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Aortic valve stenosis

Dr. Gloria Ayuba

Disclosures

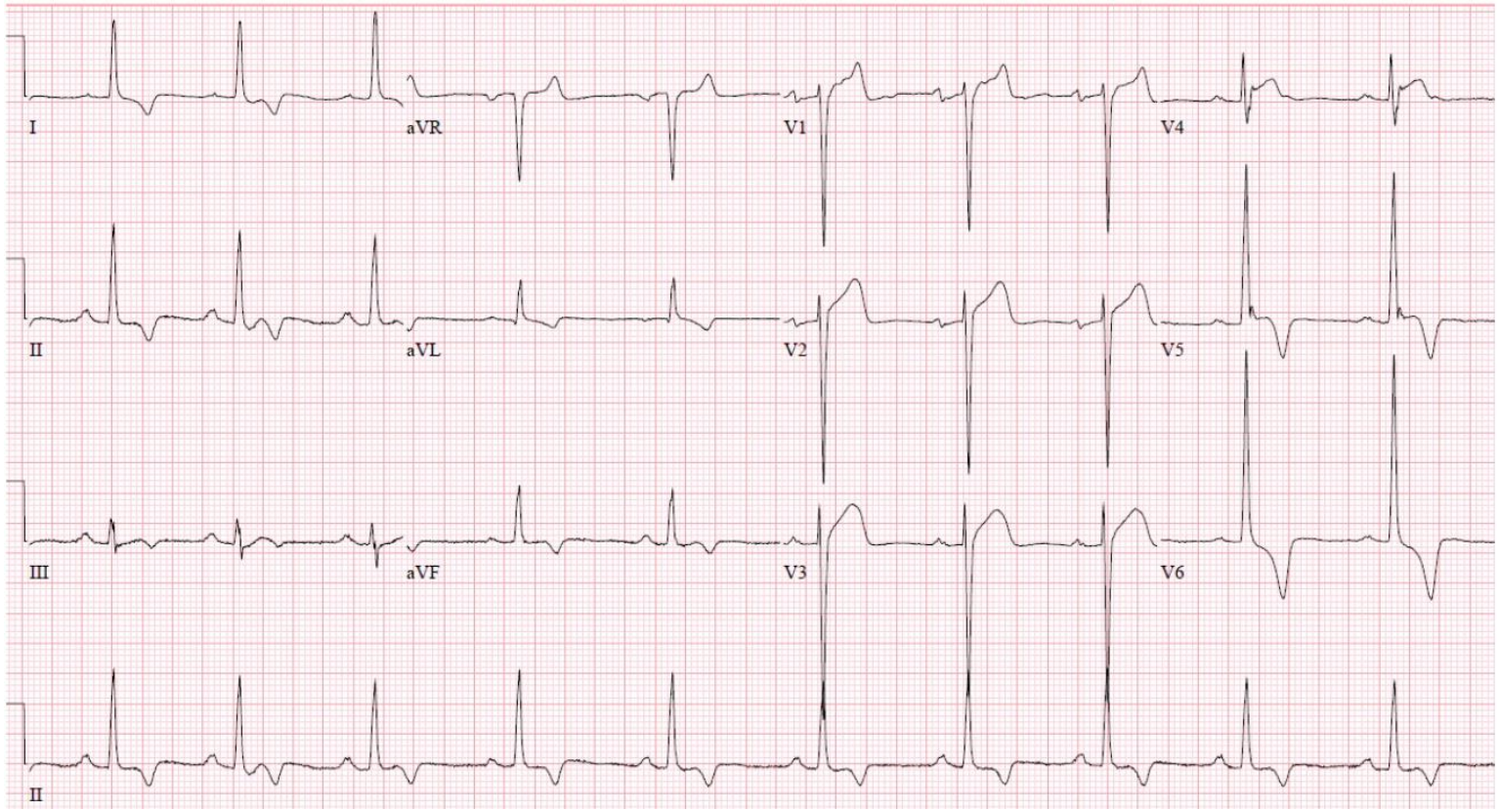
- None

Case

- 85 y.o. female referred by PCP incidental cardiac murmur and an abnormal echo
- PMH: DM2, CKD, PAF, HLD,COPD, OA of Hip

