echocardiography in assessment of patients with valvular heart diseases

Vietnam National Heart Association Scientific Meeting, 2017

"Contemporary approach to management of heart failure"

Thanh Hoa Province, Vietnam

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Director of Echocardiography

Chair, Ethics Committee

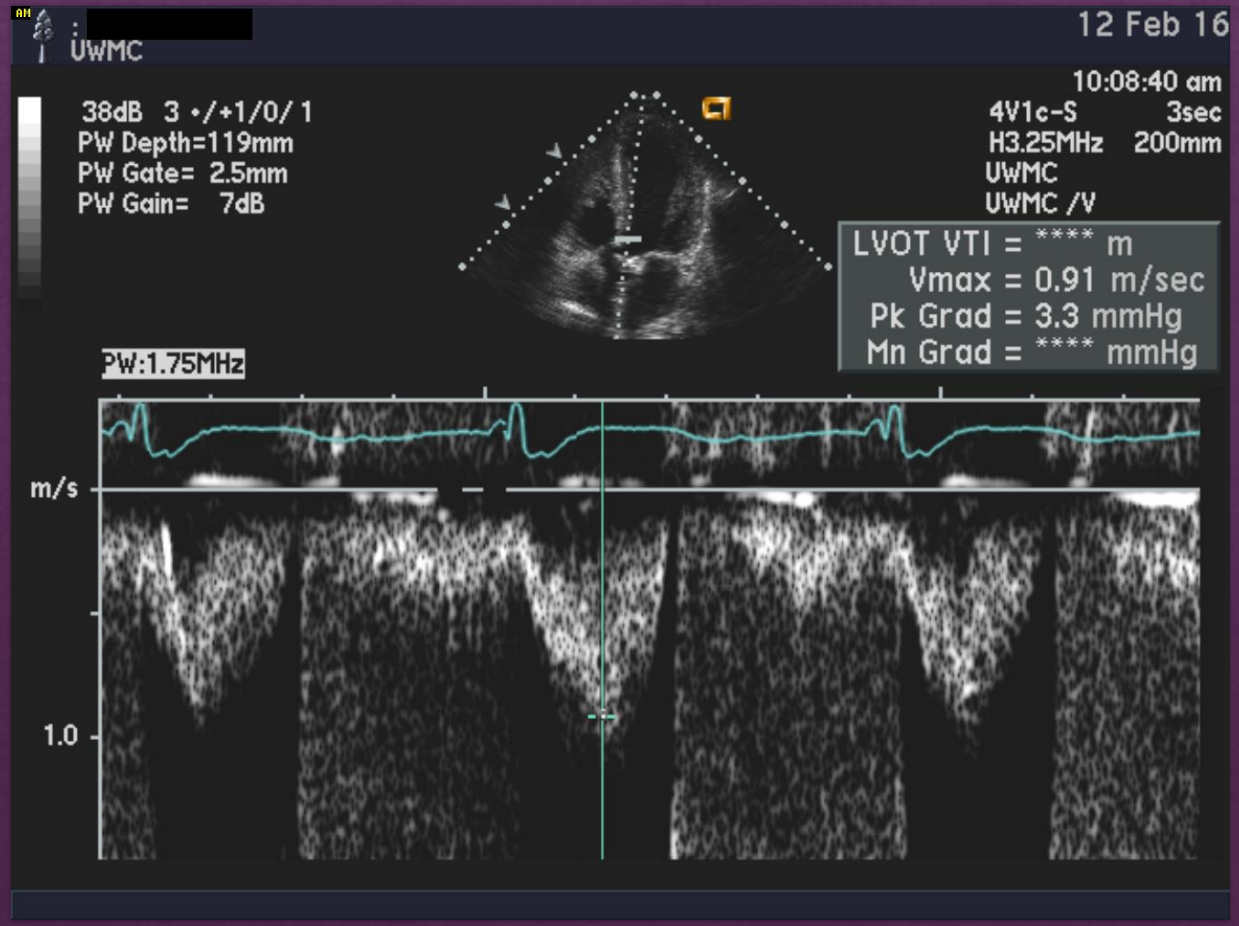
University of Washington Medical Center

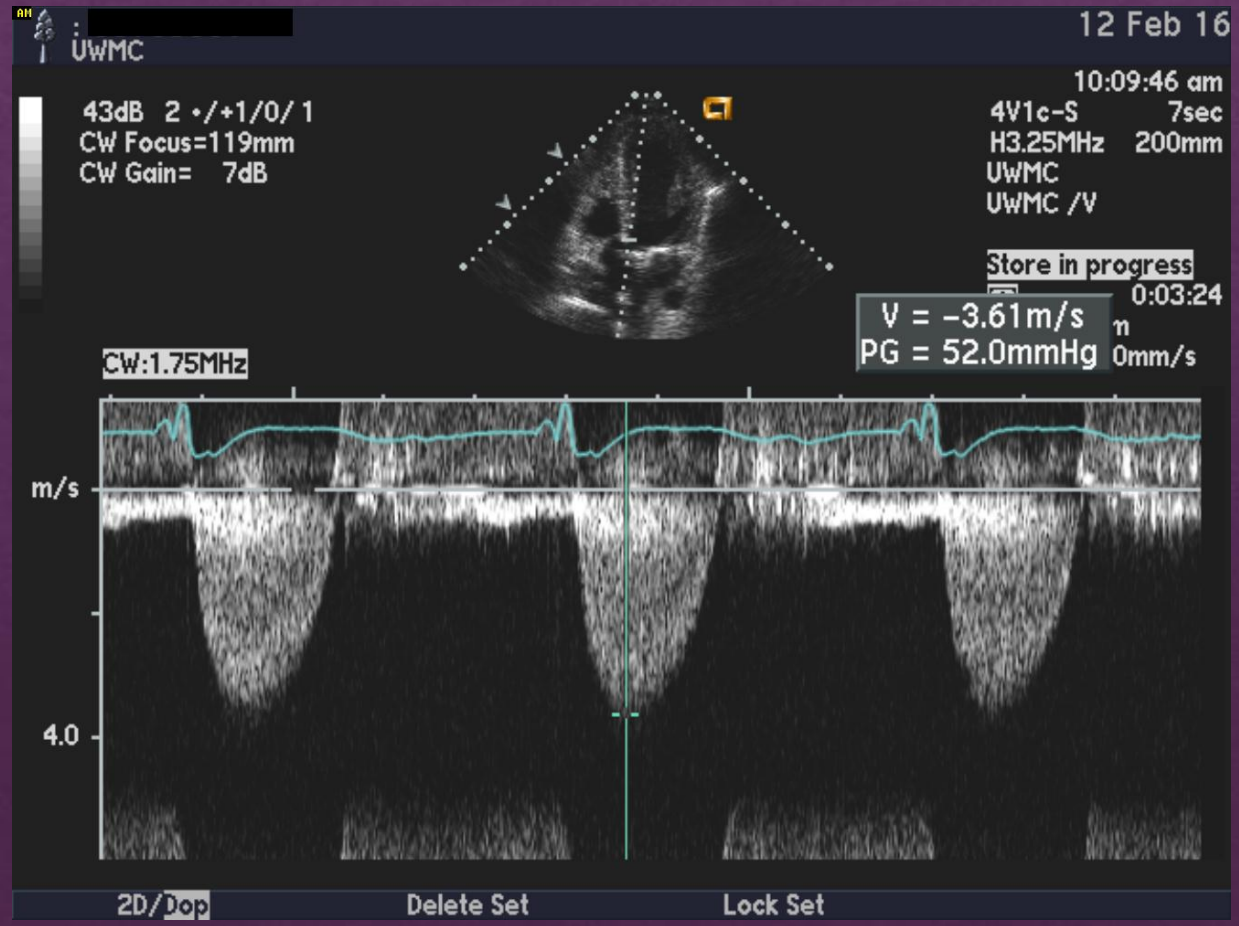
Disclosures

- None

Question: Would you replace this valve?

LV vel 0.9/ AV vel 3.6=0.25, AVA 1.0cm2, 0.5cm2/m2. Mean gradient 33mmHg





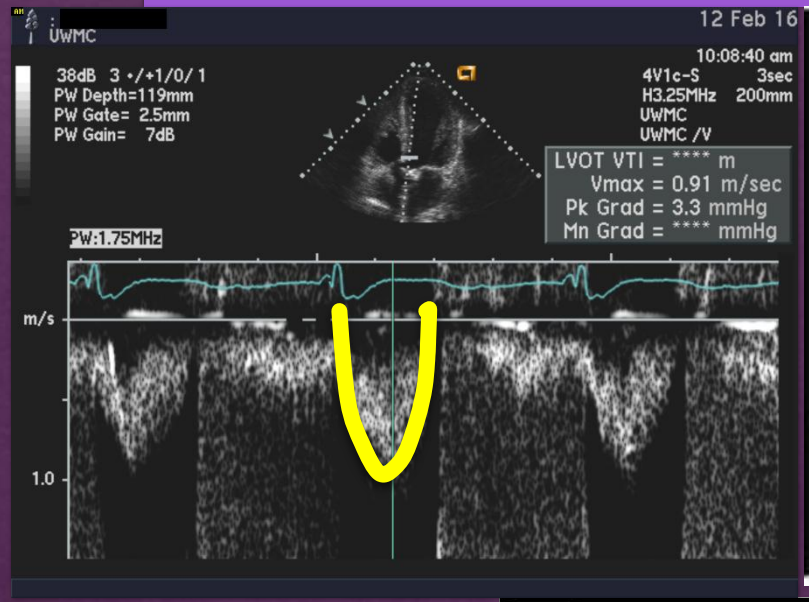
LVEF 33%, SVi<35ml.

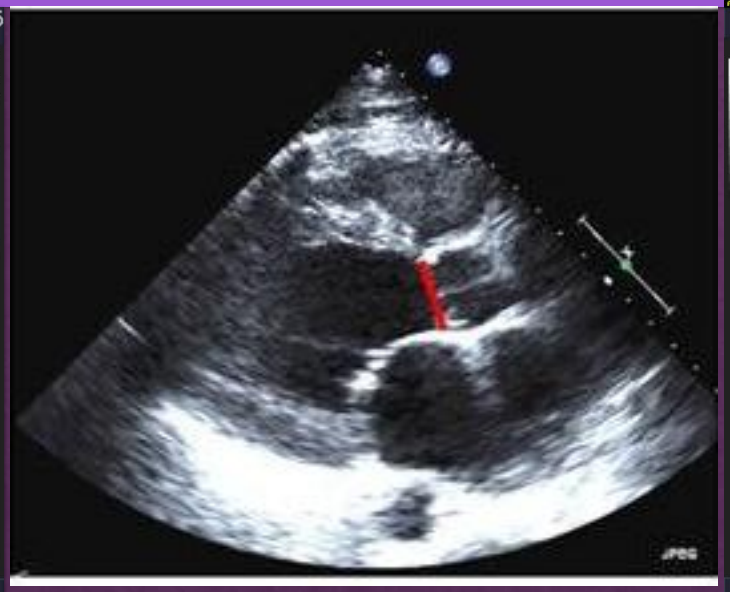
Patient factors

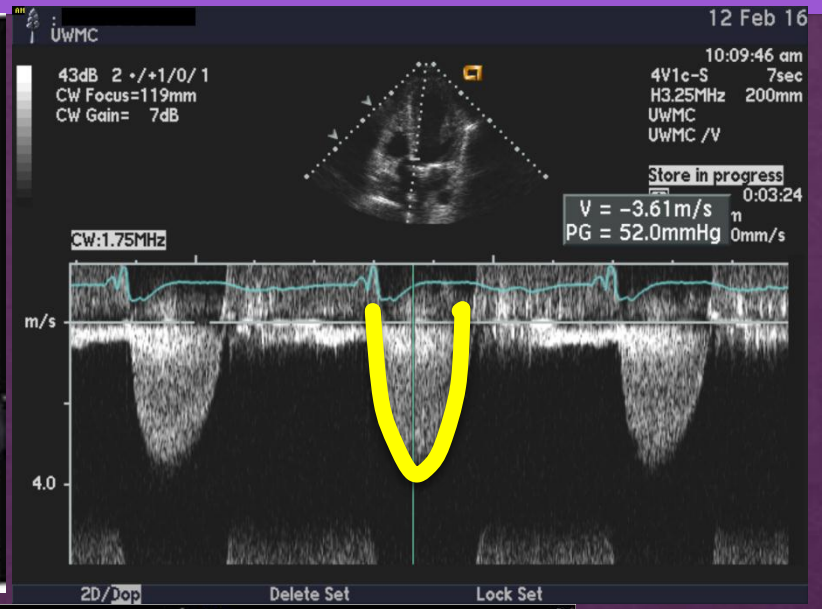
- Symptoms? ---questionable.
- Can the patient afford valve replacement? ---Yes
- What is the body surface area? —$2.0m^2$
- Comorbidities --moderate COPD
- Surgical Risk --STS 3.3%

