Stress Echocardiography

Steven J. Lester MD, FRCP(C), FACC, FASE

MAYO CLINIC

DISCLOSURE

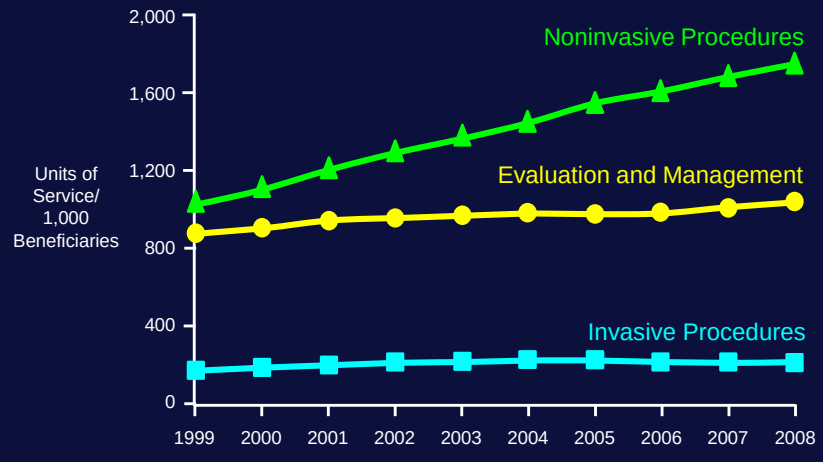
Relevant Financial Relationship(s)

None

Off Label Usage

None

Growth in Services Provided by Cardiologists



Andrus and Welch, Circ Cardiovasc Qual Outcomes. 2012;5:31-36.

Appropriate Use Criteria

ACCF/AHA/ASE/ASNC/HFSA/HRS/SCAI/SCCT/SCMR/STS 2013 Multimodality Appropriate Use Criteria for the Detection and Risk Assessment of Stable Ischemic Heart Disease

A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons

Multimodality Writing Group for Stable Ischemic Heart Disease

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RALPH G. BRINDIS, MD, MPH, MACC, *MODERATOR*, * CHRISTOPHER M. KRAMER, MD, FACC, *WRITING COMMITTEE LIAISON*, * LESLEE J. SHAW, PhD, FACC, FASNC, FAHA, *WRITING COMMITTEE LIAISON*, * MANUEL D. CERQUEIRA, MD, FACC, FASNC,† JERSEY CHEN, MD, FAHA,‡ LARRY S. DEAN, MD, FACC, FAHA, FSCAI,§ REZA FAZEL, MD, FACC,* W. GREGORY HUNDLEY, MD, FACC,‖ DIPTI ITCHHAPORIA, MD, FACC,* PAUL KLIGFIELD, MD, FACC, FAHA,* RICHARD LOCKWOOD, MD,* JOSEPH EDWARD MARINE, MD, FACC,¶ ROBERT BENJAMIN McCULLY, MD, FACC, FASE,#

Journal of Cardiac Failure Vol. 20 No. 2 2014

Stress Echo
Appropriate Use

Symptomatic

- ECG uninterpretable
- Unable to exercise
- Intermediate (10-90%) to high (>90%) pretest likelihood**

Asymptomatic

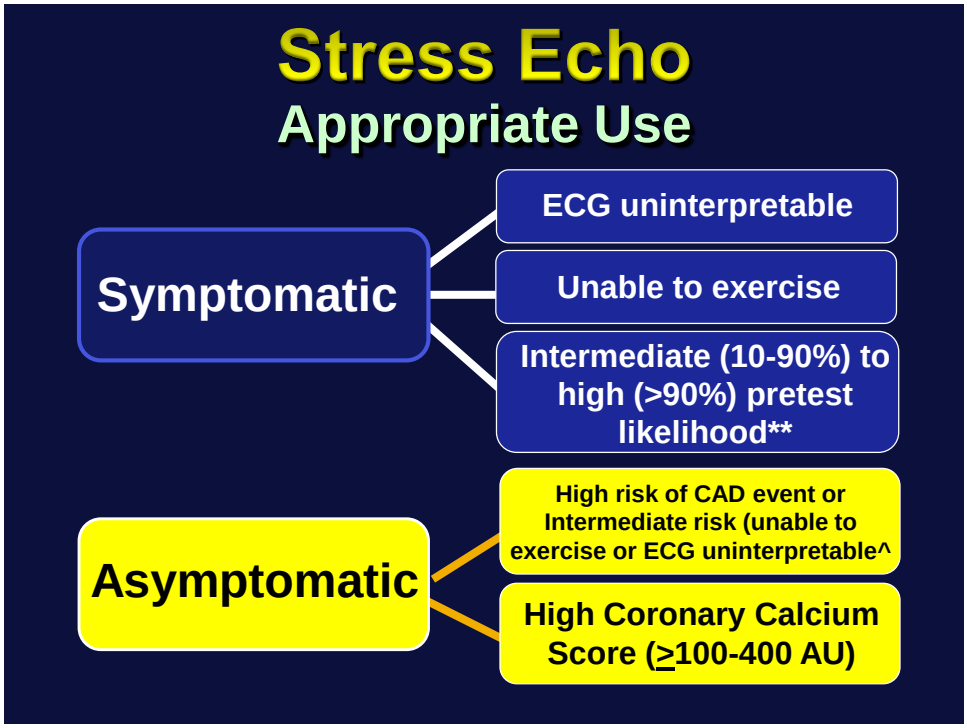
Diamond and Forrester Pre-Test Probability of CAD by Age, Sex and Symptoms

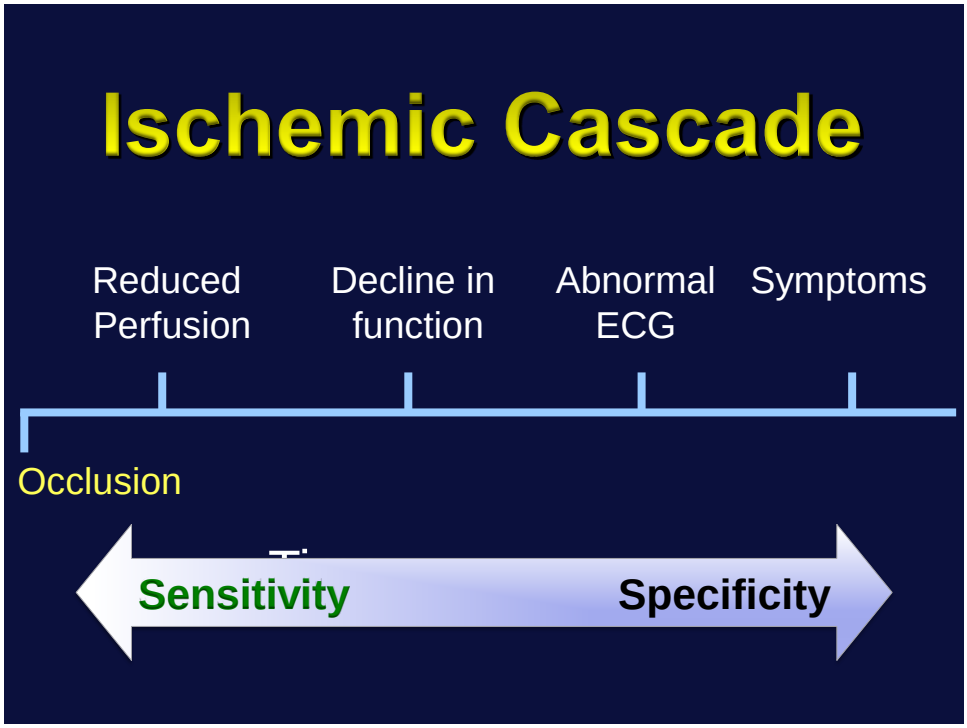
Age (years)	Sex	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40-49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50-59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

Typical (Definite): 1. Substernal chest pain or discomfort; 2. provoked by exertion or emotional stress; 3. relieved by rest and/or nitrogylcerin

Atypical (Probable): Chest pain or discomfort that lacks one of the Characteristics for definite or typical angina.

Nonanginal Chest Pain: Chest pain or discomfort that meets one or none of the Typical angina characteristics.


Stress Echo
Appropriate Use
Symptomatic
ECG uninterpretable
Unable to exercise
Intermediate (10-90%) to high (>90%) pretest likelihood**
Asymptomatic
High risk of CAD event or Intermediate risk (unable to exercise or ECG uninterpretable^
High Coronary Calcium Score (≥100-400 AU)


Ischemic Cascade
Reduced Perfusion
Decline in function
Abnormal ECG
Symptoms
Occlusion
Sensitivity
Specificity

Cardiac Imaging

Prediction of Mortality and Major Cardiac Events by Exercise Echocardiography in Patients With Normal Exercise Electrocardiographic Testing

Alberto Bouzas-Mosquera, MD,* Jesús Peteiro, MD, PHD,* Nemesio Álvarez-García, MD,* Francisco J. Broullón, MS,† Victor X. Mosquera, MD,‡ Lourdes García-Bueno, MD,* Luis Ferro, MD,* Alfonso Castro-Beiras, MD, PHD*§

- **16.7% of patients who did not develop chest pain or ischemic ECG changes developed new or worsening regional wall motion abnormalities (+ Exercise Echo)**
- **Significant prognostic implications for predicting Mortality and MACE.**

Methods We studied 4,004 consecutive patients (2,358 men, mean age [± SD] 59.6 ± 12.5 years) with interpretable

313 patients died, and 183 patients had a MACE before any revascularization procedure. The 5-year mortality and MACE rates were 6.4% and 4.2% in patients without ischemia versus 12.1% and 10.1% in those with ischemia, respectively ($p < 0.001$). In the multivariate analysis, ΔWMSI remained an independent predictor of mortality (hazard ratio [HR]: 2.73, 95% confidence interval [CI]: 1.40 to 5.32, $p = 0.003$) and MACE (HR: 3.59, 95% CI: 1.42 to 9.07, $p = 0.007$). The addition of the EE cise hemodynamic data significantly increased the ($p = 0.005$) and MACE ($p = 0.009$).

Conclusions The use of EE provides significant prognostic information for predicting mortality and MACE in patients with interpretable ECG and normal exercise ECG testing. (J Am Coll Cardiol 2009;53:1981–90)

J Am Coll Cardiol 2009;53:1981-90

Characteristics and Outcomes of Patients With Abnormal Stress Echocardiograms and Angiographically Mild Coronary Artery Disease <50% Stenosis or Normal Coronary Arteries

Aaron M. From, MD, Garvan Kane, MD, PhD, Charles Bruce, MD, Patricia A. Pellikka, MD, Christopher Scott, MS, and Robert B. McCully, MD, *Rochester, Minnesota*

Background: Abnormal cardiac stress imaging findings are not always associated with angiographically significant coronary artery disease. The outcomes of patients with such false-positive findings have not been extensively examined. The aim of this retrospective study was to describe the characteristics and outcomes of patients with abnormal stress echocardiographic findings who had false-positive results compared with those who had true-positive results.

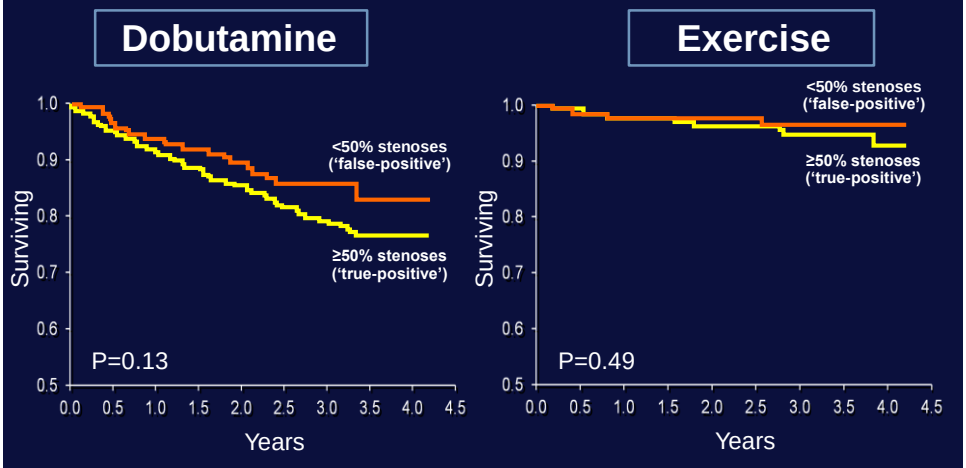
Methods: Of 1,477 consecutive patients (mean age, 66 ± 12 years; 61% men) with abnormal stress echocardiographic findings who underwent coronary arteriography within 30 days, death from any cause was ascertained.

Results: At coronary arteriography, 997 patients (67.5%) had true-positive results, defined by the presence of angiographically significant coronary artery disease (≥50% stenoses), and 480 (32.5%) had false-positive results, defined by <50% stenoses or normal coronary arteries. Of the subgroup of patients with markedly abnormal stress echocardiographic findings (n = 605), 28% had <50% stenoses or normal coronary arteries. During an average follow-up period of 2.4 ± 1.0 years, there were 140 deaths. The adjusted likelihood of subsequent death for patients with <50% stenoses compared to patients with ≥50% stenoses after abnormal stress echocardiography was 1.05 (95% confidence interval, 0.86-1.31; $P = .62$).