EKG

- NSR
- LVH with strain



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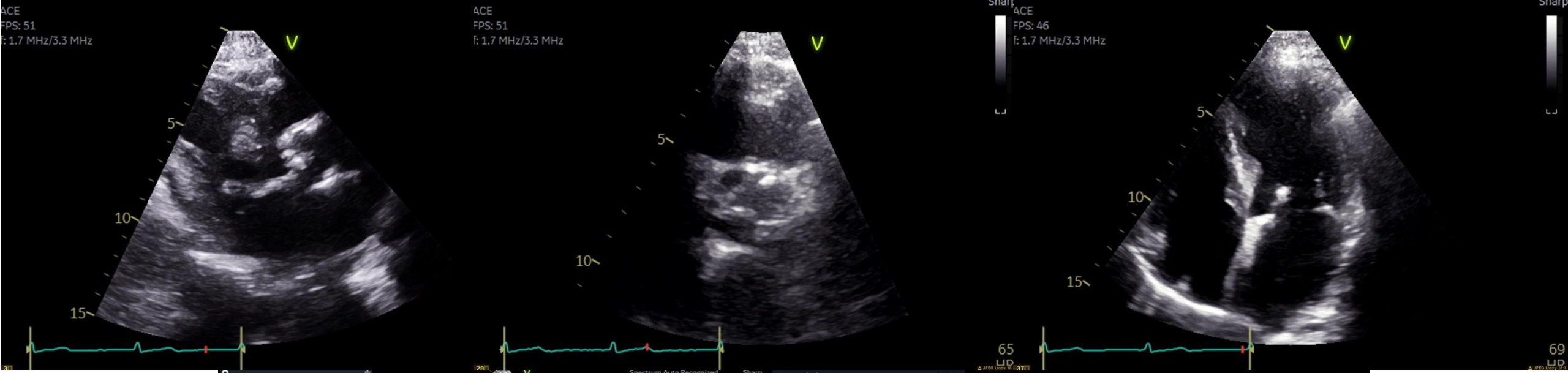