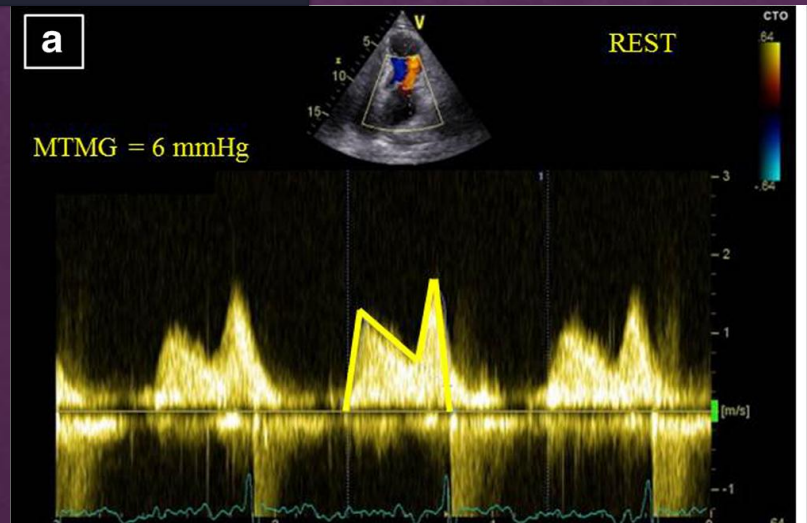
Echo Tools

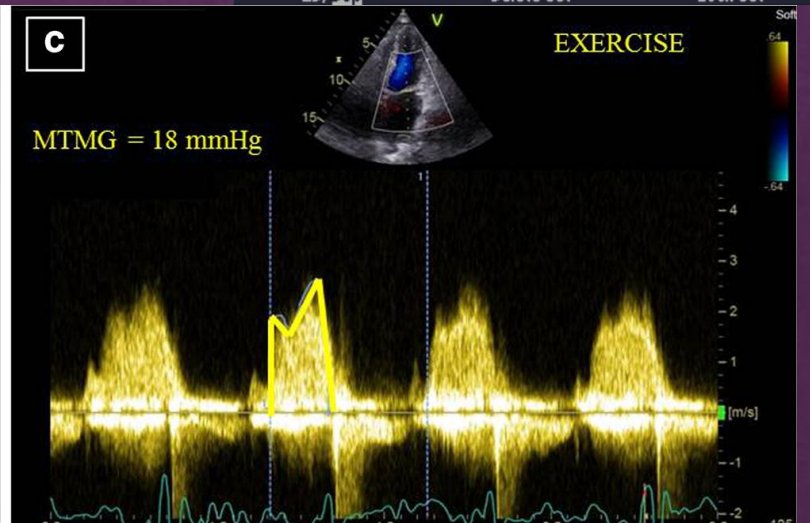
Peak Velocities and Mean Gradients, Valve Area



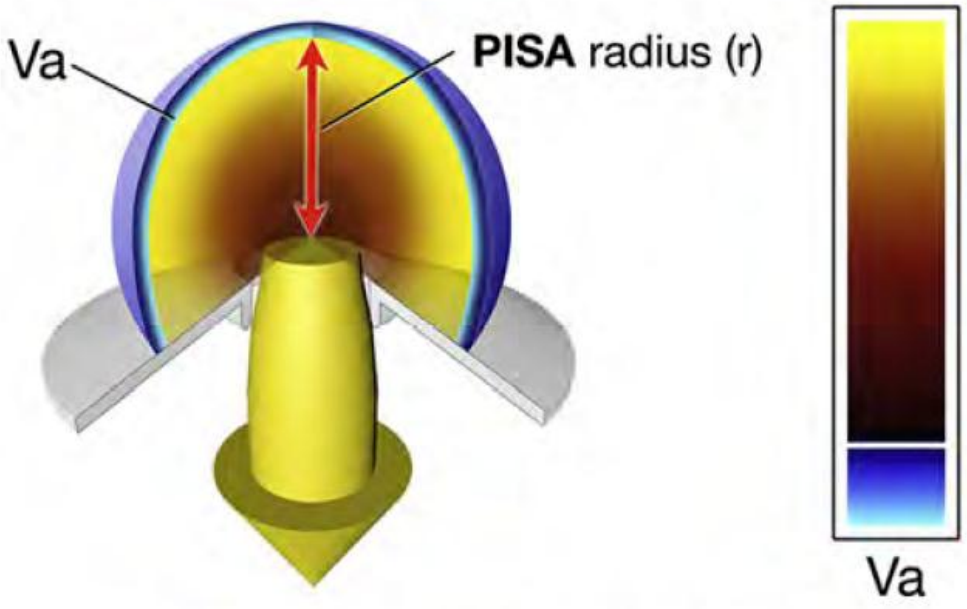




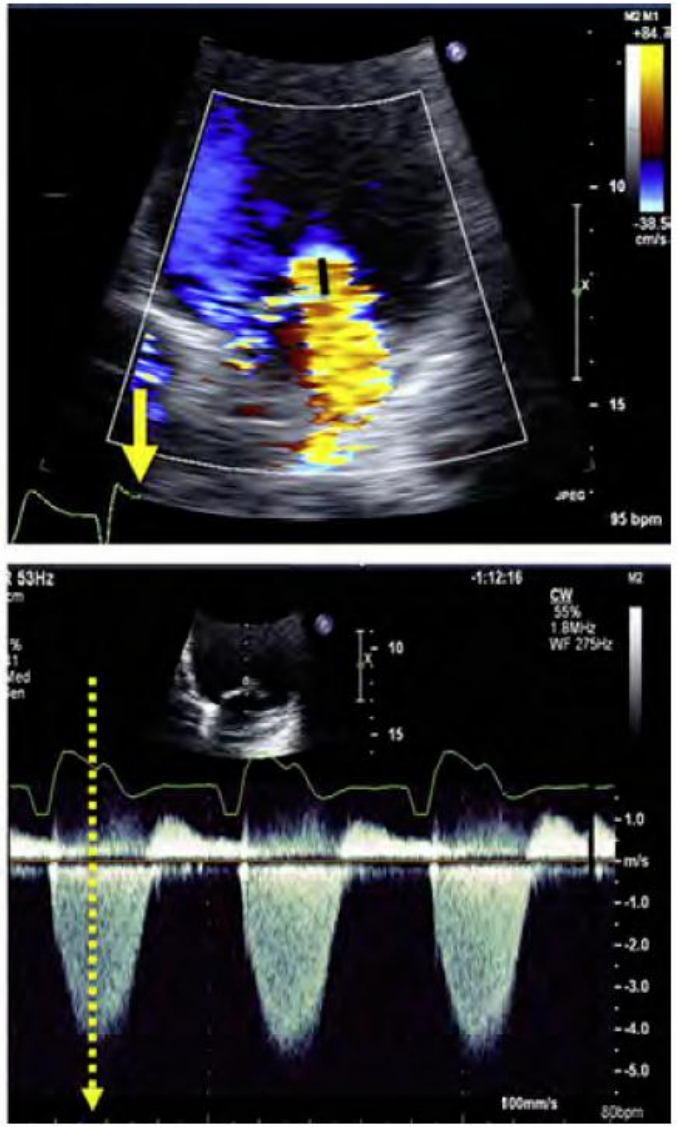




Flow Convergence Method



$$\text{Reg Flow} = 2\pi r^2 \times Va$$
$$EROA = \text{Reg Flow}/PKV_{Reg}$$
$$\text{R Vol} = EROA \times VTI_{Reg}$$



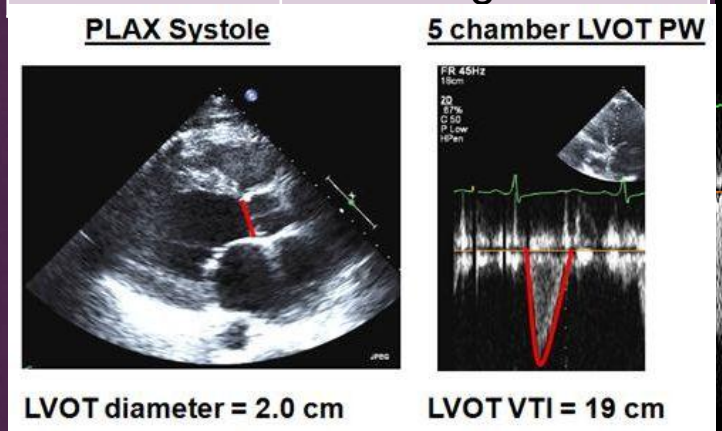
Zoghbi, J Am Soc Echocardiogr, 2017

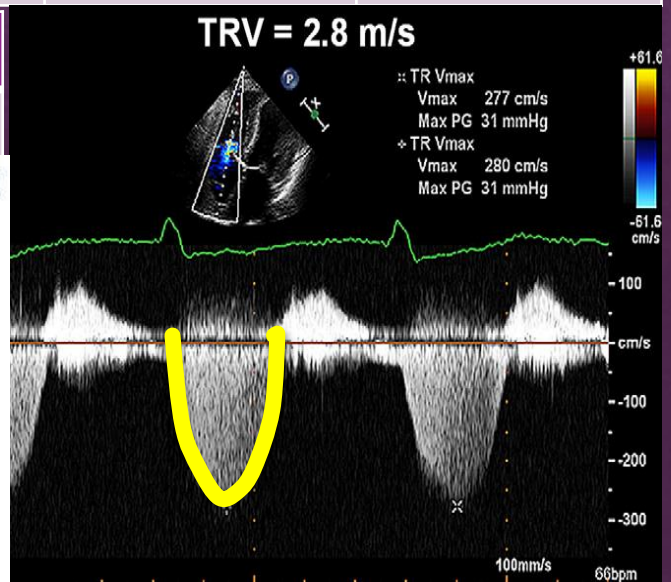
Pulmonary pressures

- Pulmonary pressures are affected by the resistance of the vessels, the back pressure from the left side (mitral stenosis or regurgitation) **but also the cardiac output**
- Up to ½ of elderly healthy individuals can have PASP>60mmHg at peak exercise
- Mean PA pressures or PASP should therefore be “corrected” for age an and cardiac output