Conclusions: A sizable proportion of patients with for coronary angiography have false-positive fr were similar to those of patients with true-positive results. This finding suggests that patients with false-positive results on stress echocardiography should still receive intensive risk factor management and careful clinical follow-up. (J Am Soc Echocardiogr 2010;23:207-14)

J Am Soc Echocardiogr 2010;23:207-14

Abnormal Stress Echo Outcome



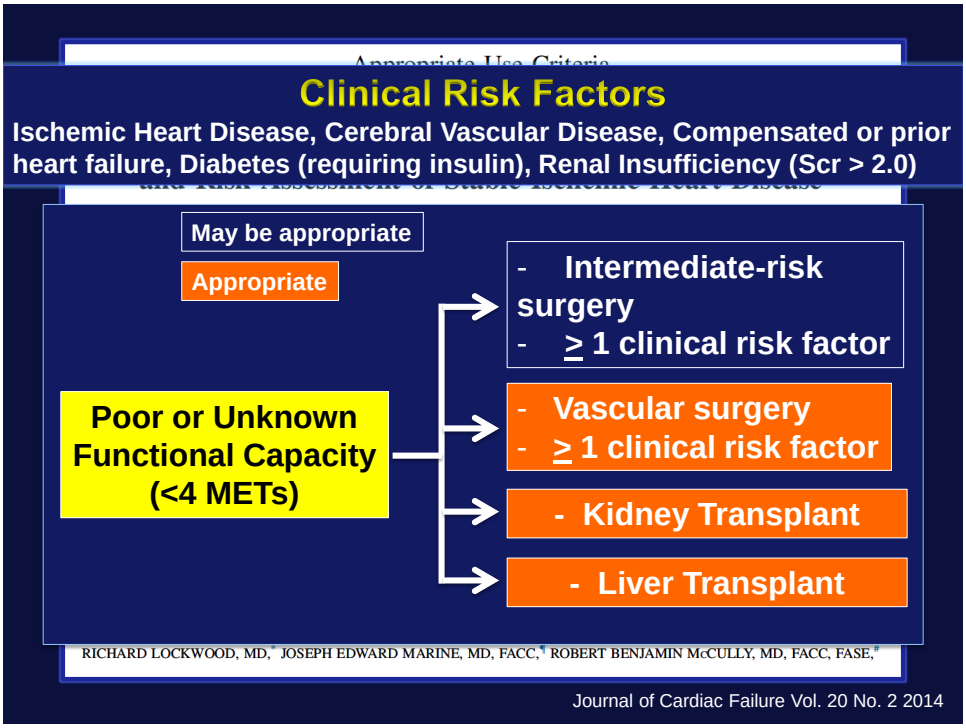
From et al. J Am Soc Echocardiogr 2010;23:207-14

It is Not Always about the **Anatomy.**

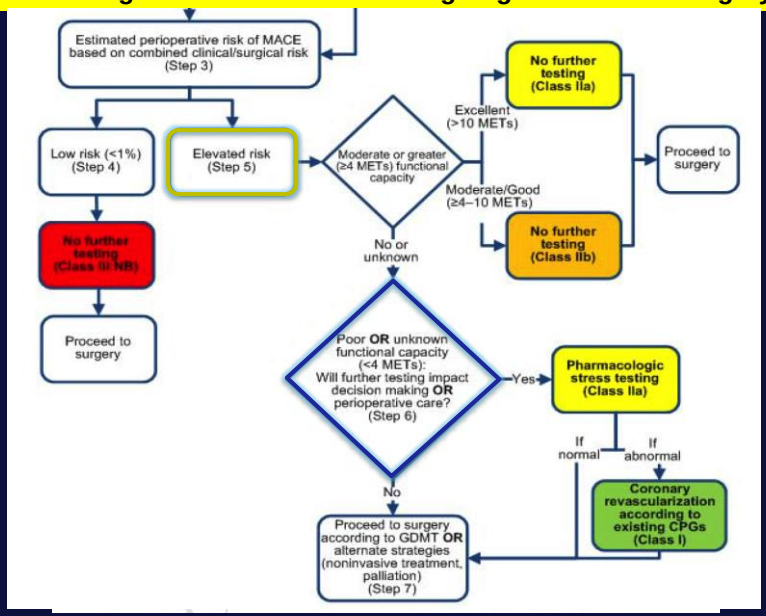
But it is Always about the **Physiology.**

Case

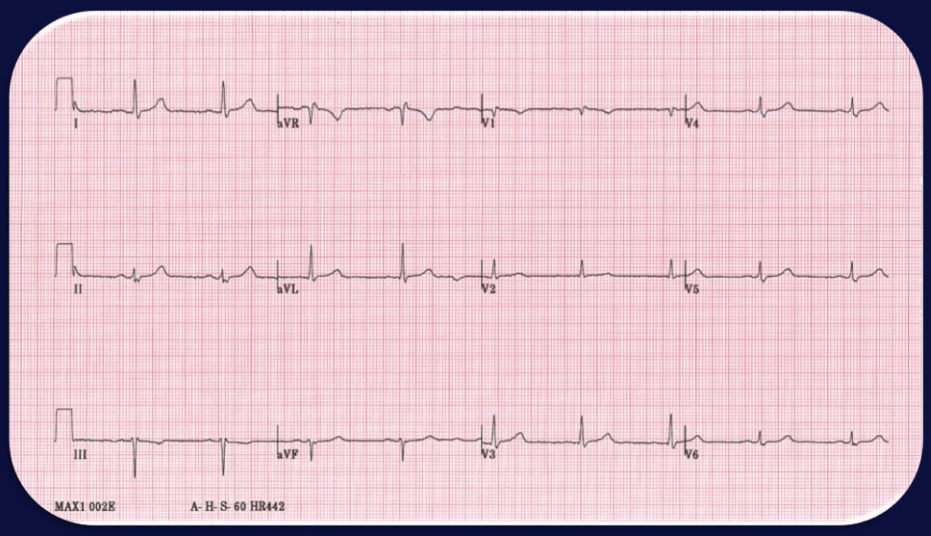
- 73 year old male
- No antecedent CV disease history. Asymptomatic
- Reduced functional capacity due to orthopedic limitations
- Hypertension, diabetes
- Pre-operative cardiac risk stratification prior to an orthopedic procedure

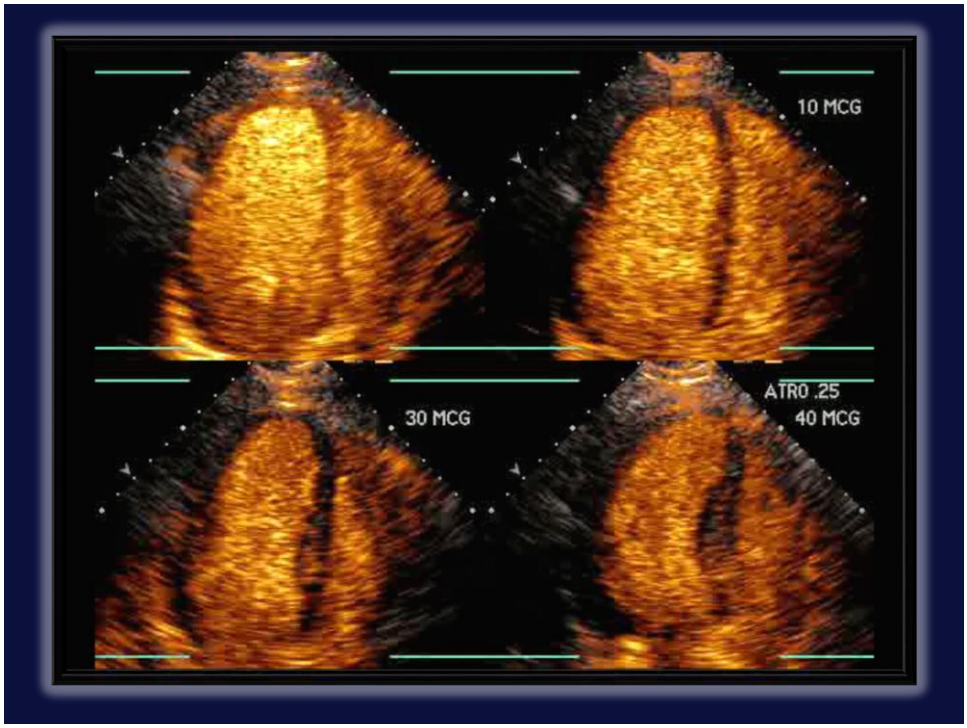


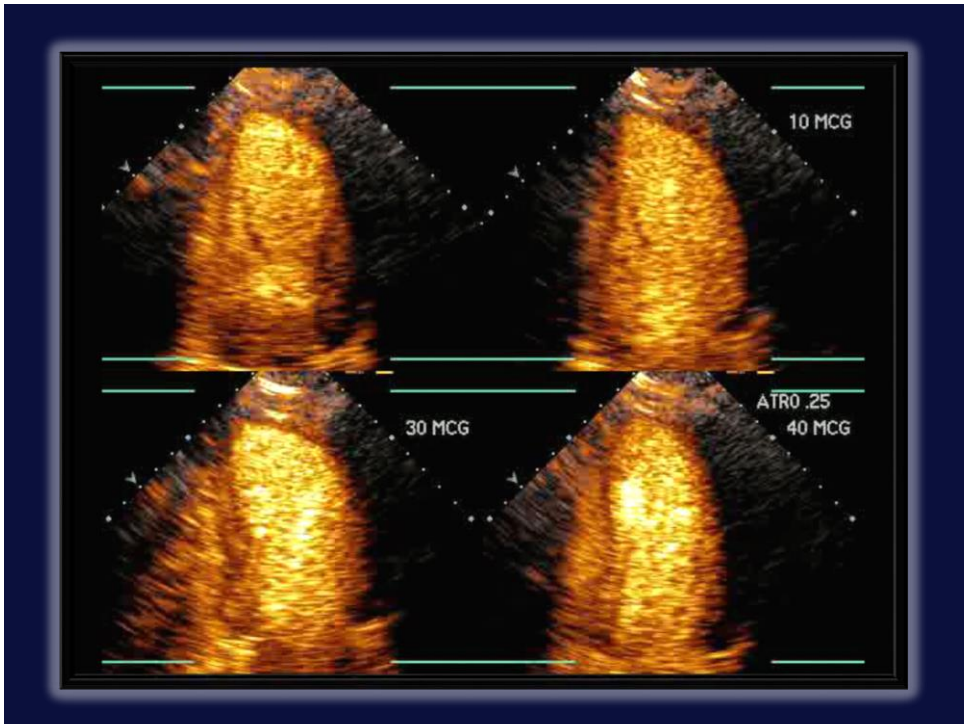
2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery

