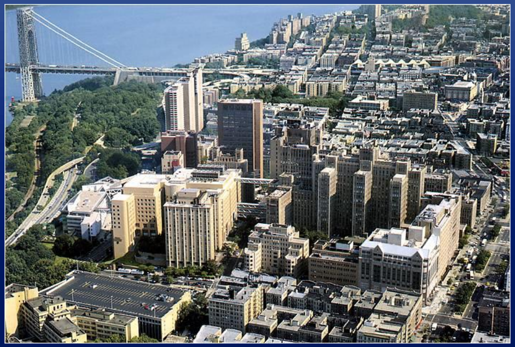
ECHO 2017

APRIL 1ST, 2017

11:05-11:25 AM

# *ASE Guidelines: The clinical Use of Stress Echocardiography in Non-Ischemic Heart Disease*




Rebecca T. Hahn, MD

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# Disclosures

- Speaker: Philips Healthcare, Boston Scientific, Medtronic, Edwards Lifescience
- Consultant: St. Jude Medical, Abbott Vascular

# 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

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*Lancellotti, P et al. J Am Soc Echocardiogr 2017;30:101-38*

# Types of Stress Tests

- Exercise stress testing preserve the integrity of the electromechanically response and provides valuable information regarding functional status
  - It is the test of choice for most applications
  - Echocardiography at the time of exercise also allows links to be drawn among symptoms, cardiovascular workload, wall motion abnormalities, and haemodynamic responses, such as pulmonary pressure and transvalvular flows and gradients.

# Choice of Exercise

- Treadmill stress
  - Higher maximum heart rate (2-3x baseline)
  - SBP ↑≥50% with ↓SVR
  - ↑Contractility 3-4x
  - Functional aerobic capacity well-defined
  - Associated with increase in LVED volume initially, followed by smaller volumes with ↑HR.
- Bicycle stress
  - Higher blood pressure in supine position
  - Shorter duration of exercise/max workload and lower HR in setting of earlier leg fatigue.
  - Allows continuous imaging and Doppler assessment, including peak stress

# Types of Stress Tests

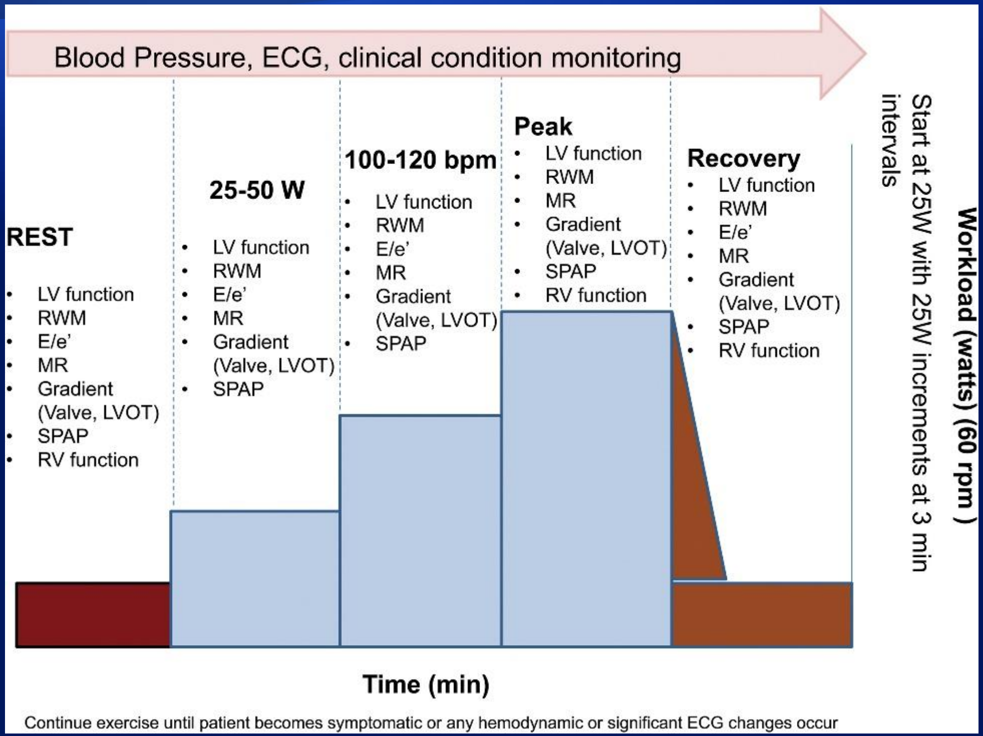
- Pharmacologic Stress does not replicate the complex hemodynamic and neurohormonal changes triggered by exercise.
  - Dobutamine stress is a useful modality for the evaluation of contractile and flow reserve, wall motion.  Contraindicated in HCM
  - Vasodilator stress is particular useful for the assessment of both wall motion and coronary flow reserve. Can be used in HCM

# Pharmacologic Stress

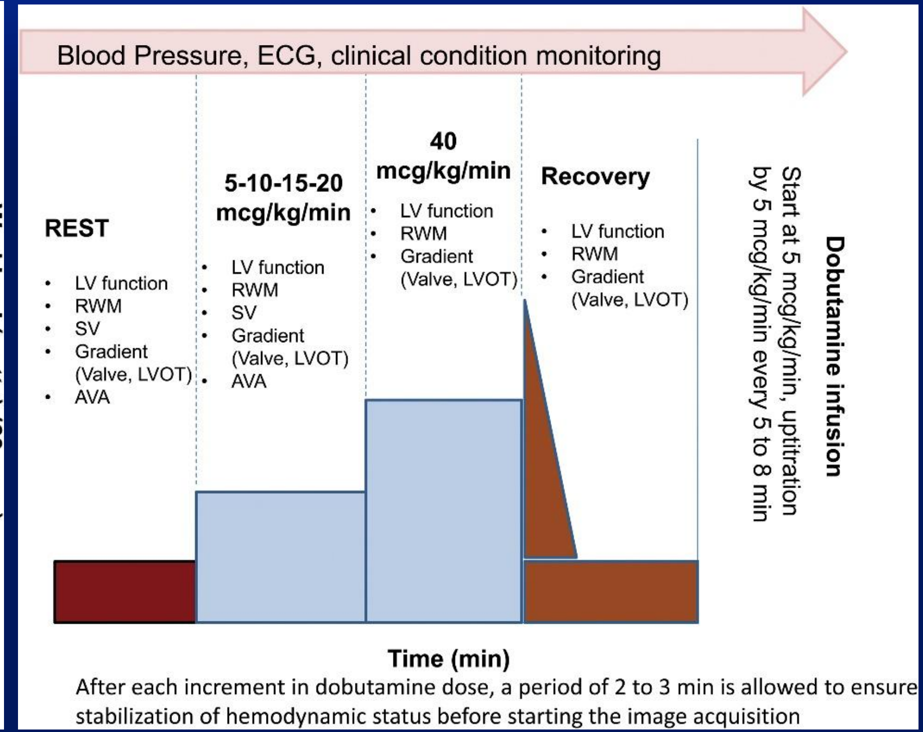
- Dobutamine stress
  - ↑HR (2-3x) and contractility (>4x)
  - Mild ↑BP (1.5-2x) initially with ↓BP (vasodilator) at higher doses
  - Less recruitment of venous blood volume (LV volumes and wall stress less than exercise stress)
- Vasodilator stress (dipyridamole, adenosine or regadenoson)
  - Small ↓BP, ↑ HR and minor ↑ contractility
  - Generates a supply-demand mismatch and ↓subendocardial flow in areas of coronary stenosis

# Stress Protocols

## Exercise echocardiography protocol and parameters




## Dobutamine echocardiography protocol and parameters




***DSE:***

- ***5-8 minute stages starting at 5 $\mu$g/kg/min, titrating in increments of 2.5-5 $\mu$g/kg/min up to 20 $\mu$g/kg/min***
- ***40 $\mu$g/kg/min may be required for inotropic reserve in patients with HR or on $\beta$-blockers***

# Diagnostic end-points, causes of test cessation and definition of abnormal stress test

| Diagnostic end-points | Causes of test cessation | Abnormal test ($\geq$ 1 criteria) |
| --- | --- | --- |
| • Max dose/Workload<br>• Target heart rate<br>• Obvious ECG positivity<br>• Obvious Echo positivity<br>• Severe chest pain | • Intolerable symptoms<br>• Muscular exhaustion<br>• Hypertension (220/120 mmHg)<br>• Symptomatic hypotension (>40 mmHg decrease)<br>• Arrhythmias (SVT, AF, frequent or complex ventricular ectopy) | • Symptoms: angina, dyspnea, dizziness, syncope or near-syncope, fatigue at low workload<br>• Ischemia<br>  • $\geq$ 2 mm ST segment depression in comparison to baseline level<br>  • New or worsening RWMA<br>• Arrhythmias (NS and SVT)<br>• Specific targeted features* |

- Asterisk indicates specific targeted features relates to cut-off values associated with poor outcome in defined population (i.e. >50 mmHg intraventricular obstruction).

# Definitions

- Interventricular Obstruction → LVOT gradient >50mmHg
- Contractile Reserve →
  - ↑ LVEF by≥5%
  - ↑ GLS by≥2%
- Flow Reserve → ↑ forward stroke volume by ≥ 20%.
- Ischemia → New or worsening wall motion abnormality
- Recruitable viable myocardium → Improvement of RWM motion by ≥ 1 grade in dysfunctioning segments

# Asymptomatic Patients with Severe Valve Disease

| Disease State | Aim of Test |
|---|---|
| Severe MR *Exercise* | Assess symptoms and ex-tolerance, ± SPAP ↑ >60 mmHg, EF ↑<4%, ± GLS ↑<-2% |
| Severe MS *Exercise* | Assess symptoms and ex-tolerance, ± ↑ Mean grad >15 mmHg, ± SPAP ↑ >60 mmHg |
| Severe AR *Exercise* | Assess symptoms and ex-tolerance and contractile reserve |
| Severe AS *Exercise* | Assess symptoms and ex-tolerance, ±LVEF ↓, ± SBP ↓ or <20 mmHg rise, ST depression, RWMA, contractile reserve, GLS, SPAP ↑ >60 mmHg, ↑ mean gradient >18-20 mmHg |
| Flow AS (low EF) *DSE* | Flow reserve, gradient, valve area |

# Definitions

- Dynamic primary MR
  ***Exercise***
  → An increase by ≥ 1 grade in MR SPAP ≥ 60 mmHg, and a lack of contractile reserve (<5% increase in EF or <2% increment inGLS
- Dynamic Secondary MR
  ***Exercise***
  → ΔEROA ≥10-13 $mm^2$
- Fixed AS
  ***Exercise***
  → MPG↑ ≥18-20 mmHg
- Fixed MS ***Exercise***
  → MPG↑>15 mmHg
  ***DSE***
  → MPG↑ >18 mmHg
- Abnormal Prosthetic Mitral Valve ***ESE or DSE***
  → MPG↑>10 mmHg
- Abnormal Prosthetic Aortic Valve
  ***ESE or DSE***
  → MPG↑>20mmHg
- RV Dysfunction
  ***Exercise***
  → TAPSE <19 mm (Primary MR)

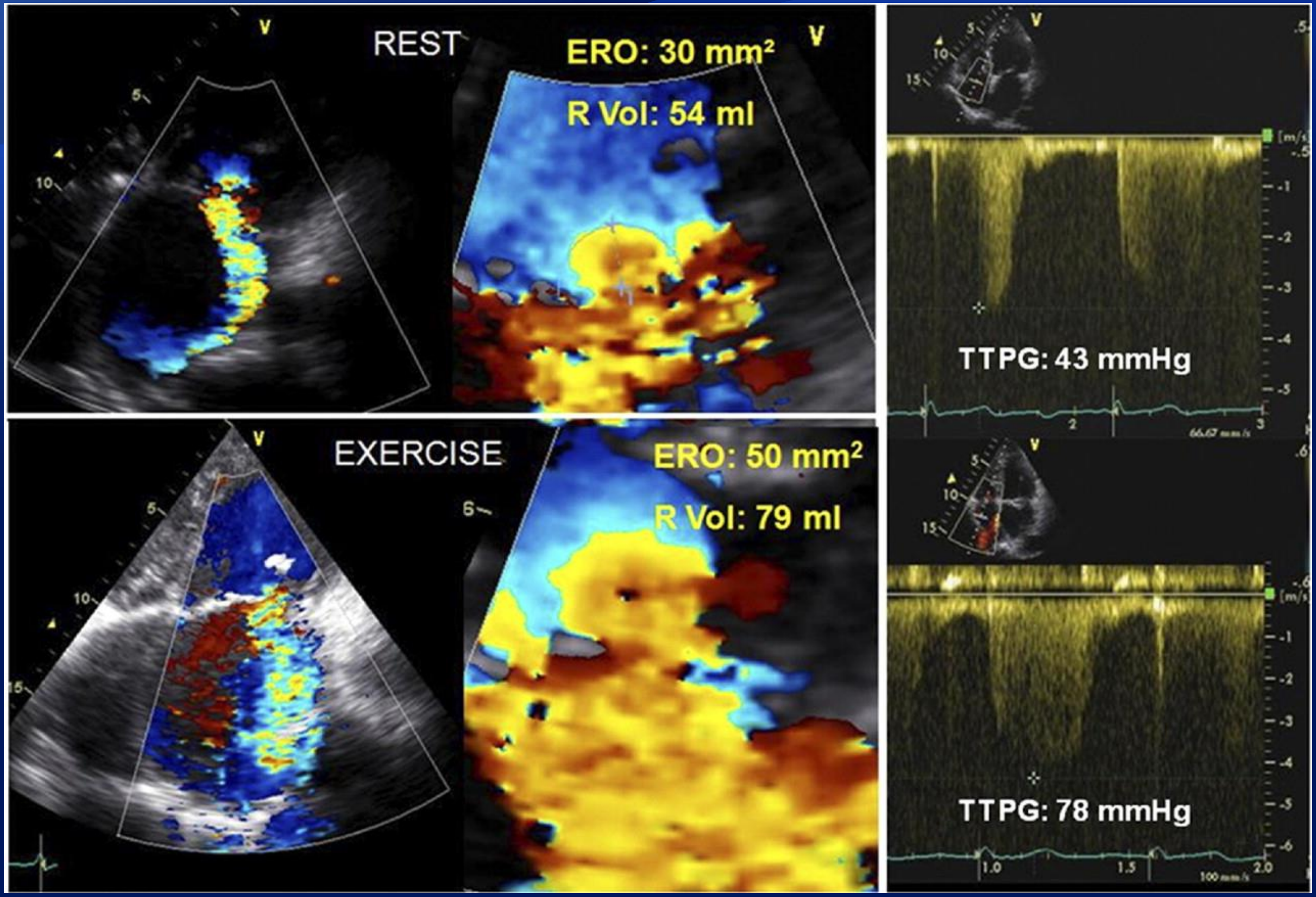
# Exercise Stress Testing for MR

- Exercise capacity itself is a predictor of the development of symptoms or LV dysfunction in asymptomatic patients with MR
- In symptomatic patients with mild MR at rest, exercise echocardiography may be useful in elucidating the cause of symptoms
  - Increase in severity of MR
  - Increase in pulmonary arterial pressure
    - PASP >60 mm Hg during exercise has been suggested as a threshold value above which asymptomatic patients with severe MR might be referred for surgical valve repair
- Response of LV similar to pts with AR
  - Prognostic importance unknown
  - Strain imaging may be useful