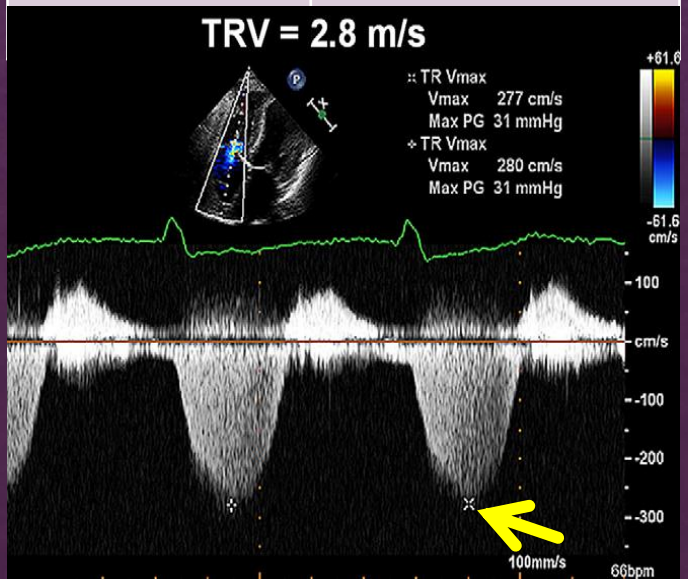
	<10L/min	10-20L/min	>20L/min
Mean PAP(mmHg)	34	45	52

mPAP-CO	<3mmHg/L/min



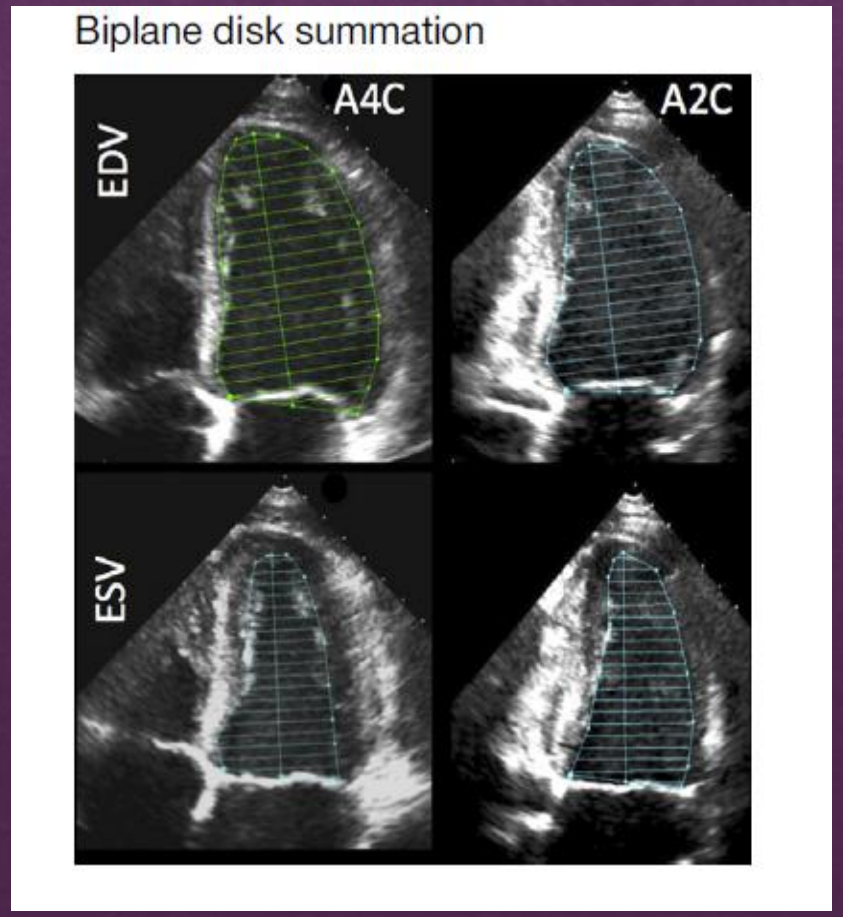


	<10L/min
Systolic	<50mmHg

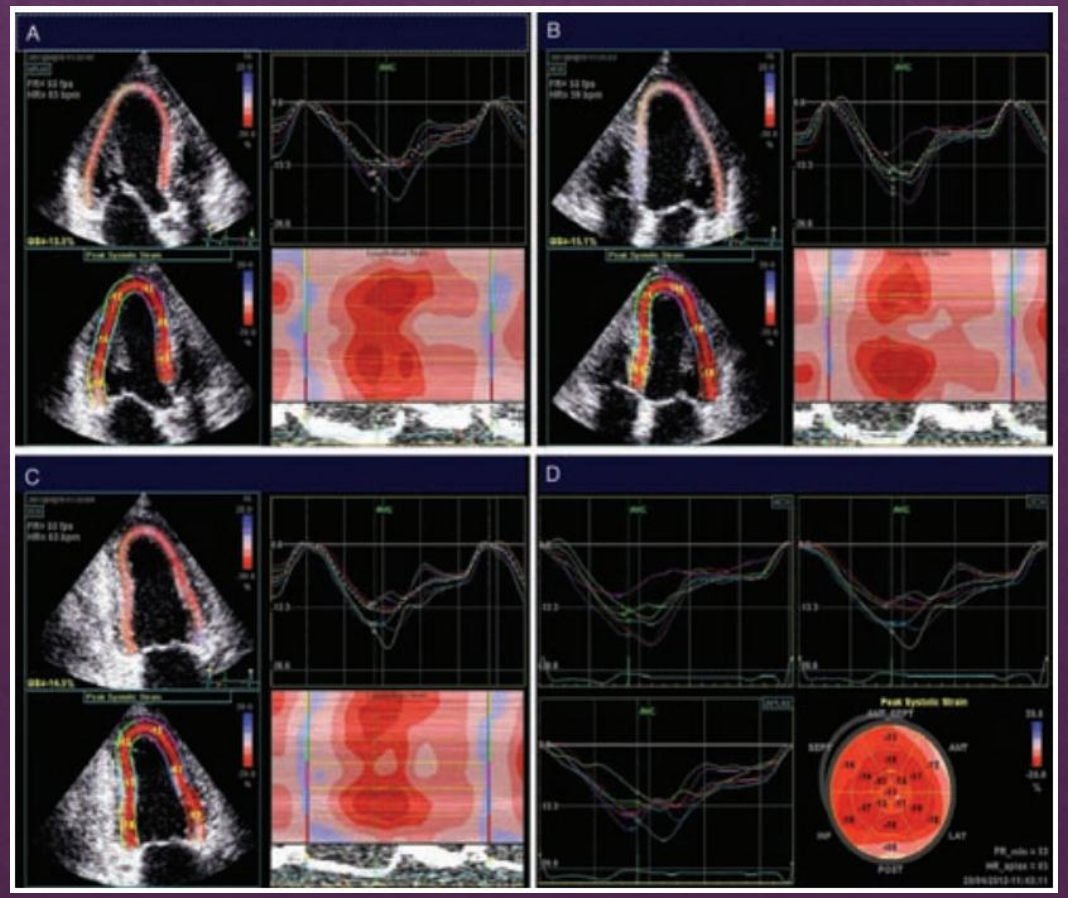


LV systolic function

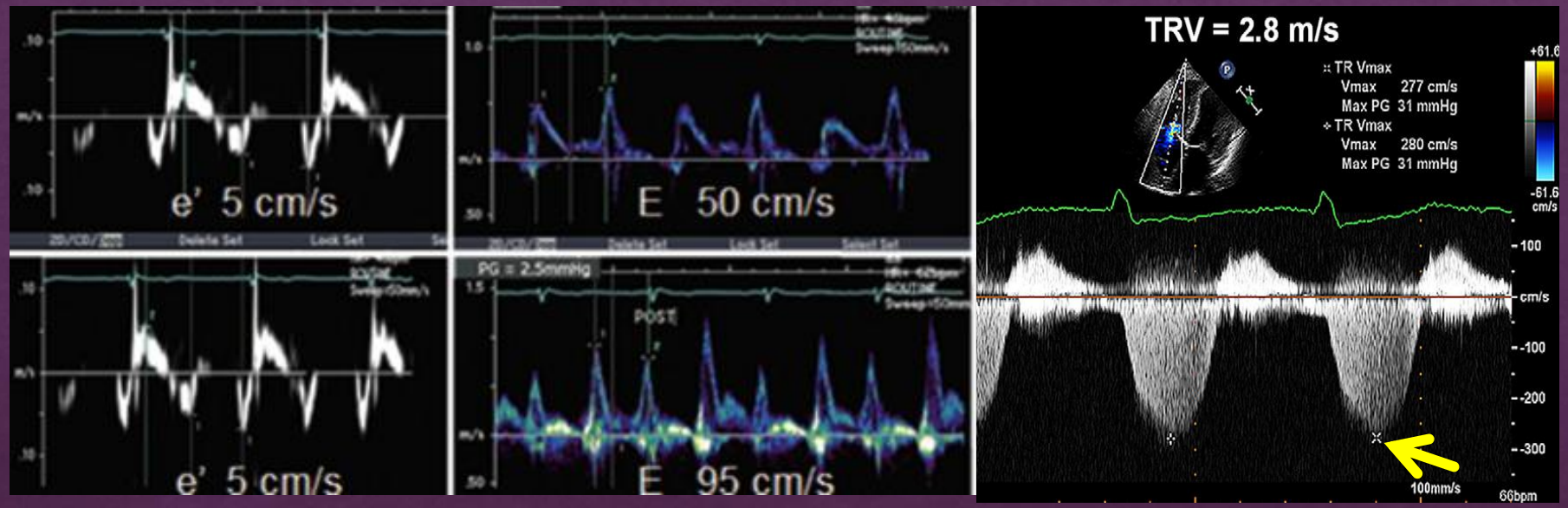
- Left Ventricular Ejection Fraction



- Global Longitudinal Peak Systolic Strain



Diastolic stress testing



- Wait for heart rate to decrease (merging of e' and a' signals)
- E/e'>14
- TRV>2.8m/2

Surrogate for LV filling pressures

Nagueh J Am Soc Echocardio, 2016 :29,(4), 277–314

Low Dose Dobutamine Stress Echo for True Aortic Stenosis vs. Pseudostenosis

Recommendations on the Echocardiographic Assessment of Aortic Valve Stenosis:

Table 4 Low dose dobutamine protocol

Starting dobutamine dose of 2.5 to 5 mcg/kg/min

⇩ Increase dose 2.5 to 5 mcg/kg/min every 3-5 minutes

Maximum dobutamine dose of 20 mcg/kg/min

Infusion stopped when:

1) Maximum dobutamine dose reached (20 mcg/kg/min)
2) Positive result obtained
3) Heart rate rises 10-20 bpm over baseline or exceeds 100 bpm
4) Symptoms, blood pressure fall, or significant arrhythmias

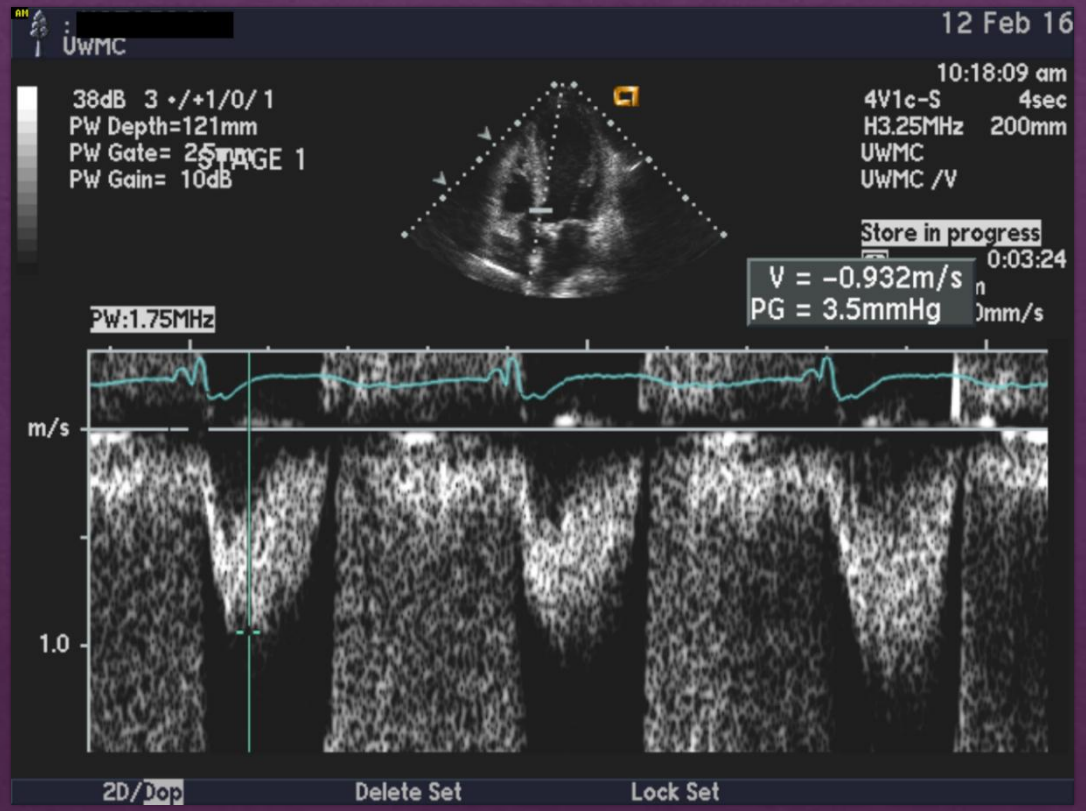
Positive Result:

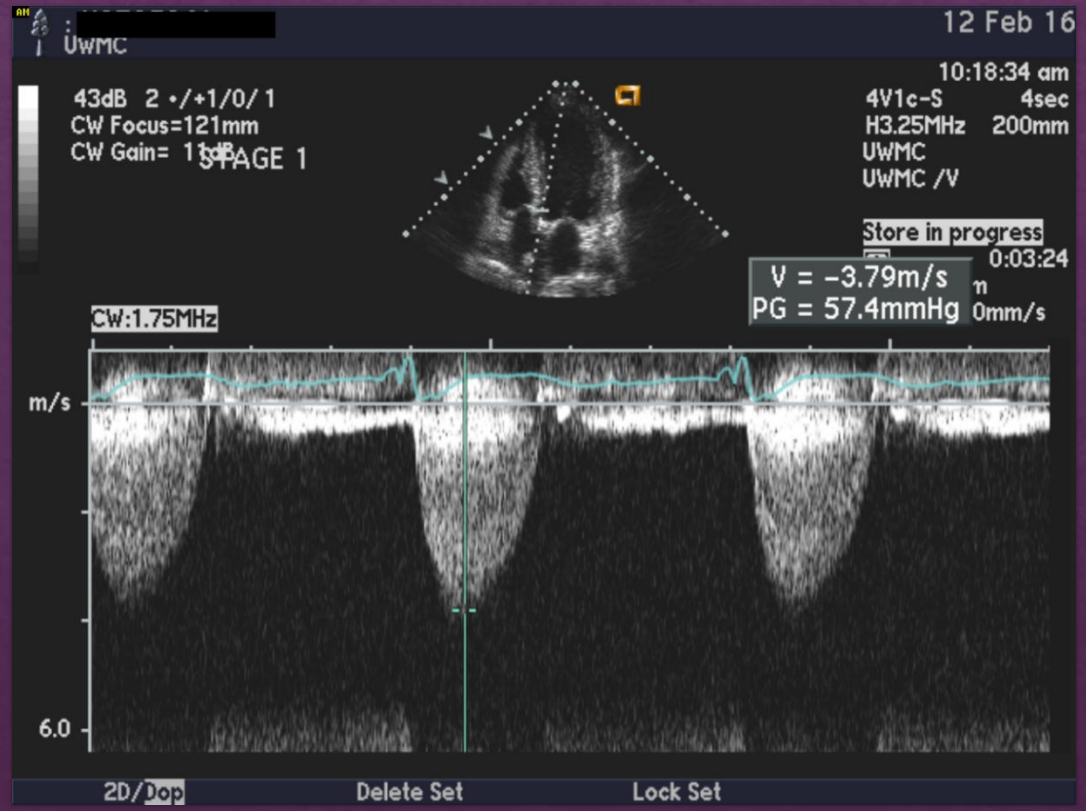
- An increase in effective AVA to a final valve area >1.0 cm2 suggests that stenosis is not severe [47].
- Severe stenosis is suggested by an AS jet velocity ≥4.0 m/s or a mean gradient > 30-40 mmHg provided that valve area does not exceed 1.0 cm^2 at any flow rate [50,51].
- Absence of contractile reserve (failure to increase SV by >20%) is a predictor of a high surgical mortality and poor long-term outcome although valve replacement may improve LV function and outcome even in this subgroup [52].

Baumgartner, J Am Soc Echocardiogr 201

LV vel 0.93/ AV vel 3.79=0.24, AVA=1.0cm2, 0.5cm2/m2

(Baseline: LV vel 0.9/ AV vel 3.6=0.25, AVA 1.0cm2, 0.5cm2/m2, mean grad 33mmHg)

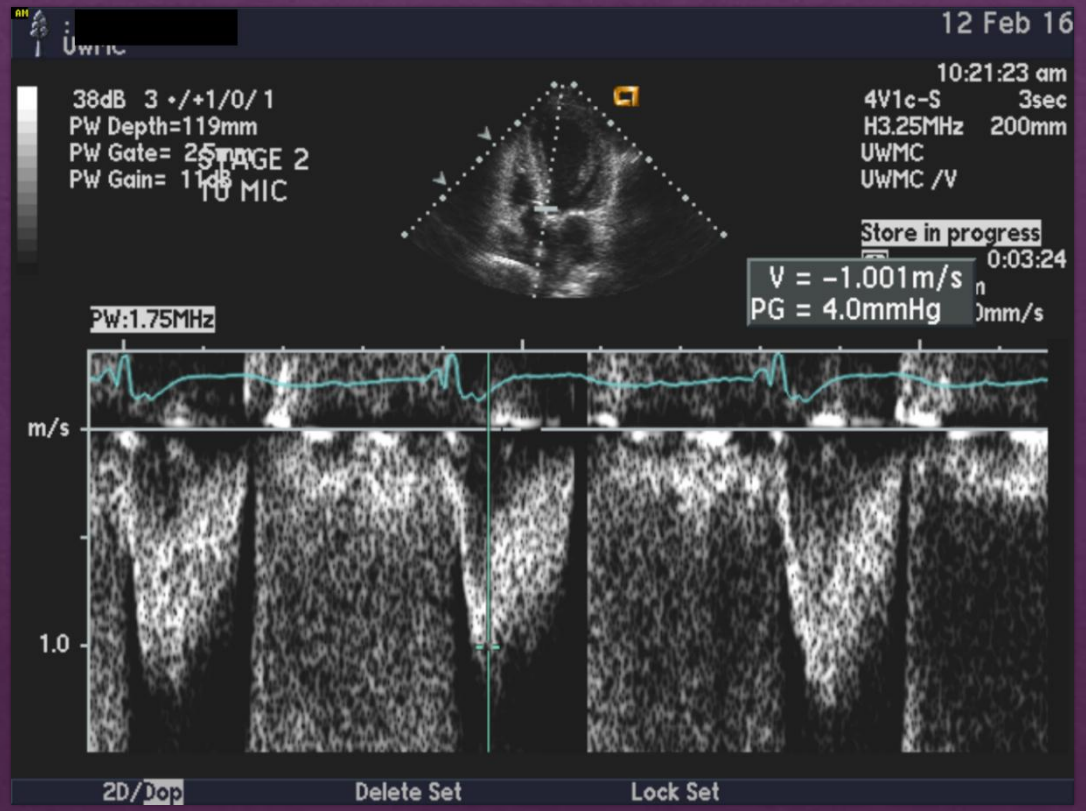




Stage 1: 5mcg/kg/min

LV vel 1.0/ AV vel 4.31=0.23, AVA=1.0cm2, 0.5cm2/m2

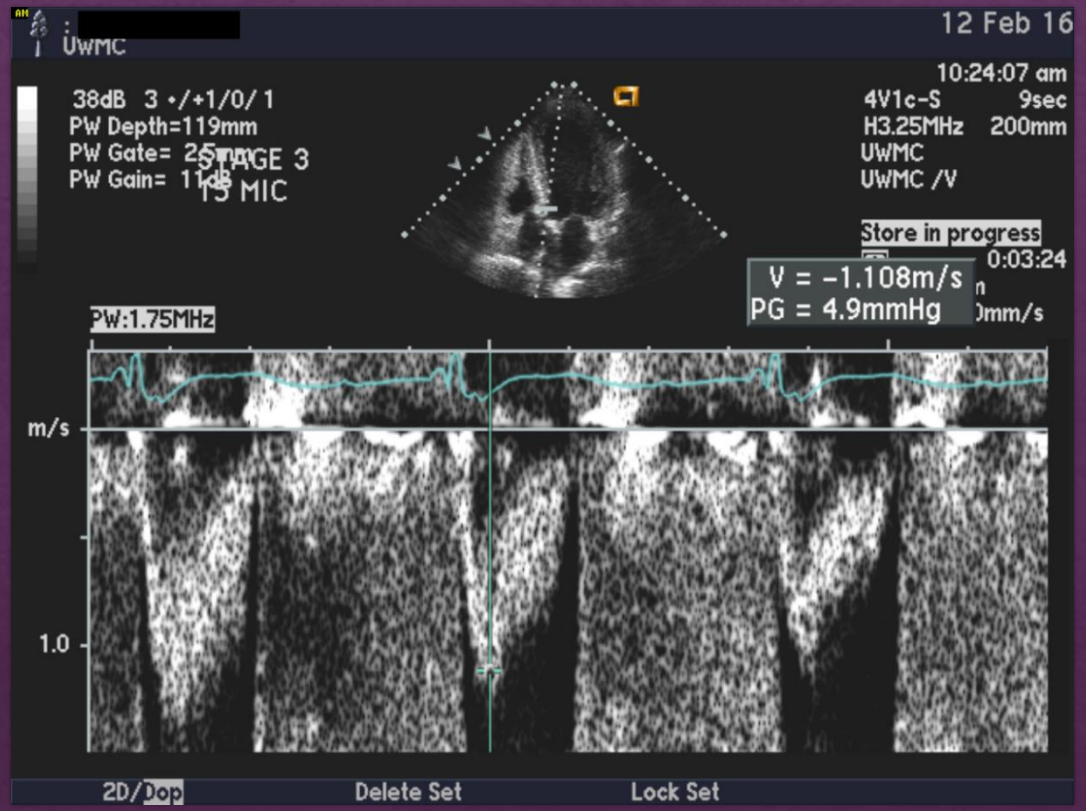
(Baseline: LV vel 0.9/ AV vel 3.6=0.25, AVA 1.0cm2, 0.5cm2/m2, mean grad 33mmHg)

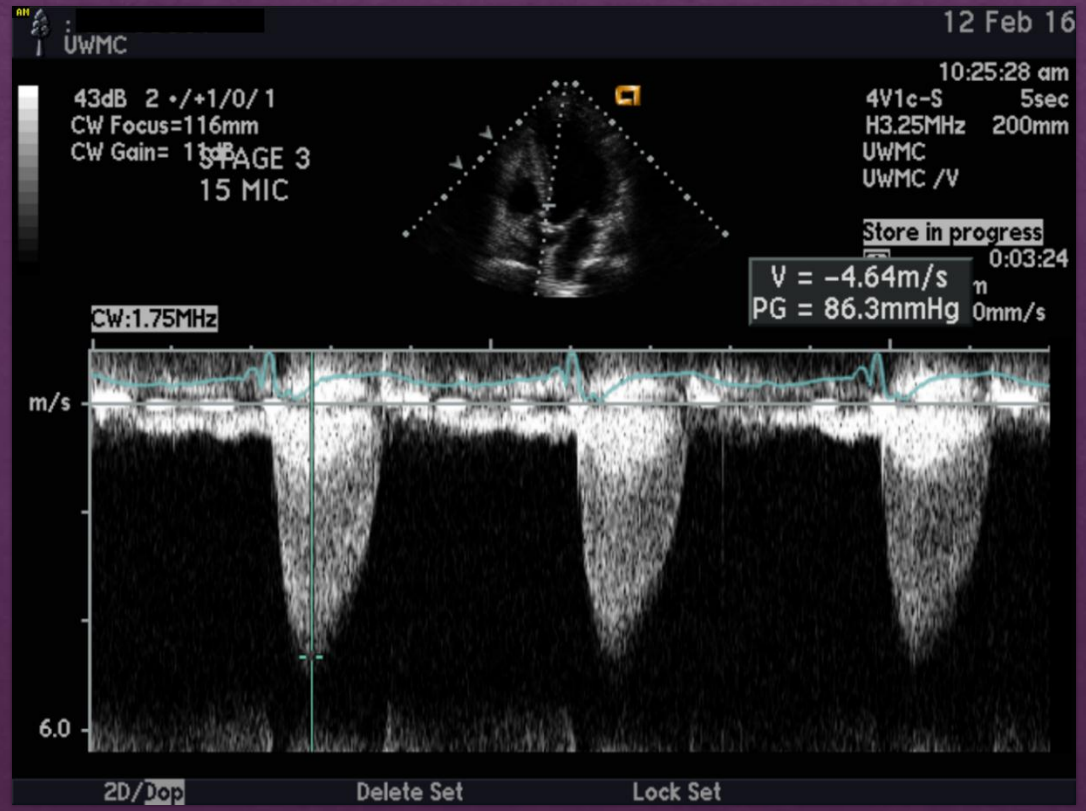


Stage 2: 10 mcg/kg/min

LV vel 1.11/ AV vel 4.64=0.24, AVA=1.0cm2, 0.5cm2/m2, mean gradient 49mmHg

(Baseline: LV vel 0.9/ AV vel 3.6=0.25, AVA 1.0cm2, 0.5cm2/m2, mean grad 33mmHg)