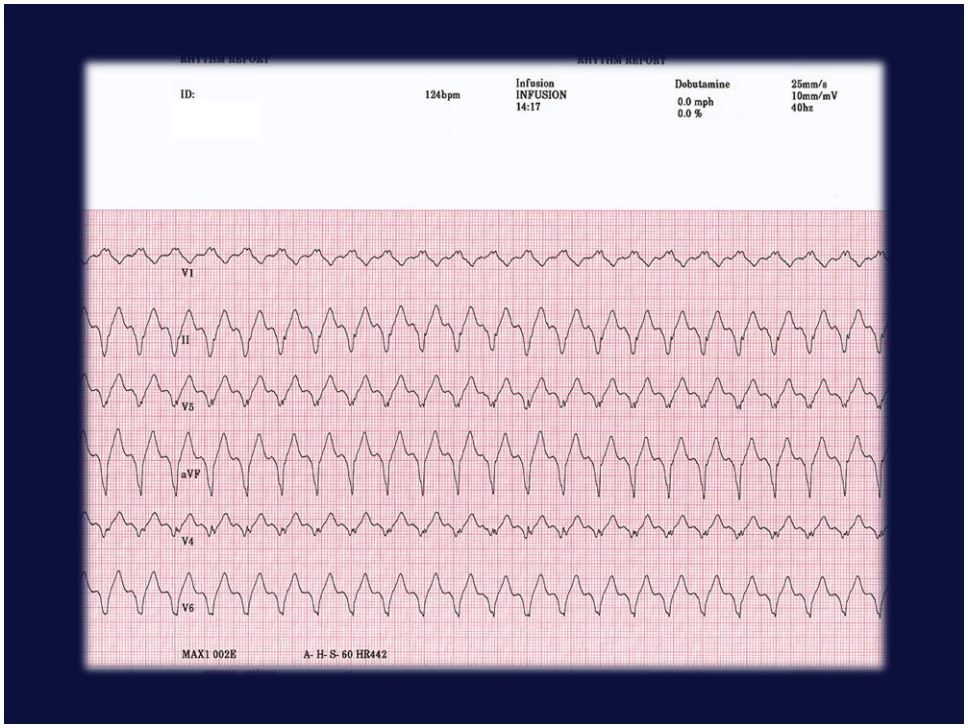


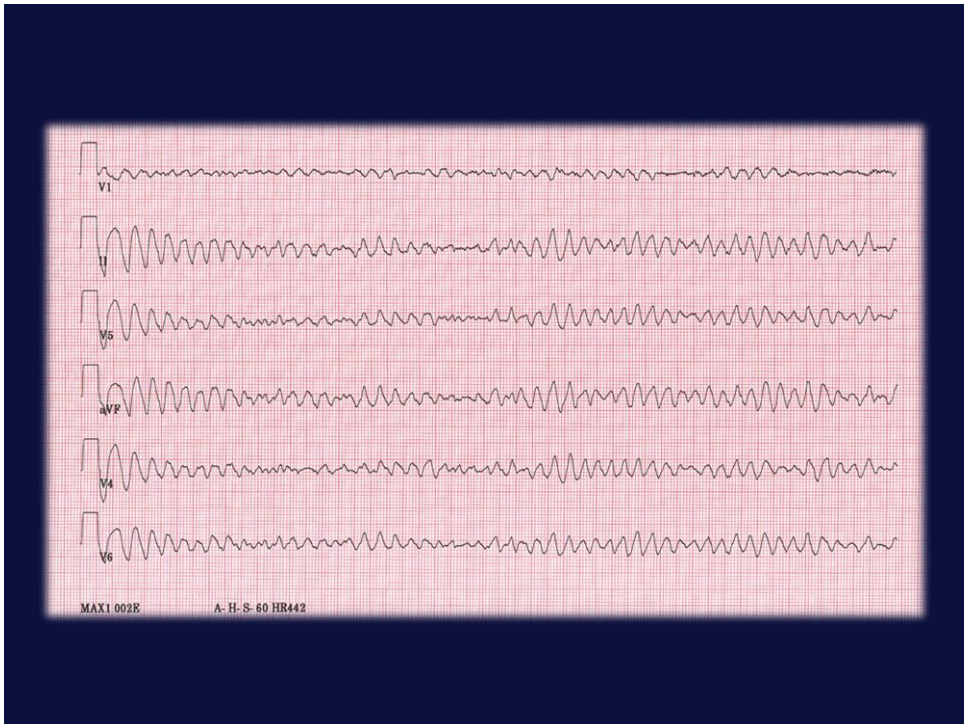
Resting ECG

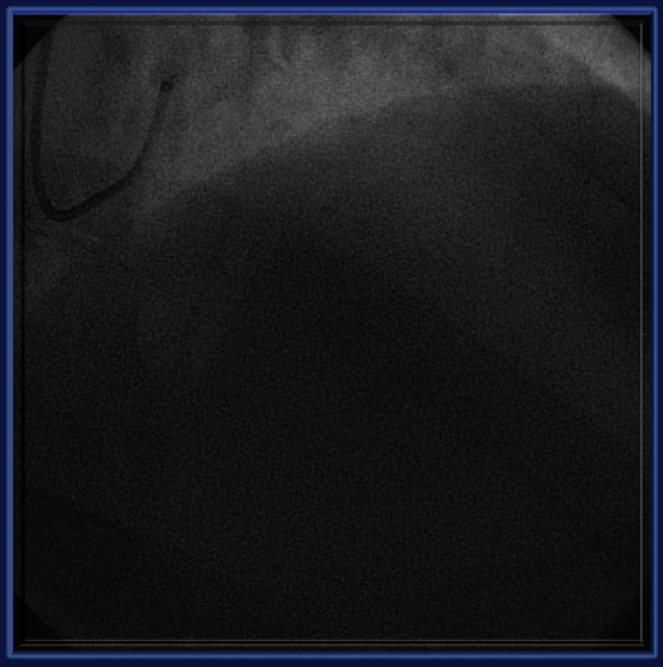



10 MCG
30 MCG
ATRO .25
40 MCG


10 MCG
30 MCG
ATRO .25
40 MCG


ID:
124bpm
Infusion
INFUSION
14:17
Debutamine
0.0 mph
0.0 %
25mm/s
10mm/mV
40hz
V1
II
V5
aVF
V4
V6
MAX1 002E
A- H- S- 60 HR442


V1
II
V5
aVF
V4
V6
MAX1 002E
A- H- S- 60 HR442



Objectives

1. Stress Modalities
2. Interpretation
3. Test Characteristics: Diagnosis
4. Prognostic Value
5. Safety
6. Other Uses
7. Appropriate Use

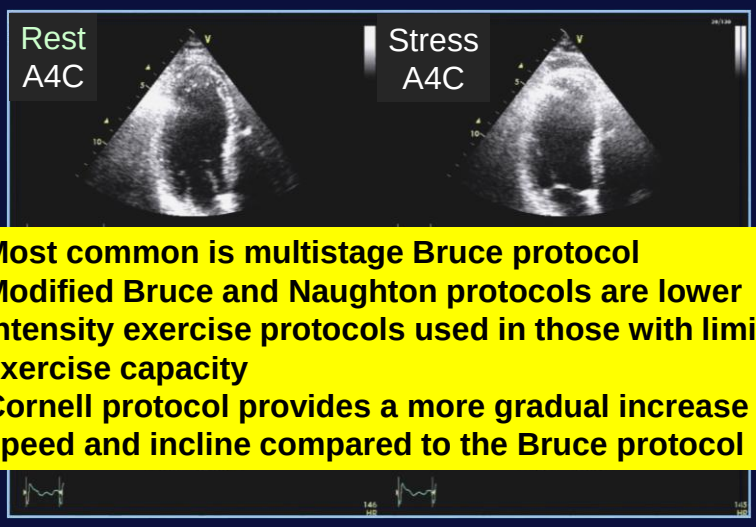
Stress Echocardiography
Modalities

Exercise
- Treadmill
- Bicycle
  - -Supine
  - -Upright

Pharmacologic
- Dobutamine / Atropine
- Vasodilator
  - -Dipyradamole
  - -Adenosine

Other
- Handgrip
- Pacing

Stress Echocardiography
Treadmill



- Most common is multistage Bruce protocol
- Modified Bruce and Naughton protocols are lower intensity exercise protocols used in those with limited exercise capacity
- Cornell protocol provides a more gradual increase in speed and incline compared to the Bruce protocol

Stress Echocardiography Bicycle

- The cycles are calibrated in kiloponds or Watts which can then be converted to metabolic equivalents (METs).
- It may allow image acquisition during exercise… Doppler information.

Treadmill Versus Supine Bicycle

Hemodynamic Effects	Upright	Supine
Duration and Maximum Workload	>	
Heart Rate	>	
End-diastolic Volume		>
Mean Arterial Pressure		>
Wall Stress		>
Myocardial Oxygen Demand		>
Filling Pressures		>

Exercise Stress Echocardiography Indications To Stop

Absolute

- ST elevation ≥ 1 mm in leads without Q waves
- Ventricular tachycardia
- Decrease in systolic blood pressure > 10 mm Hg from baseline with other signs of ischemia
- Moderate to severe angina
- Nervous system symptoms
- Signs of poor perfusion (cyanosis, pallor)
- Technical difficulties with ECG or blood pressure monitoring
- Patient's desire to stop

Relative

- Arrhythmias other than ventricular tachycardia
- ST or QRS changes including horizontal or downsloping ST depression > 2 mm
- Development of bundle branch block or intraventricular conduction delay that cannot be distinguished from ventricular tachycardia
- Increasing chest pain
- Decrease in systolic blood pressure > 10 mm Hg from baseline without other signs of ischemia
- Fatigue, shortness of breath, wheezing, leg cramps, claudication
- Hypertensive response (> 250 mm Hg systolic and/or > 115 mm Hg diastolic)

Stress Echocardiography Pharmacologic

Inotropic / Dobutamine

- Dobutamine acts directly on β-1 adrenergic receptors → Increase in HR and Contractility (4x in normal subjects and < 2x in those with DCM)
- As dobutamine dose increases there is a greater β-2 response resulting in peripheral vasodilation which may lead to a drop in BP
- Compared with exercise LV volumes and wall stress increase less with dobutamine.

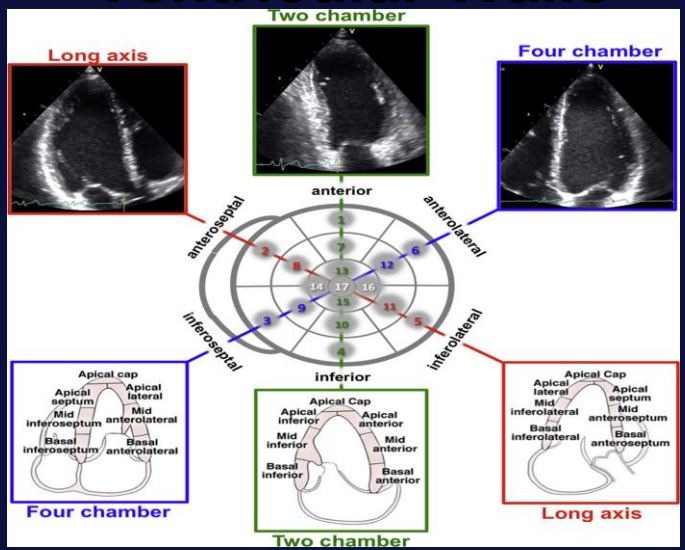
Stress Echocardiography Pharmacologic

Vasodilators

- Dipyridamole, adenosine, regadenoson
- Small decrease in BP and increase in HR
- If obstructive epicardial disease or microcirculatory dysfunction

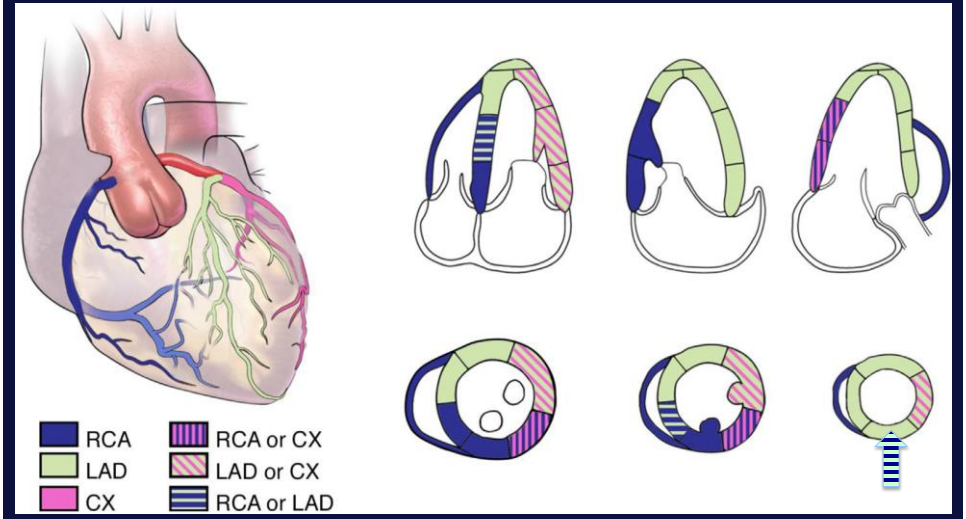
Heterogeneity of coronary blood flow between areas subtended by stenosis Vs. normal coronary arteries.

Segmental Analysis of Left Ventricular Walls



Lang RM et al. J Am Soc Echocardiogr 2015;28:1-39

Arterial Distribution



Lang RM et al. J Am Soc Echocardiogr 2015;28:1-39

Stress Echocardiography
Interpretation

Change in LV Ejection Fraction

- **Increase EF: Normal** (global contractile reserve in patients with no resting dysfunction is defined by ≥ 5% increase in LVEF)
- **No change or decrease: Abnormal**

Change in LV end-systolic size / volume

- **Decrease: Normal** (Flow reserve is defined by ≥ 20% increase in forward stroke volume)
- **No change or increase: Abnormal (**supine bike)**

Regional LV Function Evaluation

- **Wall thickening, Wall motion Score Index**

Segmental Wall Motion Scoring

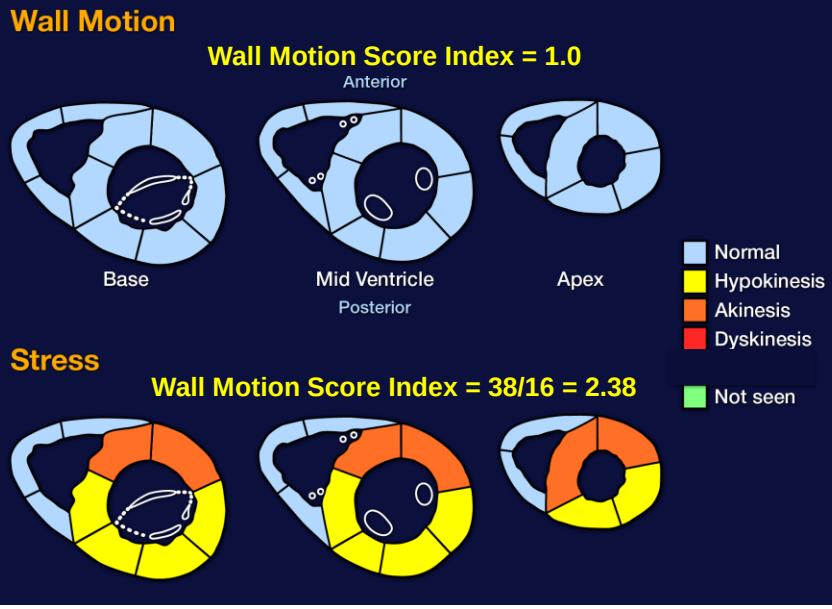
1 = Normal or hyperdynamic: (systolic increase in thickness >50%)