# Ischemic MR

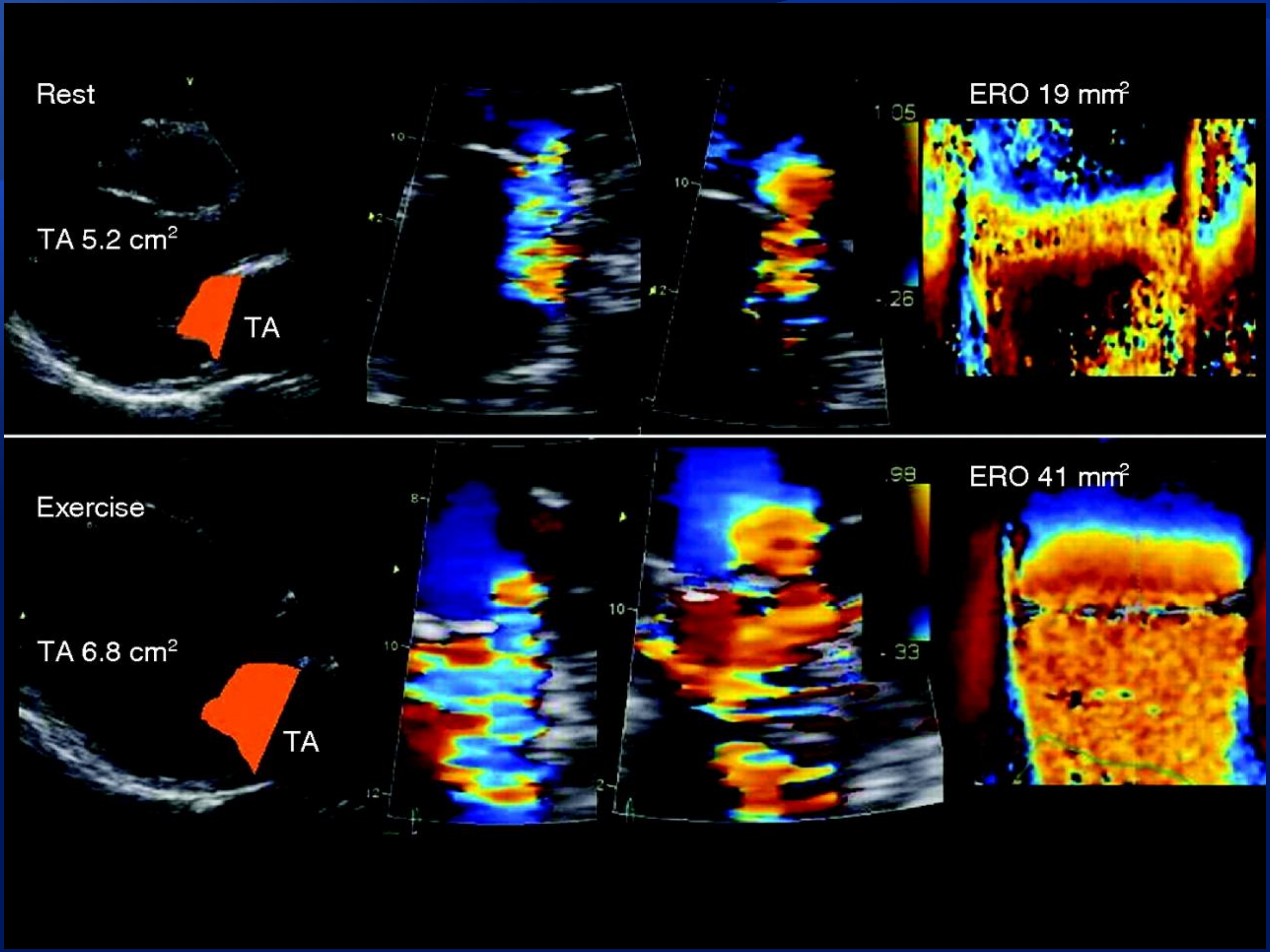
- Mitral regurgitation should be quantitated at rest and during exercise
  - The regurgitant jet area is not reproducible and should preferably not be used
  - **The PISA (proximal isovelocity surface area) method is reproducible and reliable if the flow-convergence region is appropriate.**
  - The Doppler method is an alternative in patients with a suboptimal flow-convergence definition.
    - Regurgitant volumes calculated by the Doppler method are usually slightly larger than those obtained with the PISA method
    - The results of the two methods may therefore be averaged.
- The ERO area appears to be the most robust parameter for quantifying mitral regurgitation at rest and during exercise.
  - ERO ≥ 20 mm2 is prognostically significant
  - An increase in ERO ≥13 $mm^2$ during exercise is associated with both mortality and hospital admission for worsening heart failure

# *Exercise Echocardiography in Ischemic Mitral Regurgitation*




***Picano, E. et al. J Am Coll Cardiol 2009;54:2251-2260***

## *End-systolic stop frame images and proximal flow-convergence region at rest and during exercise in a patient with chronic posterior myocardial infarction and functional mitral regurgitation.*



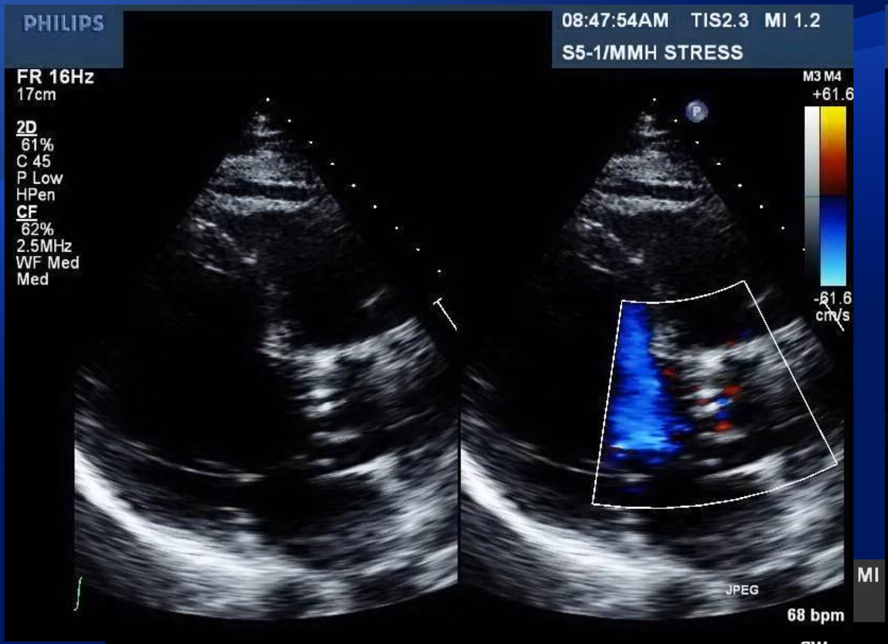

*Piérard L A , Lancellotti P Heart 2007;93:766-772*

HEART

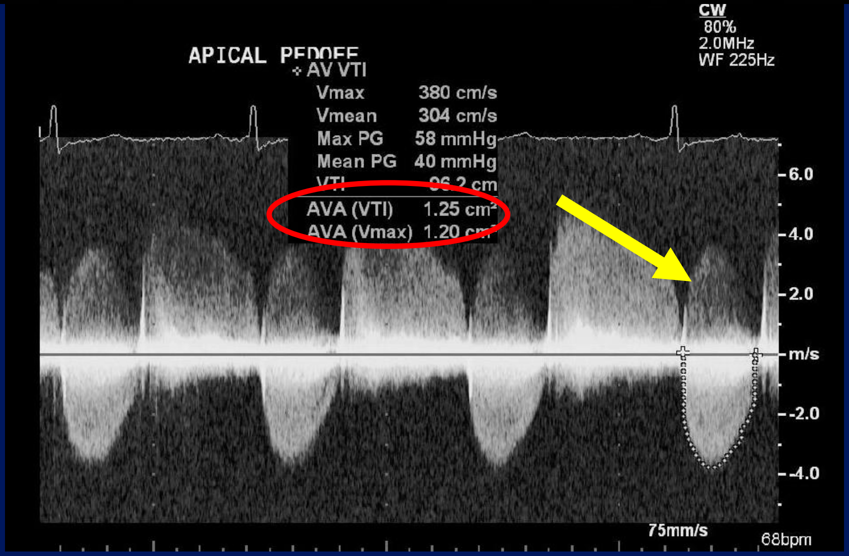
# Exercise Stress Testing for AR (Case courtesy of Linda Gillam)

- 32 yr. old Male (asymptomatic but sedentary)
- History: Bicuspid Aortic valve with mixed valvular disease (moderate to severe AR, moderate AS)
- Indication:
  - Functional capacity
  - Ventricular response to exercise
  - Transvalvular gradients

# Baseline








***Aortic mean PG of 40mmHg,***
***Peak PG of 58mmHg a***
***AVA of 1.2cm2***
***PHT is 353millisec***

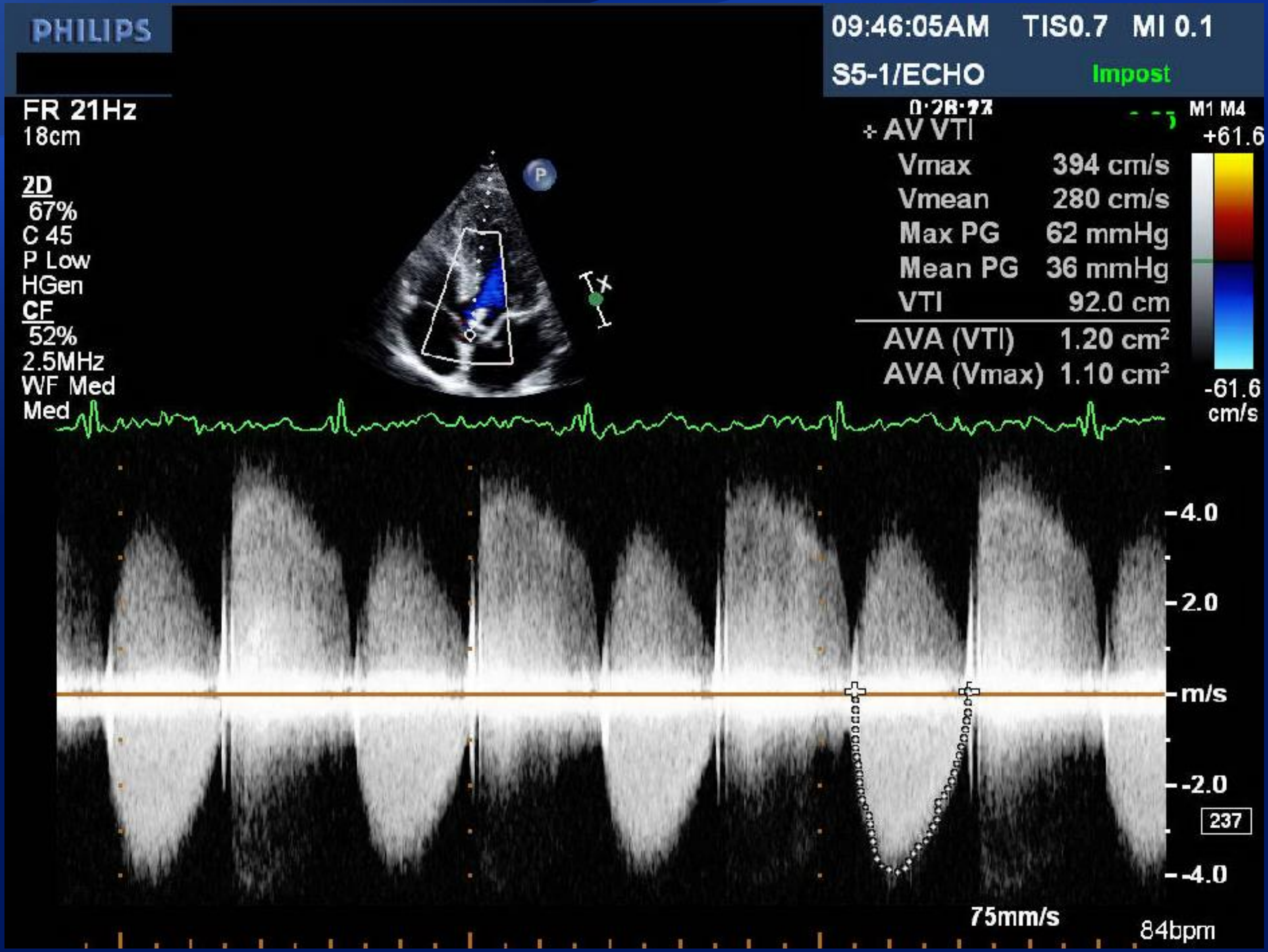
# Stress Echo Performed

- Exercised for 9 min. Bruce protocol /14% grade, speed 3.4 mph/10 METs; stopped because of dyspnea

 -Exercise tolerance reduced for age
 -Symptomatic based on response at low level exercise