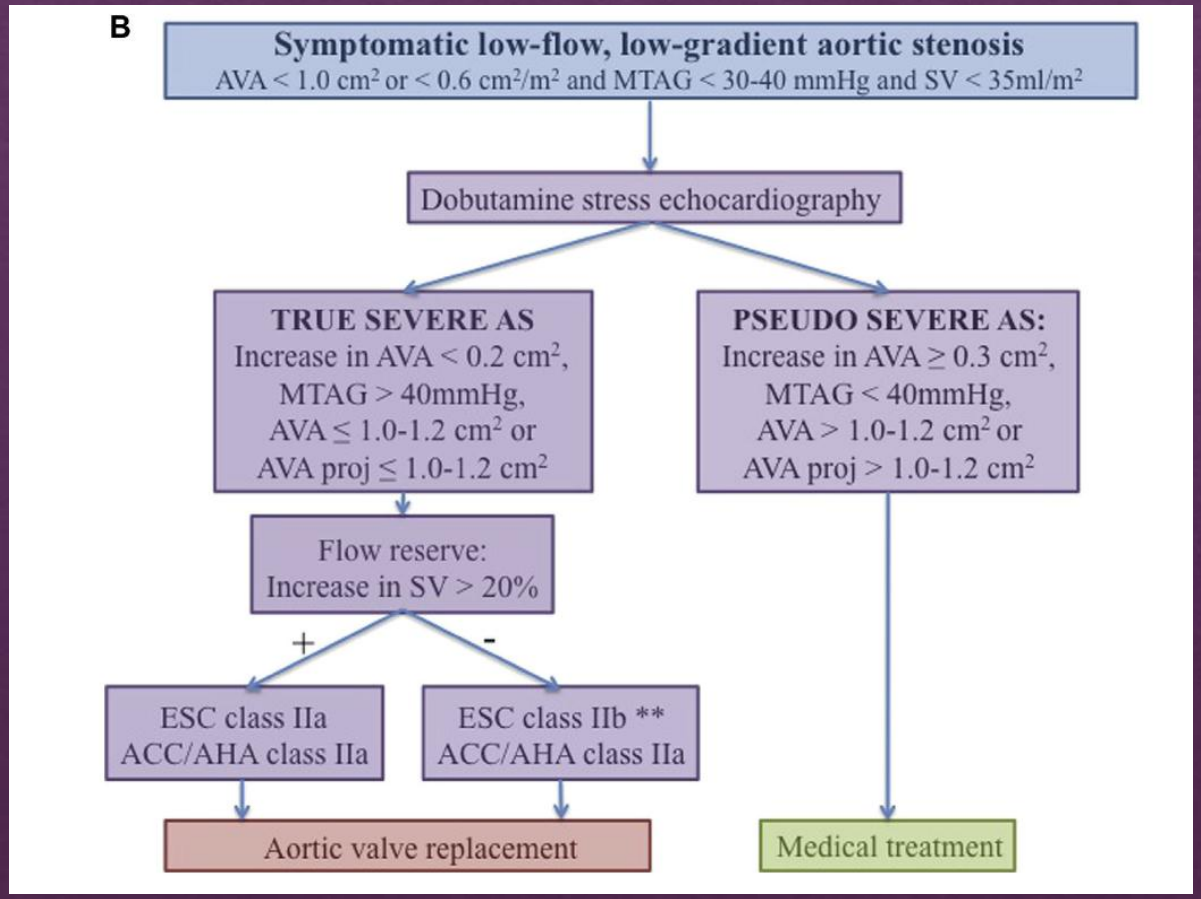




Stage 3: 15mcg/kg/min

What did the test show us?

- Stroke volume: 19% increase
- AVA 1.0cm2
- **Indexed AVA 0.5cm2/m2**
- **AVA did not increase by 0.2m2**
- **Stress mean gradient 49mmHg**



Henri, Canadian Journal of Cardiology 30 (2014) 1012e1026

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Transthoracic Echo Report

CONCLUSIONS:

1. Transcatheter aortic valve with normal function. Averaged peak velocity is 1.8 m/s. Trace paravalvular regurgitation.

2. **Normal left ventricular size and function with an ejection fraction of 65-70%** although beat to beat variability makes quantitation difficult. Mild concentric hypertrophy.

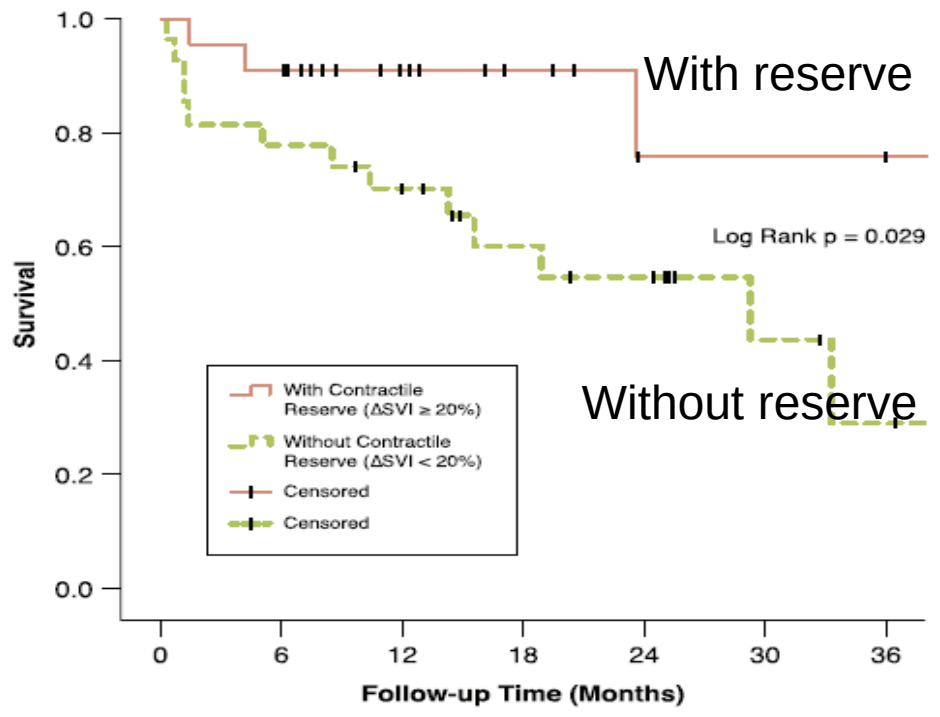
3. Thickened mitral leaflets but only mild regurgitation.

4. Mildly elevated pulmonary pressures of 31-36 mmHg. Normal right ventricular size and function.

Low Flow Low Gradient Aortic Stenosis Prognosis

- Patients unable to increase Stroke Volume by 20% with Dobutamine are at high risk, even with surgical valve replacement.
- What about TAVR?

FIGURE 1 Kaplan-Meier Survival Curves of Patients With Low-Gradient Severe Aortic Stenosis With and Without Flow Reserve

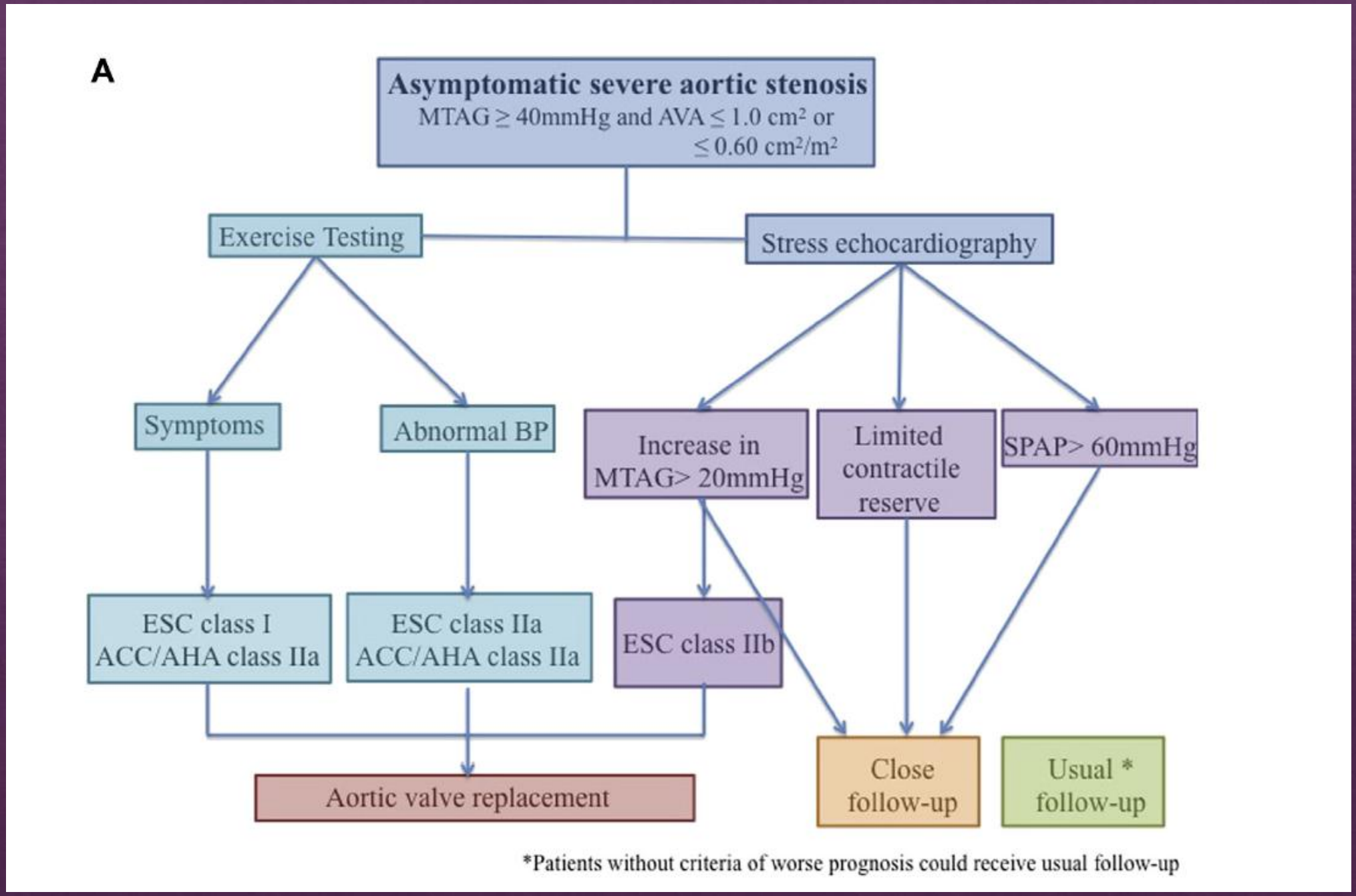


Number at Risk

With Reserve	22	20	12	8	4	4	4
Without Reserve	27	21	17	11	9	4	2

Hayek, JACC: CV Imag 8 (3) 2015

What about asymptomatic patients with normal LVEF and severe aortic stenosis?