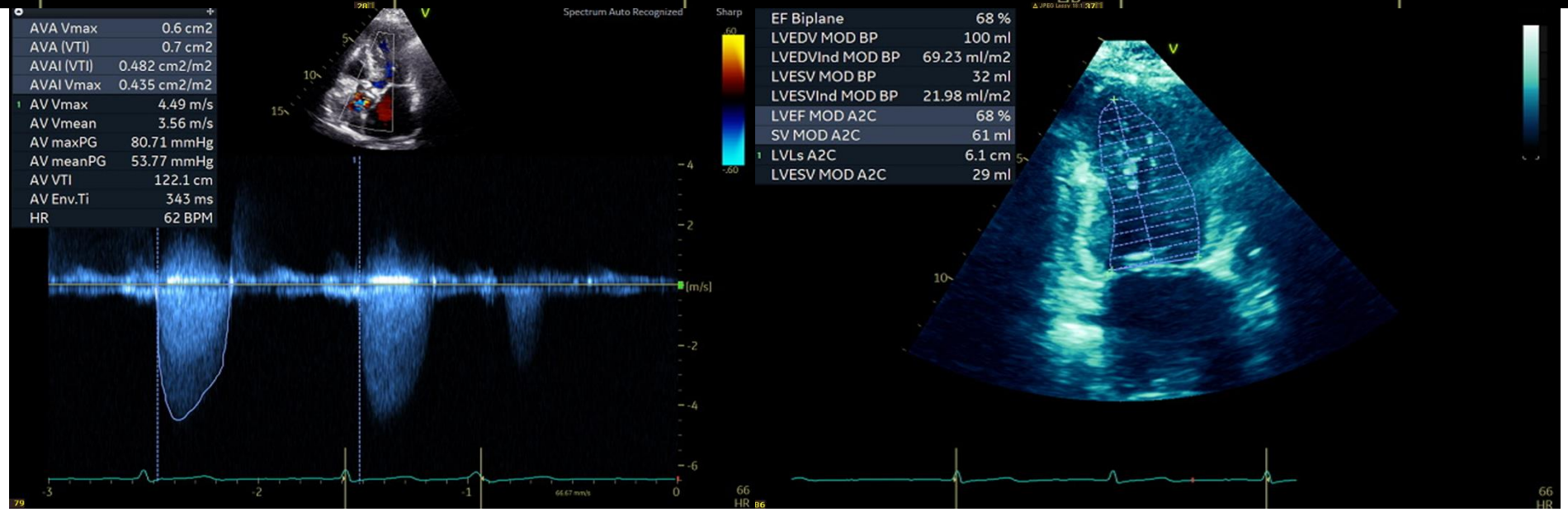

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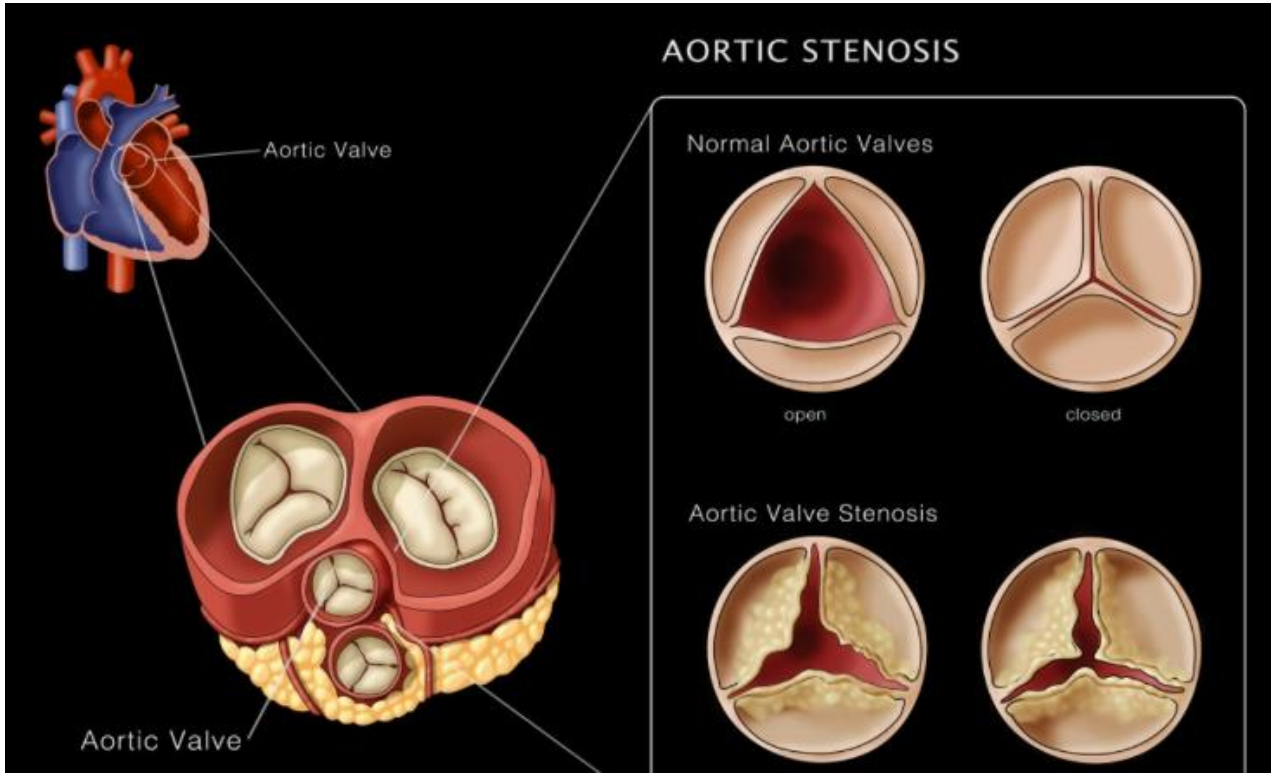
Case

- Echo: LVEF 68%, peak velocity 4.5 m/s, mean gradient 54 mmHg, AVA 0.7cm^2
- No symptoms

Objectives

- Definition
- Etiology and pathophysiology
- Epidemiology
- Classification
- Management