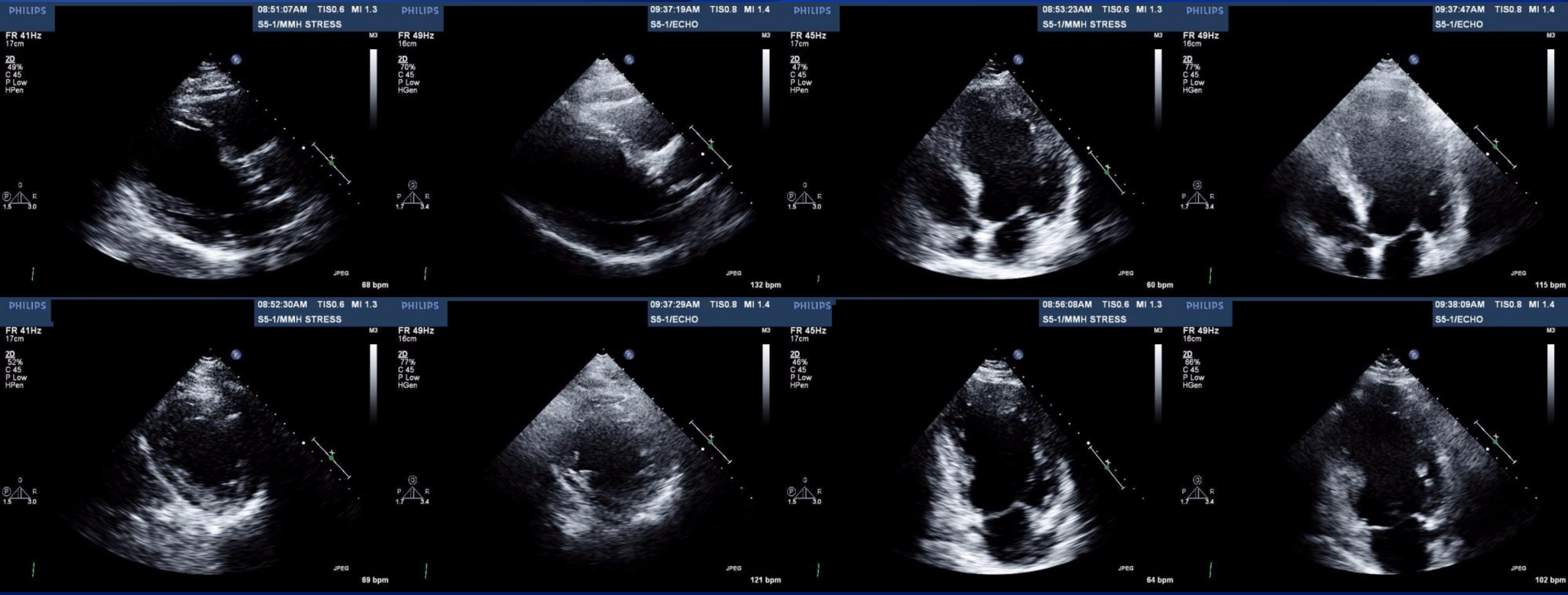
Achieved Peak HR: 155bpm & BP: 148/62mmHg

# Peak - Aortic PG & AVA




*Mean Ao PG 36mmHg/Peak Ao PG 62mmHg AVA 1.20cm2*
*PHT shortens*

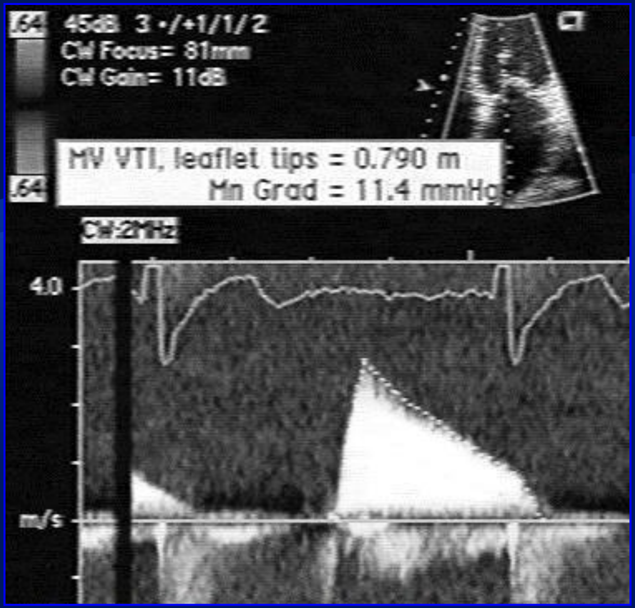
# AR Stress: Contractile Reserve



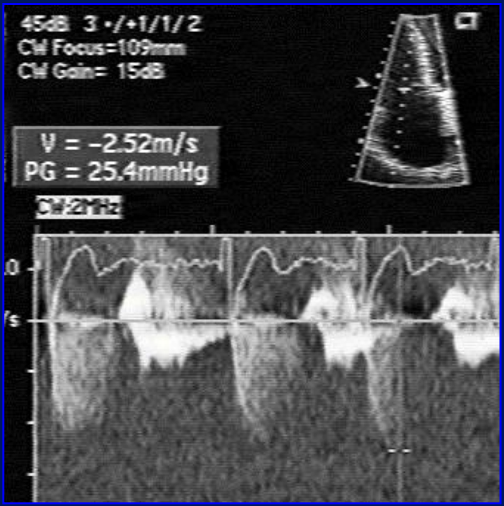

- ***EF at Baseline (66%) vs. EF Peak exercise (55%)***
- ***LVEDd/LVESd cavity size change***

  ***(Base) = 6.9/4.2(cm) vs. (Peak) 7.0/4.7(cm)***

# Case MS



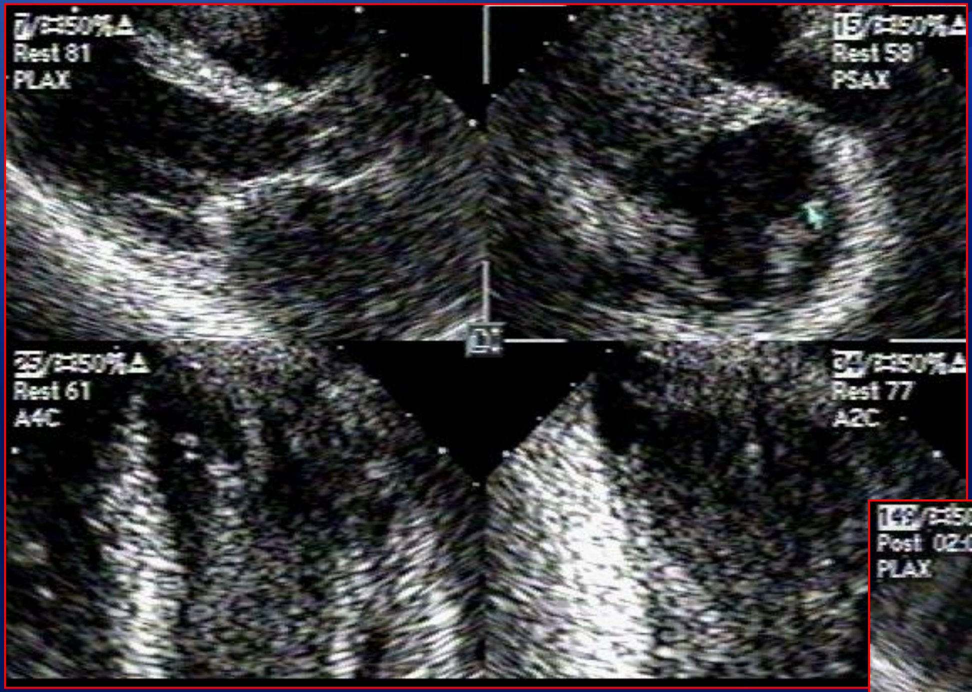

***MOVA by PHT = 1.6 cm^2***
***Mean gradient = 10 mmHg***




***TR = 2.5 m/s***

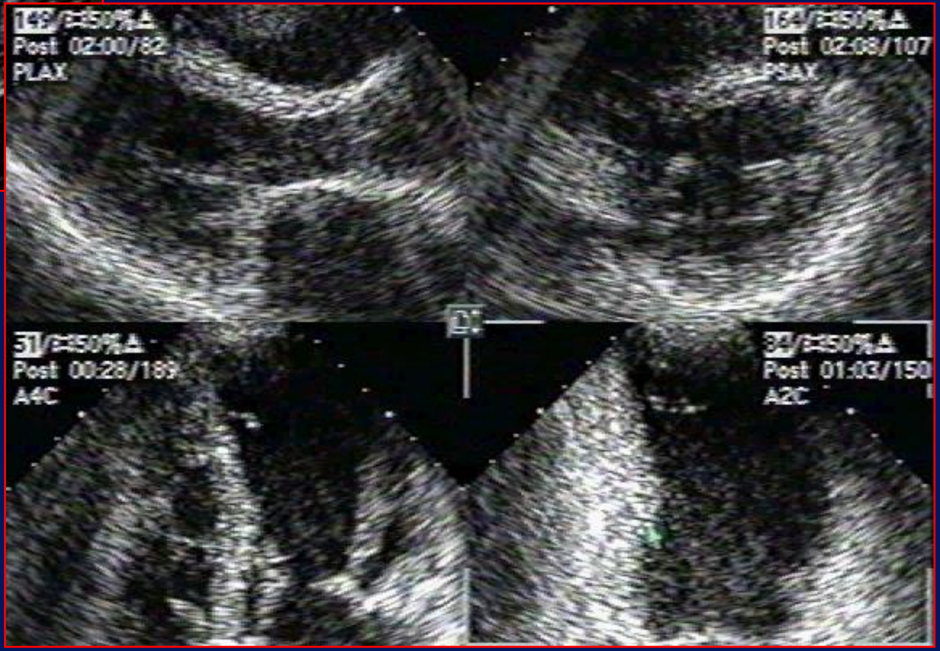
***50 year old woman with history of asthma and rheumatic fever who presents with exertional dyspnea (Class III NYHA).***

# Case MS

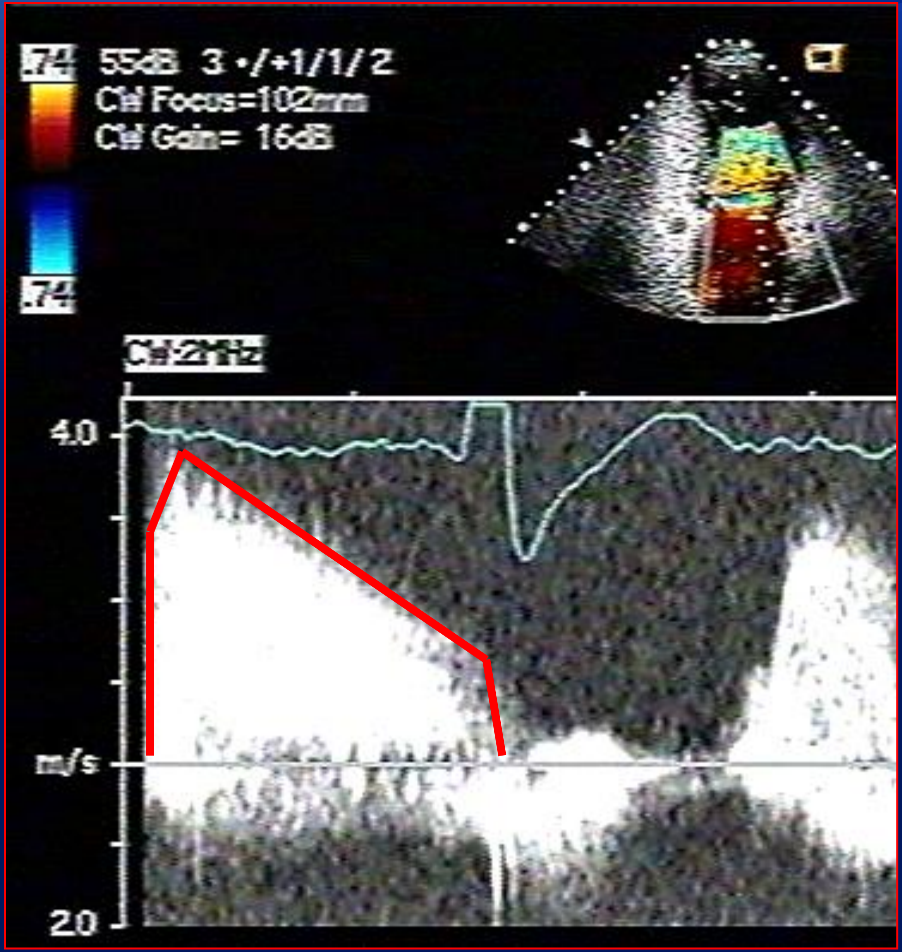



*Resting Study*

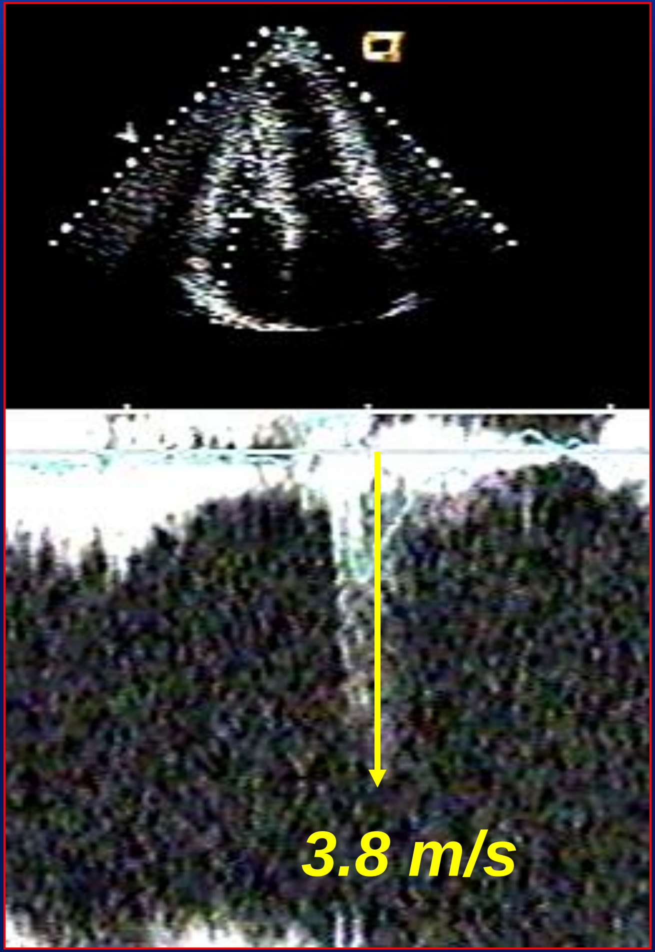
*Post Exercise*



# Case MS




*Mean gradient = 25 mmHg*




*TR = 3.8 m/s*

*Gradient = 58 mHg (add assumed RAP)*

# Stress Echo in Mitral Stenosis

- Calculation of mitral valve area by Doppler methods is controversial
  - Reliability of PHT calculation questionable
- Mean transmitral gradients and peak tricuspid regurgitant velocities are reliable
- Patient's symptoms reliable

