Aortic Stenosis

Calvin Madrigal, PGY 5

Objectives

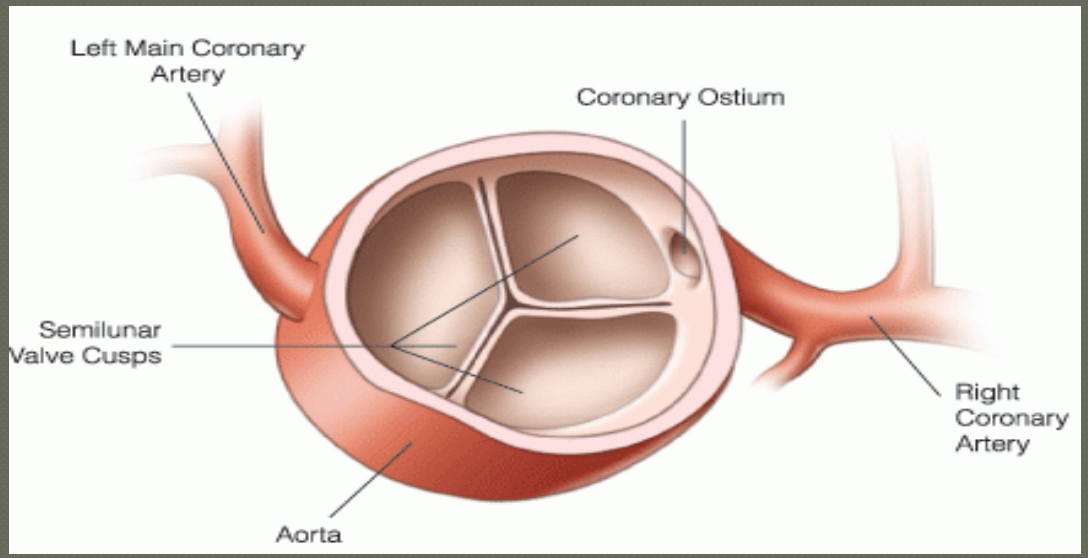
- 1. Prevalence of aortic stenosis in patients over the age of 65 in developed countries.
- 2. The prognosis between asymptomatic versus symptomatic disease.
- 3. Describe the three symptoms of aortic stenosis and the pathophysiology associated with these symptoms.
- 4.Describe the physical examination findings in patients with aortic stenosis and the reason for the absence of these findings.

Objectives

- 5.Define severe aortic stenosis and know the management for :
  - Severe symptomatic patient who is a candidate for Surgery.
  - Severe symptomatic patient who is not a candidate for surgery.
  - Moderate aortic stenosis who needs a CABG.
  - Severe asymptomatic aortic stenosis
- 6.Differentiate true aortic stenosis from "pseudostenosis and why it is important.

Aortic Valve

- Semilunar valve (Pulmonic and Aortic)
- Tricuspid (Left/right coronary cusp and noncoronary cusp)
- Normal area: 3-4cm^2
- Normal transvalvuar Velocity: <2m/s



Aortic Stenosis Epidemiology

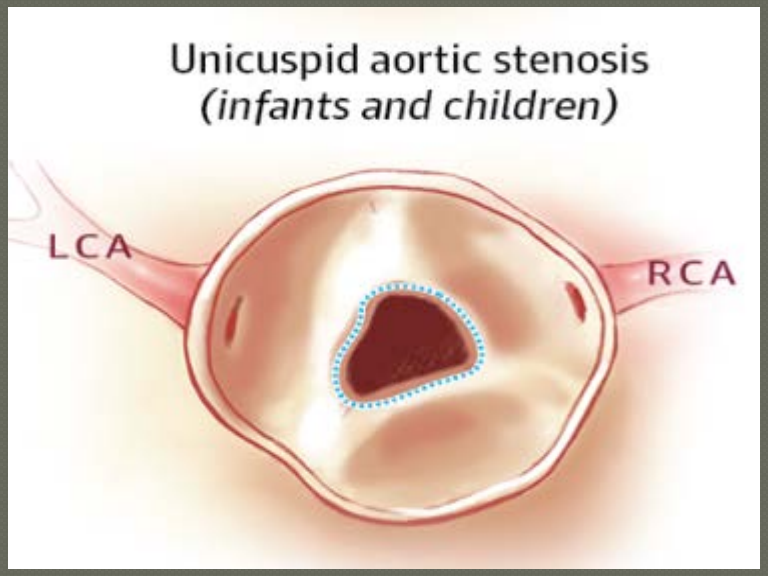
- The most common cause of left ventricular outflow obstruction in adults.
- Prevalence: Increases with age, 2-7% of all patients > 65 are reported to have AS.
- Valvular heart disease accounts for 10-20% of all cardiac surgical procedures in the US.
- Approximately 2/3 of all heart valve operations are for AS.
- Without intervention, mortality rates reach as high as 75% in 3 years once symptoms develop.

Aortic Stenosis Etiology

- Three primary causes :
  I. Age associated calcific changes
  II. Congenital aortic valve disease
     a) Unicupsid
     b) Bicuspid
  III. Rheumatic valve disease

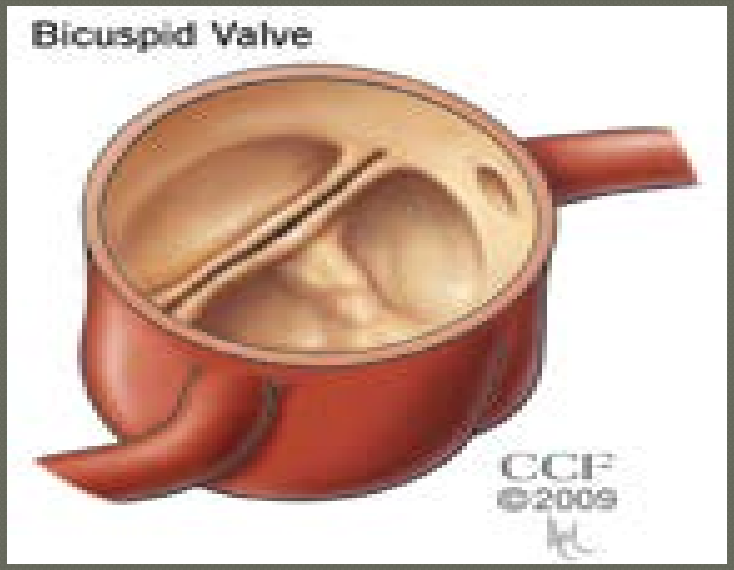
Aortic Stenosis Etiology

- Congenital aortic valve disease
  - Unicuspid: Typically produce severe obstruction in infancy and most frequent malformation found in fatal valuvar AS in children <1 year.



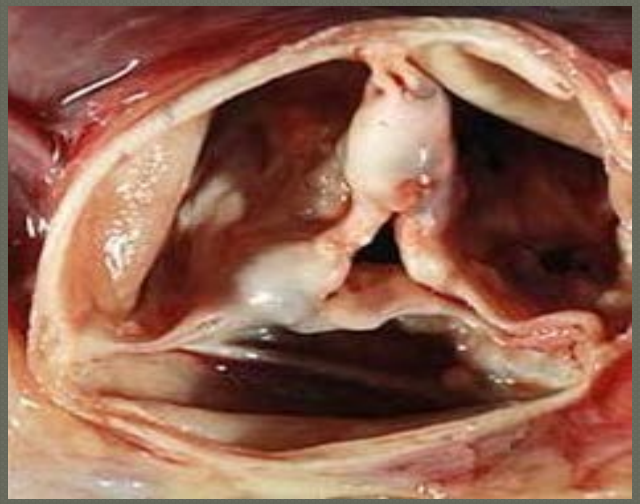
Aortic Stenosis Etiology

- Congenital aortic valve disease
  - Bicuspid: Present in 1-2% of the population with a greater prevalence for males.Commonly associated with coarctation of the aorta and aortic aneurysm. Earlier presentation of symptoms when compared to trileaflet valve.



Aortic Stenosis Etiology

- Rheumatic valve disease
  - Leads to adhesions and fusions of the commissures and cusps with subsequent stiffening.
  - Orifice is reduced to a small round or triangular opening and often associated with concomitant aortic regurgitation.
  - Remains a problem in developing countries



Aortic Stenosis Etiology

- Calcific aortic valve disease (senile)
  - Most common cause of AS in adults
  - Once considered to represent normal mechanical stress on the valve.
  - The evolving concept is that the disease is a mixture of genetic, proliferative and inflammatory changes resulting in calcification and subsequent immobilization of cusps.
  - Linked to genetic polymorphisms, involving vitamin D receptors, interleukin-10 alleles and apolipoprotein E4 allele
  - Risk factors include: Elevated LDL, lipoprotein(a), diabetes, smoking and hypertension.