2 = Hypokinetic: delay in the velocity or onset of contraction (<30-40% systolic increase in thickness)

3 = Akinesis or minimal thickening: <10%

4 = Dyskinetic: Systolic outward motion of the segment

Wall Motion Score Index



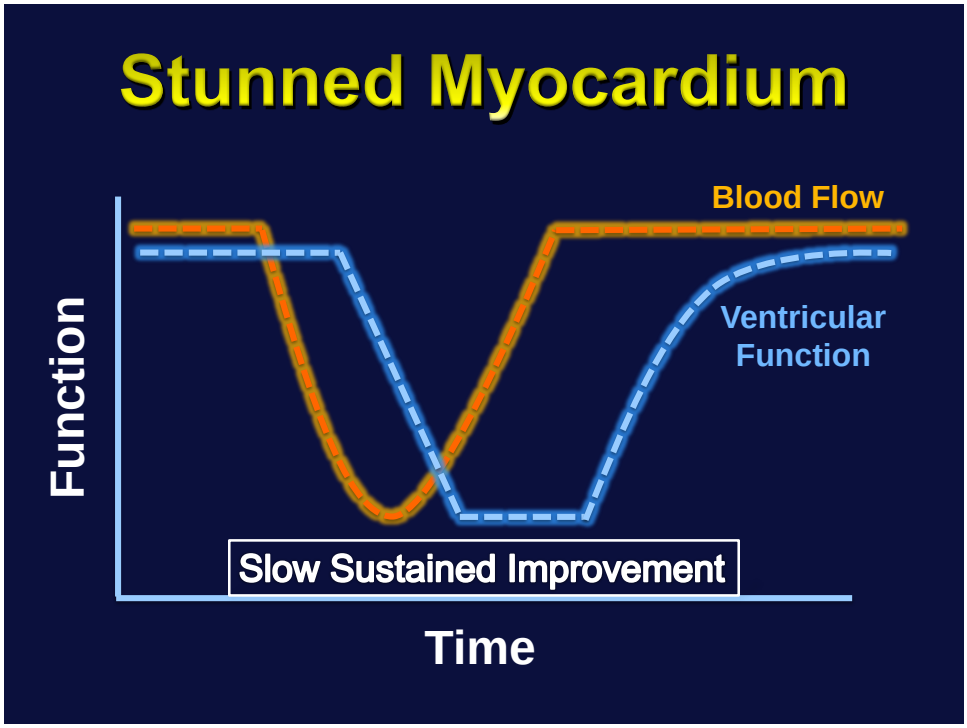
Interpretation Of Wall Motion

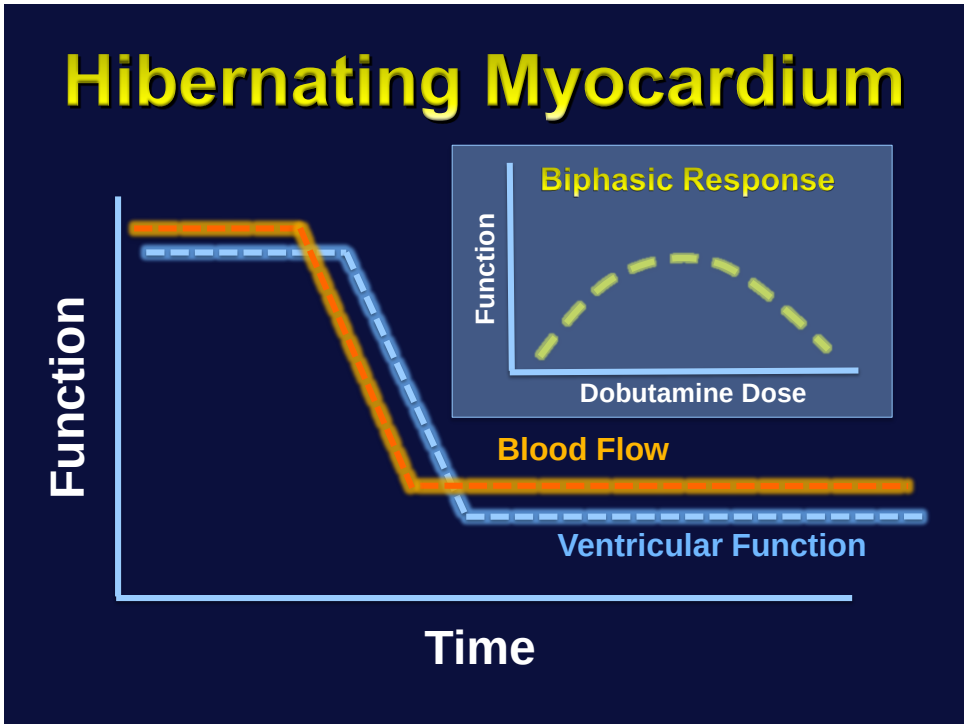
Rest	Stress	Interpretation
Normokinetic	Normal-hyperkinetic	Normal
Normokinetic	Wall Motion abnormality (segment worsens function)	Ischemic Response
Hypokinetic	Akinetic / Dyskinetic (segment worsens function)	Ischemic Response
Resting Dysfunction	Fixed / No Change in Function	Infarct / Necrotic
Resting Dysfunction	Slow Sustained Improvement	Stunning or Cardiomyopathy
Resting Dysfunction	Biphasic Response	Hibernating
Akinetic	Dyskinetic	Passive / Mechanical

Cause of Wall Motion Abnormalities

Wall Motion Abnormalities at Rest

- Ischemic heart disease
  - -Infarction
  - -Stunned / Hibernating
- Conduction
  - -Pacing
  - -LBBB
- Cardiomyopathy
- Myocarditis
- Right ventricular volume / pressure overload


Stunned Myocardium
Blood Flow
Ventricular Function
Function
Slow Sustained Improvement
Time


Hibernating Myocardium
Biphasic Response
Function
Dobutamine Dose
Function
Blood Flow
Ventricular Function
Time

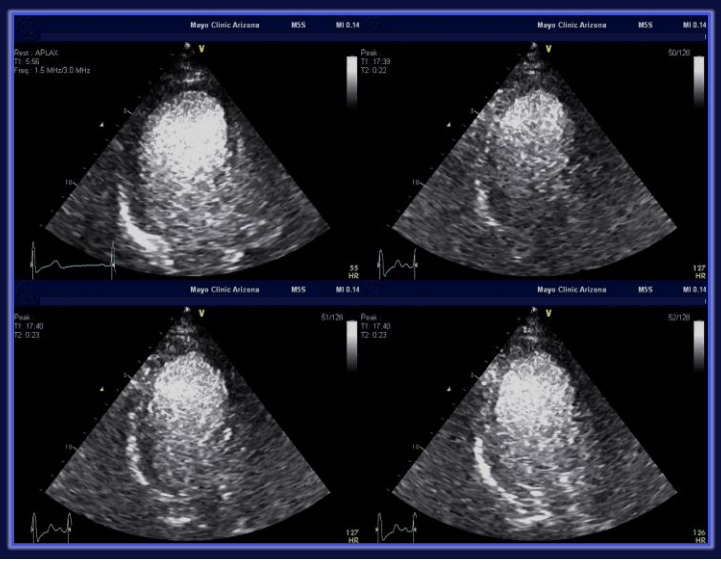
Cause of Wall Motion Abnormalities

Wall Motion Abnormalities at Rest

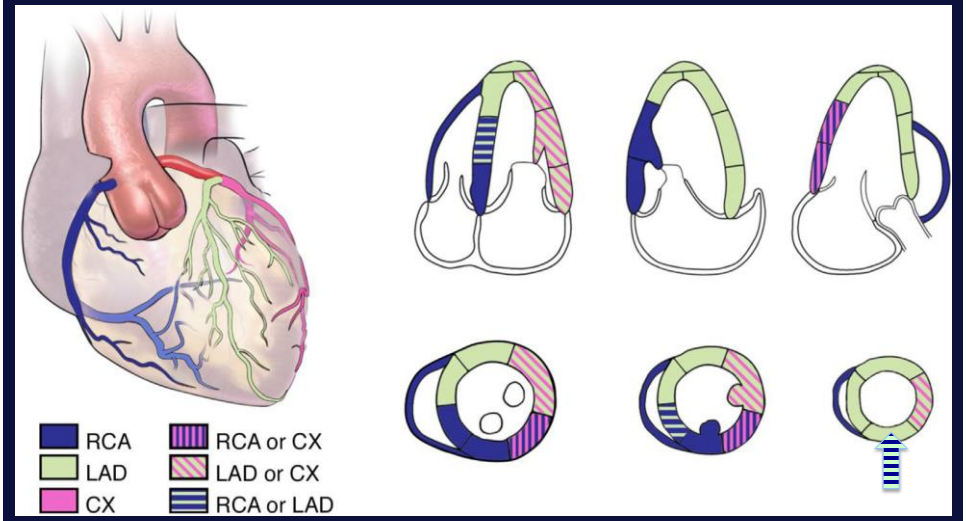
- Ischemic heart disease
  - -Infarction
  - -Stunned / Hibernating
- Conduction
  - -Pacing
  - -LBBB
- Cardiomyopathy
- Myocarditis
- Right ventricular volume / pressure overload

Wall Motion Abnormality

Conduction



Arterial Distribution



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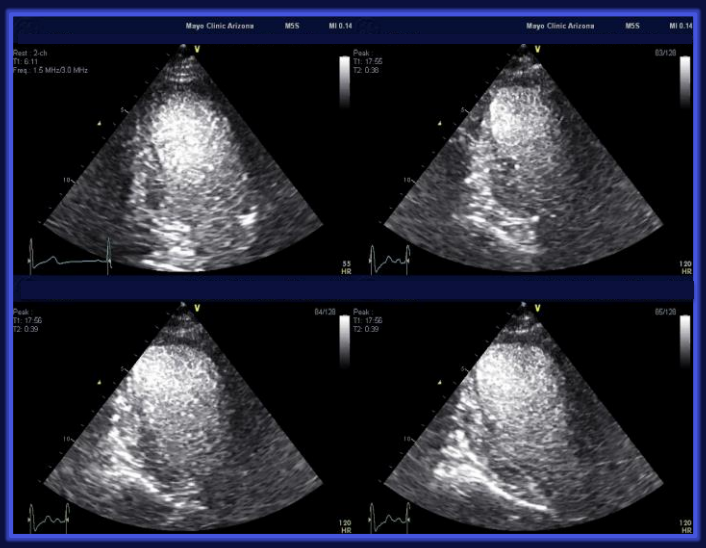
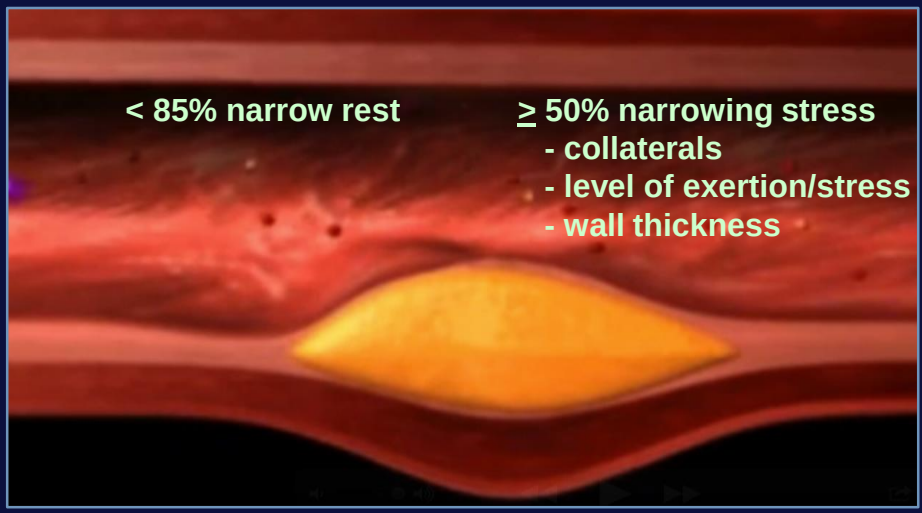
Wall Motion Abnormality
Conduction