***Exercise-induced pulmonary hypertension(>60-70 mmHg) warrants close follow-up***

*Nishimura, RA et al JAmCollCardiol 2014 Jun 10;63(22):2438-88*

THE PRESENT AND FUTURE

STATE-OF-THE-ART REVIEW

# Natural History, Diagnostic Approaches, and Therapeutic Strategies for Patients With Asymptomatic Severe Aortic Stenosis

Philippe Généreux, MD,[a,b,c] Gregg W. Stone, MD,[a,b] Patrick T. O'Gara, MD,[d] Guillaume Marquis-Gravel, MD,[c] Björn Redfors, MD, PhD,[b,e] Gennaro Giustino, MD,[f] Philippe Pibarot, DVM, PhD,[g] Jeroen J. Bax, MD, PhD,[h] Robert O. Bonow, MD,[i] Martin B. Leon, MD[a,b]

*Généreux et al J Am Coll Cardiol. 2016 May 17;67(19):2263-88*

# Observational Studies of comparing AVR vs. Observation in Asymptomatic Severe AS Patients

| Authors | AS definition | N | Age | Female | Follow-up (median) |
|---|---|---|---|---|---|
| Pellikka et al 1990 | Severe AS<br>Doppler PV ≥4m/s | 143<br>30 AVR<br>113 Medical | 72 (mean)<br>40 to 94 | 38% | AVR 21 m<br>Medical 20 m |
| Otto et al 1997 | Moderate-severe AS;<br>Doppler PV ≥2m/s | 123 | 63±16<br>22 to 84 | 30% | 2.5 ±1.4 yrs |
| Pai et al 2006 | Severe AS<br>AVA <0.8cm² | 338<br>99 AVR<br>239 Medical | 71±15 | 49% | 3.5 years |
| Kang et al 2010 | Very severe AS<br>AVA ≤0.75 cm² AND<br>PV≥4.5 m/s or a<br>MG ≥50 mmHg | 197<br>102 AVR<br>95 Medical | 63±12 | 50% | AVR 1265 d<br>Medical 1769 d |
| Taniguchi et al 2015 | Severe AS<br>AVA: <1cm2<br>MG: >40mmhg<br>PV: >4m/s | 1808<br>291 AVR<br>1517 Medical | AVR<br>71.6±8.7<br>Medical<br>77.8±9.4 | 60% | 1361 d |

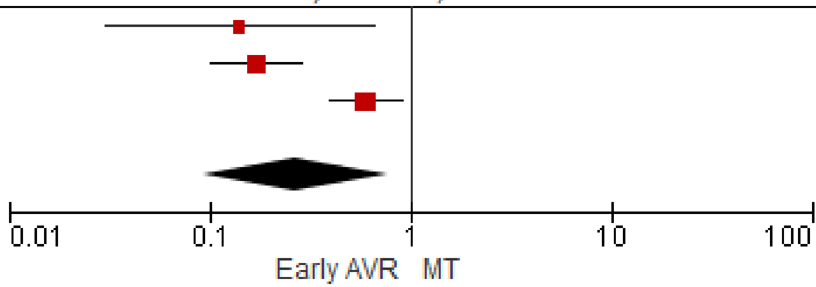
Généreux et al *J Am Coll Cardiol. 2016 May 17;67(19):2263-88*

# *All-Cause Mortality:* *AVR vs. Medical Therapy in Asymptomatic Severe AS*

| Study or Subgroup | log[Hazard Ratio] | SE | Weight | Hazard Ratio IV, Random, 95% CI |
|---|---|---|---|---|
| Kang et al | -1.9661 | 0.786 | 22.1% | 0.14 [0.03, 0.65] |
| Pai et al | -1.772 | 0.2707 | 38.2% | 0.17 [0.10, 0.29] |
| Taniguchi et al | -0.5108 | 0.2069 | 39.8% | 0.60 [0.40, 0.90] |
| **Total (95% CI)** | | | **100.0%** | **0.27 [0.09, 0.77]** |

Heterogeneity: Tau² = 0.67; Chi² = 15.22, df = 2 (P = 0.0005); I² = 87%
Test for overall effect: Z = 2.46 (P = 0.01)

Hazard Ratio
IV, Random, 95% CI



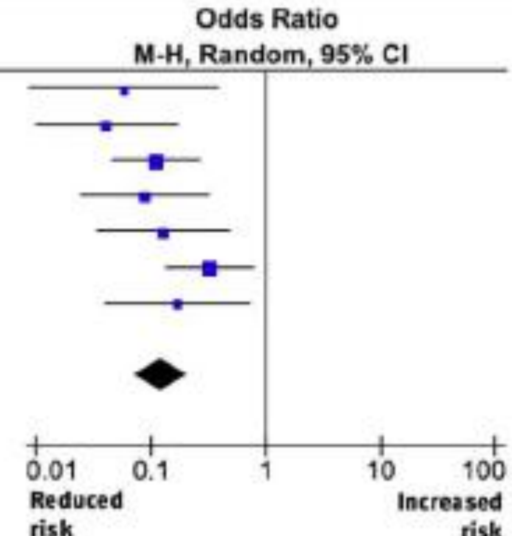

***Adjusted: ~3.7 fold increase in all-cause Mortality***

*Généreux et al J Am Coll Cardiol. 2016 May 17;67(19):2263-88*

# Meta-Analysis of Prognostic Value of Stress Testing in Patients With Asymptomatic Severe Aortic Stenosis

Asim M. Rafique, MD[a], Simon Biner, MD[a,b], Indraneil Ray, MD[a], James S. Forrester, MD[a], Kirsten Tolstrup, MD[a], and Robert J. Siegel, MD[a,*]

| Study or Subgroup | Normal Stress Test | Abnormal Stress Test | Weight | Odds Ratio M-H, Random, 95% CI |
|---|---|---|---|---|
| Alborino 2002 | 2/12 | 14/18 | 7.1% | 0.06 [0.01, 0.38] |
| Amato 2001 | 3/22 | 35/44 | 11.4% | 0.04 [0.01, 0.17] |
| Das 2005 | 10/79 | 26/46 | 22.3% | 0.11 [0.05, 0.27] |
| Lancellotti 2005 | 4/43 | 14/26 | 13.3% | 0.09 [0.02, 0.32] |
| Marechaux 2007 | 10/26 | 20/24 | 12.6% | 0.13 [0.03, 0.47] |
| Peidro 2007 | 10/35 | 37/67 | 22.5% | 0.32 [0.13, 0.78] |
| Takeda 2001 | 13/36 | 10/13 | 10.9% | 0.17 [0.04, 0.73] |
| **Total** | **52/253** | **156/238** | **100.0%** | **0.12 [0.07, 0.21]** |




Heterogeneity: $Tau^2 = 0.13$; $Chi^2 = 8.08$, df = 6 ($P = 0.23$); $I^2 = 26\%$
Test for overall effect: $Z = 7.63$ ($P < 0.00001$)

***Abnormal stress test associated with ~8 fold increase in CV Events***

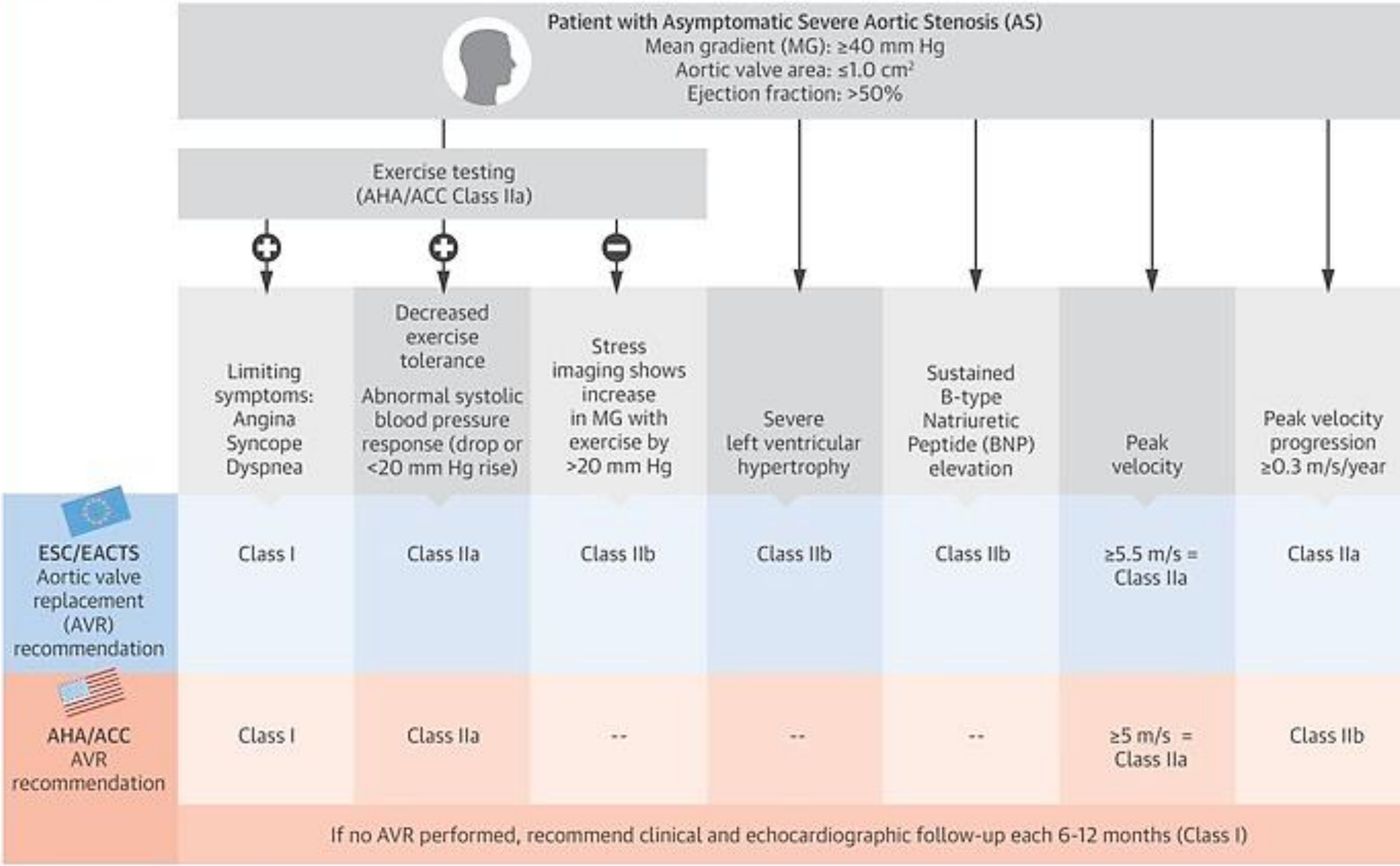
*Rafique et al. Am J Cardiol 2009;104:972–977*

# AHA/ACC Guidelines

- Exercise testing can also identify a limited exercise capacity, abnormal BP response, or arrhythmia.
- An abnormal hemodynamic response
  - Hypotension or failure to increase BP (<20 mm Hg increase) with exercise
  - Symptoms
  - ST-segment abnormalities with
    - However, electrocardiographic ST-segment depression is seen in >80% of patients with AS with exercise and is nonspecific for diagnosis of CAD.
  - Ventricular tachycardia was reported in early exercise studies but has not been reported in contemporary series.

***Nishimura R et al. 2014***

## CENTRAL ILLUSTRATION: Treatment Algorithm for Asymptomatic Severe Aortic Stenosis: Basis of Current American and European Guidelines



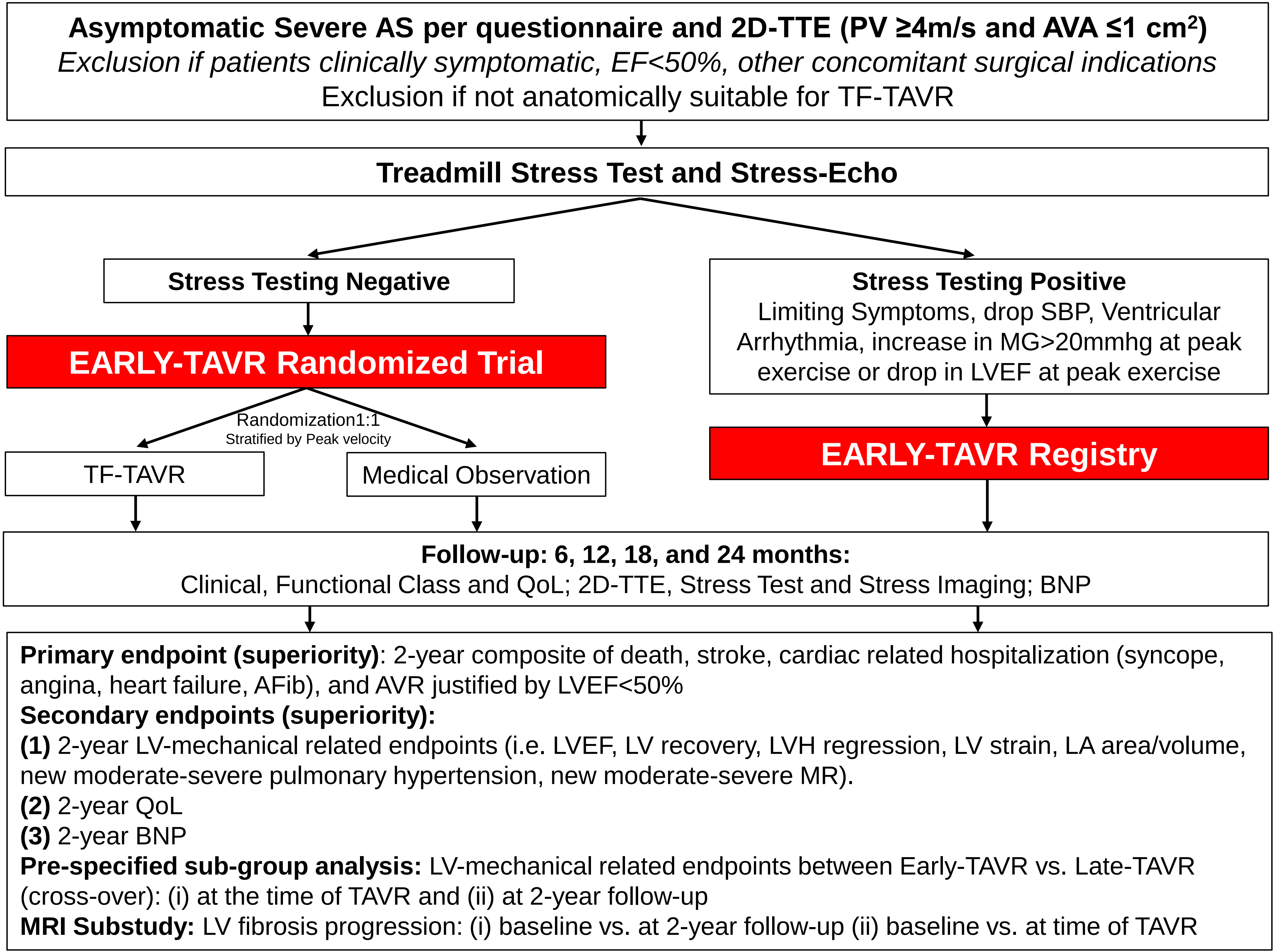

Généreux, P. et al. J Am Coll Cardiol. 2016;67(19):2263-88.