Aortic Stenosis Etiology

- Calcific aortic valve disease (senile)

TABLE 63-1 Strength of Associations in Observational and Epidemiologic Studies of Clinical Risk Factors and Calcific Aortic Valve Disease (CAVD)

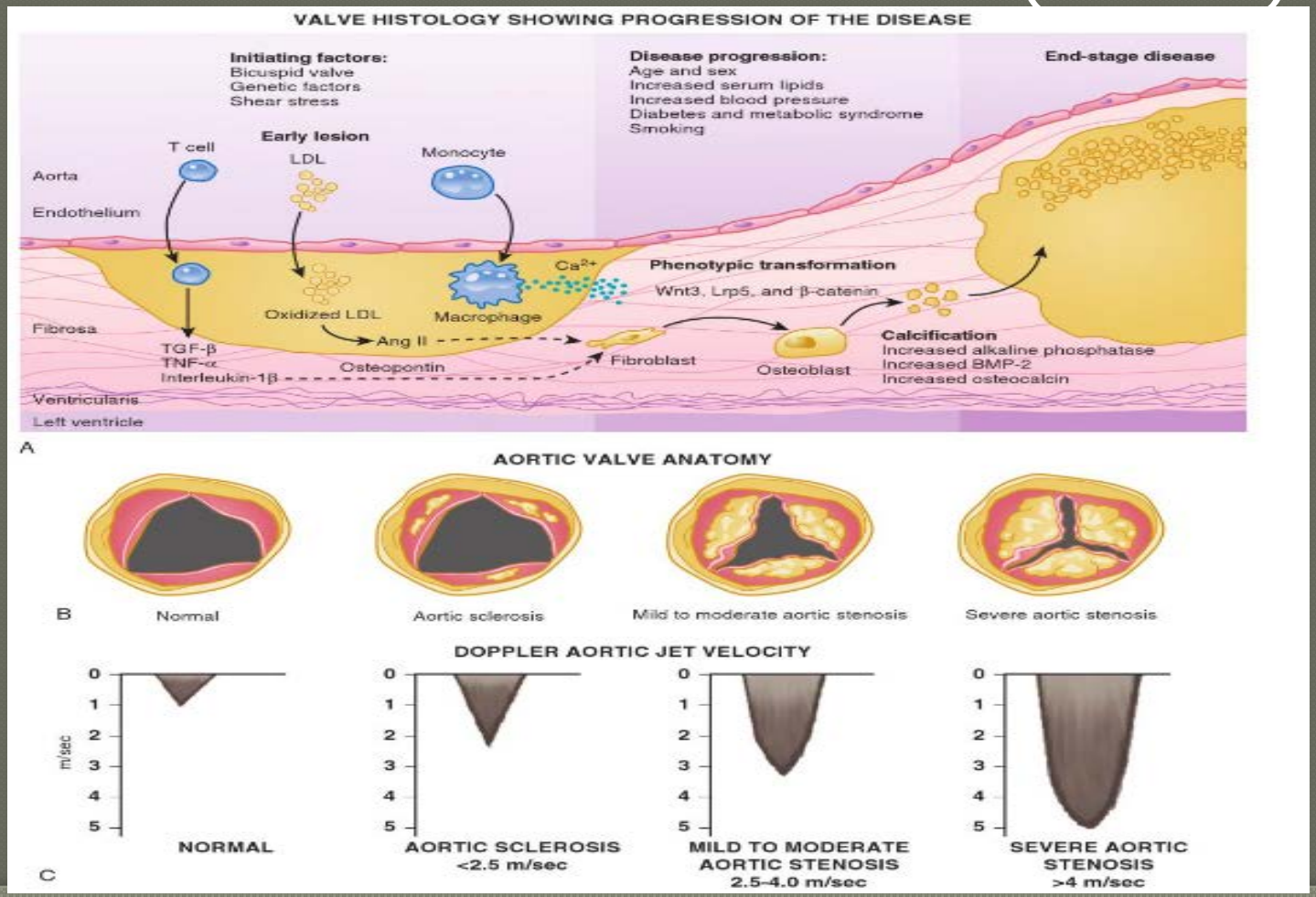
	CAVD ANALYSIS		
RISK FACTOR	Cross-Sectional	Incident	Progression
Age	+++	+++	+++
Male sex	++/–	++	0
Height	++	++	0
BMI	++	++	0
Hypertension	++	++	0
Diabetes	+++	+++	0
Metabolic syndrome	++	++	+
Dyslipidemia	++	++	0
Smoking	++	++	+
Renal dysfunction	+	0	0
Inflammatory markers	+	0	0
Phosphorus levels	++	0	N/A
Calcium levels	0	0	N/A
Baseline calcium score	N/A	N/A	+++

TABLE 63-2 Candidate Gene Association Studies for Calcific Aortic Valve Disease

STUDY (YEAR)	GENE	LOCATION	PHENOTYPE	CASES	RISK VARIANT	*P* VALUE
Ortlepp et al, 2001	Vitamin D receptor	12q12-q14	Severe AS	100	B allele	.001
Avakian et al, 2001	ApoB	2p24-p23	Severe AS	62	X+	.007
	ApoE	19q13.2	AS	43	ApoE 2/4 + 3/4 genotypes	.03
Nordström et al, 2003	Estrogen receptor α	6q25.1	AVR	41	PvuII polymorphism	.03
	TGF-β receptor type1	9q33-q34	AVR	41	AocI polymorphism	*
Ortlepp et al, 2004	Interleukin-10_ ENREF_95	1q31-q32	Ex vivo atomic absorption	187	3 promoter polymorphisms	.03
	Chemokine receptor 5	3p21.31	Ex vivo atomic absorption	187	32–base pair deletion	.04
Moura et al, 2012	Paraoxonase 1	7q21-22	Moderate AS	67	Q192R polymorphisms	.03
Kamstrup et al, 2014	Lipoprotein (a)	6q26-27	AS with or without AVR	454	LPA genotypes rs10455872, rs3798220	.001
Mahmut et al, 2014	LP PLA2	rs1805017	Ex vivo	40	Upregulation of PLA2G family of genes	.001

Aortic Valve Etiology

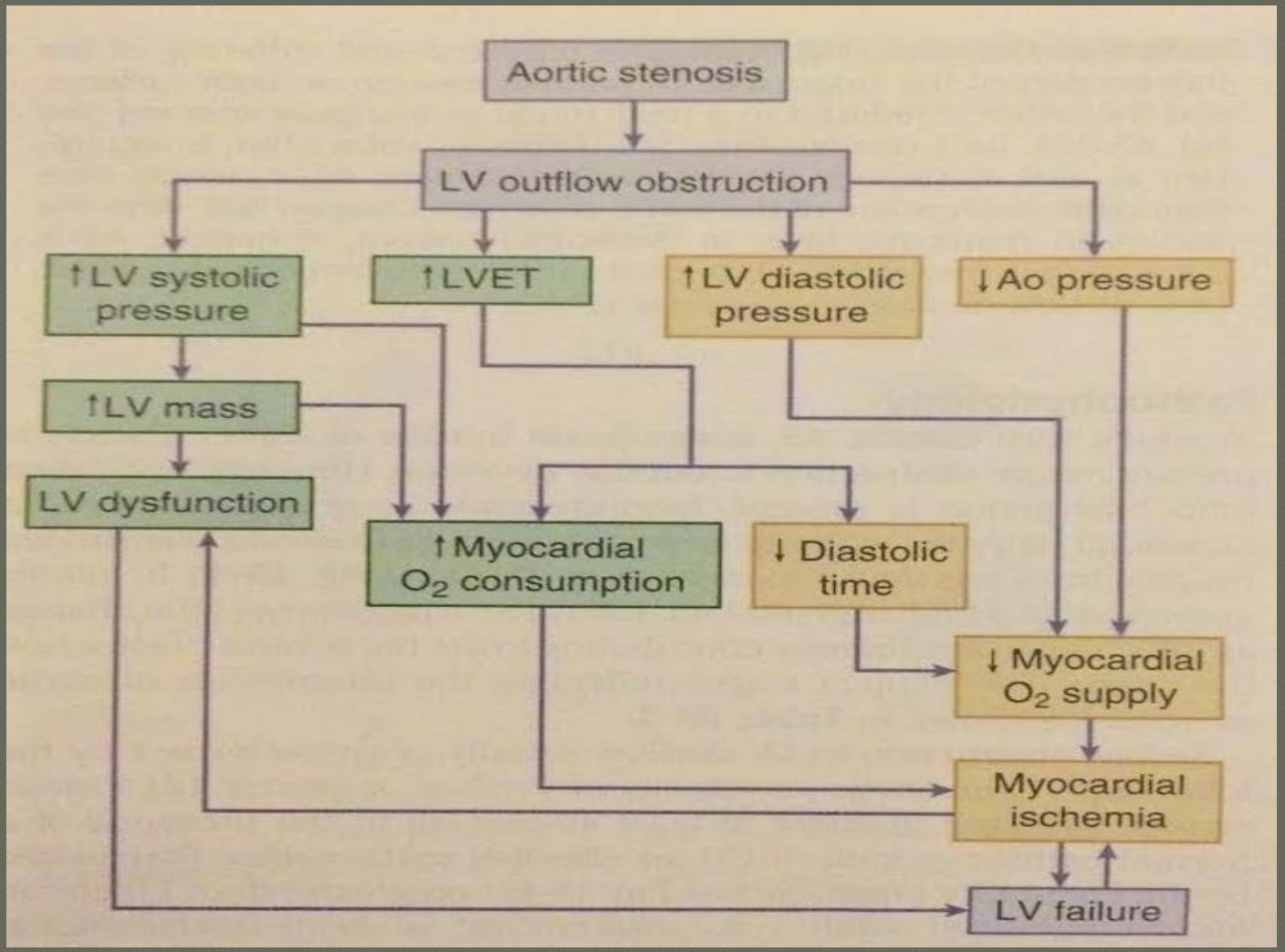
- Calcific aortic valve disease (senile)



Aortic Stenosis Pathophysiology

- Outflow obstruction
  - Increased LV systolic pressure leads to increased LV mass with subsequent diastolic dysfunction and increase in myocardial O_2 consumption.
  - Increased LV ejection time leads to increased myocardial O_2 consumption and decreased diastolic time.
  - Increased LV diastolic pressure leads to decreased myocardial O_2 supply
  - Decreased aortic pressure leads to decreased myocardial O_2 supply
  - Myocardial O_2 consumption exceeds myocardial O_2 supply and LV failure develops.