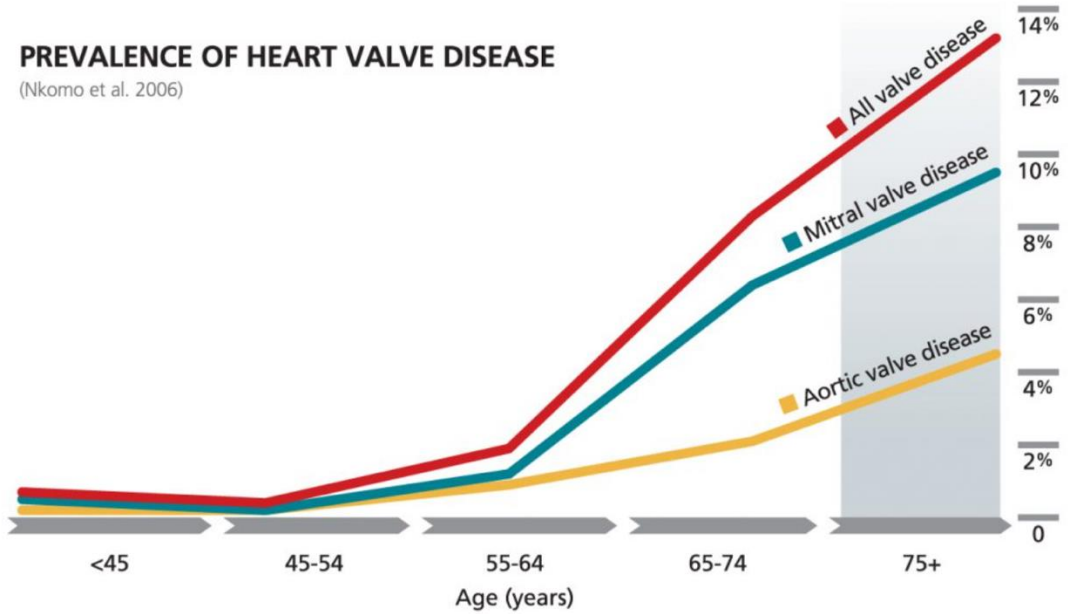
Normal Aortic Valve



- 3 thin cusps
- Good leaflet separation
- Unrestricted opening
- Valve area ~ 3 to 4 cm2

Aortic stenosis

- Aortic valve disease is common
- Prevalence rate 4-7% (65 years of age or older)