# ***E***valuation of a Strategy of Transcatheter ***A***ortic Valve ***R***eplacement Compared to a Strategy of Medica***L*** Observation in the Treatment of As***Y***mptomatic Severe Aortic Stenosis: ***EARLY-TAVR trial***

***Philippe Généreux, MD, Gregg W. Stone, MD,***

***Ori Ben-Yehuda, MD, Martin B. Leon, MD***

***October 10th, TCT 2015, San Francisco,***

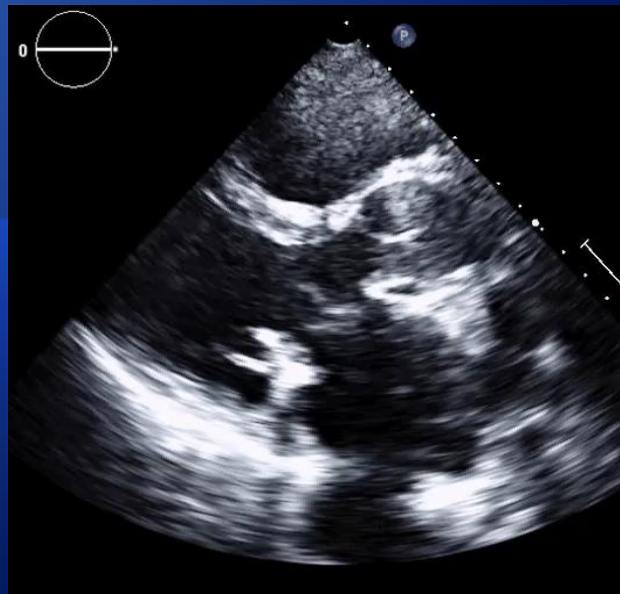


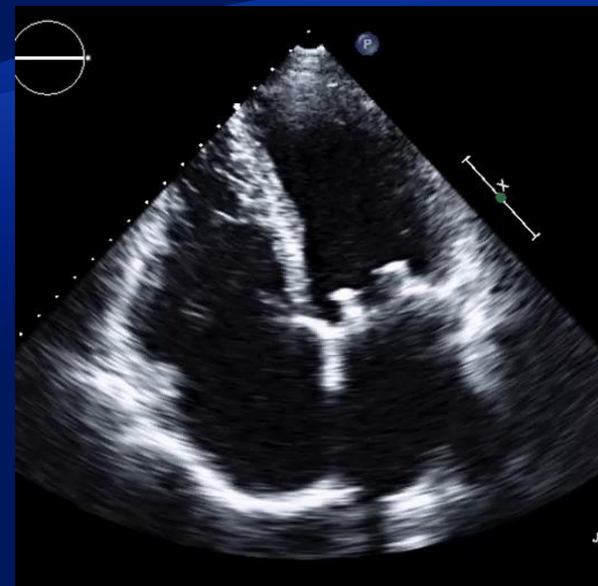
Asymptomatic Severe AS per questionnaire and 2D-TTE (PV ≥4m/s and AVA ≤1 cm²)
Exclusion if patients clinically symptomatic, EF<50%, other concomitant surgical indications
Exclusion if not anatomically suitable for TF-TAVR
Treadmill Stress Test and Stress-Echo
Stress Testing Negative
EARLY-TAVR Randomized Trial
Randomization1:1
Stratified by Peak velocity
TF-TAVR
Medical Observation
Stress Testing Positive
Limiting Symptoms, drop SBP, Ventricular Arrhythmia, increase in MG>20mmhg at peak exercise or drop in LVEF at peak exercise
EARLY-TAVR Registry
Follow-up: 6, 12, 18, and 24 months:
Clinical, Functional Class and QoL; 2D-TTE, Stress Test and Stress Imaging; BNP
Primary endpoint (superiority): 2-year composite of death, stroke, cardiac related hospitalization (syncope, angina, heart failure, AFib), and AVR justified by LVEF<50%
Secondary endpoints (superiority):
(1) 2-year LV-mechanical related endpoints (i.e. LVEF, LV recovery, LVH regression, LV strain, LA area/volume, new moderate-severe pulmonary hypertension, new moderate-severe MR).
(2) 2-year QoL
(3) 2-year BNP
Pre-specified sub-group analysis: LV-mechanical related endpoints between Early-TAVR vs. Late-TAVR (cross-over): (i) at the time of TAVR and (ii) at 2-year follow-up
MRI Substudy: LV fibrosis progression: (i) baseline vs. at 2-year follow-up (ii) baseline vs. at time of TAVR

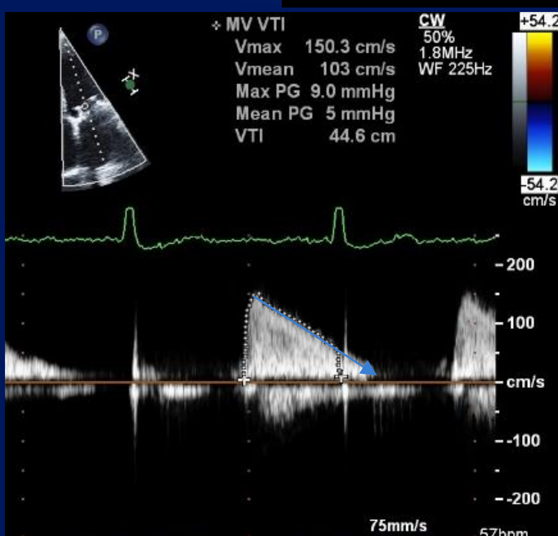
# Symptomatic Patients with Non-severe Valve Disease

| Disease State | Aim of Test |
| --- | --- |
| Non-severe regurgitation (MR and AR)<br>***Exercise*** | Assess increase in regurgitation, ± SPAP ↑ >60 mmHg, EF ↑<4% |
| Non-severe MS<br>***Exercise or low-dose DSE*** | ↑ Mean grad >15 mmHg (ex) or >18 mmHg (DSE), ± SPAP ↑ >60 mmHg |
| Non-severe AS or paradoxical low-flow AS<br>***Exercise*** | Assess peak/mean gradient, increase and change in valve area |
| Equivocal PPM (AVR or MVR)<br>***Exercise or low-dose DSE*** | Assess gradient and valve area change |
| Mitral Annuloplasty resting mean gradient >3 mmHg | Mean gradient ≥7 mmHg, peak exercise SPAP ≥ 50 mmHg |

# MVR

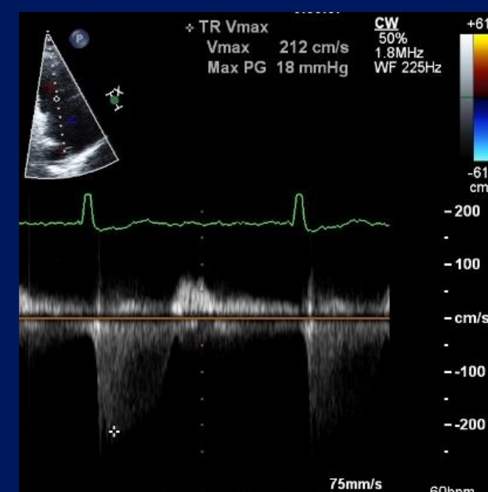







Mean gradient = 5 mmHg

- *27 mm CE MVR 2 years ago*
- *Persistent DOE*
- *MVOA calculated to 1.7 cm2*
- *Deceleration time = 120 msec*




TR Vmax = 2.1 m/s

# Approach to High Gradient in an Mitral Prosthetic Valve

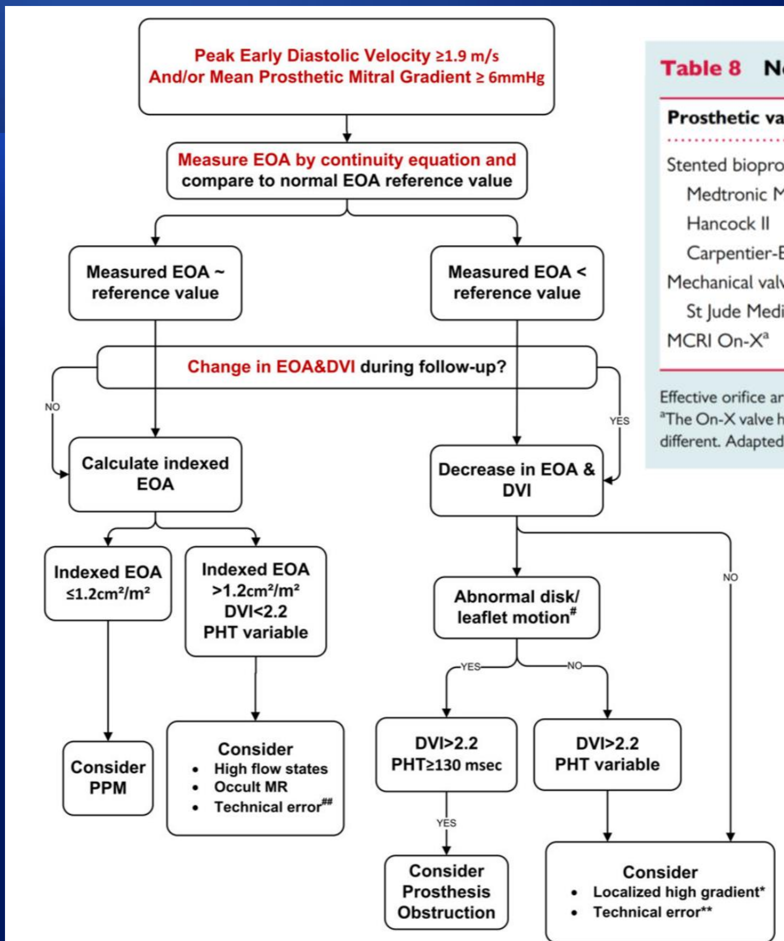



**Table 8** Normal reference values of effective orifice areas for the prosthetic mitral valves

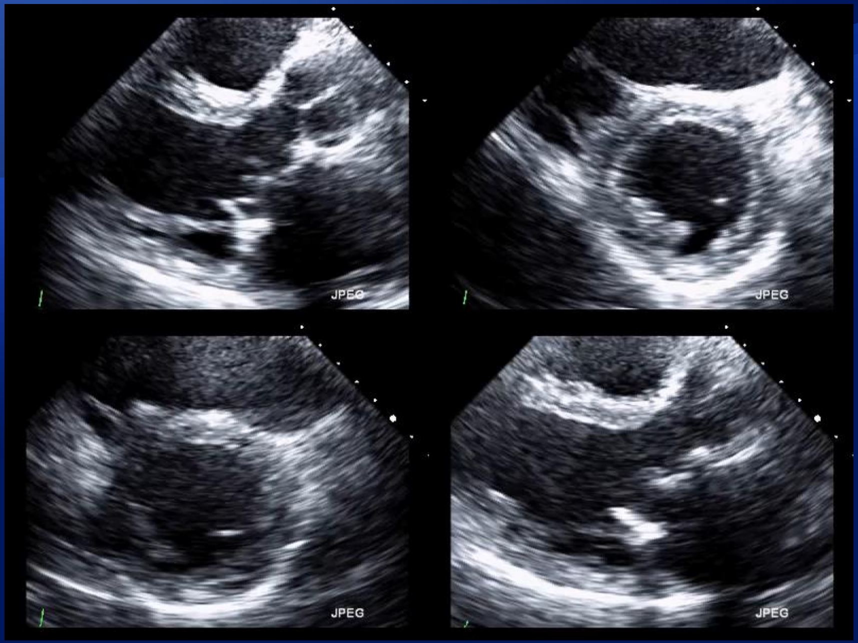
| Prosthetic valve size (mm) | 25 | 27 | 29 | 31 | 33 |
|---|---|---|---|---|---|
| Stented bioprosthetic valves | | | | | |
| Medtronic Mosaic | 1.5 ± 0.4 | 1.7 ± 0.5 | 1.9 ± 0.5 | 1.9 ± 0.5 | – |
| Hancock II | 1.5 ± 0.4 | 1.8 ± 0.5 | 1.9 ± 0.5 | 2.6 ± 0.5 | 2.6 ± 0.7 |
| Carpentier-Edwards Perimount | 1.6 ± 0.4 | 1.8 ± 0.4 | 2.1 ± 0.5 | – | – |
| Mechanical valves | | | | | |
| St Jude Medical Standard | 1.5 ± 0.3 | 1.7 ± 0.4 | 1.8 ± 0.4 | 2.0 ± 0.5 | 2.0 ± 0.5 |
| MCRI On-X[a] | 2.2 ± 0.9 | 2.2 ± 0.9 | 2.2 ± 0.9 | 2.2 ± 0.9 | 2.2 ± 0.9 |