Aortic Stenosis Pathophysiology



Aortic Stenosis Symptoms

- Cardinal Symptoms
  I. Exertional Dyspnea
  II. Angina
  III. Syncope

Aortic Stenosis Symptoms

- Exertional Dyspnea
  - Most common clinic presentation in severe AS.
  - Associated with decrease in exercise tolerance and fatigue.
  - Symptoms are due to the inability to increase cardiac output with exercise.
  - LV diastolic dysfunction and subsequent rise in end-diastolic pressure can lead to pulmonary congestion.

Aortic Stenosis Symptoms

- Angina
  - Occurs in approximately 2/3 of patients with severe AS, approximately 50% of whom have significant CAD.
  - In those without CAD, angina is due to increase oxygen requirement for the hypertrophied myocardium and reduction of O_2 delivery secondary to excessive compression of coronary vessels and decreased diastolic time.
  - In those with CAD, angina is due to a combination of epicardial coronary compression and O_2 imbalance. Very rarely due calcific emboli to the coronary vessels.

Aortic Stenosis Symptoms

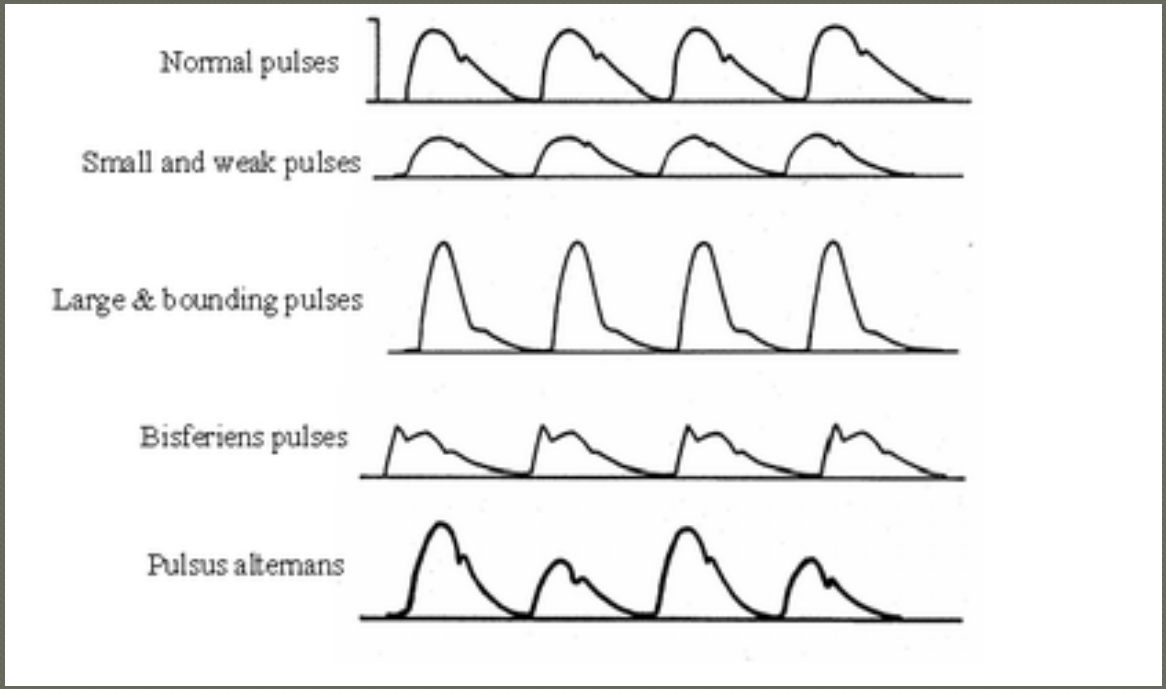
- Syncope
  - Systemic vasodilation during exertion leads to decline in arterial pressure. In the setting of a fixed cardiac output this leads to reduced cerebral perfusion.
  - Malfunction of the baroceptors via activation of the mechanosensitive vagal afferents in response to outflow obstruction leads to a vasodepressor response.
  - Loss of atrial contribution to LV filling in the setting of transient Afib can also lead to decline in CO and subsequent syncope.
  - Transient AV block due to extension of calcification into the conduction system can lead to syncope due to bradycardia or loss of atrial contribution to LV filling.

Aortic Stenosis Physical Exam

- Key features of physical examination
  1. Carotid upstroke – Pulsus parvus et tardus
     - Reflects arterial pressure wave form
     - Palpation of carotid pulse demonstrates a weak pulse (parvus)
     - Simultaneous Palpation of the carotid upstroke while auscultating the heart will demonstrate peak carotid upstroke closer to S2 as opposed to S1 (tardus).
     - Above findings specific for severe AS but not sensitive as concurrent conditions such as systemic hypertension can affect the carotid impulse.

Aortic Stenosis Physical Exam

- Key features of physical examination
  I. Carotid upstroke – Pulsus parvus et tardus

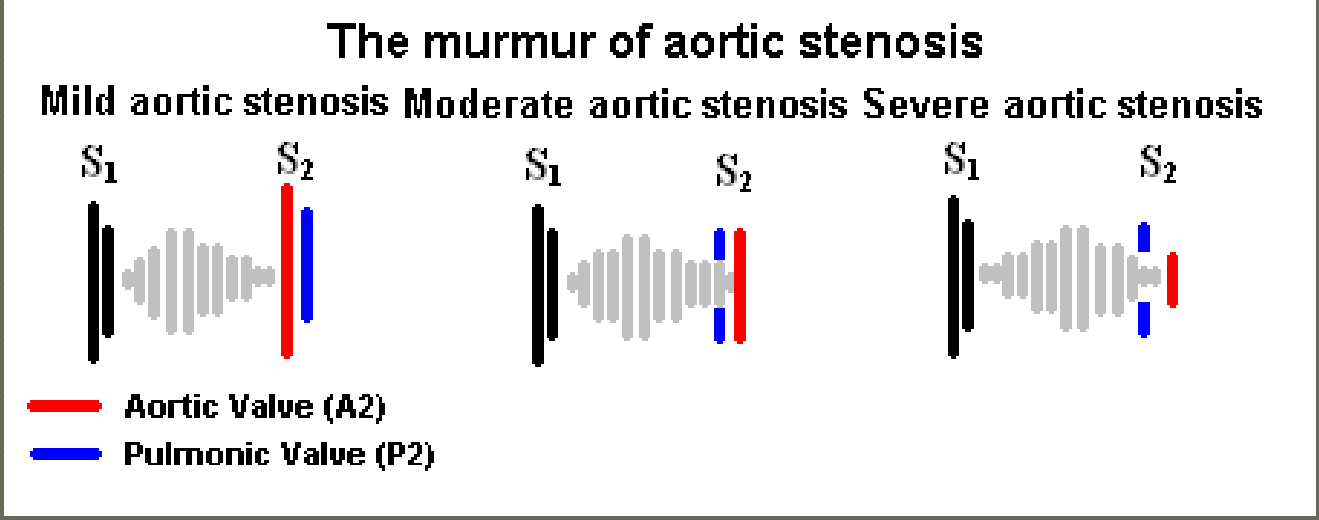


Aortic Stenosis Physical Exam

- Key features of physical exam
  II. Murmur
    - Best heard over the 2nd RICS
    - Harsh Crescendo-decrescendo systolic murmur
    - Radiates to the carotids
    - High frequency can radiate to apex mimicking MR – Gallavardian phenomenon.
    - Intensity of the murmur is an insensitive marker for severity.
    - Late peaking murmur indicates severe AS.
    - Squatting augments murmur (increase SV)
    - Valsalva and handgrip maneuver decrease murmur due to decreased preload and increased afterload, respectively