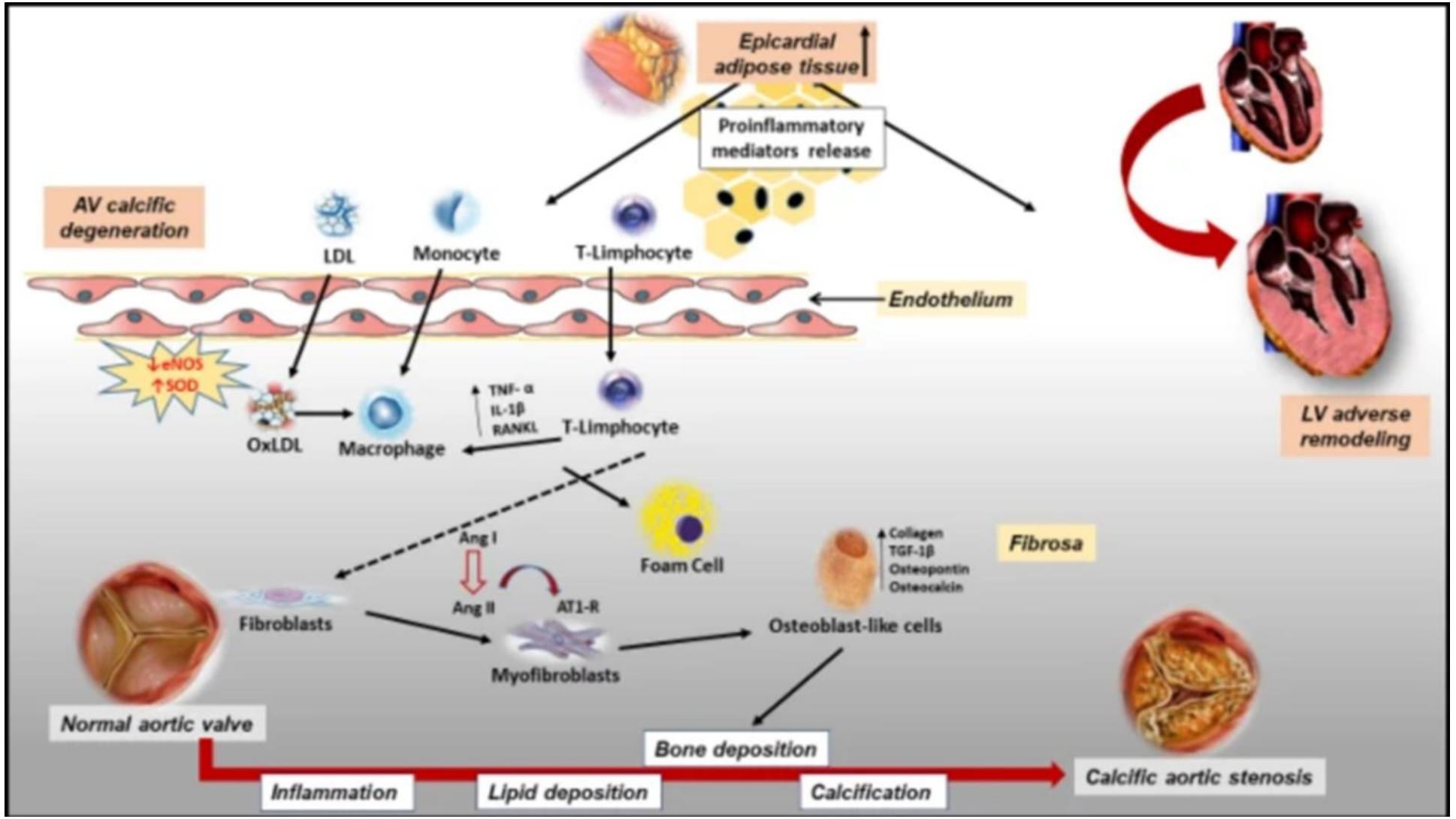


At risk for developing AS

- Aortic valve sclerosis
- Chest irradiation
- Congenital abnormalities
- Infections (rheumatic fever/infective endocarditis)
- HD risk factors (HLD, tobacco use)