Henri, Canadian Journal of Cardiology 30 (2014) 1012e1026

Exercise stress testing?

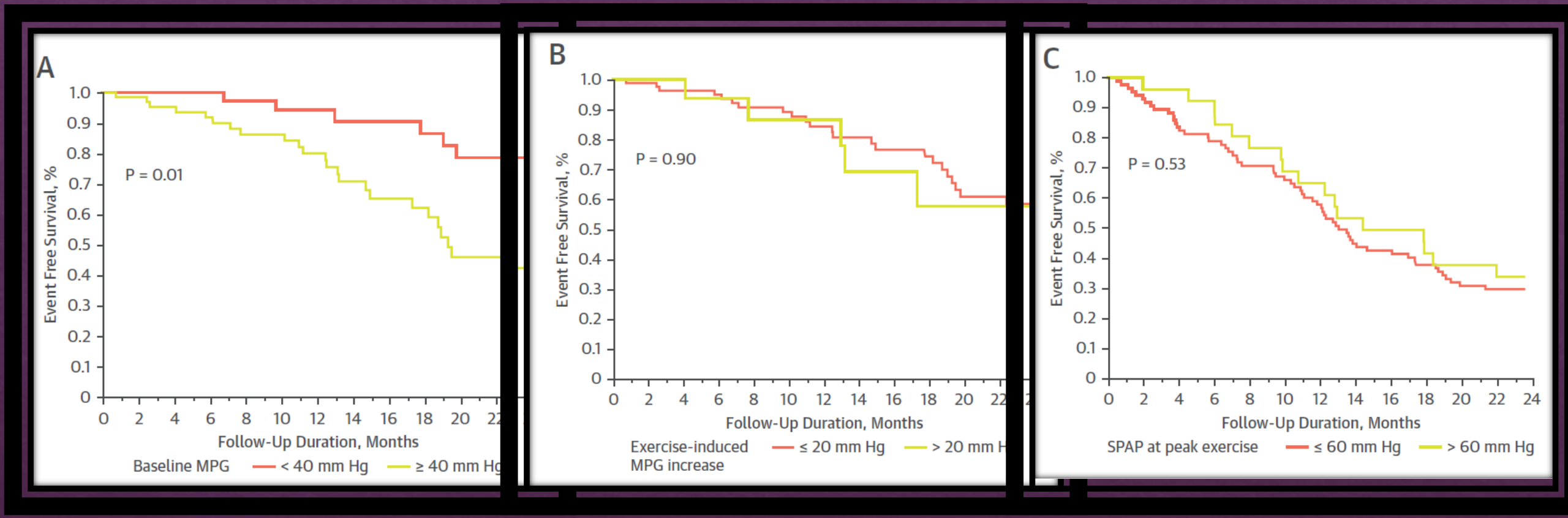
- Prognosis

- 148 patients
- Asymptomatic
- LVEF >50%
- Moderate to severe AS
- Bicycle stress

- Positive exercise→replacement
  - Drop in BP
  - Symptoms
  - ST segment depression
  - Sustained ventricular arrhythmia
  - Drop in LVEF or RWMA
- Positive echo→replacement
  - MPG>20mmHg
  - PASP>60mmHg
- Neither → observation

Goublaire J Am Coll Cardiol Img 201

Resting MPG but not exercise MPG or exercise SPAP were correlated with outcomes

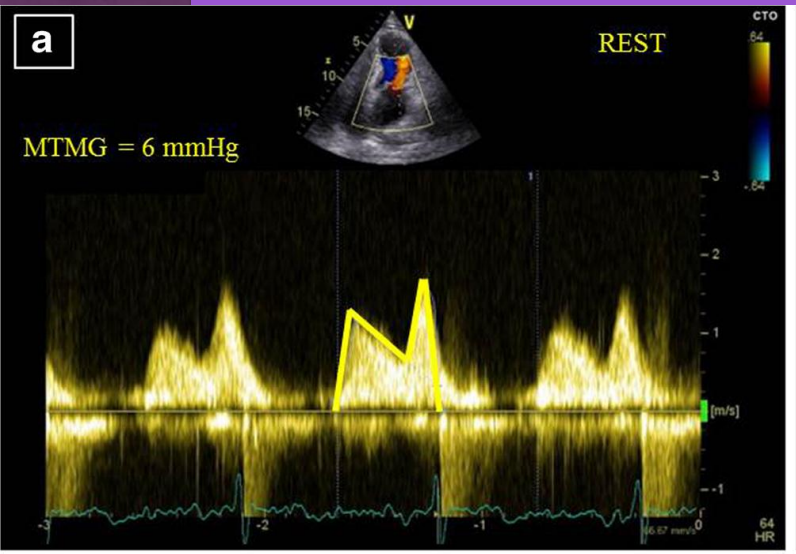


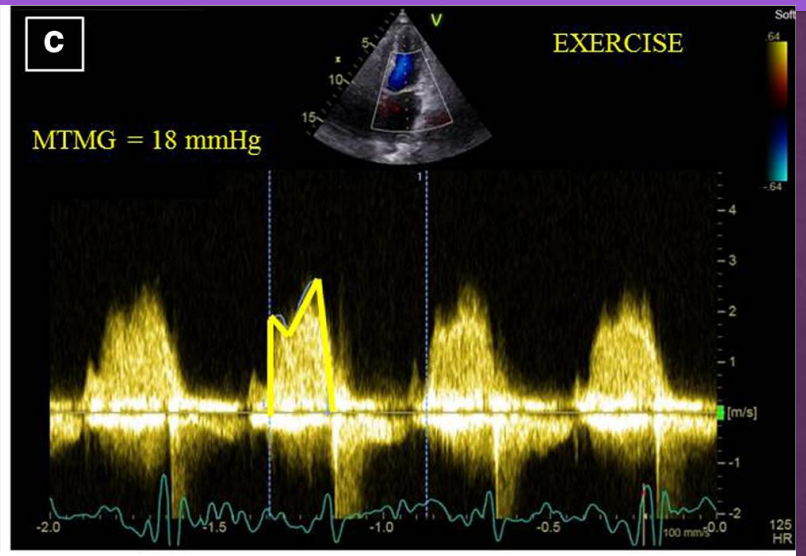
→Exercise testing with LVEF and RWMA +/- diastolic stress testing may be all that is needed

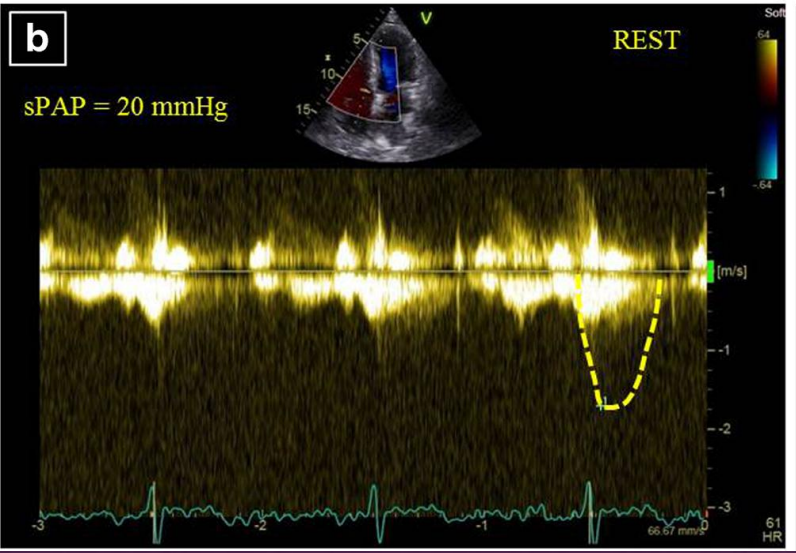
Goublaire J Am Coll Cardiol Img 201

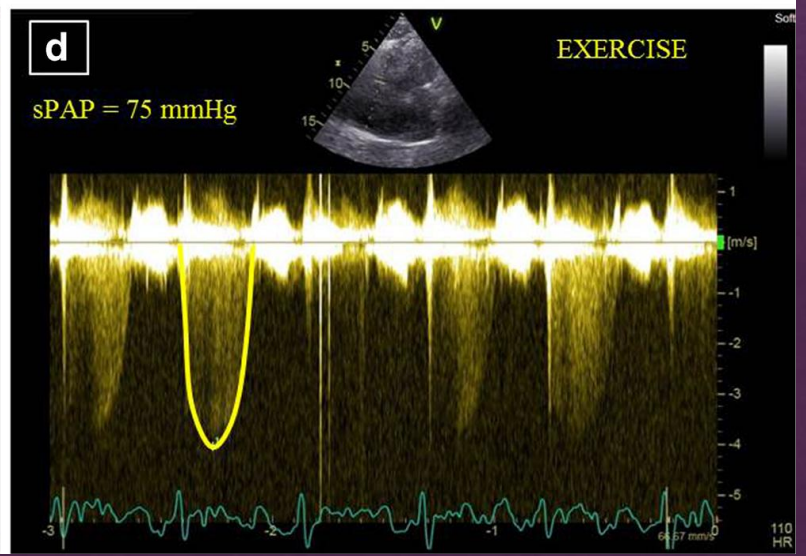
Stress Echo and Mitral Valve Disease

Mitral Stenosis









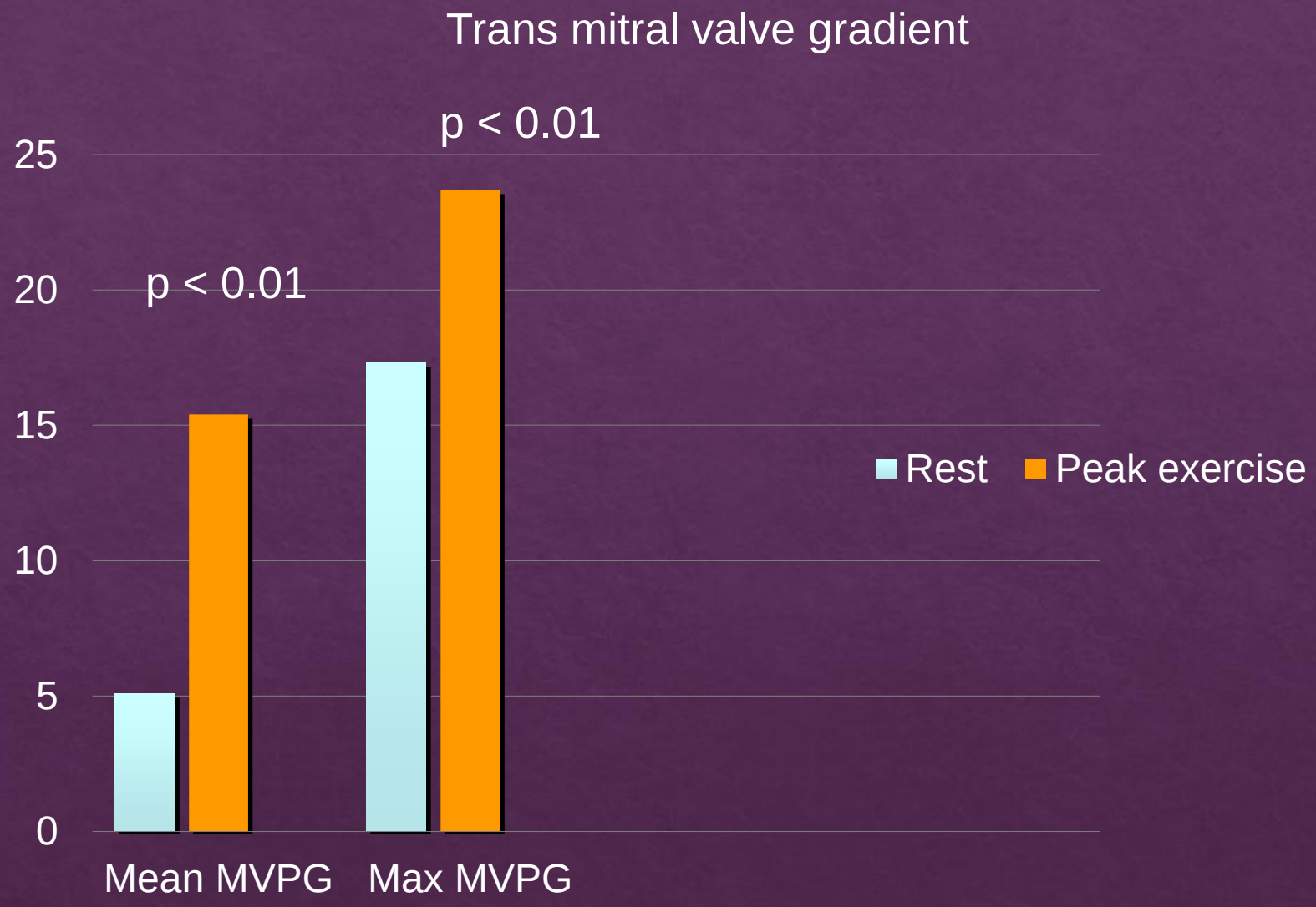
- MVA 1.5cm2
- Mean transmitral gradient>15mmHg
- Systolic pulmonary artery pressure >60mmHg*
- Mean PAP-CO > 3mmHg