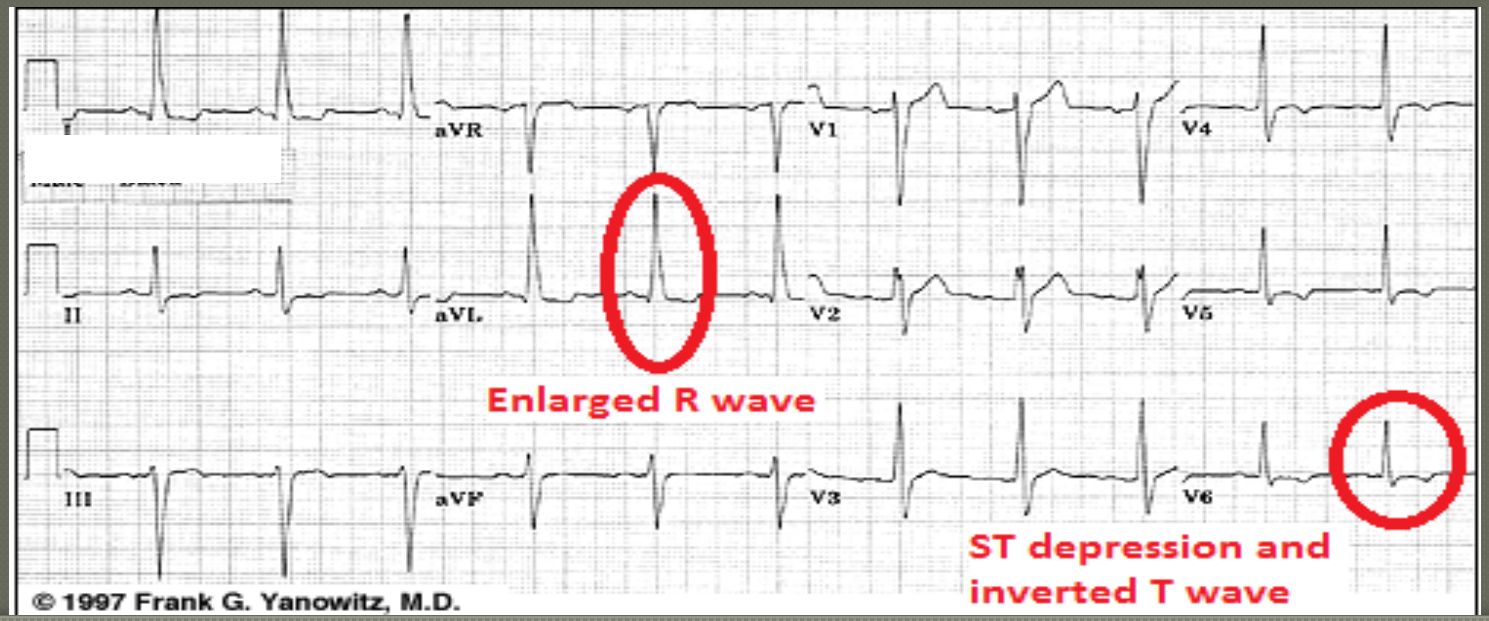
Aortic Stenosis Physical Exam

- Key features of physical exam
  - III. Effects on S2
    - Single S2, calcification and immobility of the aortic valve make A2 inaudible and P2 is only heard.
    - Paradoxical split (LBBB or prolonged LV systole)
    - Normally splitting excludes severe AS.



Aortic Stenosis Diagnostic Studies

- EKG
  - LV hypertrophy
  - Left atrial enlargement
  - AV or IVD depending on the extension of calcific infiltrates in to the conduction system.



Aortic Stenosis Diagnostic Studies

- Echocardiography
  - Standard approach for following and evaluating patients with AS.
  - Accurate at assessing valve anatomy and severity of calcification.
  - Assessment of LV function.
  - Doppler allows measurements of transaortic jet velocity.
  - Valve area and mean transaortic gradient can be calculated using continuity equation and Bernoulli equation, respectively.

Aortic Stenosis Diagnostic Studies

- Echocardiography

AHA Guidelines for Severity of Aortic Stenosis

	Valve Area (cm2)	Maximum Aortic Velocity (mmHg)	Mean Pressure Gradient (mmHg)
Mild	1.5-2	2.5-3.0	< 25
Moderate	1.0-1.5	3.0-4.0	25-40
Severe	0.6-1.0	>4.0	>40
Critical	< 0.6		

Aortic Stenosis Diagnostic Studies

- Cardiac Catheterization
  - Recommended when noninvasive testing is inconclusive , clinical and echocardiographic findings are discordant.
  - Recommended prior to surgical intervention to assess coronary arteries.

Aortic Stenosis Stages

- In 2014, AHA/ACC published updated classification of VHD into 4 stages (A-D)

Table 3. Stages of Progression of VHD

Stage	Definition	Description
A	At risk	Patients with risk factors for development of VHD
B	Progressive	Patients with progressive VHD (mild-to-moderate severity and asymptomatic)
C	Asymptomatic severe	Asymptomatic patients who have the criteria for severe VHD: C1: Asymptomatic patients with severe VHD in whom the left or right ventricle remains compensated C2: Asymptomatic patients with severe VHD, with decompensation of the left or right ventricle
D	Symptomatic severe	Patients who have developed symptoms as a result of VHD

VHD indicates valvular heart disease.

Aortic Stenosis Stages

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
A	At risk of AS	• Bicuspid aortic valve (or other congenital valve anomaly) • Aortic valve sclerosis	• Aortic V_{max} <2 m/s	• None	• None
B	Progressive AS	• Mild-to-moderate leaflet calcification of a bicuspid or trileaflet valve with some reduction in systolic motion or • Rheumatic valve changes with commissural fusion	• Mild AS: Aortic V_{max} 2.0–2.9 m/s or mean ΔP <20 mm Hg • Moderate AS: Aortic V_{max} 3.0–3.9 m/s or mean ΔP 20–39 mm Hg	• Early LV diastolic dysfunction may be present • Normal LVEF	• None

Aortic Stenosis Stages

C: Asymptomatic severe AS					
C1	**Asymptomatic severe AS**	• Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening	• Aortic V_{max} ≥4 m/s or mean ΔP ≥40 mm Hg • AVA typically is ≤1.0 cm^2 (or AVAi ≤0.6 cm^2/m^2) • Very severe AS is an aortic V_{max} ≥5 m/s or mean ΔP ≥60 mm Hg	• LV diastolic dysfunction • Mild LV hypertrophy • Normal LVEF	• None: Exercise testing is reasonable to confirm symptom status
C2	**Asymptomatic severe AS with LV dysfunction**	• Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening	• Aortic V_{max} ≥4 m/s or mean ΔP ≥40 mm Hg • AVA typically ≤1.0 cm^2 (or AVAi ≤0.6 cm^2/m^2)	• LVEF <50%	• None

Aortic Stenosis Stages

D: Symptomatic severe AS					
D1	**Symptomatic severe high-gradient AS**	• Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening	• Aortic V_{max} ≥4 m/s or mean ΔP ≥40 mm Hg • AVA typically ≤1.0 cm^2 (or AVAi ≤0.6 cm^2/m^2) but may be larger with mixed AS/AR	• LV diastolic dysfunction • LV hypertrophy • Pulmonary hypertension may be present	• Exertional dyspnea or decreased exercise tolerance • Exertional angina • Exertional syncope or presyncope
D2	**Symptomatic severe low-flow/low-gradient AS with reduced LVEF**	• Severe leaflet calcification with severely reduced leaflet motion	• AVA ≤1.0 cm^2 with resting aortic V_{max} <4 m/s or mean ΔP <40 mm Hg • Dobutamine stress echocardiography shows AVA ≤1.0 cm^2 with V_{max} ≥4 m/s at any flow rate	• LV diastolic dysfunction • LV hypertrophy • LVEF <50%	• HF • Angina • Syncope or presyncope
D3	**Symptomatic severe low-gradient AS with normal LVEF or paradoxical low-flow severe AS**	• Severe leaflet calcification with severely reduced leaflet motion	• AVA ≤1.0 cm^2 with aortic V_{max} <4 m/s or mean ΔP <40 mm Hg • Indexed AVA ≤0.6 cm^2/m^2 and • Stroke volume index <35 mL/m^2 • Measured when patient is normotensive (systolic BP <140 mm Hg)	• Increased LV relative wall thickness • Small LV chamber with low stroke volume • Restrictive diastolic filling • LVEF ≥50%	• HF • Angina • Syncope or presyncope

Vignette 1

- Mr A, 83 y/o male presents with shortness of breath and peripheral edema. His pulse is 64 bpm and his BP 110/90. Auscultation reveals an absents aortic second heart sound with a late peaking systolic murmur best heard over the 2nd RICS.

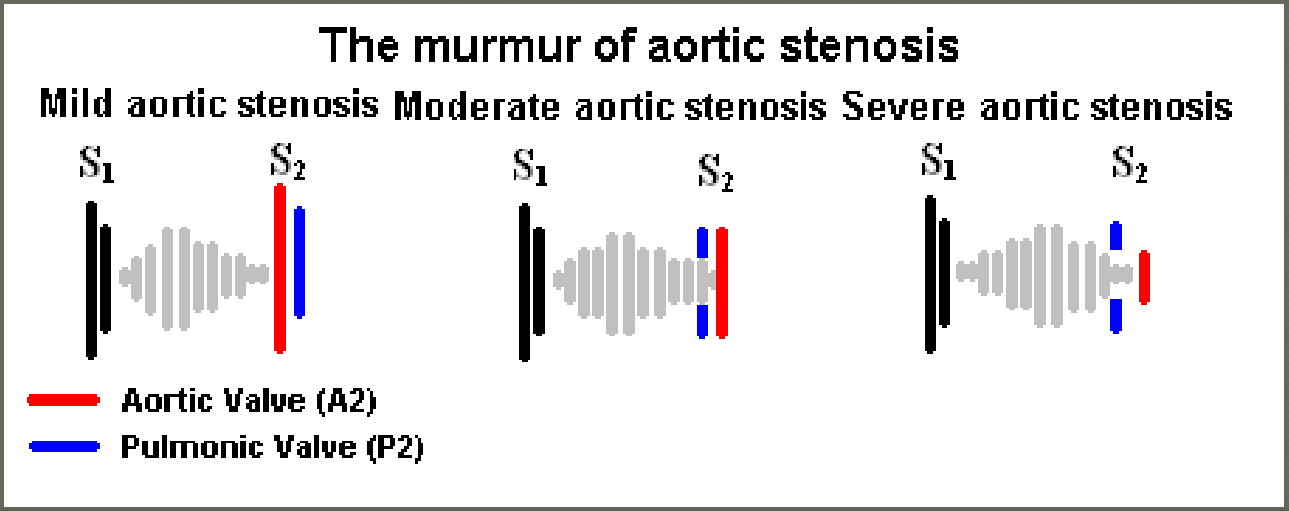
He has a pmh of HTN and HLD, otherwise his renal and pulmonary functions are normal.