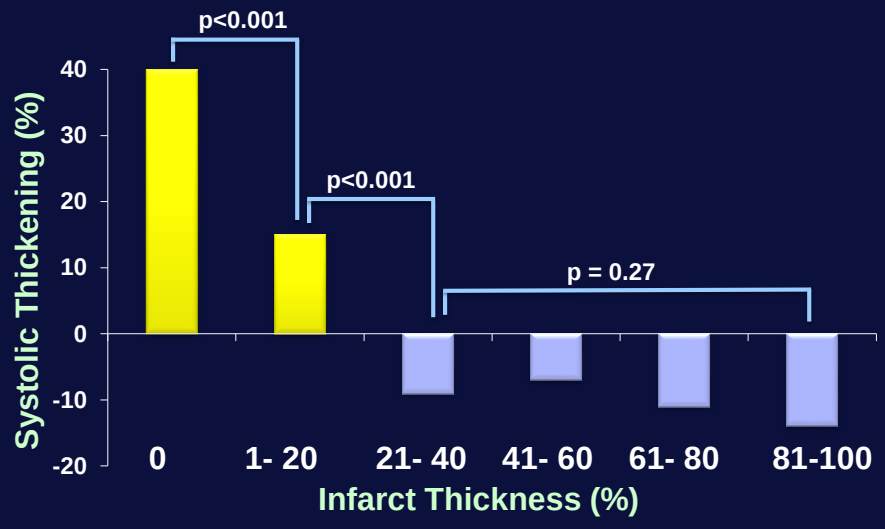
Cause of Wall Motion Abnormalities

Wall Motion Abnormalities at Rest	Wall Motion Abnormalities during Stress
• Ischemic heart -Infarction -Stunned / Hibernating •Conduction -Pacing -LBBB •Cardiomyopathy •Myocarditis •Right ventricular volume / pressure overload	• Ischemia with obstructive epicardial CAD • Ischemia in the absence of epicardial obstruction -hypertensive response -microvascular disease • Cardiomyopathy • Rate-related LBBB • Pulmonary

Wall Motion Abnormality
Diameter Stenosis



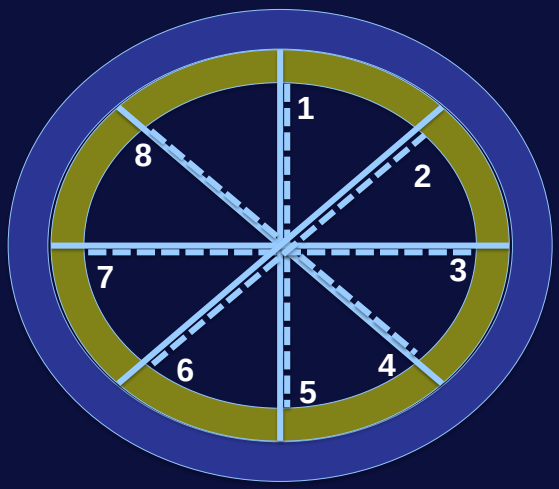
Transmural Extent of Infarct Thickness and Systolic Thickening



Lieberman et al. Circulation 1981;63;739-46

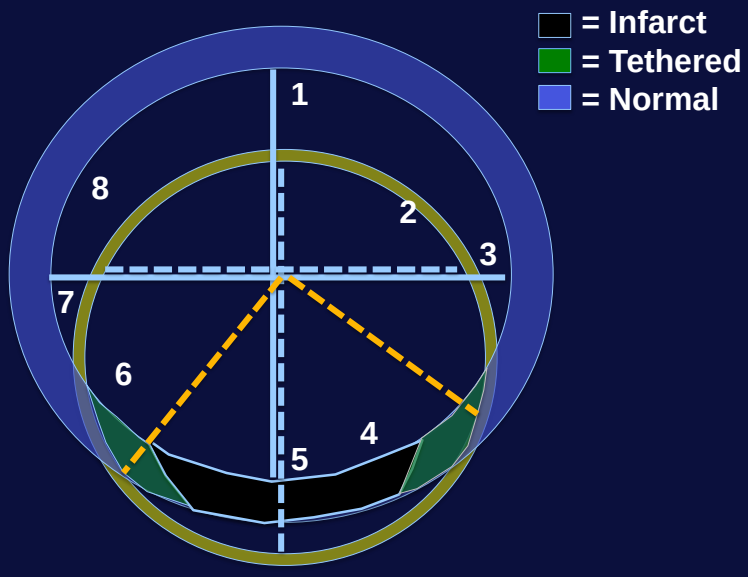
Quantitative Evaluation of Left Ventricular Function

Chordal Center Line Analysis (Centroids)

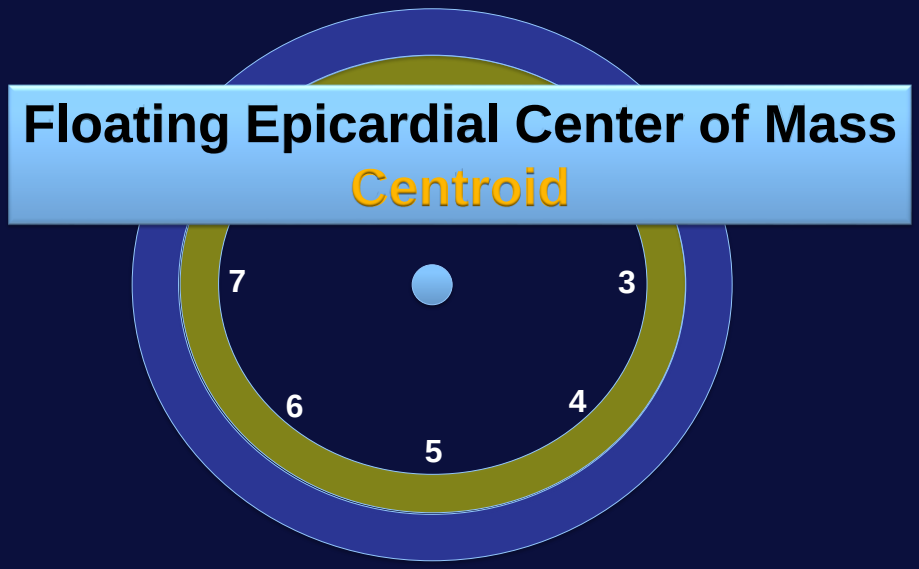


Dyskinesis

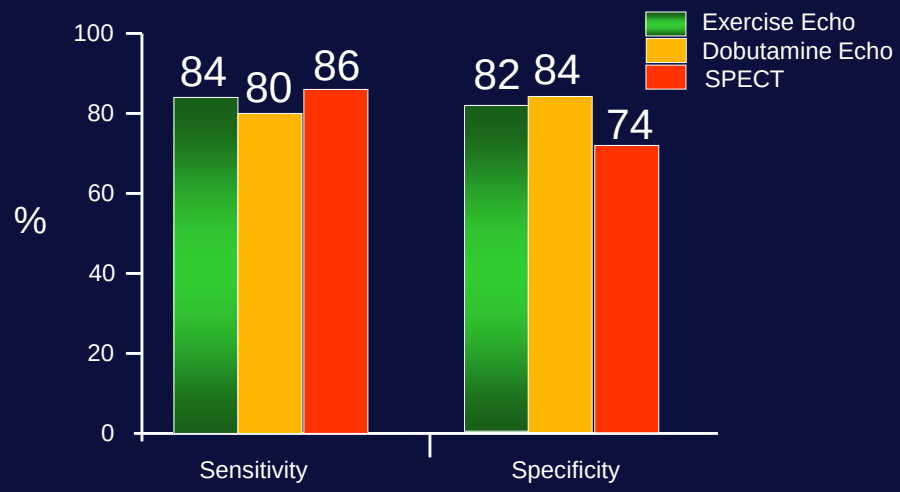
Tethering



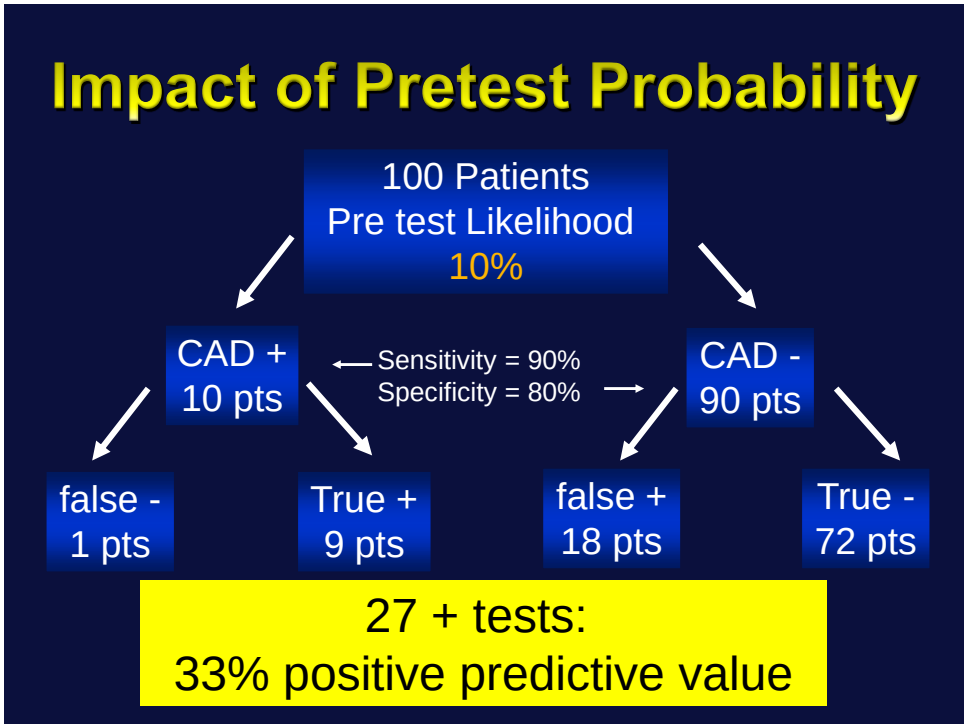
Translation and Rotation

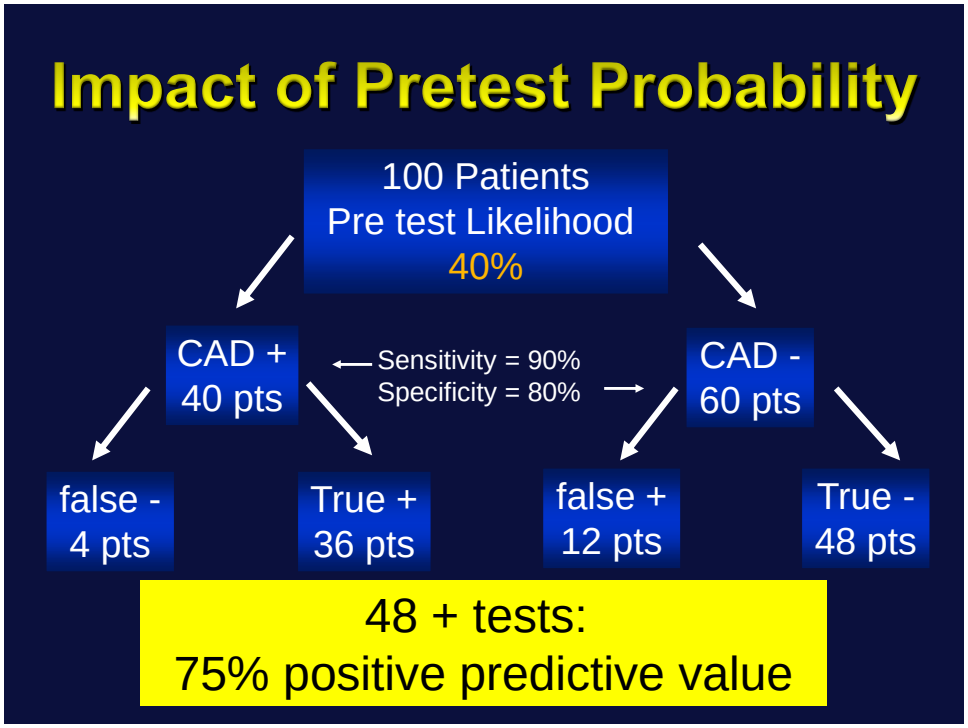


Test Characteristics:
Diagnosis - CAD



Schuijf Eur J Nucl Med Mol Imaging 2006;33:93


Impact of Pretest Probability
100 Patients
Pre test Likelihood
10%
CAD +
10 pts
Sensitivity = 90%
Specificity = 80%
CAD -
90 pts
false -
1 pts
True +
9 pts
false +
18 pts
True -
72 pts
27 + tests:
33% positive predictive value


Impact of Pretest Probability
100 Patients
Pre test Likelihood
40%
CAD +
40 pts
Sensitivity = 90%
Specificity = 80%
CAD -
60 pts
false -
4 pts
True +
36 pts
false +
12 pts
True -
48 pts
48 + tests:
75% positive predictive value

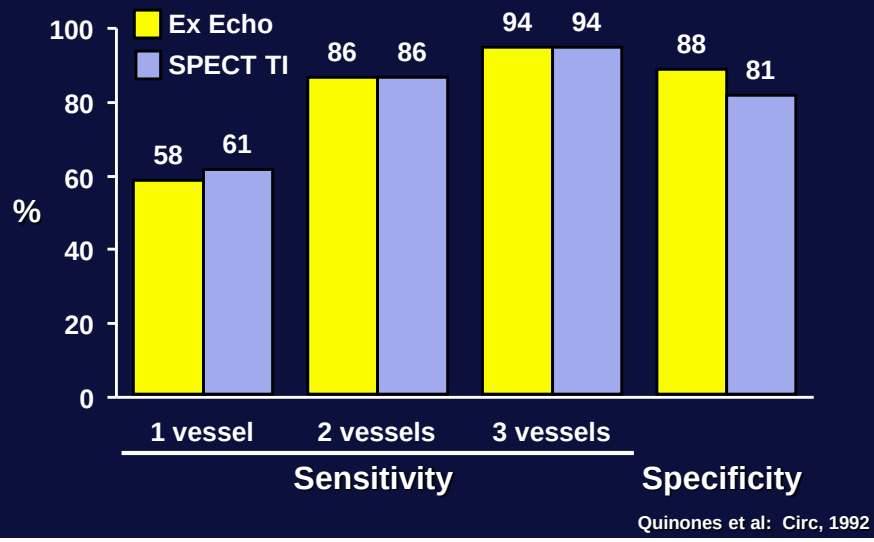
Test Characteristic:
Diagnostic Criteria