Voilliot, Curr Treat Options Cardio Med (2017) 19:17

THE ROLE OF BICYCLE EXERCISE ECHOCARDIOGRAPHY IN PATIENTS WITH MITRAL STENOSIS

Hoai Nguyen T. Thu, Quang Nguyen N., Loi Do Doan (VNHI)
Thomas G. Allison (Mayo Clinic, MN, USA)
David T. Linker.
James N. Kirkpatrick (University of Washington)

Hemodynamic echocardiographic parameters in mitral stenosis



✓ 32 patients (49%) developed mean MVPG >15mmHg,

Hemodynamic echocardiographic parameters in mitral stenosis

Parameters	Rest	Peak exercise	p
sPAP	28.3 ± 10.5	50.5 ± 14.5	< 0.001*
LAV (ml)	58.3 ± 11.6	82.5 ± 21.6	< 0.001*
MR 1 - 2+	38 (56.7%)	39 (58.2%)	ns
TR 3 - 4+	15 (22.4%)	20 (29.9%)	< 0.05*
MV area (PHT)	1.4 ± 0.39	1.3 ± 0.41	ns

Trans mitral valve gradient changes in patients with sinus rhythm and patient with A-fib

Mitral Stenosis Stress Testing

- Mean gradient >15mmHg
- Effects on Pulmonary Pressures, left atrial size
- Atrial fibrillation may cause false positive

Mitral Regurgitation

Table 2. Key values in degenerative mitral regurgitation and level of recommendation for treatment

Parameters	Cutoff	Level	Guidelines
EROA	≥40 mm^2		European
RV	≥60 mL		European
LVEF	>30 < 60%	I	European
LVESD	≥45 < 55 mm	I	European
LVESD	≥40 mm with flail leaflet	IIa	European
Resting sPAP	>50 mmHg	IIa	European
Left atrial volume	≥60 mL/m^2	IIb	European
Exercise sPAP	≥60 mmHg	IIb	European
Exercise increase in EROA	Moderate MR and CABG	IIa	European

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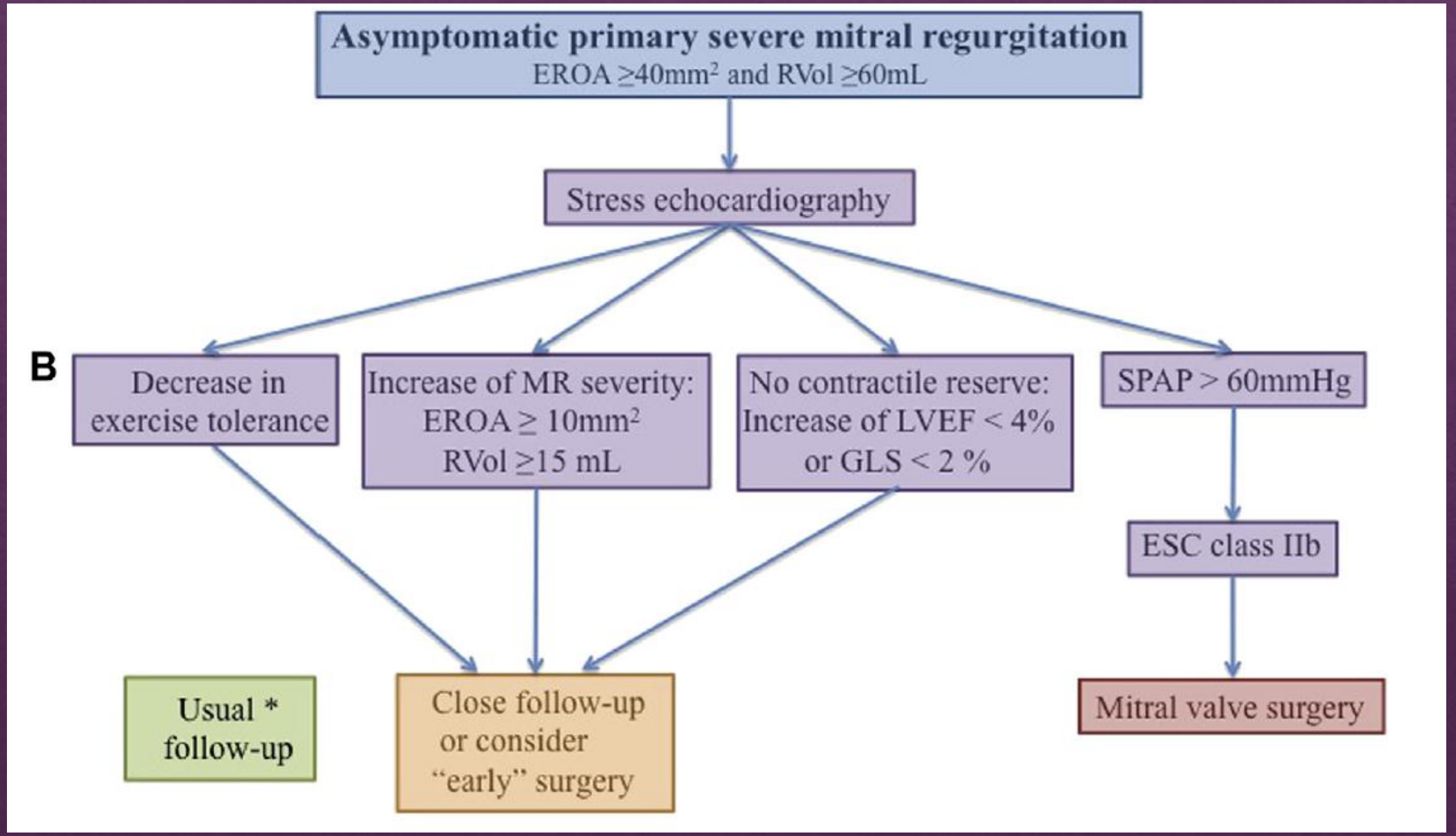


Henri, Canadian Journal of Cardiology 30 (2014) 1012e1026

Exercise Echo and Moderate Mitral Regurgitation

- Patients without an indication for intervention
  - Asymptomatic
  - Normal or severely reduced LVEF
  - LV size not enlarged
  - PASP<50mmHg
  - Moderate MR
    - Vena Contract <0.7cm, EROA <40mm2, <RV 60ml
- Dyspnea
- PASP>60mmHg
- EROA increased >10mm2
- RV increased >15ml
- TAPSE <19mm
- (Fractional area change)

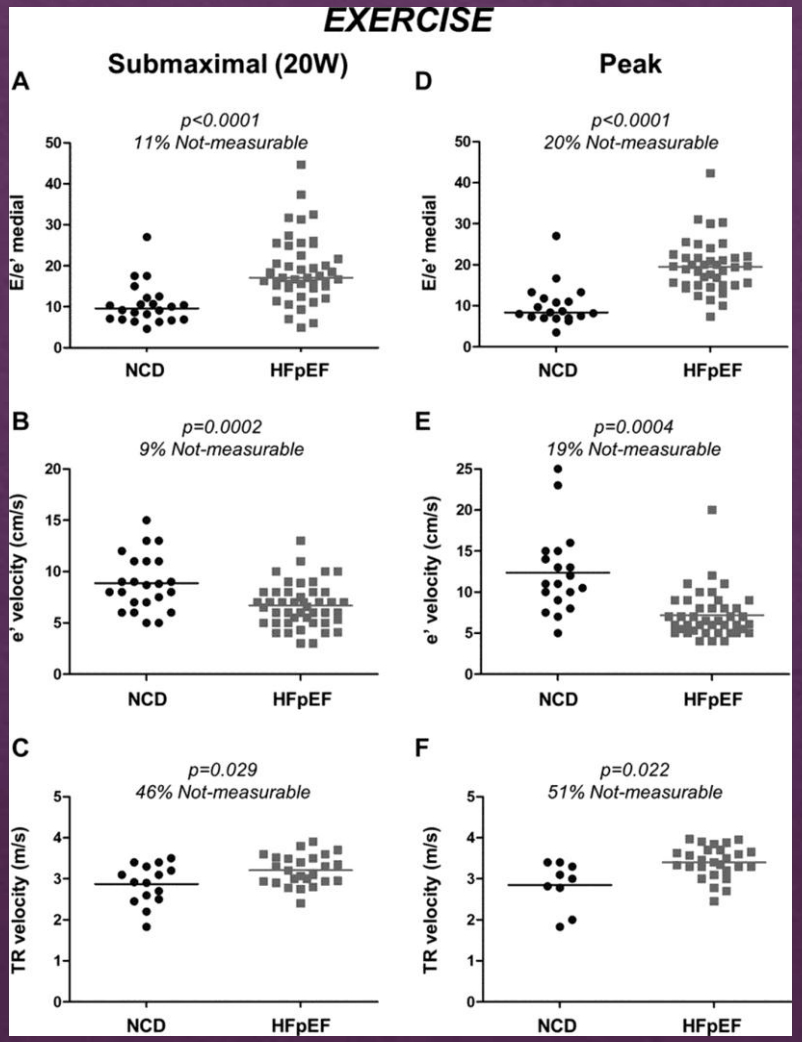
Voilliot, Curr Treat Options Cardio Med (2017) 19:17

Summary: Stress Echo in Valve Disease

1. Uncover symptoms
2. LV Systolic Dysfunction/Failure to Improve
3. Diastolic Dysfunction
4. Stenosis severity
   - Mean Gradient
   - (Aortic) Valve Area
5. Regurgitation severity
   - EROA
   - Regurgitant Volume
6. "Secondary effects"
   - PASP (remember limitations)
   - RV systolic function
   - Left atrial size?