Vignette 1 continued

- What features are concerning in regards to the patient physical exam?

Absent aortic second heart sound

Late peaking systolic murmur



Vignette 1 continued

- What diagnostic study would like to order?
  - Echocardiogram
    - LV EF: 55%
    - Mean gradient: 60mmHg
    - AVA: 0.6cm2
    - Peak Velocity: 4.6 m/s
- What stage is the patient?
  - D1

Vignette 1

- Mr. A is appreciative of your thorough evaluation and asks, " What is next?"
  - A. Tell Mr. A that his disease is severe and you will continue to monitor with surveillance echocardiograms.
  - B. Initiate guideline directed medical therapy.
  - C. Tell Mr. A that all is well and is free to go home.
  - D. Refer for surgical aortic valve replacement

Vignette 1

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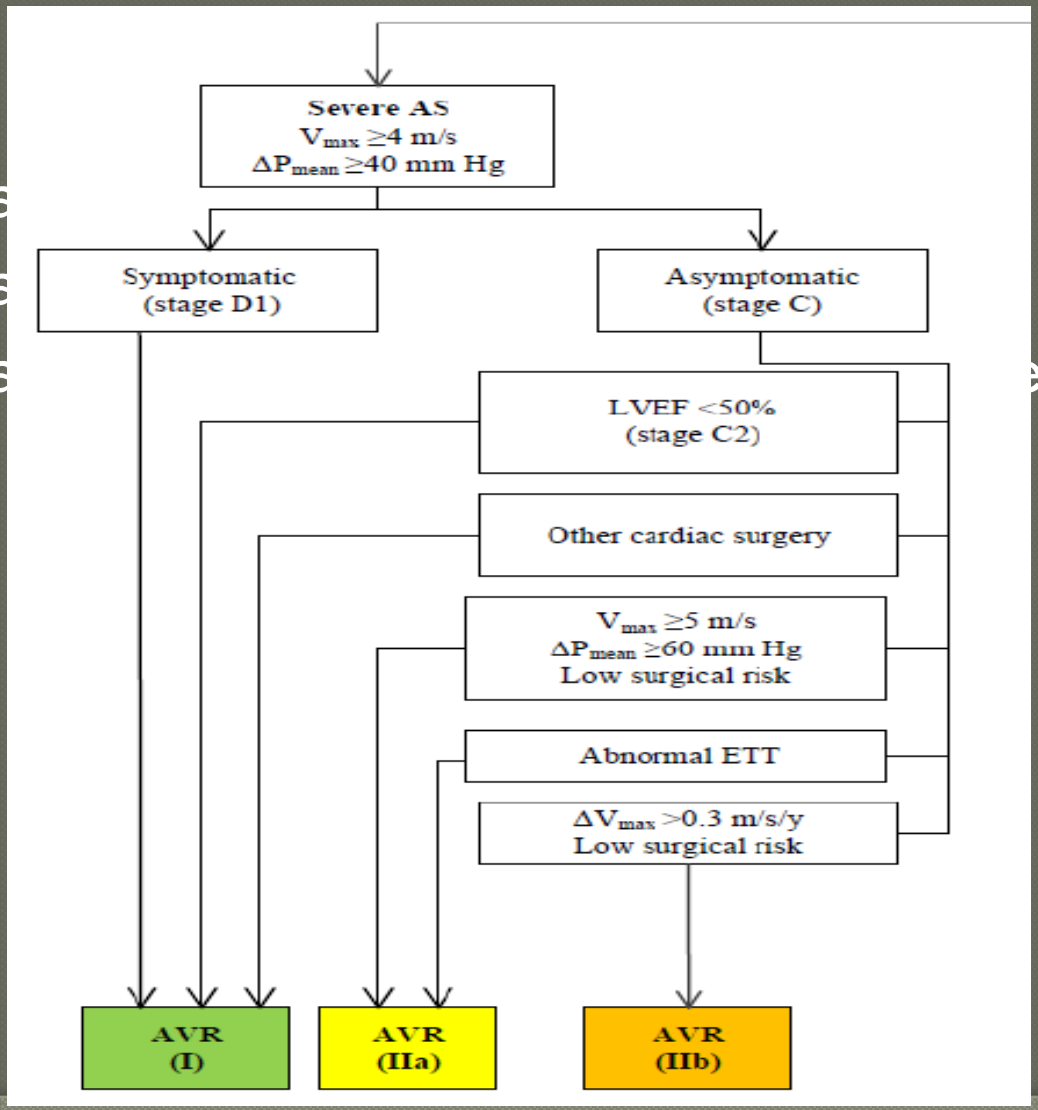


Vignette 2

Mr. B, 79 y/o male with HTN and HLD presents to the outpatient clinic with worsening shortness of breath and chest discomfort.

You order an EKG which demonstrates LVH and an echocardiogram which demonstrates an LV EF of 25%, a calcified aortic valve with a mean gradient of 28mmHg, AVA of 0.8cm2 and peak velocity of 3.16m/s.

Vignette 2

- Does the patient's aortic stenosis account for his symptoms? Does the patient have severe AS? What would you like to do next?
  - A. The patient symptoms are secondary to heart failure. Optimize his medical regimen.
  - B. The patient has moderate aortic stenosis. Repeat echo in 6-12months.
  - C. Order a dobutamine stress echo to assess for severe AS versus pseuodstenosis.

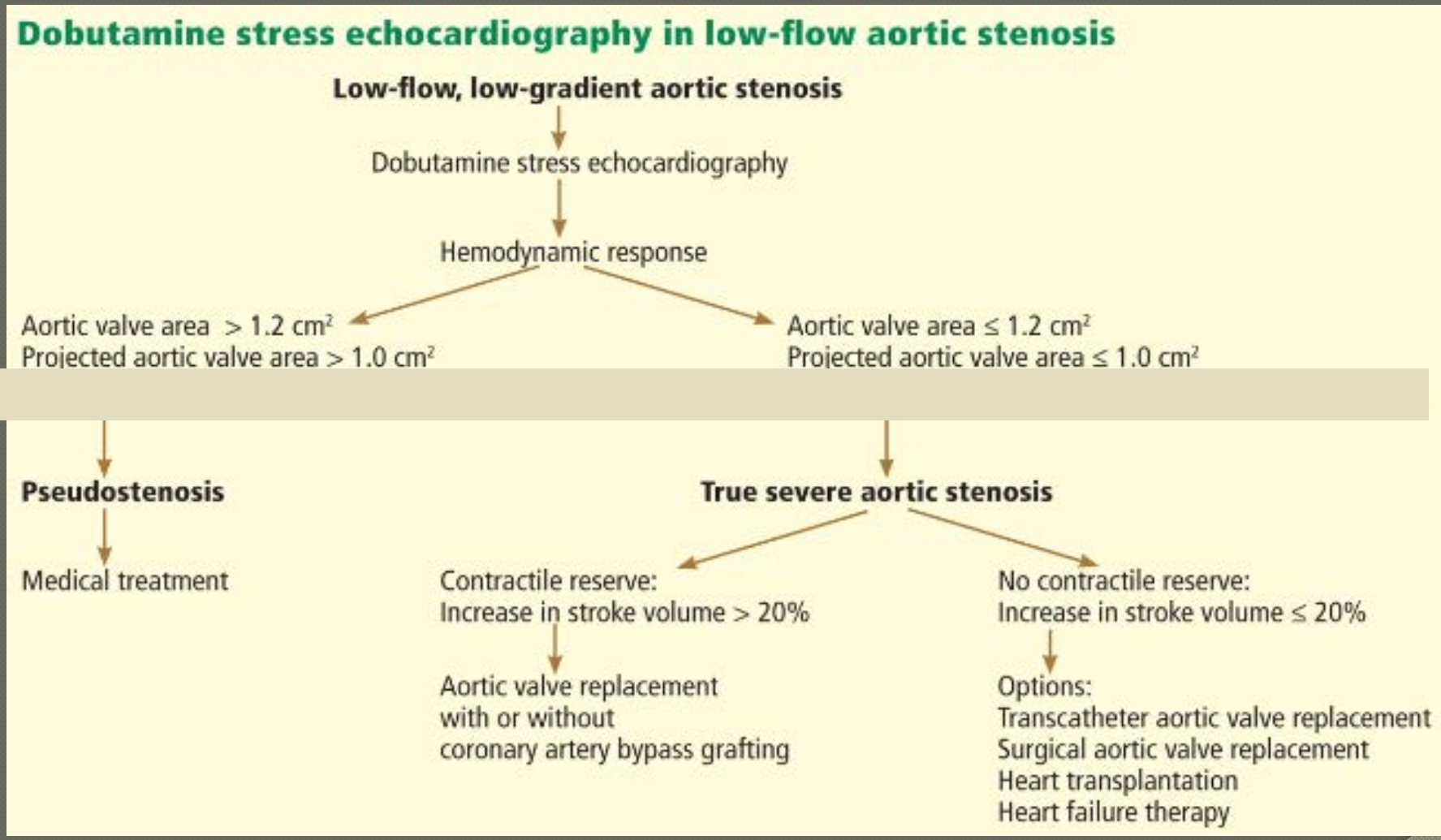
Vignette 2

- Differentiating true aortic stenosis from "pseudostenosis and its importance.
  - Dobutamine stress echo (DSE) has a class IIa indication in patient with stage D2 aortic stenosis.
  - It can differentiate true severe aortic stenosis (Stage D2) from "pseudostenosis". This is paramount as the former is associated with improved long-term outcomes with AVR and the latter has no benefit from AVR.
  - Allows for assessment of contractile reserve, defined as an increase SV > 20%. Patient's without contractile reserve have higher operative mortality.