Etiology

- Congenital
- Rheumatic
- Degenerative



Conte et al. Aging Clinical and Experimental Research. 2021;33:1765–70

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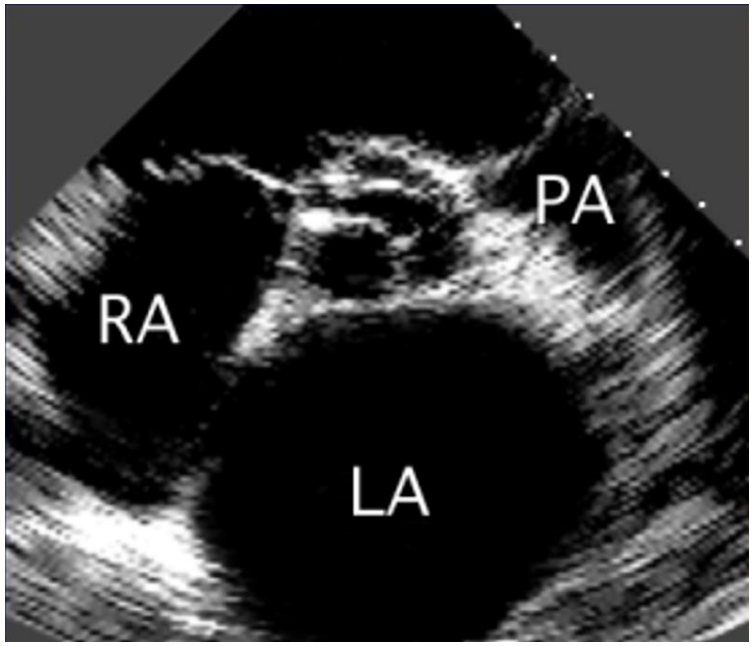
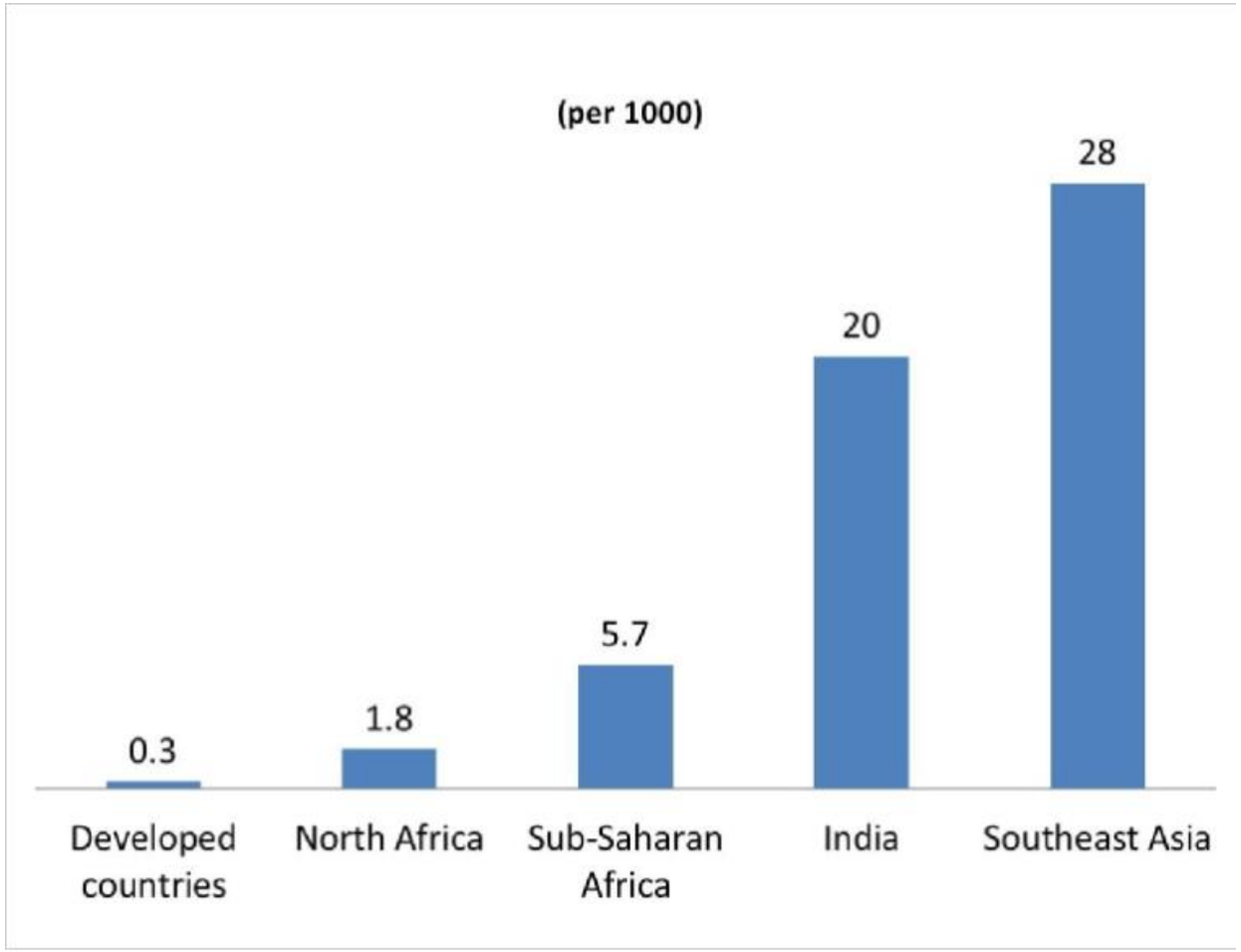
Rheumatic Aortic Stensosis: Less calcification, More commissural fusion





Curr Opin Pediatr. 2015;27:116-23

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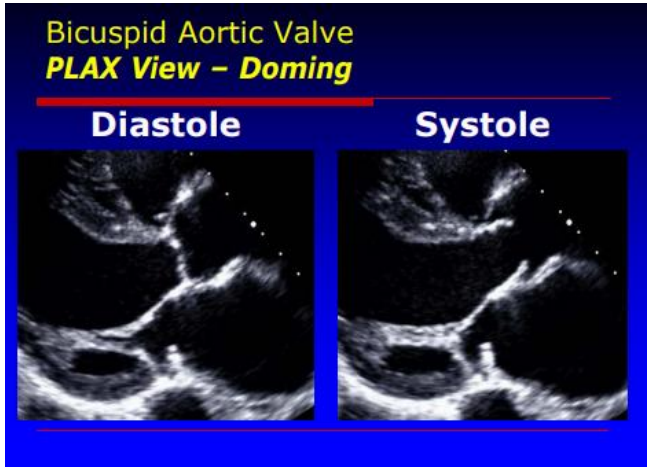
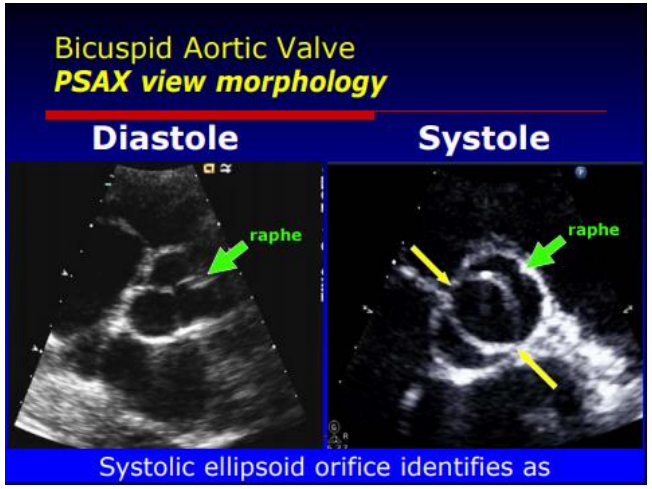
Congenital