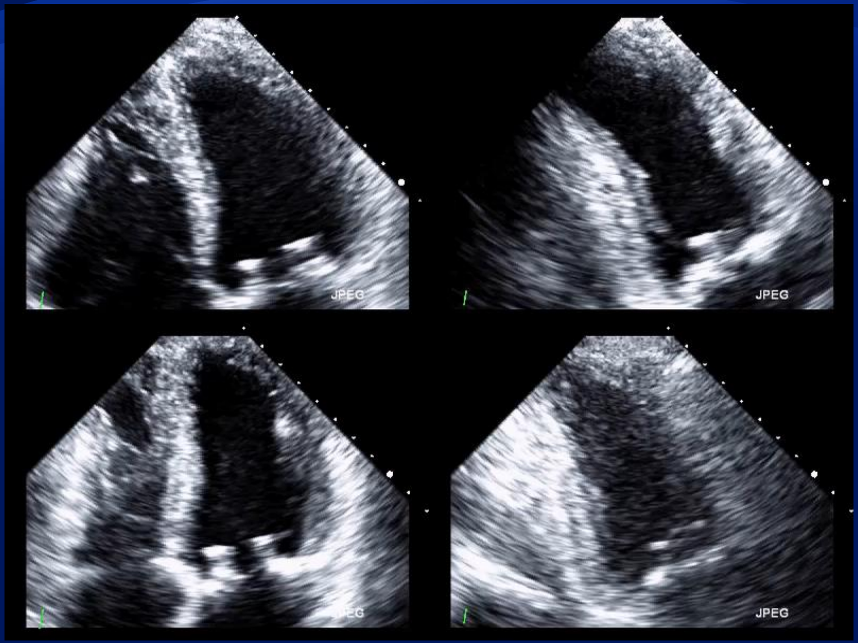
Effective orifice area is expressed as mean values available in the literature. Further studies are needed to validate these reference values.
[a]The On-X valve has just 1 size for 27 to 29 and 31 to 33 mm prostheses. In addition, the strut and leaflets are identical for all sizes (25 to 33 mm); only the size of the sewing cuff is different. Adapted with permission from Ref. 7.

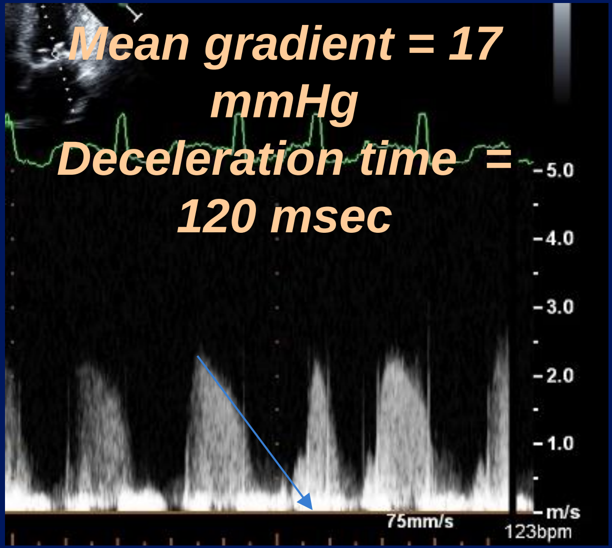
- *27 mm CE MVR 2 years ago*
- *Persistent DOE*
- *MVOA calculated to 1.7 cm2*

*Lancellotti P et al. Eur Heart J Cardiovasc Imaging. 2016 Jun;17(6):589-90.*

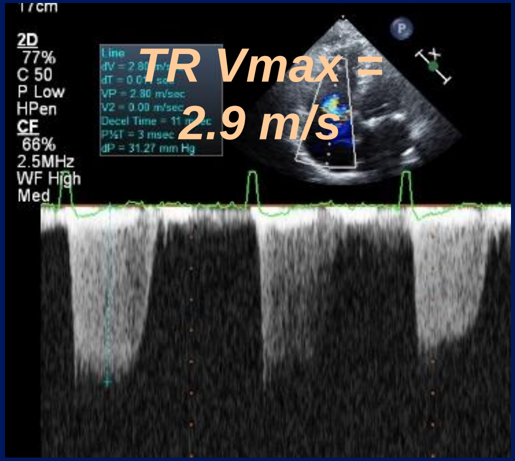
# MVR: Stress








*Mean gradient = 17 mmHg*
*Deceleration time = 120 msec*




*TR Vmax = 2.9 m/s*

*Symptomatic patient-prosthesis mismatch*

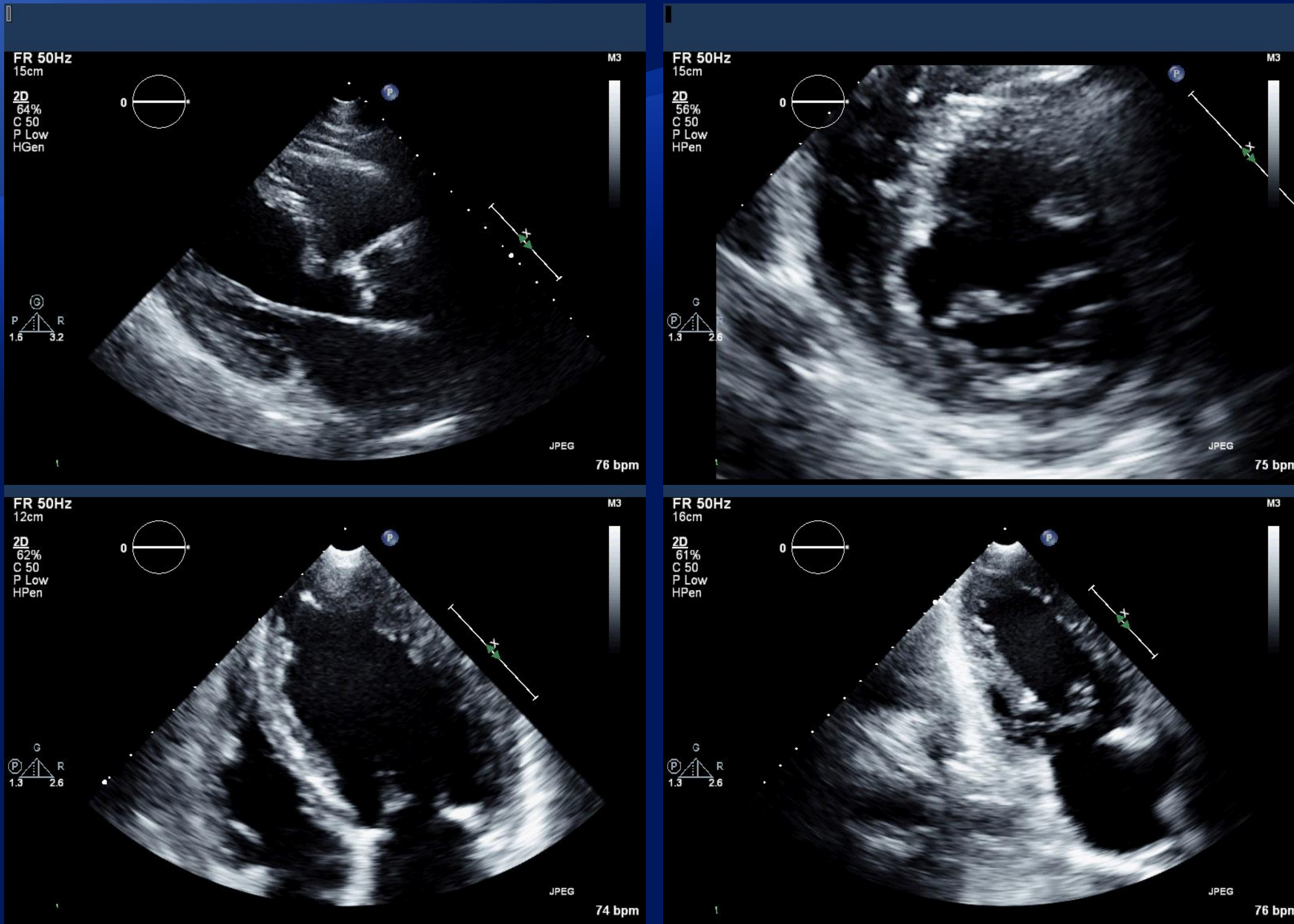
# S.B.

| Clinical History | |
|---|---|
| Age | 83 years |
| Gender | Female |
| Medical history | Heart Failure<br>Arterial Hypertension<br>Hypercholesterolemia |
| Rx | ASA 81 mg QD<br>Metoprolol ER 50 mg QD<br>Furosemide 40 mg QD<br>Spironolactone 37.5 mg QD<br>Atorvastatin 20 mg QD |

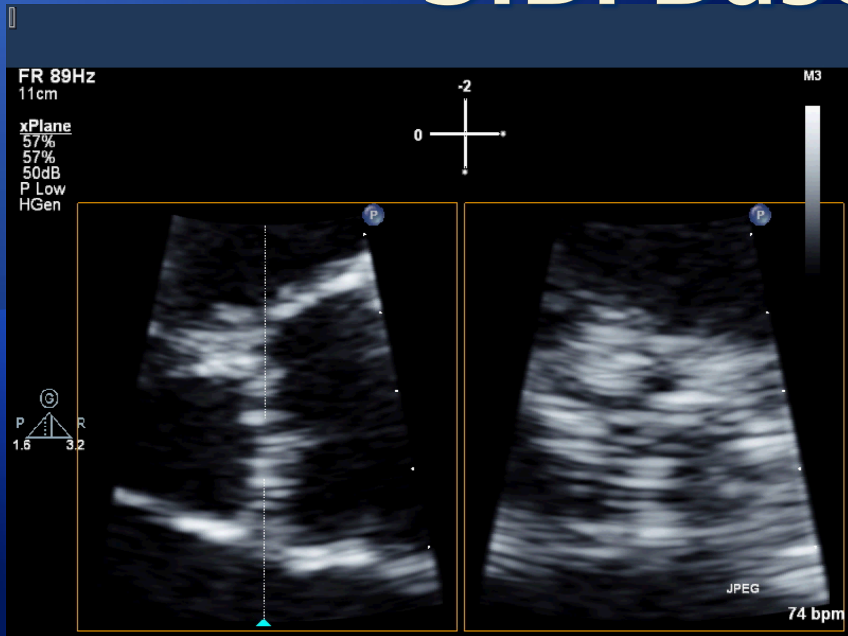
- Heart Failure NYHA class III, ACC/AHA stage C
- Creatinine 0.81 mg/dL
- NT pro-BNP 9 952 pg/mL
- ECG: Sinus rhythm. LBBB

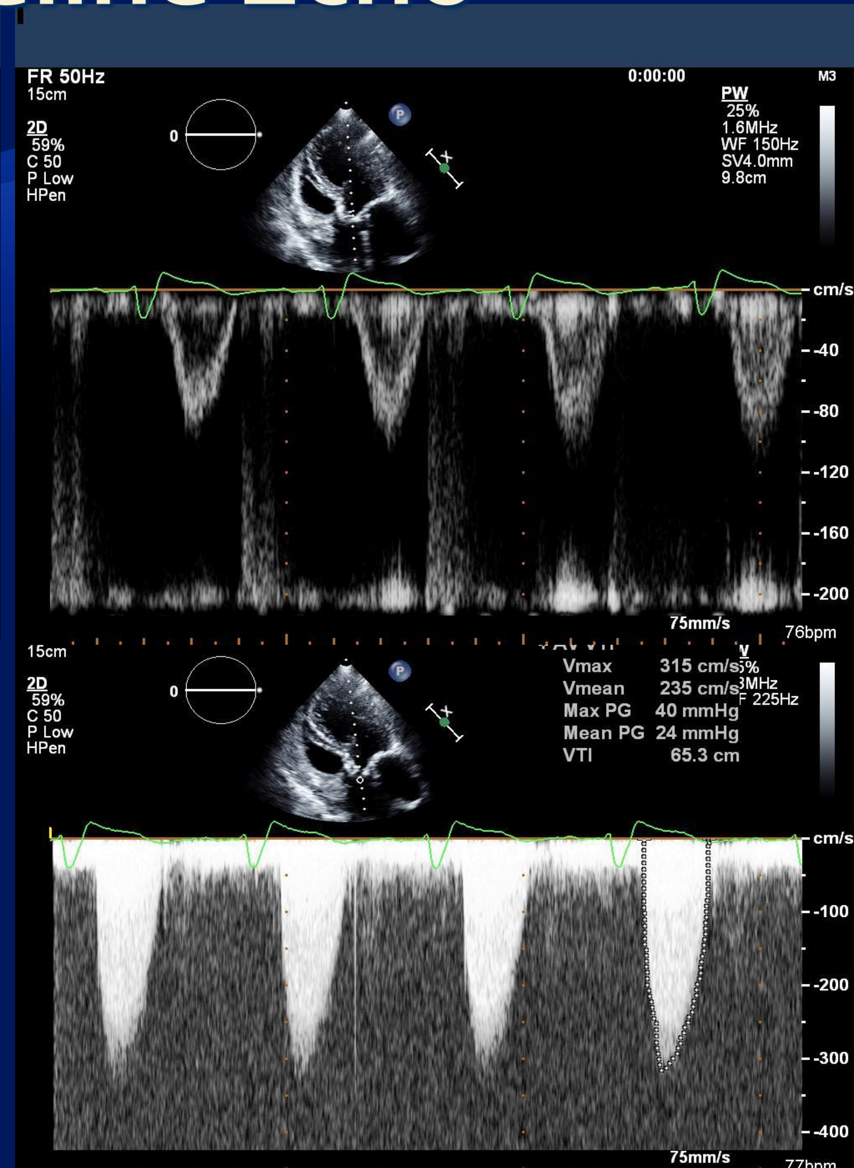
| Physical Examination |
|---|
| Height: 5ft 3in Weight: 115 lbs BSA 1.53 $m^2$ |
| BP 124/70; HR 68 bpm |
| No jugular venous distention<br>Soft S2 III/VI SM RUSB<br>Clear lungs<br>No edema |