Sensitivity

1 Segment, > 1 Segment, LV dilation

Specificity

Test Characteristics
Exercise Echo vs SPECT TI



Quinones et al: Circ, 1992

Stress Echocardiography

Risk of adverse event
Prognosis

Detection/Exclusion CAD
Diagnosis

Normal SECHO
Physical or Pharmacologic

Very Low Risk

- **< 1% per year risk of MI, cardiac death or late revascularization**

Low Risk

- **1-3% per year risk of MI, cardiac death or late revascularization**

-submaximal stress (men <7 METS, women < 5 METS)

-LVEF <40%

Mertz et al. J Am Coll Cardiol 2007;49:227–37
Sicari et al. European Heart Journal (2009) 30, 278–289

Safety of Stress Echocardiography Supervised by Registered Nurses: Results of a 2-Year Audit of 15,404 Patients

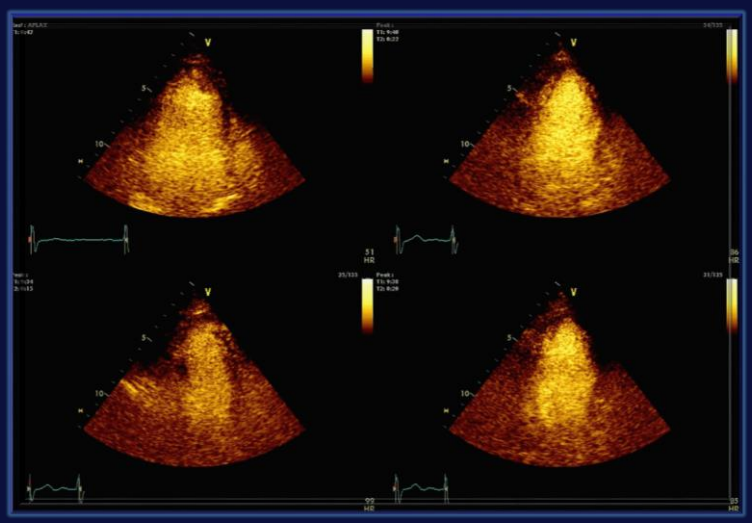
Garvan C. Kane, MD, PhD, Mary J. Hepinstall, RN, Glenda M. Kidd, RN,

	ExEcho n=8592	DSE n= 6755	P value	Total n = 5349
Overall Complication Rate	8 (0.09%)	47 (0.7%)	<0.001	55 (0.36%)
Arrhythmia Requiring Rx	4 (0.05%)	39 (0.58%)	<0.001	43 (0.28%)
SVT / AF	4 (0.05%)	33 (0.49%)	<0.001	37 (0.24%)
VT / VF	0	6 (0.09%)	<0.005	6 (0.04%)
Markedly + / Prolonged CP requiring hospitalization	3 (0.03%)	5 (0.07)	0.56	8 (0.05%)
Symptomatic hypotension requiring hospitalization	1 (0.01%)	3 (0.04%)	0.44	4 (0.03%)
Transfer to Hospital	5 (0.06%)	21 (0.31%)	0.0005	26 (0.17)
Cardiac Rupture or Death	0	0	----	0

comparable with previously reported studies evaluating the safety of stress echocardiography supervised by physicians.

Stress Echocardiography

Diastolic Stress Test



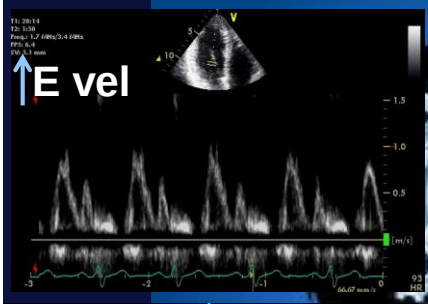
Diastolic Stress Echocardiography: A Novel Noninvasive Diagnostic Test for Diastolic Dysfunction Using Supine Bicycle Exercise Doppler Echocardiography

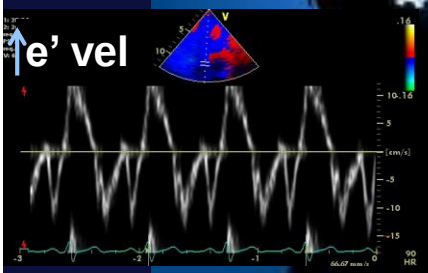
Jong-Won Ha, MD, PhD, Jae K. Oh, MD, Patricia A. Pellikka, MD, Steve R. Ommen, MD, Vicky L. Stussy, RN, RDCS, Kent R. Bailey, PhD, James B. Seward, MD, and A. Jamil Tajik, MD, *Rochester, Minnesota*

Left ventricular filling pressures can be estimated reliably by combining mitral inflow early diastolic velocity (E) and annulus velocity (E′). An increased E/E′ ratio reflects elevated filling pressures and may be useful in assessing an abnormal increase in filling pressures for patients with diastolic dysfunction. The purpose of this study was to evaluate the feasibility of supine bicycle exercise Doppler echocardiography for assessing left ventricular diastolic pressure during exercise. Mitral inflow and septal mitral annulus velocities were measured at rest and during supine [illegible] **crements) in** [illegible] **years) referred** [illegible] **None had echocardiographic or electrocardiographic evidence of myocardial ischemia with exercise. Patients were classified according to E/E′ ratio at rest: 26 had E/E′ ≤ 10 at rest (group 1) and 19 had E/E′ > 10 (group 2). For group 1, 17 had no increase in E/E′ during exercise (group 1A) and 9 did (group 1B). For group 2, E/E′ did not increase during exercise. Despite different responses of E/E′, there was no significant difference in changes of mitral inflow indices (E, A, E/A, deceleration time) between groups. Although the percentage of dyspnea as a primary reason for stopping exercise was similar for the groups, exercise duration was significantly shorter for groups 1B (7.2 ± 2.5 minutes) and 2 (7.1 ± 3.3 minutes) than in group 1A (10.4 ± 3.7 minutes, *P* = .0129). Diastolic stress echocardiography using** [illegible] **ble for demonstration) with exercise** [illegible] **sure) with exercise** [illegible] **st the hemodynamic consequences of exercise-induced increase in diastolic filling pressure can be demonstrated noninvasively with exercise Doppler echocardiography. (J Am Soc Echocardiogr 2005;18:63–8.)**

J Am Soc Echocardiogr 2005;18:63-8

What do we expect?

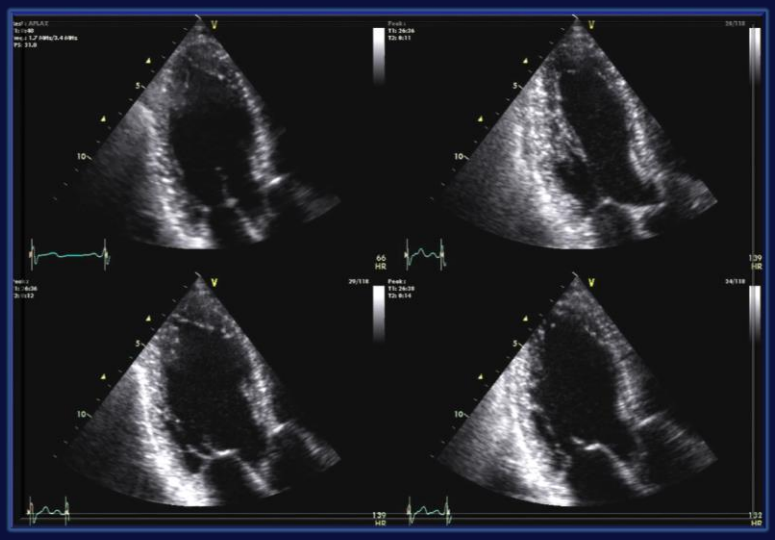




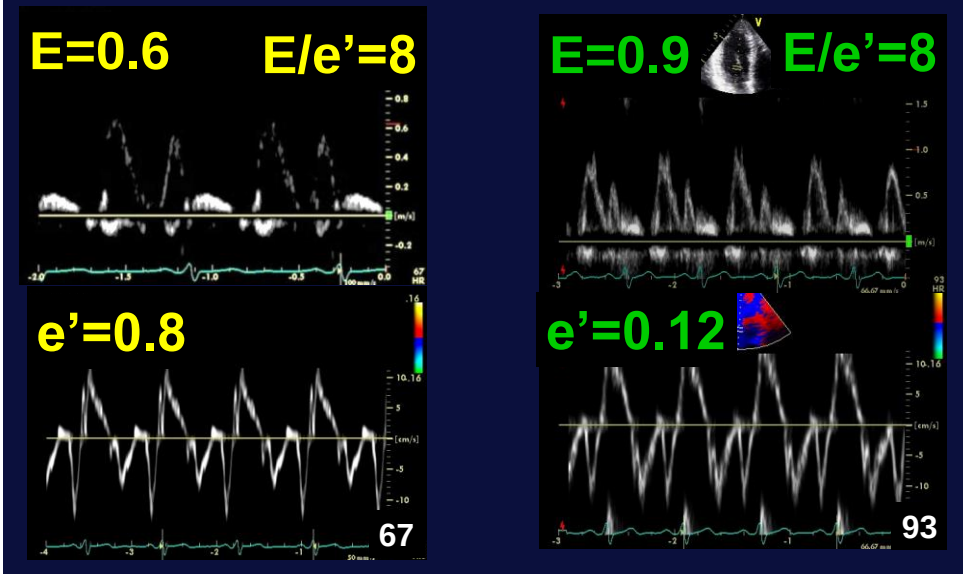
Case

- 55 year old male
- No known CAD
- Hypertension & exertional dyspnea

Stress Echo



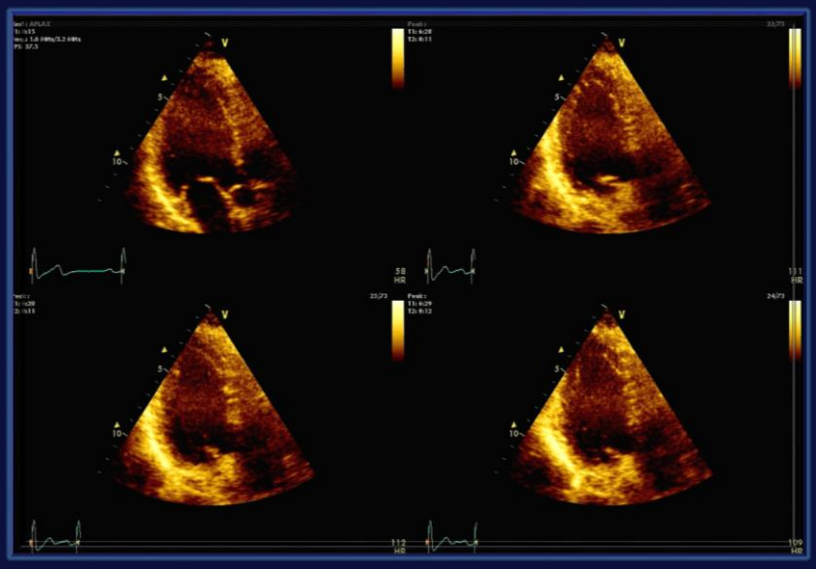
Diastolic Stress Test



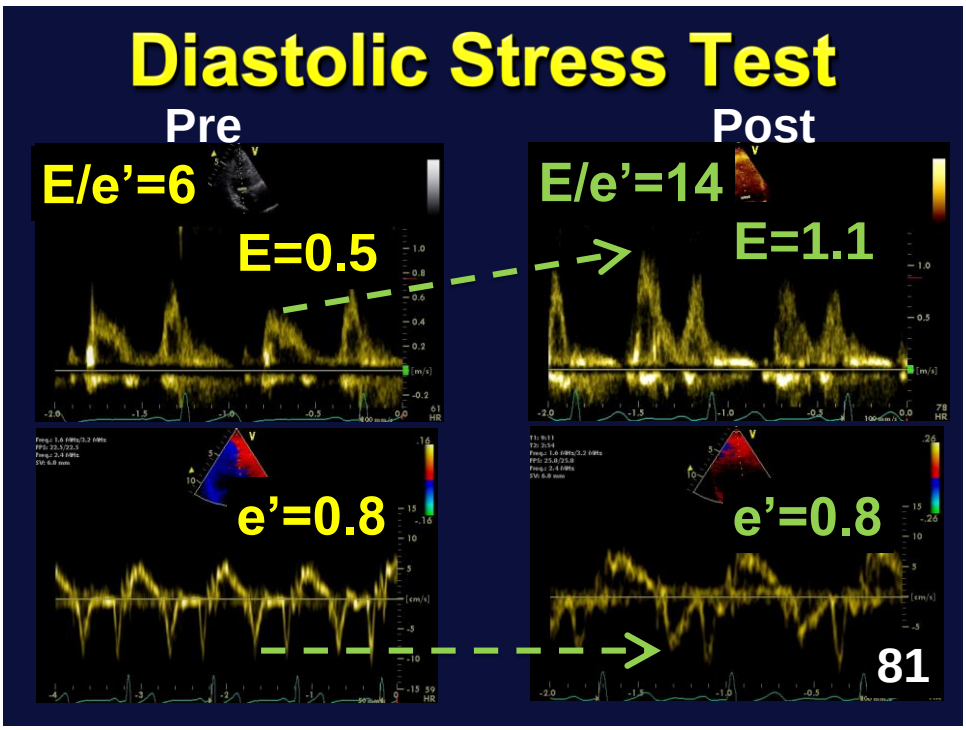
Case

- 67 year old male
- No known CAD
- Diabetes and hypertension
- Complains of dyspnea on exertion (NYHA II)