Class IIa

1. **Low-dose dobutamine stress testing using echocardiographic or invasive hemodynamic measurements is reasonable in patients with stage D2 AS with all of the following (46-48), *(Level of Evidence: B):***
   a. **Calcified aortic valve with reduced systolic opening;**
   b. **LVEF less than 50%;**
   c. **Calculated valve area 1.0 cm^2 or less; and**
   d. **Aortic velocity less than 4.0 m per second or mean pressure gradient less than 40 mm Hg.**

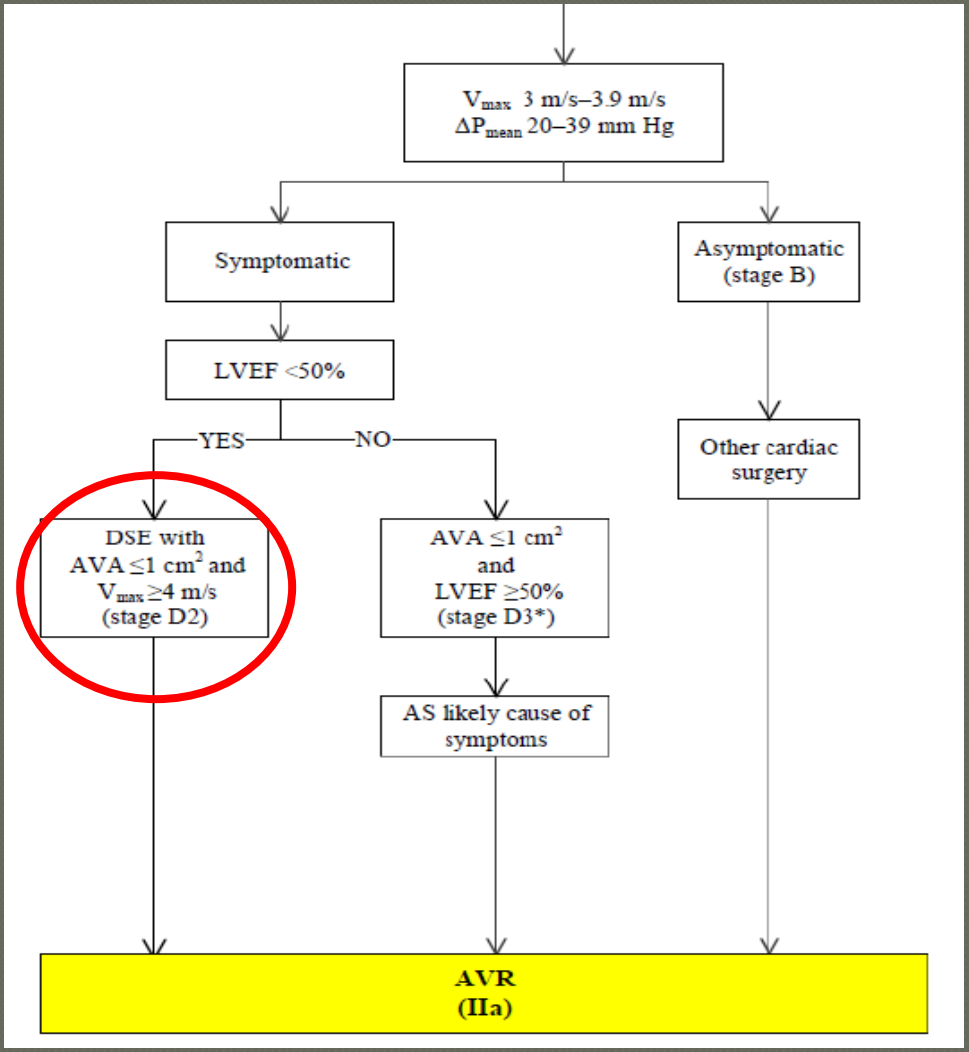
Vignette 2


Dobutamine stress echocardiography in low-flow aortic stenosis
Low-flow, low-gradient aortic stenosis
Dobutamine stress echocardiography
Hemodynamic response
Aortic valve area > 1.2 cm²
Projected aortic valve area > 1.0 cm²
Aortic valve area ≤ 1.2 cm²
Projected aortic valve area ≤ 1.0 cm²
Pseudostenosis
Medical treatment
True severe aortic stenosis
Contractile reserve:
Increase in stroke volume > 20%
Aortic valve replacement
with or without
coronary artery bypass grafting
No contractile reserve:
Increase in stroke volume ≤ 20%
Options:
Transcatheter aortic valve replacement
Surgical aortic valve replacement
Heart transplantation
Heart failure therapy

Vignette 2

- Mr. B underwent DSE and results demonstrated increase in EF, SV and transvalvular gradient suggestive of true severe AS and contractile reserve. You subsequently refer him for AVR.

Vignette 2


V_{max} 3 m/s–3.9 m/s
ΔP_{mean} 20–39 mm Hg
Symptomatic
Asymptomatic (stage B)
LVEF <50%
YES
NO
Other cardiac surgery
DSE with AVA ≤1 cm² and V_{max} ≥4 m/s (stage D2)
AVA ≤1 cm² and LVEF ≥50% (stage D3*)
AS likely cause of symptoms
AVR (IIa)

Vignette 3

- Mr. C, 81 y/o male with HTN and HLD presents to the ER with chest pain. EKG demonstrates nonspecific ST changes with elevated troponin. He is diagnosed with NSTEMI. A LHC is performed and reveals triple vessel disease.
  Echocardiogram is ordered and demonstrates an EF of 55% and aortic stenosis with a AVA 1.2cm2 and a mean gradient of 28mmHg and peak velocity 3.31 m/s

Vignette 3

- What is the stage and the severity of the patient aortic stenosis?
  - A. Stage A, mild AS
  - B. Stage D, severe AS
  - C. Stage C, moderate AS
  - D. Stage B, moderate AS

B	Progressive AS	• Mild-to-moderate leaflet calcification of a bicuspid or trileaflet valve with some reduction in systolic motion or • Rheumatic valve changes with commissural fusion	• Mild AS: Aortic V_{max} 2.0–2.9 m/s or mean ΔP <20 mm Hg • Moderate AS: Aortic V_{max} 3.0–3.9 m/s or mean ΔP 20–39 mm Hg	• Early LV diastolic dysfunction may be present • Normal LVEF	• None

Vignette 3

- How would manage the patient's aortic stenosis?
  - A. Monitor with surveillance echocardiogram every 6-12 months.
  - B. Medical management with statin and ACE inhibitor.
  - C. Perform PCI to obstructive lesions and monitor AS as outpatient.
  - D. Refer CABG and AVR.

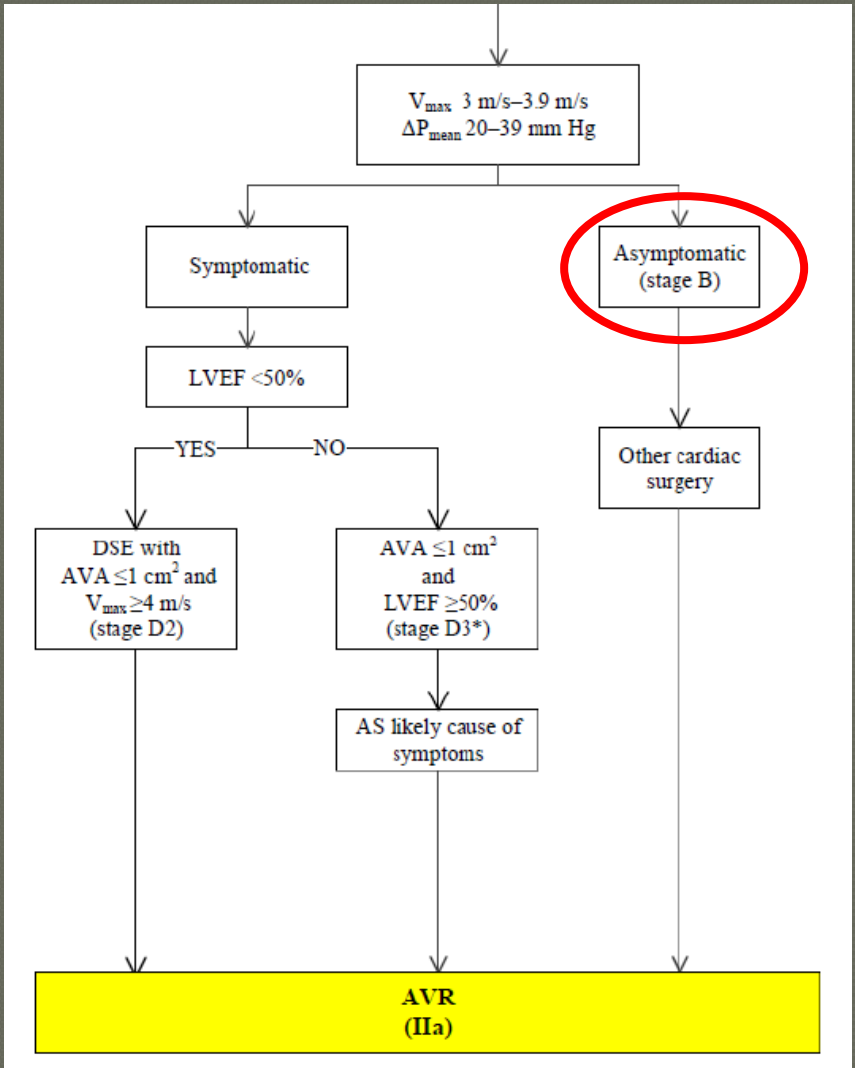
Vignette 3

- AHA/ACC guidelines for VHD state that AVR is a class IIa indication for moderate AS (stage B) undergoing cardiac surgery.
- Stage B patient, otherwise, follow the below surveillance regimen.