Bicuspid Aortic valve

- Most common congenital anomaly
- Commissure may be horizontal or vertical
- Accelerated calcification -> premature stenosis
- Proximal aortopathy
- Associated abnormalities - coarctation





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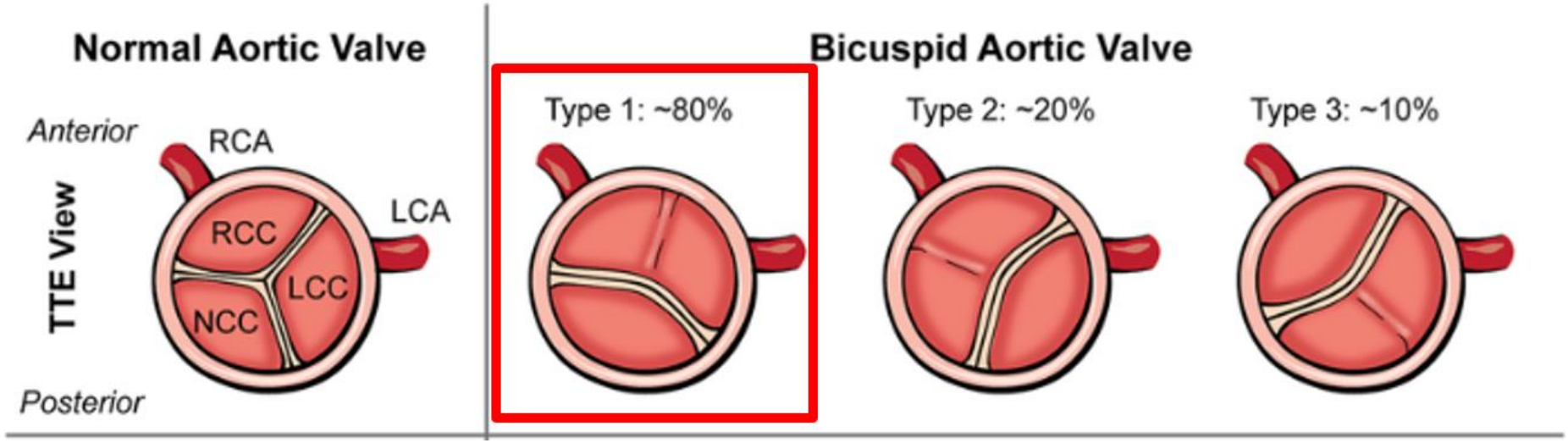
Bicuspid AV morphology