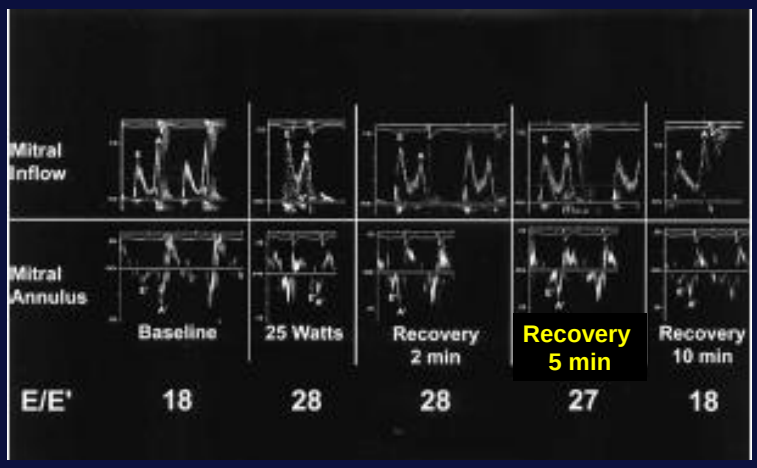
Stress Echo



Diastolic Stress Test



Important Observations From the Initial Studies



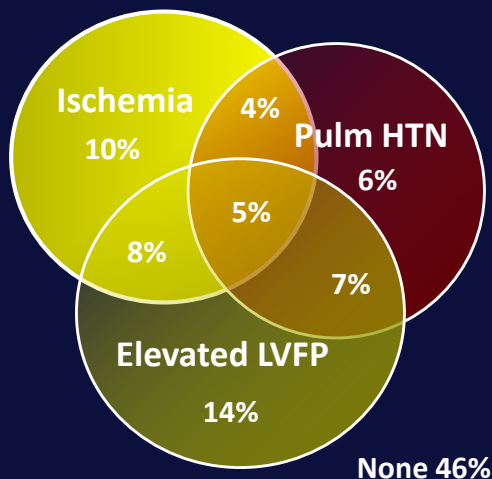
Ha et al J Am Soc Echocardiol 2005;18:63-8

Important Observations From the Initial Studies

- Those with increased filling pressure at baseline will further increase filling pressure with exercise
- Therefore, those who benefit most from diastolic stress testing are those with normal resting LVFP but abnormal relaxation (grade I)

Exercise-limiting Dyspnea

Courtesy Rob McCully



Ischemia 27%

Pulmonary HTN 22%

Elevated LVFP 34%

Any abnormality 54%

None 46%

n=630

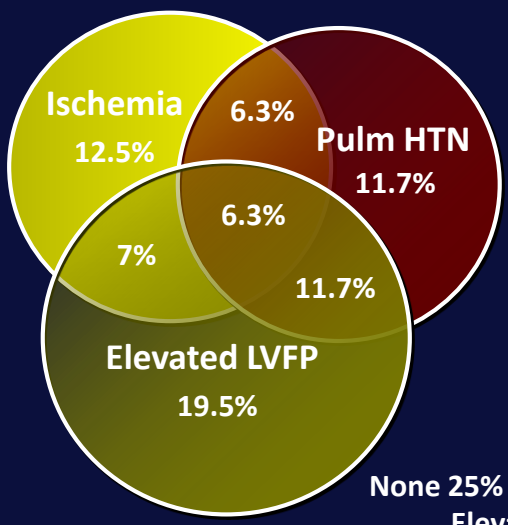
Elevated LVFP: ex. E/e' >13

Pulm HTN: ex. RVSP >50 mm Hg

Reduced Exercise Capacity

Women <5 METs, Men <7 METS

Courtesy Rob McCully



Ischemia 32%

Pulmonary HTN 36%

Elevated LVFP 45%

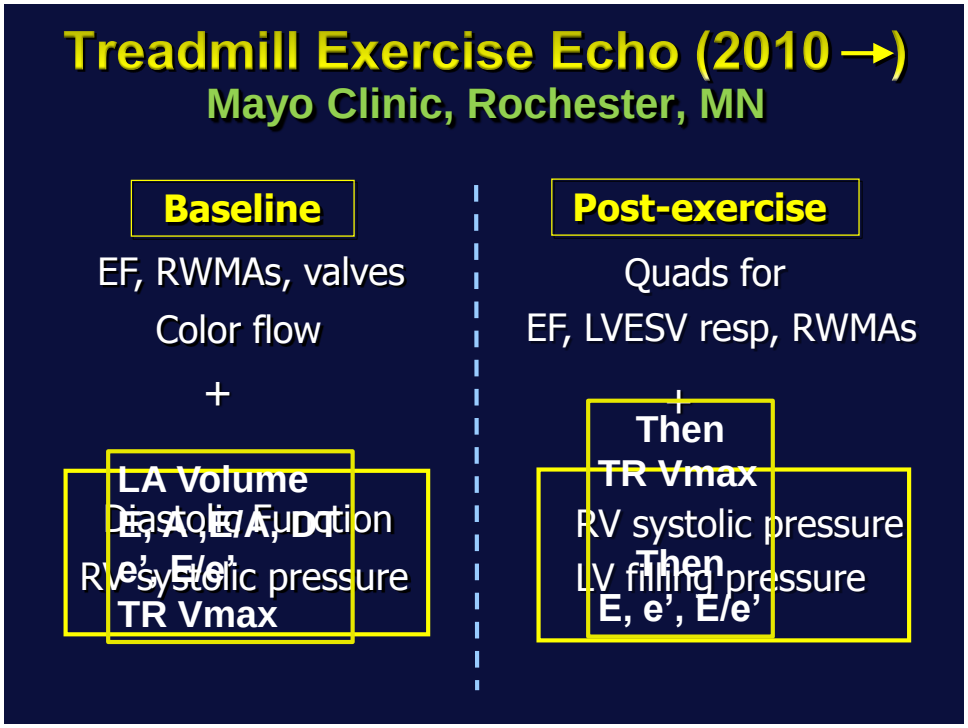
Any abnormality 75%

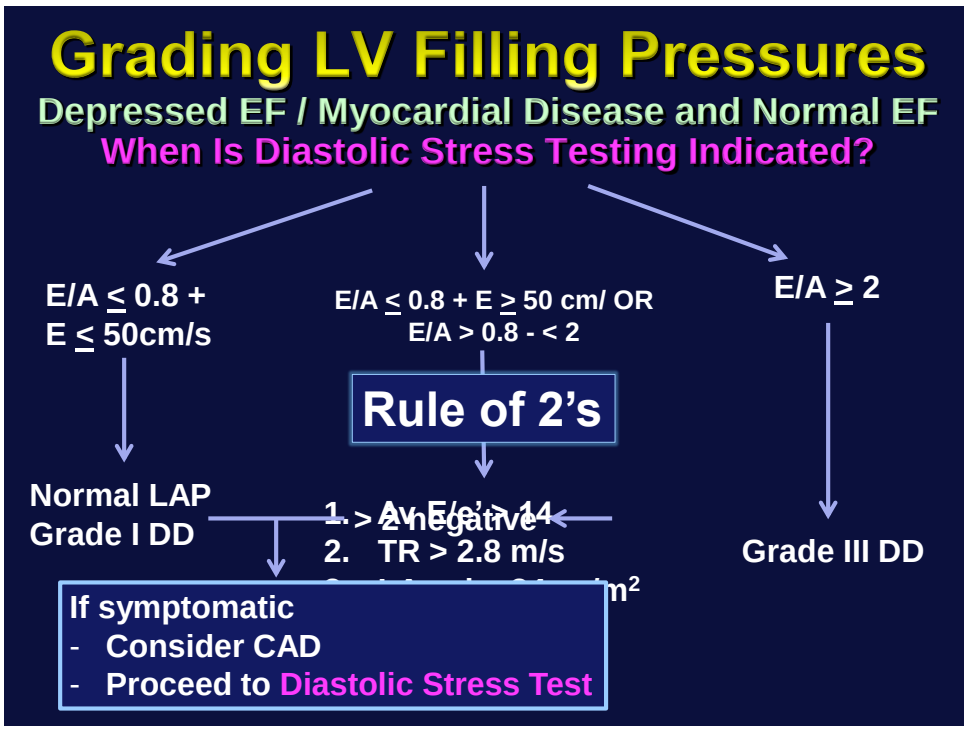
None 25%

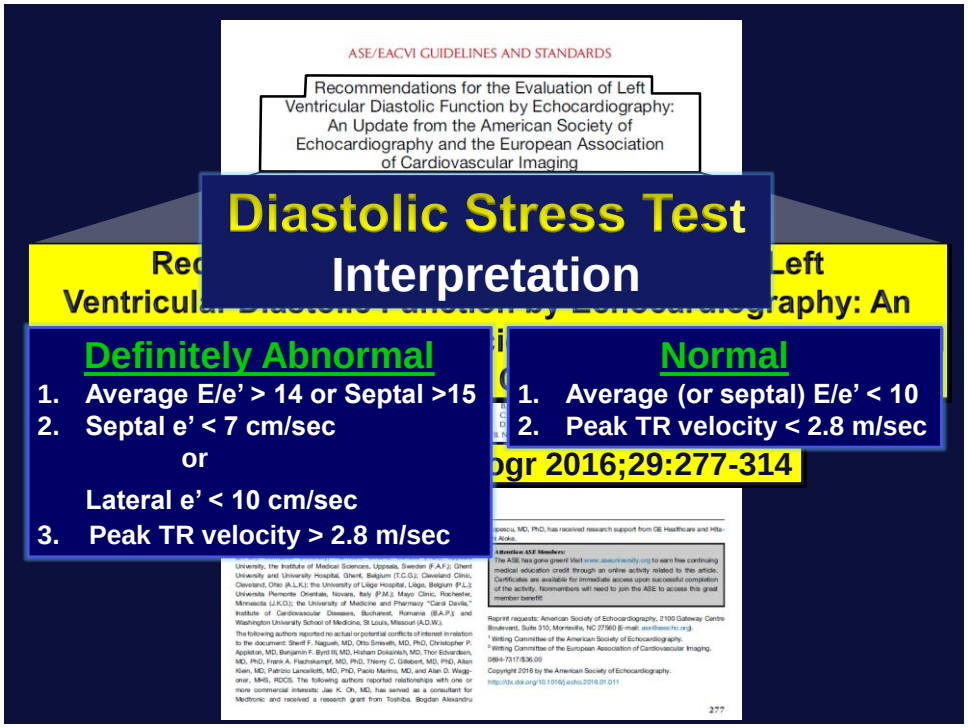
n=128

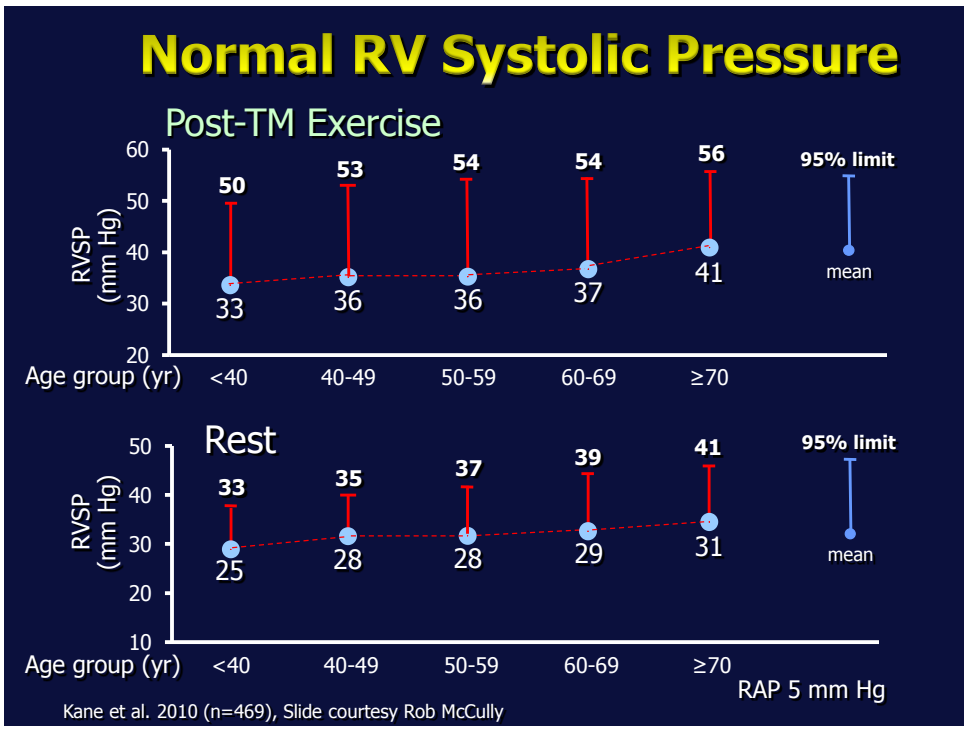
Elevated LVFP: ex. E/e' >13

Pulm HTN: ex. RVSP >50 mm Hg


Treadmill Exercise Echo (2010 →)
Mayo Clinic, Rochester, MN
Baseline
EF, RWMAs, valves
Color flow
+
LA Volume
Diastolic Function
E, A, E/A, DT
e', E/e'
RV systolic pressure
TR Vmax
Post-exercise
Quads for
EF, LVESV resp, RWMAs
+
Then
TR Vmax
RV systolic pressure
Then
LV filling pressure
E, e', E/e'