Table 4. Frequency of Echocardiograms in Asymptomatic Patients with VHD and Normal Left Ventricular Function

Stage	Valve Lesion			
Stage	**Aortic Stenosis***	**Aortic Regurgitation**	**Mitral Stenosis**	**Mitral Regurgitation**
Progressive (stage B)	Every 3–5 y (mild severity V_{max} 2.0–2.9 m/s) every 1–2 y (moderate severity V_{max} 3.0–3.9 m/s)	Every 3–5 y (mild severity) Every 1–2 y (moderate severity)	Every 3–5 y (MVA >1.5 cm^2)	Every 3–5 y (mild severity) Every 1–2 y (moderate severity)
Severe (stage C)	Every 6-12 mo (V_{max} ≥4 m/s)	Every 6–12 mo Dilating LV: more frequently	Every 1–2 y (MVA 1.0–1.5 cm^2) Once every year (MVA <1.0 cm^2)	Every 6–12 mo Dilating LV: more frequently

Vignette 3

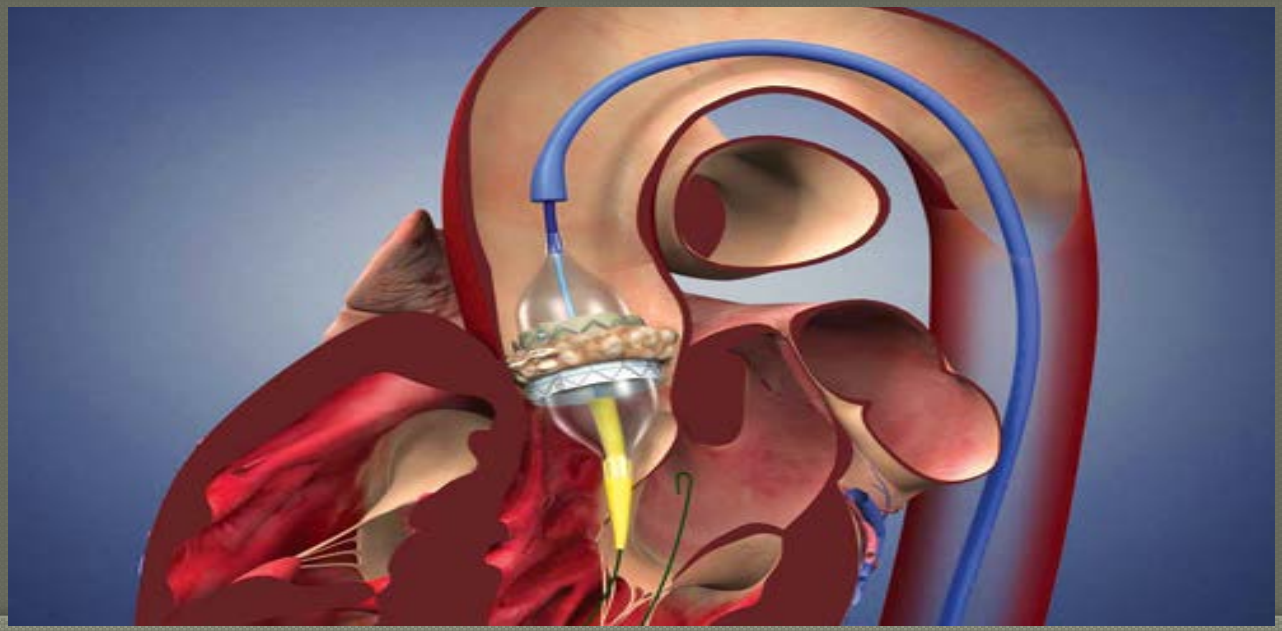

V_{max} 3 m/s–3.9 m/s
ΔP_{mean} 20–39 mm Hg
Symptomatic
Asymptomatic (stage B)
LVEF <50%
YES
NO
Other cardiac surgery
DSE with AVA ≤1 cm² and V_{max} ≥4 m/s (stage D2)
AVA ≤1 cm² and LVEF ≥50% (stage D3*)
AS likely cause of symptoms
AVR (IIa)

Vignette 4

- Mr. E, 84 y/o male has severe aortic stenosis (AVA 0.6cm2 and mean gradient of 56mmHg), CAD s/p CABG, moderate COPD, CKD, HTN, HLD and DMII. He presents with worsening shortness of breath over the past month. Your impression is that he is very frail.
- How would you manage Mr. E's aortic stenosis?
  - A. Medical management as he is high risk.
  - B. Recommend balloon valvuloplasty.
  - C. Repeat echocardiogram.
  - D. Refer for transcatheter aortic valve replacement (TAVR)

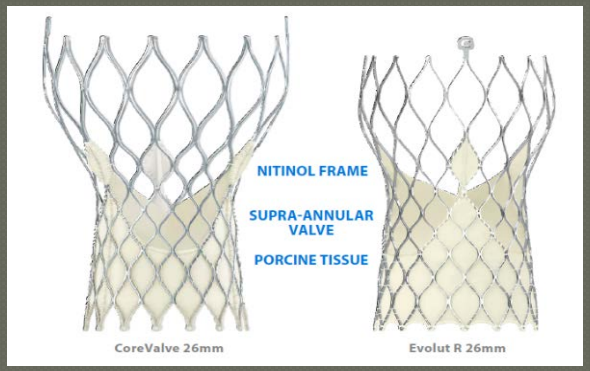
Vignette 4

- TAVR
  - Class I: TAVR is recommend in patients who have an indication for AVR with prohibitive surgical risk and a predicted post-TAVR survival greater than 12 months.
  - Class IIa: TAVR is recommended in patients who have an indication for AVR with a high surgical risk.



Vignette 4

- FDA approved in 2011, Edward Sapien valve and Medtronic CoreValve are available in the US.



- Outcomes of TAVR in the PARTNER trial demonstrated that those treated with TAVR had significantly better survival compared to medical therapy and similar long term outcomes (2years) compared to SAVR in high risk surgical patients.

Vignette 4

- FDA approved, Edward Sapien valve for intermediate risk patient in August 2016 based on Partner II trial
- The Partner II trial demonstrated that TAVR in intermediate-risk patients is associated with low mortality, strokes, and regurgitation at 1 year. The propensity score analysis indicates a significant superiority composite outcome with TAVR compared with surgery

Vignette 4

- Partner III trial is currently in progress. The trial is evaluating TAVR in low risk patient with severe aortic regurgitation.

Vignette 5

- Mr. D, 74 y/o male with HTN, HLD and AS presents for his annual echocardiogram. He lives a sedentary lifestyle but feels well with performing his ADLs. He denies dyspnea on exertion, chest pain or syncope.
- His Echo demonstrates preserved EF, AVA of 0.7cm2,mean gradient 70mmHg and peak velocity 4.7m/s. The prior year he had a mean gradient of 40 and peak velocity of 4.0m/s

How would you manage his aortic stenosis?

- A. Continue yearly surveillance echocardiograms.
- B. Refer for exercise treadmill test to elicit symptoms.
- C. Discontinue yearly surveillance echocardiograms.