Cám ơn vì sự quan tâm của bạn

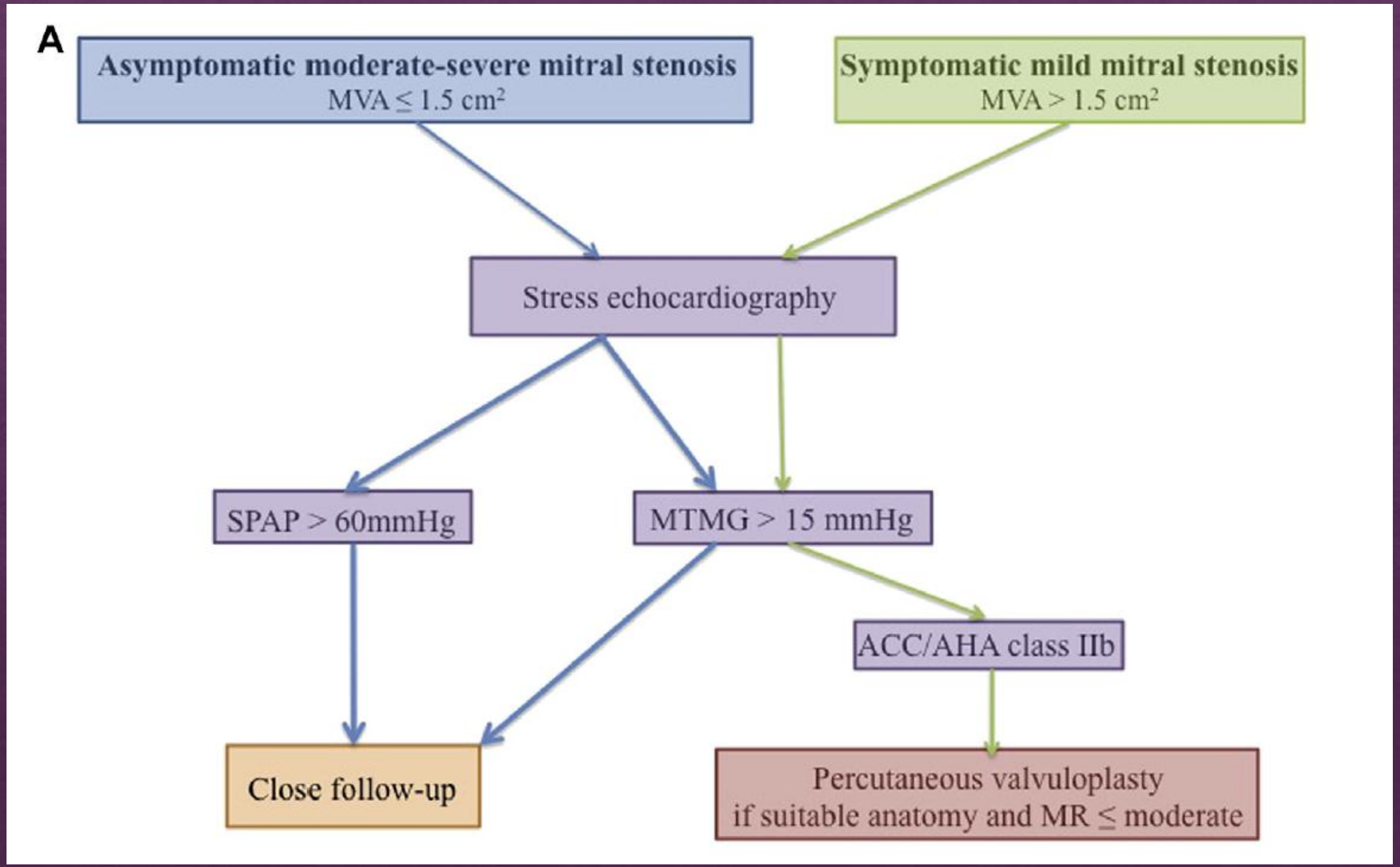
Echocardiographic hemodynamic and ventricular function indices during exercise.

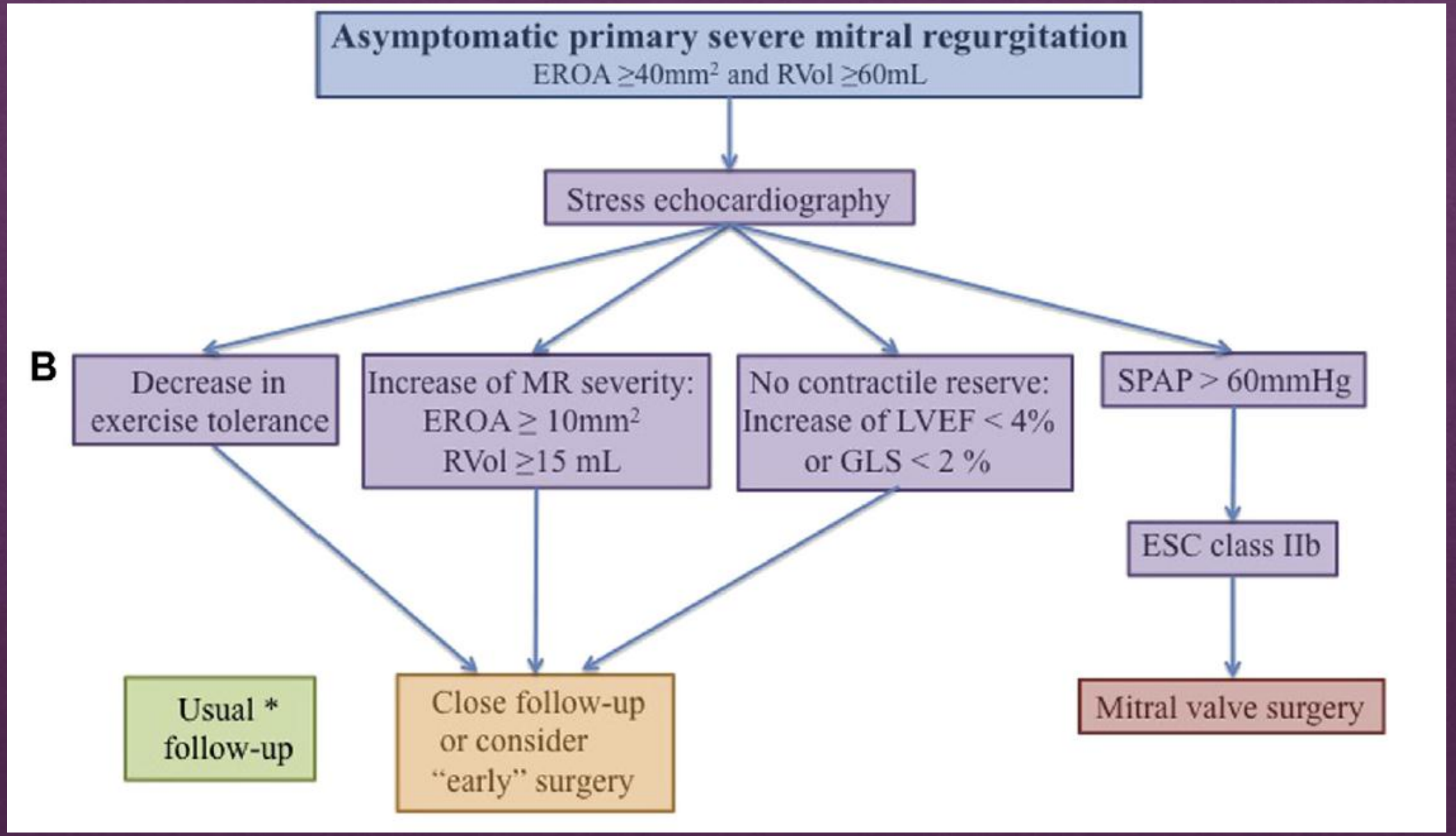


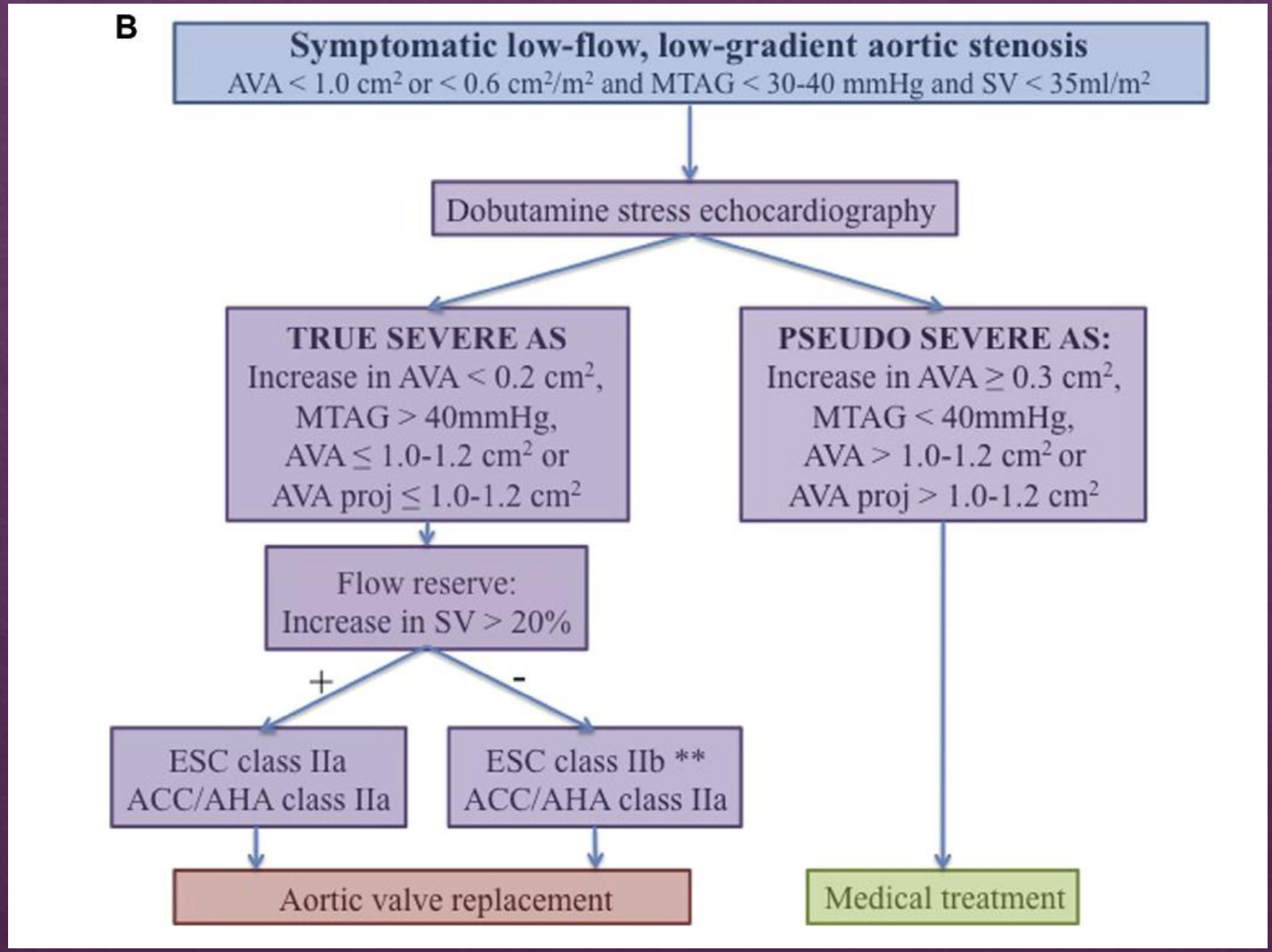
Masaru Obokata et al. Circulation. 2017;135:825-838

NCD=Non Cardiac Dyspnea

HFpEF=Heart Failure, Preserved Ejection Fraction


A
Asymptomatic moderate-severe mitral stenosis
MVA ≤ 1.5 cm²
Symptomatic mild mitral stenosis
MVA > 1.5 cm²
Stress echocardiography
SPAP > 60mmHg
MTMG > 15 mmHg
ACC/AHA class IIb
Close follow-up
Percutaneous valvuloplasty
if suitable anatomy and MR ≤ moderate


Asymptomatic primary severe mitral regurgitation
EROA ≥40mm² and RVol ≥60mL
Stress echocardiography
B
Decrease in exercise tolerance
Increase of MR severity: EROA ≥ 10mm² RVol ≥15 mL
No contractile reserve: Increase of LVEF < 4% or GLS < 2 %
SPAP > 60mmHg
ESC class IIb
Usual * follow-up
Close follow-up or consider "early" surgery
Mitral valve surgery



Henri, Canadian Journal of Cardiology 30 (2014) 1012e1026