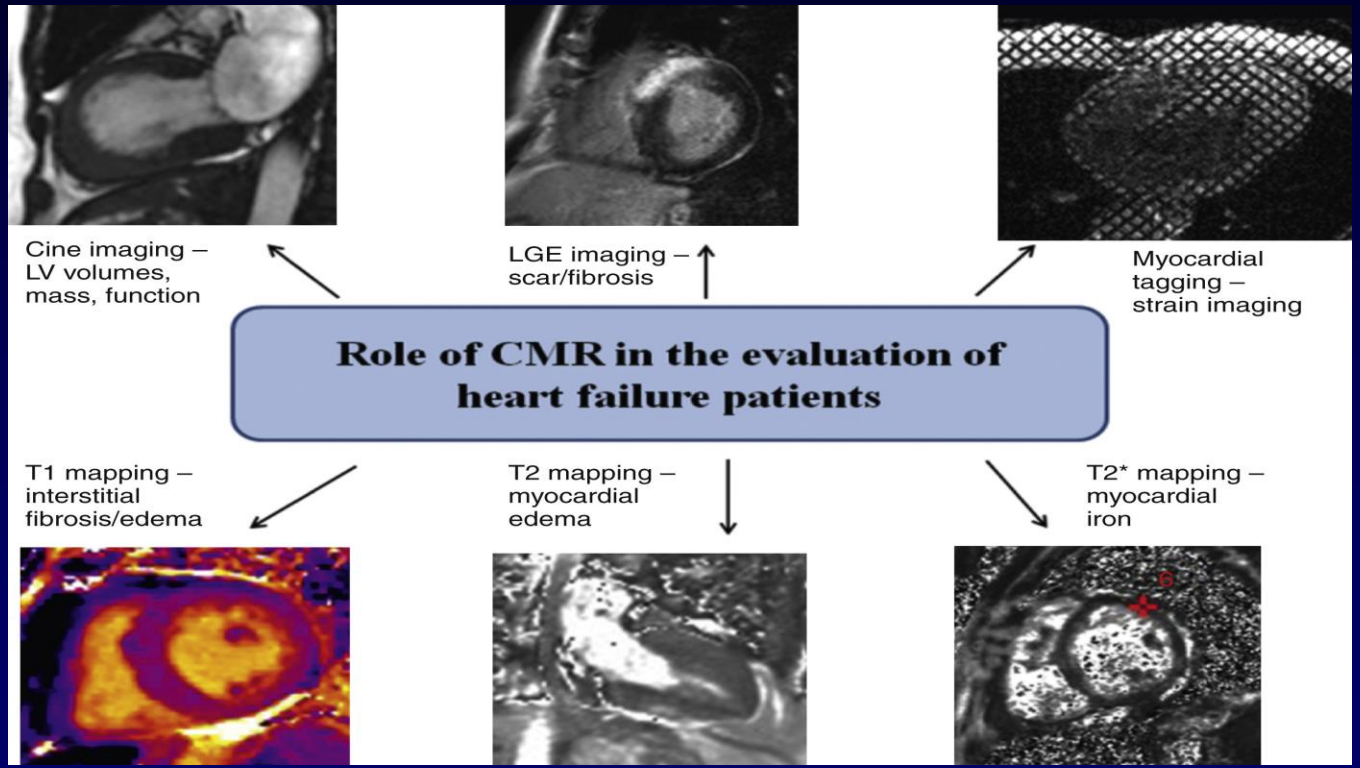


Sengupta PP et al JACC Img 2017; 10: 1056

HAND-HELD ULTRASOUND

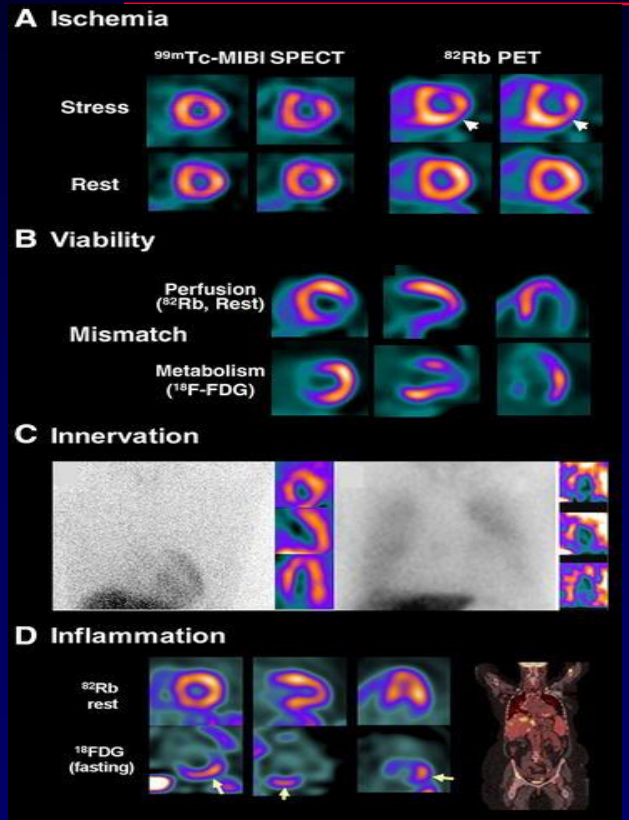
- Use by ED physicians, hospitalists, APP
- May enable more rapid, appropriate Rx

THE ROLE OF CARDIAC MAGNETIC RESONANCE IN HEART FAILURE



Sengupta PP et al, 2017
JACC Img 10: 1056

THE ROLE OF NUCLEAR CARDIOLOGY IN HEART FAILURE



• Perfusion	PET, SPECT agents
• Metabolism	FDG, C-11 agents
• Function	Gated SPECT, PET
• Cell death	PYP, annexin
• RAAS system	Labelled “prils”
• Amyloidosis	PYP, diphosphonate
• Sarcoidosis	FDG, gallium-67
• Innervation	MIBG, HED
• Microvasculature	PET MBF

Caobelli, Bengel JNC 2015; 22: 971

FUTURE DIRECTIONS FOR CARDIAC IMAGING IN HEART FAILURE

- Improved assessment of hemodynamics
- Evaluation of LV remodeling
- Better differentiation between ICM and NICM
- Addition characterization of HFpEF
- Implications of inflammation, edema, necrosis
- Non-invasive endomyocardial biopsy
- Identification of therapeutic targets
- Delineation of candidacy for ICD use
- Optimization of cardiac resynchronization therapy


THANK YOU