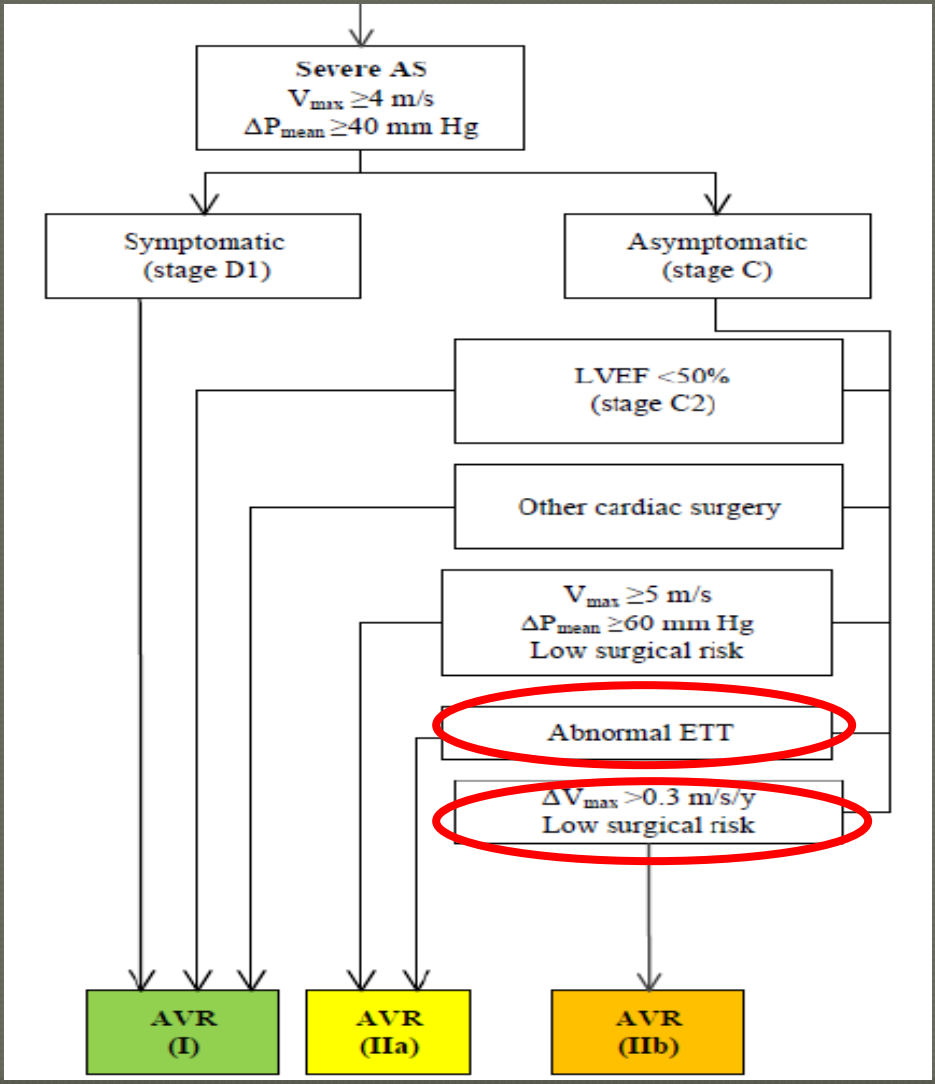
Vignette 5

- You refer Mr. D for an ETT which elicits symptoms. You subsequently refer him for AVR.

Class IIa

1. **Low-dose dobutamine stress testing using echocardiographic or invasive hemodynamic measurements is reasonable in patients with stage D2 AS with all of the following (46-48), *(Level of Evidence: B):***
    a. **Calcified aortic valve with reduced systolic opening;**
    b. **LVEF less than 50%;**
    c. **Calculated valve area 1.0 cm^2 or less; and**
    d. **Aortic velocity less than 4.0 m per second or mean pressure gradient less than 40 mm Hg.**
2. **Exercise testing is reasonable to assess physiological changes with exercise and to confirm the absence of symptoms in asymptomatic patients with a calcified aortic valve and an aortic velocity 4.0 m per second or greater or mean pressure gradient 40 mm Hg or higher (stage C) (27, 37, 38, 49). *(Level of Evidence: B)***

Vignette 5

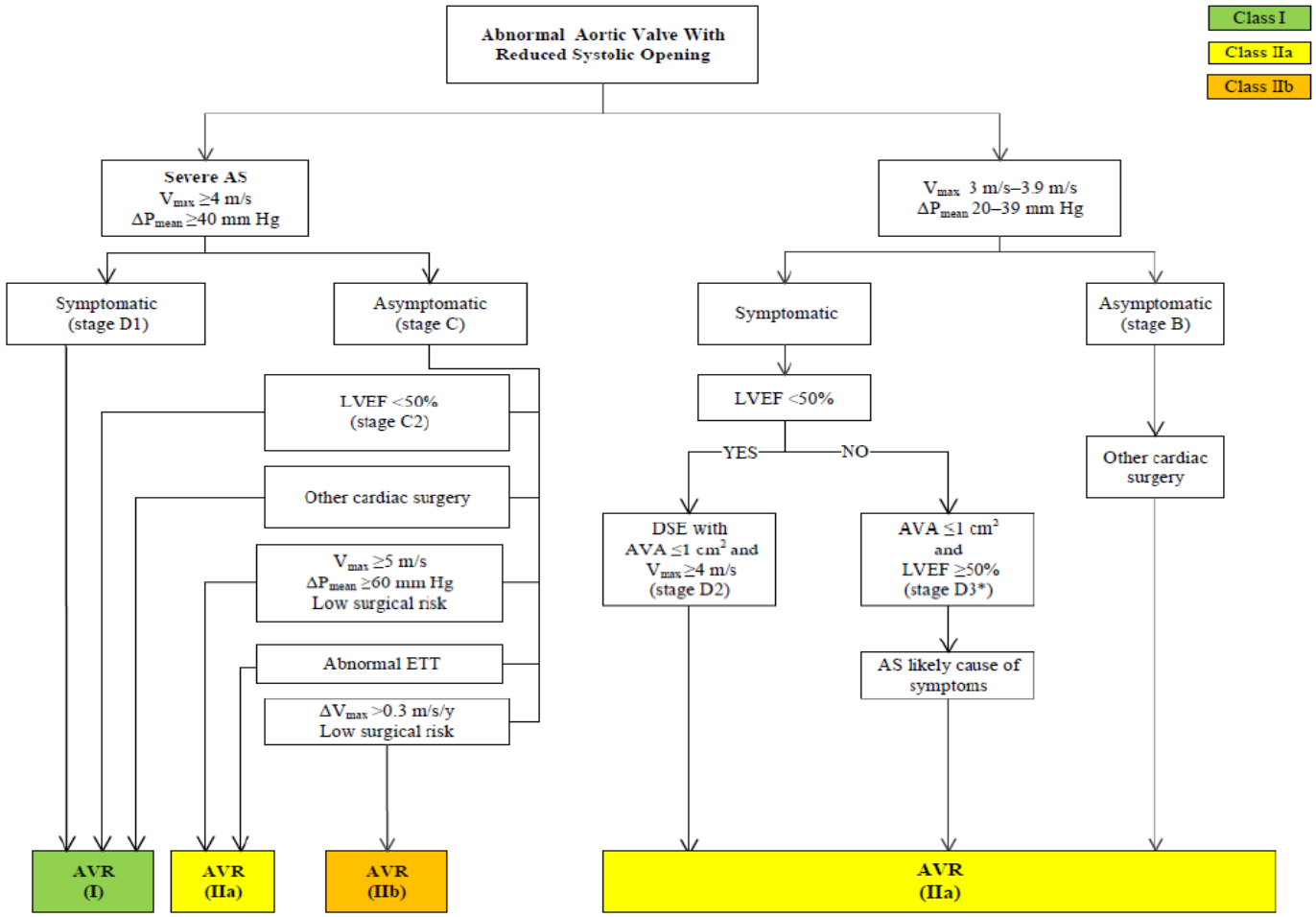

Severe AS
V_{max} ≥4 m/s
ΔP_{mean} ≥40 mm Hg
Symptomatic (stage D1)
Asymptomatic (stage C)
LVEF <50% (stage C2)
Other cardiac surgery
V_{max} ≥5 m/s
ΔP_{mean} ≥60 mm Hg
Low surgical risk
Abnormal ETT
ΔV_{max} >0.3 m/s/y
Low surgical risk
AVR (I)
AVR (IIa)
AVR (IIb)

Aortic Stenosis Management

- In the case of life-limiting comorbidities consider aortic balloon valvuloplasty for palliation.
- Balloon valvuloplasty can also be used for bridge therapy
- Nitroprusside (vasodilator therapy) may be reasonable if used with invasive hemodynamic monitoring in the acute management of patients with stage D AS and NYHA stage IV heart failure symptoms. (IIb)

Aortic Stenosis Summary

Nishimura, RA et al.
2014 AHA/ACC Valvular Heart Disease Guideline



Surgical Risk

- Link to STS calculator: http://riskcalc.sts.org/stswebriskcalc/#/

Table 5. Risk Assessment Combining STS Risk Estimate, Frailty, Major Organ System Dysfunction, and Procedure-Specific Impediments

	Low Risk (Must Meet ALL Criteria in This Column)	Intermediate Risk (Any 1 Criterion in This Column)	High Risk (Any 1 Criterion in This Column)	Prohibitive Risk (Any 1 Criterion in This Column)
STS PROM*	<4% **AND**	4% to 8% **OR**	>8% **OR**	Predicted risk with surgery of death or major morbidity (all-cause) >50% at 1 y **OR**
Frailty†	None **AND**	1 Index (mild) **OR**	≥2 Indices (moderate to severe) **OR**	
Major organ system compromise not to be improved postoperatively‡	None **AND**	1 Organ system **OR**	No more than 2 organ systems **OR**	≥3 Organ systems **OR**
Procedure-specific impediment§	None	Possible procedure-specific impediment	Possible procedure-specific impediment	Severe procedure-specific impediment

Table 5. Risk Assessment Combining STS Risk Estimate, Frailty, Major Organ System Dysfunction, and Procedure-Specific Impediments

	Low Risk (Must Meet ALL Criteria in This Column)	Intermediate Risk (Any 1 Criterion in This Column)	High Risk (Any 1 Criterion in This Column)	Prohibitive Risk (Any 1 Criterion in This Column)
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