Grading LV Filling Pressures
Depressed EF / Myocardial Disease and Normal EF
When Is Diastolic Stress Testing Indicated?
E/A ≤ 0.8 +
E ≤ 50cm/s
E/A ≤ 0.8 + E ≥ 50 cm/ OR
E/A > 0.8 - < 2
E/A ≥ 2
Rule of 2's
Normal LAP
Grade I DD
1. > Av. E/e' > 14
2. TR > 2.8 m/s
Grade III DD
If symptomatic
- Consider CAD
- Proceed to Diastolic Stress Test


ASE/EACVI GUIDELINES AND STANDARDS
Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging
Diastolic Stress Test
Interpretation
Definitely Abnormal
1. Average E/e' > 14 or Septal >15
2. Septal e' < 7 cm/sec
or
Lateral e' < 10 cm/sec
3. Peak TR velocity > 2.8 m/sec
Normal
1. Average (or septal) E/e' < 10
2. Peak TR velocity < 2.8 m/sec
ogr 2016;29:277-314


Normal RV Systolic Pressure
Post-TM Exercise
RVSP (mm Hg)
60
50
40
30
20
50
53
54
54
56
95% limit
33
36
36
37
41
mean
Age group (yr)
<40
40-49
50-59
60-69
≥70
Rest
RVSP (mm Hg)
50
40
30
20
10
33
35
37
39
41
95% limit
25
28
28
29
31
mean
Age group (yr)
<40
40-49
50-59
60-69
≥70
RAP 5 mm Hg
Kane et al. 2010 (n=469), Slide courtesy Rob McCully

Summary

1. Exertional dyspnea portends a poor prognosis (> angina).
2. An exercise induced increase in E/e' relates to changes in filling pressure and its finding has adverse prognostic significance.

Summary

3. The post exercise E/e' can be measured minutes into recovery, ideally as soon as the discrete waves are appreciated.
4. The ideal patient is one with exertional dyspnea and baseline grade I diastolic dysfunction.

2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

Developed in Collaboration With the American Association for Thoracic Surgery, American Society of Echocardiography, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons

Class IIa
Exercise testing is reasonable in selected patients with asymptomatic severe VHD to
1) confirm the absence of symptoms, or
2) assess the hemodynamic response to exercise, or
3) determine prognosis.
(Level of Evidence: B)

Lesley H. Curtis, PhD, FAHA
David DeMets, PhD
Robert A. Guyton, MD, FACC§§
Frank W. Sellke, MD, FACC, FAHA
Win-Kuang Shen, MD, FACC, FAHA
William G. Stevenson, MD, FACC, FAHA§§
Clyde W. Yancy, MD, FACC, FAHA§§

EACVI/ASE CLINICAL RECOMMENDATIONS

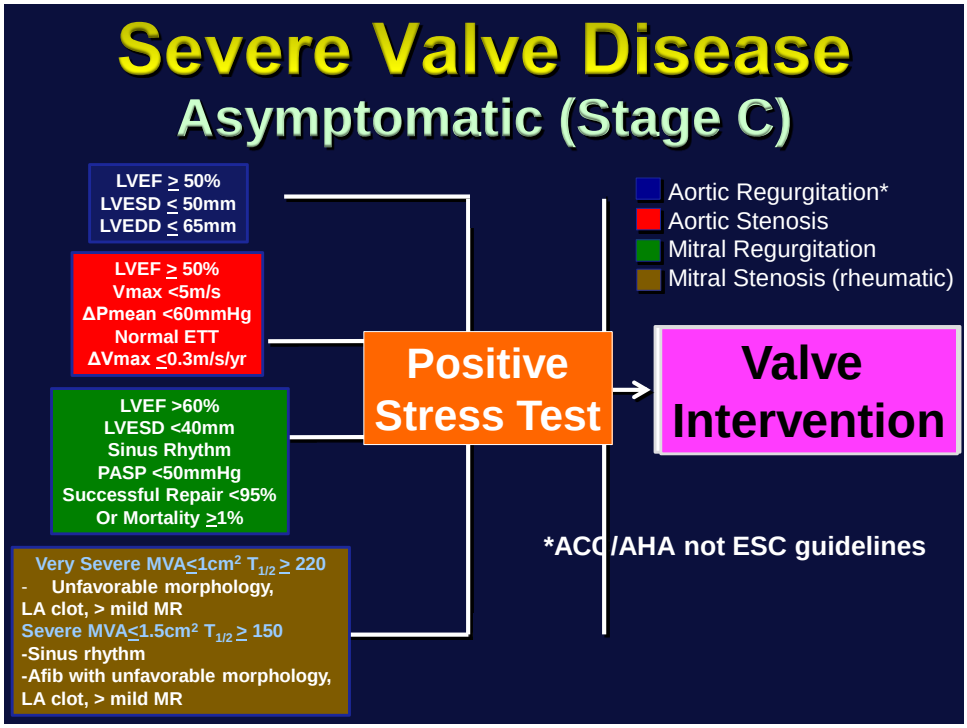
The Clinical Use of Stress Echocardiography in Non-Ischaemic Heart Disease: Recommendations from the European Association of Cardiovascular Imaging and the American Society of Echocardiography

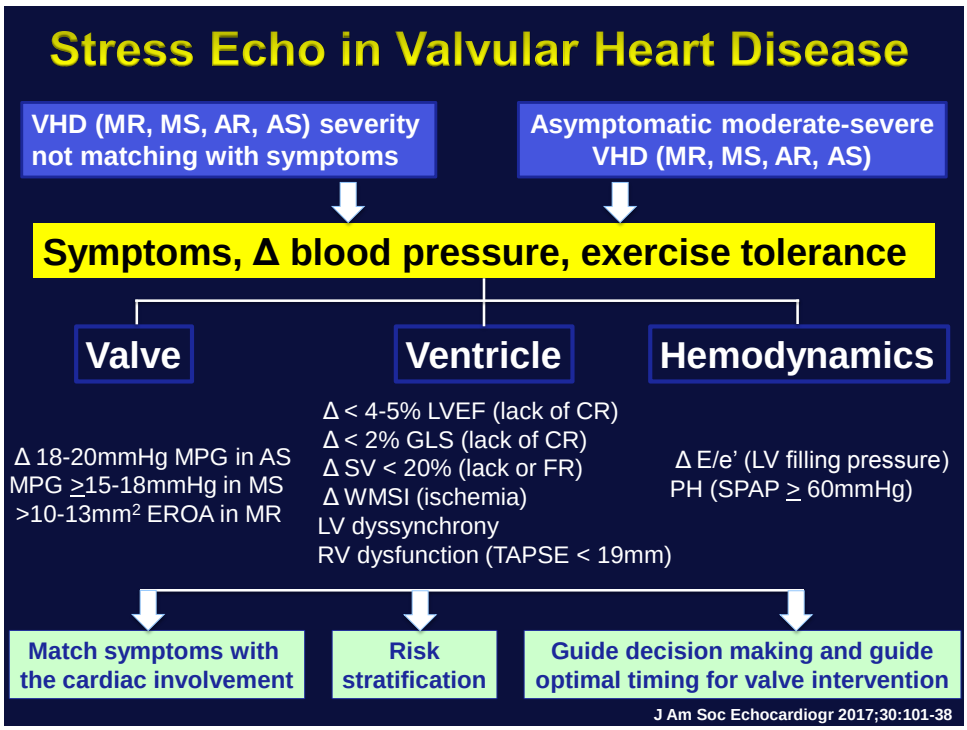
Patrizio Lancellotti, MD, PhD, FESC (Chair), Patricia A. Pellikka, MD, FASE (Co-Chair), Werner Budts, MD, PhD, Farooq A. Chaudhry, MD, FASE, Erwan Donal, MD, PhD, FESC, Raluca Dulgheru, MD, Thor Edvardsen, MD, PhD, FESC, Madalina Garbi, MD, MA, Jong Won Ha, MD, PhD, FESC, Garvan C. Kane, MD, PhD, FASE, Joe Kreeger, ACS, RCCS, RDCS, FASE, Luc Mertens, MD, PhD, FASE, Philippe Pibarot, DVM, PhD, FASE, FESC, Eugenio Picano, MD, PhD, Thomas Ryan, MD, FASE, Jeane M. Tsutsui, MD, PhD, and Albert Varga, MD, PhD, FESC, *Liège, Belgium; Bari and Pisa, Italy; Rochester, Minnesota; Leuven, Belgium; New York, New York; Rennes, France; Oslo, Norway; London, UK; Seoul, South Korea; Atlanta, Georgia; Toronto and Québec, Canada; Columbus, Ohio; São Paulo, Brazil; and Szeged, Hungary*

J Am Soc Echocardiogr 2017;30:101-38

A unique and highly versatile te
evaluation of non-ischaemic h
haemodynamics under physio
SE has become widely implemented to assess various conditions other than ischaemic heart disease. It has thus become essential to establish guidance for its applications and performance in the area of non-ischaemic heart disease. This paper summarizes these recommendations (J Am Soc Echocardiogr 2017;30:101-38.)

Keywords: Cardiomyopathy, Congenital heart disease, Heart failure, Pulmonary hypertension, Stress echocardiography, Stress test, Valvular heart disease


Severe Valve Disease
Asymptomatic (Stage C)
LVEF ≥ 50%
LVESD ≤ 50mm
LVEDD ≤ 65mm
LVEF ≥ 50%
Vmax <5m/s
ΔPmean <60mmHg
Normal ETT
ΔVmax ≤0.3m/s/yr
LVEF >60%
LVESD <40mm
Sinus Rhythm
PASP <50mmHg
Successful Repair <95%
Or Mortality ≥1%
Very Severe MVA≤1cm² T1/2 ≥ 220
- Unfavorable morphology,
LA clot, > mild MR
Severe MVA≤1.5cm² T1/2 ≥ 150
-Sinus rhythm
-Afib with unfavorable morphology,
LA clot, > mild MR
Positive Stress Test
Aortic Regurgitation*
Aortic Stenosis
Mitral Regurgitation
Mitral Stenosis (rheumatic)
Valve Intervention
*ACC/AHA not ESC guidelines


Stress Echo in Valvular Heart Disease
VHD (MR, MS, AR, AS) severity not matching with symptoms
Asymptomatic moderate-severe VHD (MR, MS, AR, AS)
Symptoms, Δ blood pressure, exercise tolerance
Valve
Ventricle
Hemodynamics
Δ 18-20mmHg MPG in AS
MPG ≥15-18mmHg in MS
>10-13mm² EROA in MR
Δ < 4-5% LVEF (lack of CR)
Δ < 2% GLS (lack of CR)
Δ SV < 20% (lack or FR)
Δ WMSI (ischemia)
LV dyssynchrony
RV dysfunction (TAPSE < 19mm)
Δ E/e' (LV filling pressure)
PH (SPAP ≥ 60mmHg)
Match symptoms with the cardiac involvement
Risk stratification
Guide decision making and guide optimal timing for valve intervention
J Am Soc Echocardiogr 2017;30:101-38

Low EF Area Gradient Mismatch

Baseline Doppler hemodynamics

Class IIa

AVR is reasonable in symptomatic patients with low-flow/low-gradient severe AS with reduced LVEF (stage D2) with a low-dose dobutamine stress study that shows an aortic velocity ≥ 4.0 m/s (or mean pressure gradient ≥ 40 mm Hg) with a valve area ≤ 1.0 cm2 at any dobutamine dose

True Severe AS (D2) IIa

Pseudo Severe AS

Conclusion

1. Understand the differences and indications for the various stress modalities.
2. Know the walls and their coronary supply.
3. Understand the methods and interpretation of wall motion.
4. Viability: stunning versus hibernation.
5. Understand the test characteristics.
6. Emerging uses: Valve Disease and SOB.
7. Appropriate use.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