# S.B. Baseline Echo LVEF 35%



# S.B. Baseline Echo




| | |
|---|---|
| LVOT diameter | 2.19 cm |
| Peak gradient | 39.7 mmHg |
| Mean gradient | 23.7 mmHg |
| AVA | 0.98 $cm^2$ (0.64 $cm^2/m^2$) |
| DVI | 0.26 |
| SV | 64.1 ml (42 $ml/m^2$) |

# DSE

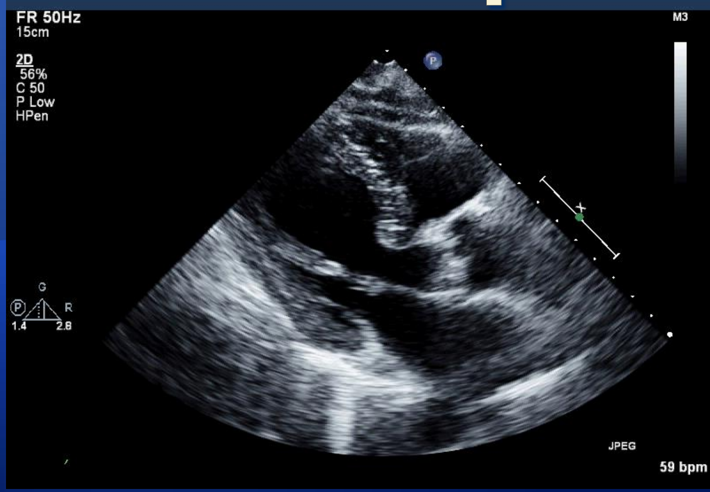
| Baseline | |
|---|---|
| Peak gradient | 34.4 mmHg |
| Mean gradient | 19.0 mmHg |
| **AVA** | **0.98 $cm^2$ (0.64$cm^2/m^2$)** |
| DVI | 0.26 |
| SV | 64.1 ml (42 $ml/m^2$) |
| LVEF | 35% |

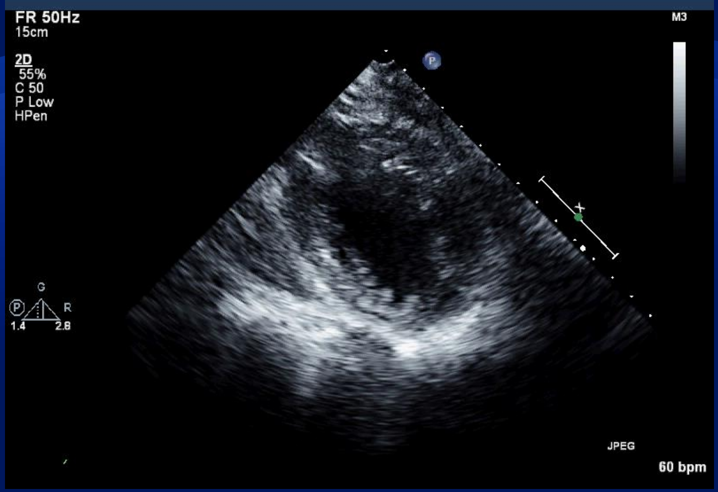
| Low dose (5 mcg/kg/min) | |
|---|---|
| Peak gradient | 39.7 mmHg |
| Mean gradient | 23.7 mmHg |
| **AVA** | **1.17 $cm^2$ (0.76$cm^2/m^2$)** |
| DVI | 0.31 |
| SV | 70.2 ml (46 $ml/m^2$) |
| LVEF | 40% |

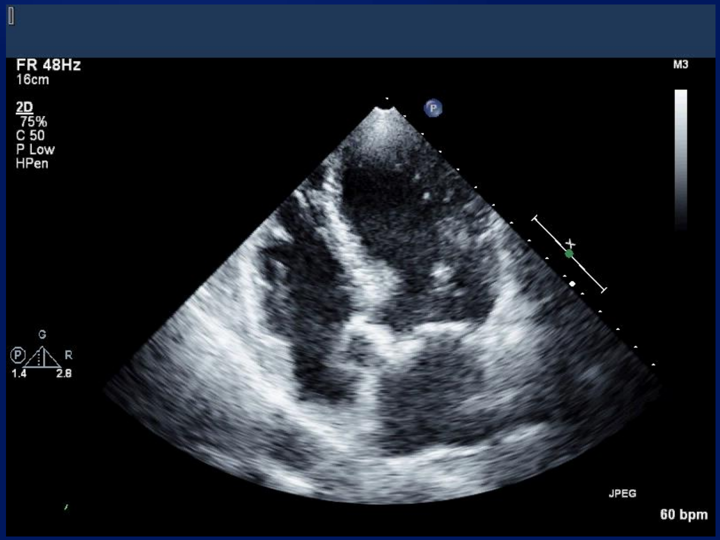
| Peak dose (15 mcg/kg/min) | |
|---|---|
| Peak gradient | 55.7 mmHg |
| Mean gradient | 25.3 mmHg |
| **AVA** | **1.28 $cm^2$ (0.84$cm^2/m^2$)** |
| DVI | 0.34 |
| SV | 71.3 ml (47 $ml/m^2$) |
| LVEF | 50% |

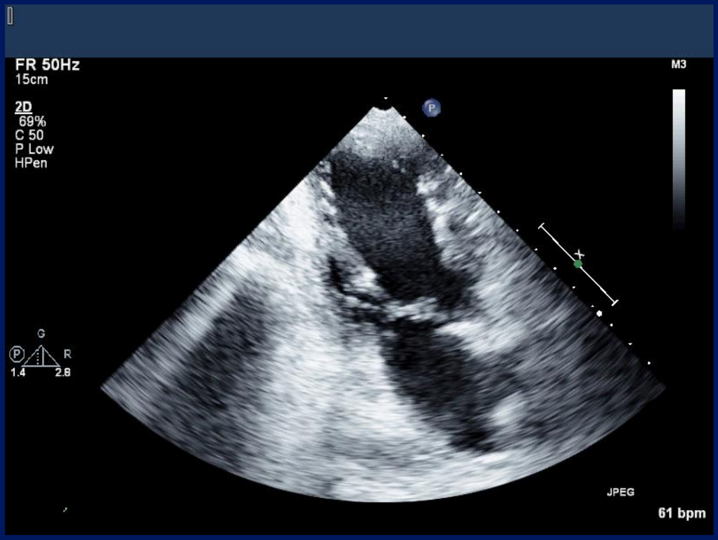
**Negative stress echo for ischemia**
**11% increase in stroke volume with increase AVA with dobutamine**

# Follow-up ECHO with GDMT



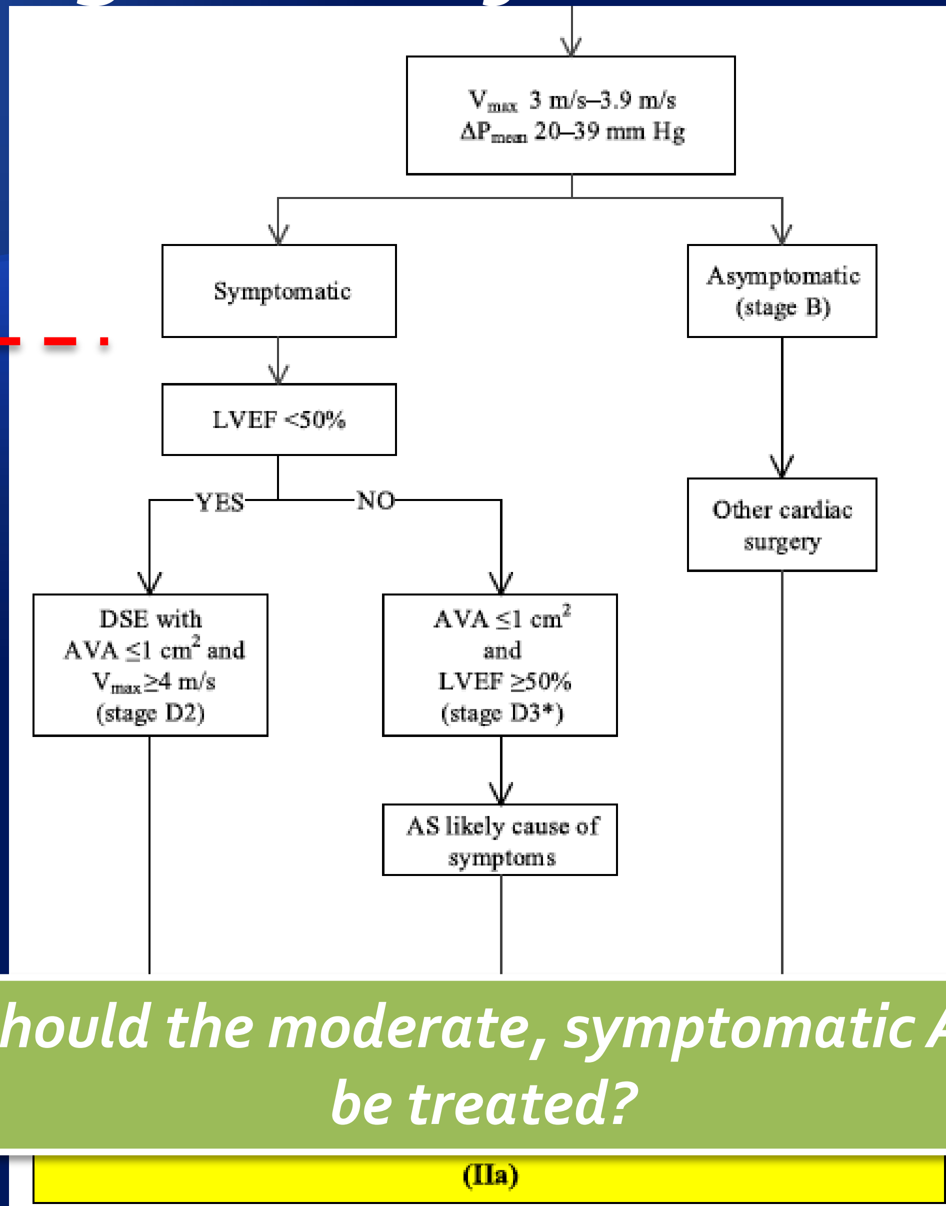




***LVEF 46%,BP 113/59 HR 56 bpm***

***NYHA Class II***

# Management of Moderate AS



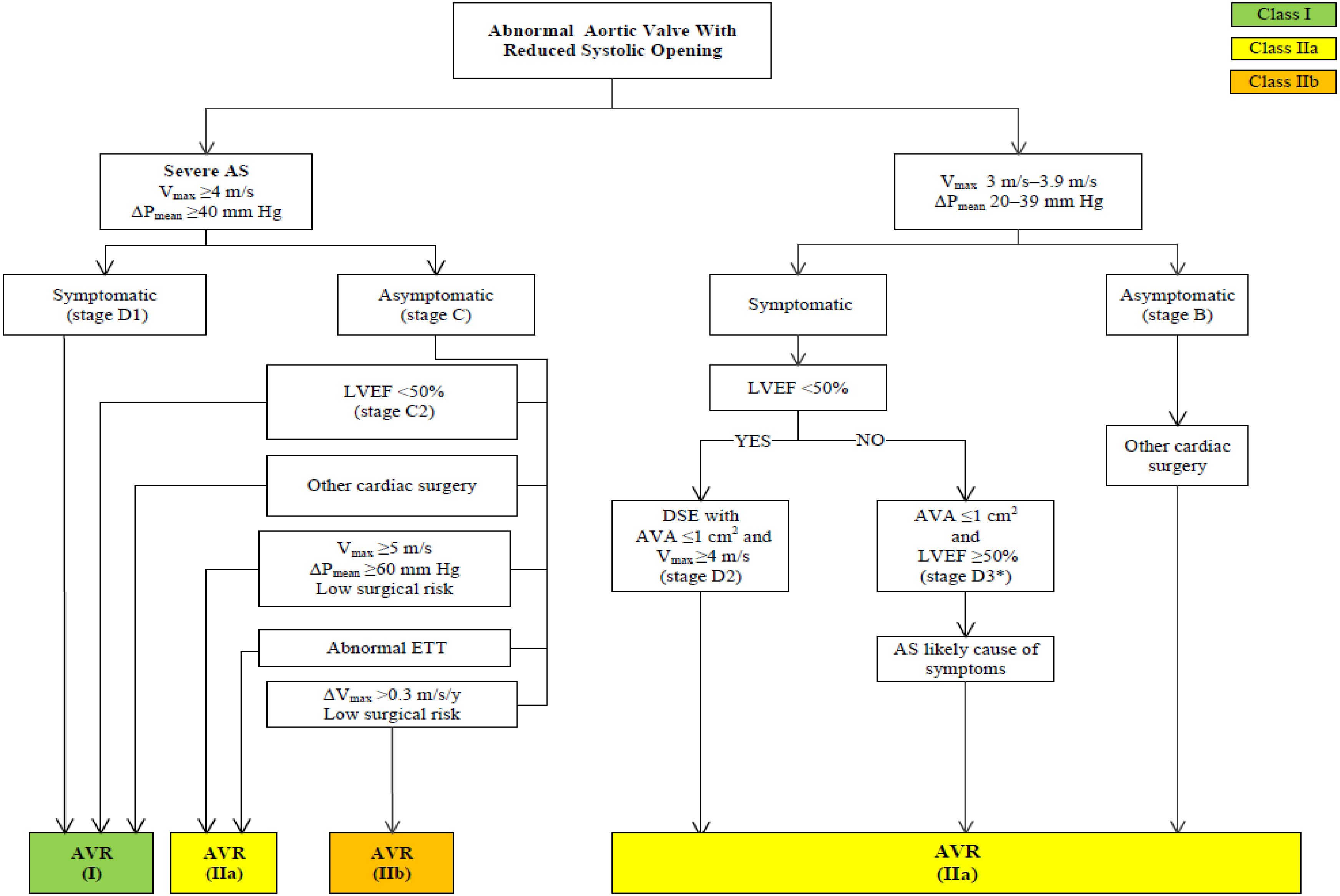

**NYHA ≥2 & EF ↓**

**TAVI?**

**Should the moderate, symptomatic AS be treated?**

*Nishimura R et al. JACC 2014;63:e57-185.*

# Indications for Aortic Valve Replacement in Patients With Aortic Stenosis

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# TAVR UNLOAD TRIAL

CRF

CARDIαLYSIS
Clinical Trial Management - Core Laboratories

Edwards Lifesciences

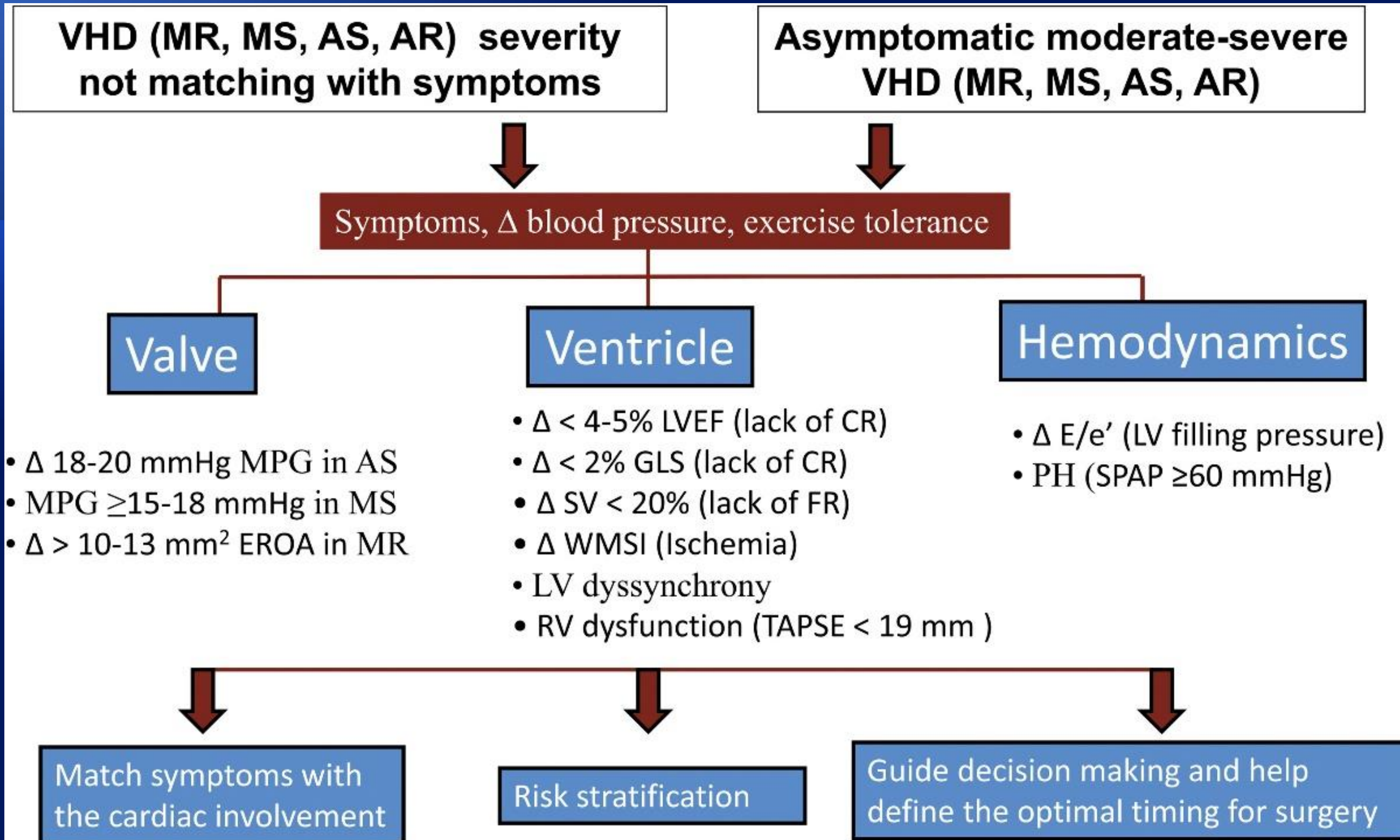
NewYork-Presbyterian

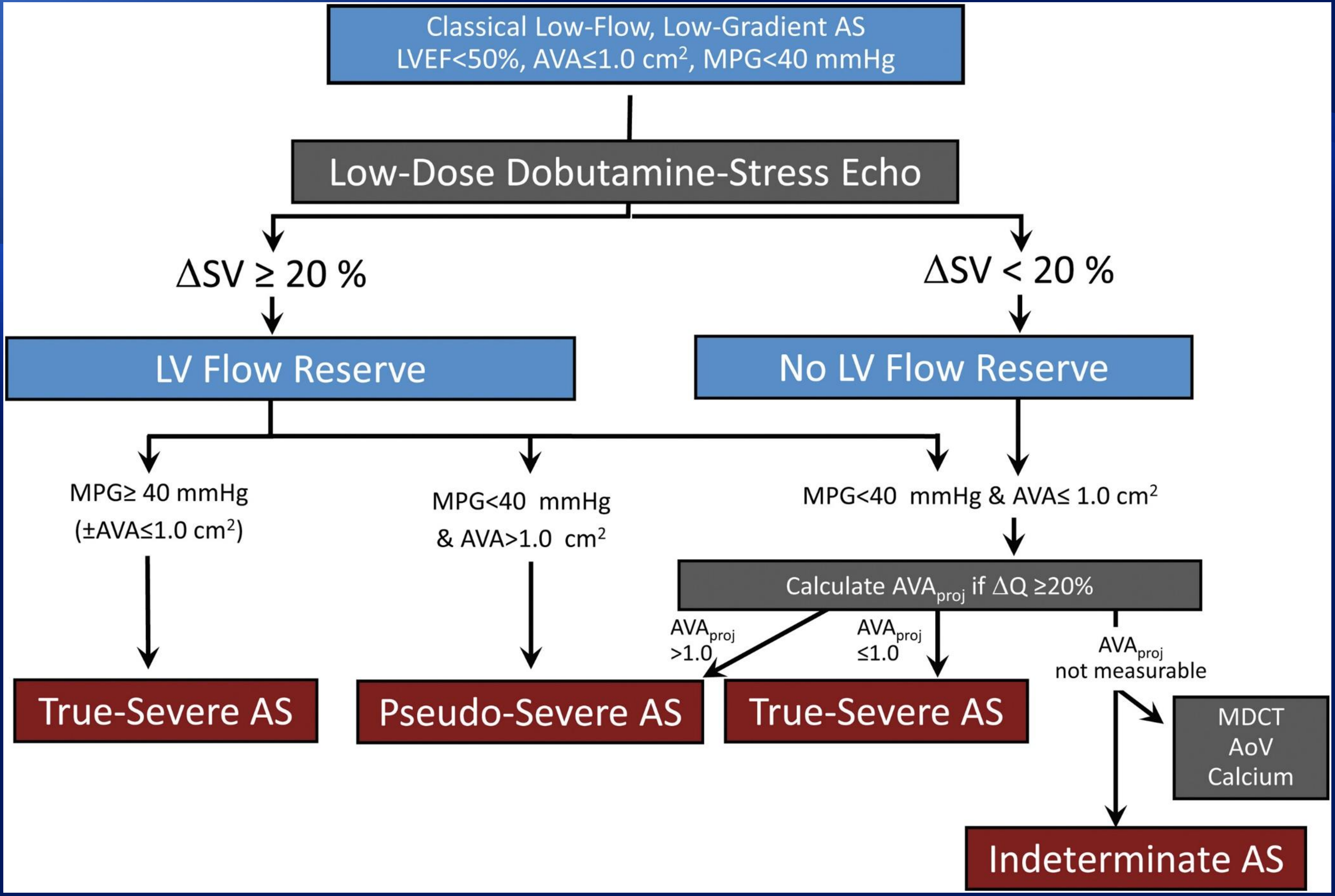
Columbia University Medical Center

Erasmus MC
Universitair Medisch Centrum Rotterdam

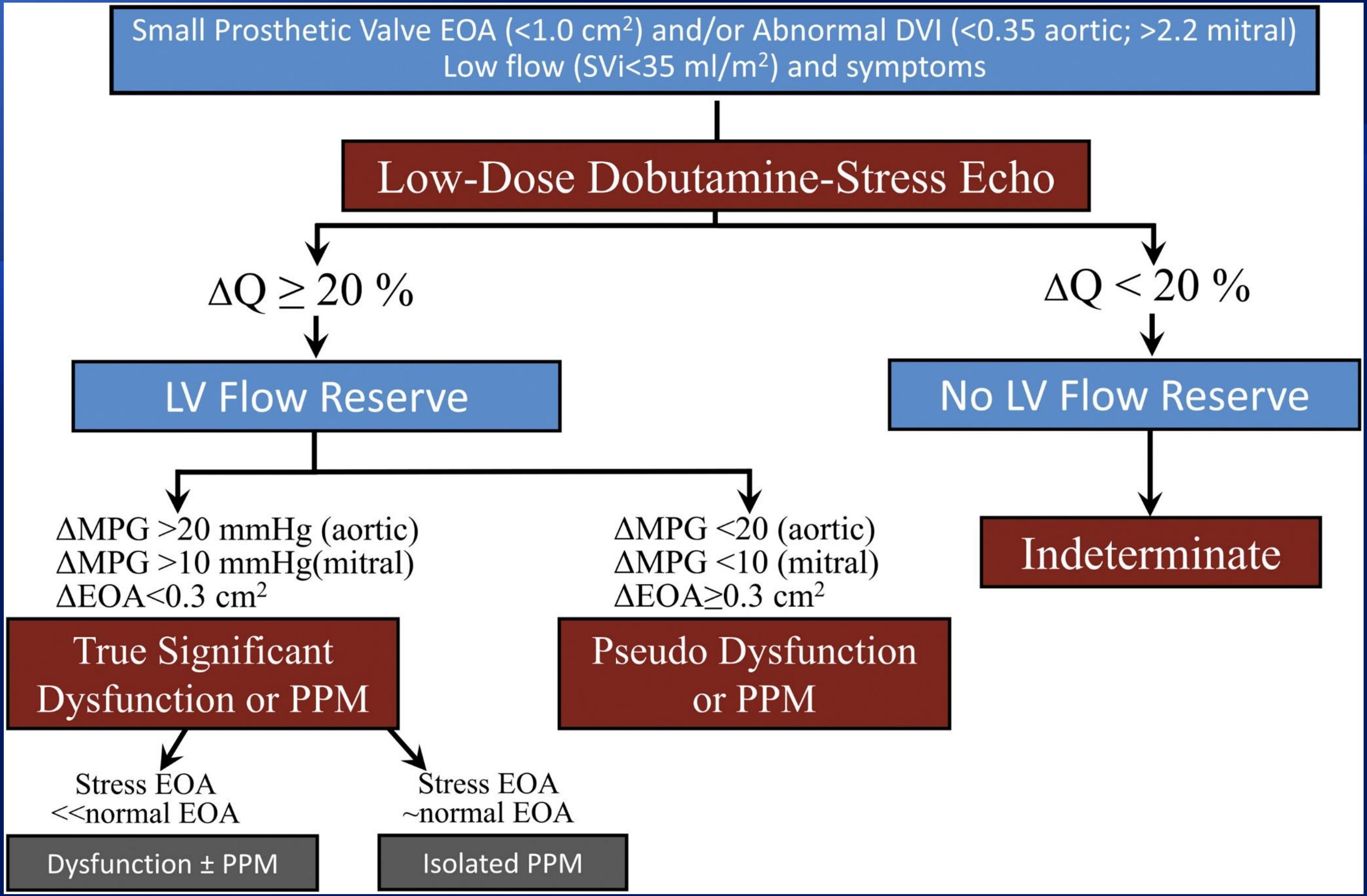
Institut universitaire de cardiologie et de pneumologie de Québec

Université Laval


VHD (MR, MS, AS, AR) severity not matching with symptoms
Asymptomatic moderate-severe VHD (MR, MS, AS, AR)
Symptoms, Δ blood pressure, exercise tolerance
Valve
Ventricle
Hemodynamics
• Δ 18-20 mmHg MPG in AS
• MPG ≥15-18 mmHg in MS
• Δ > 10-13 $mm^2$ EROA in MR
• Δ < 4-5% LVEF (lack of CR)
• Δ < 2% GLS (lack of CR)
• Δ SV < 20% (lack of FR)
• Δ WMSI (Ischemia)
• LV dyssynchrony
• RV dysfunction (TAPSE < 19 mm )
• Δ E/e' (LV filling pressure)
• PH (SPAP ≥60 mmHg)
Match symptoms with the cardiac involvement
Risk stratification
Guide decision making and help define the optimal timing for surgery



Classical Low-Flow, Low-Gradient AS
LVEF<50%, AVA≤1.0 cm², MPG<40 mmHg
Low-Dose Dobutamine-Stress Echo
ΔSV ≥ 20 %
ΔSV < 20 %
LV Flow Reserve
No LV Flow Reserve
MPG≥ 40 mmHg
(±AVA≤1.0 cm²)
MPG<40 mmHg
& AVA>1.0 cm²
MPG<40 mmHg & AVA≤ 1.0 cm²
Calculate AVAproj if ΔQ ≥20%
AVAproj
>1.0
AVAproj
≤1.0
AVAproj
not measurable
True-Severe AS
Pseudo-Severe AS
True-Severe AS
MDCT
AoV
Calcium
Indeterminate AS




***Evaluation of aortic/mitral prosthetic valves function in patients with low flow.***

# 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*

*Lancellotti, P et al. J Am Soc Echocardiogr 2017;30:101-38*

# Targeted Parameters

| Disease State | Aim of Test |
|---|---|
| Diastolic Stress Echo<br>***Exercise*** | E/e' increase ± ↑SPAP |
| HCM<br>***Exercise*** | LVOTO ± ↑SPAP, E/e' increase ± ↑SPAP, Δ MR, RWMA |
| Dilated COM<br>***Exercise*** | Δ Contractility, E/e' increase ± ↑SPAP, RWMA, Lung comets, Δ MR |

# Congenital Heart Disease

| Disease State | Aim of Test |
|---|---|
| Atrial septal defect<br>*Exercise or DSE* | ↑SPAP, RV Contractile Reserve |
| Tetralogy of Fallot<br>*Exercise* | LV/RV Contractile Reserve |
| Aortic Coarctation<br>*Exercise* | ↑Gradient, ↑LV contractility |
| Univentricular hearts<br>*Exercise* | ↑contractility, AV valve regurgitation, ΔGradients |

# THANK YOU!