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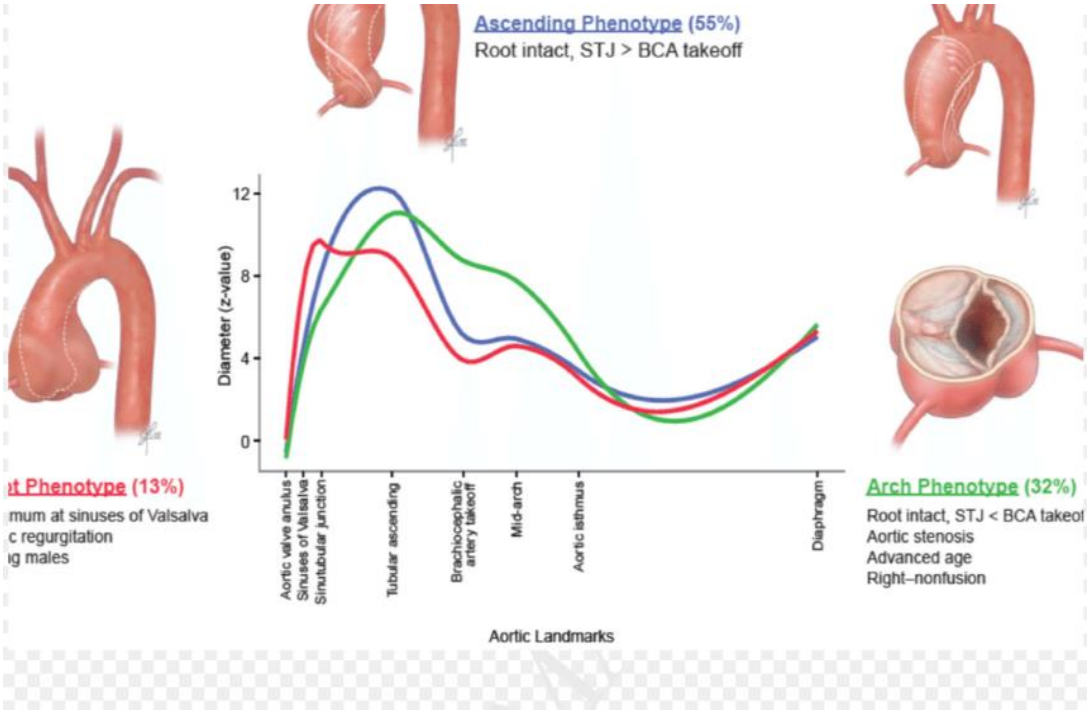
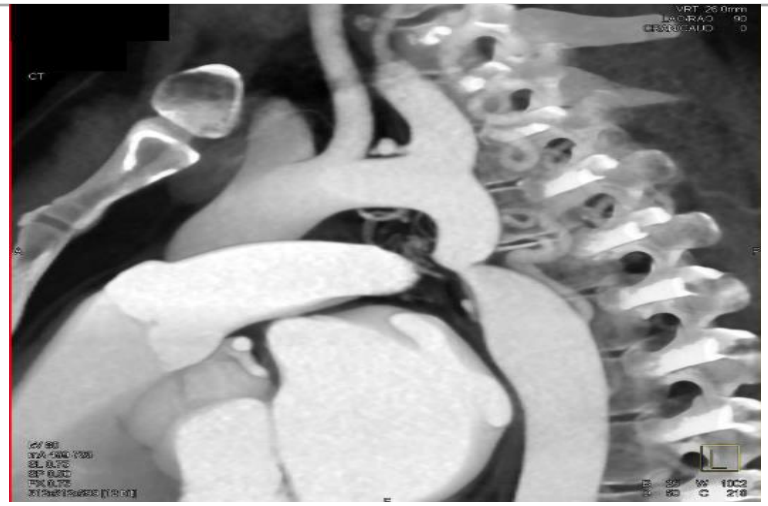
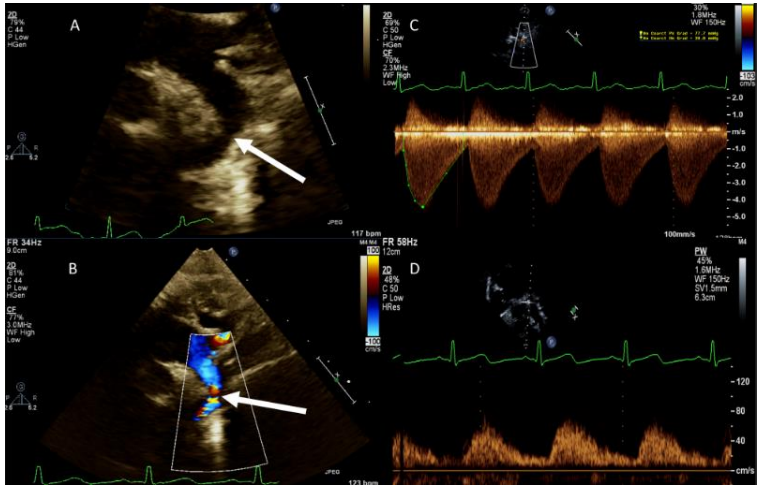
Associated lesions







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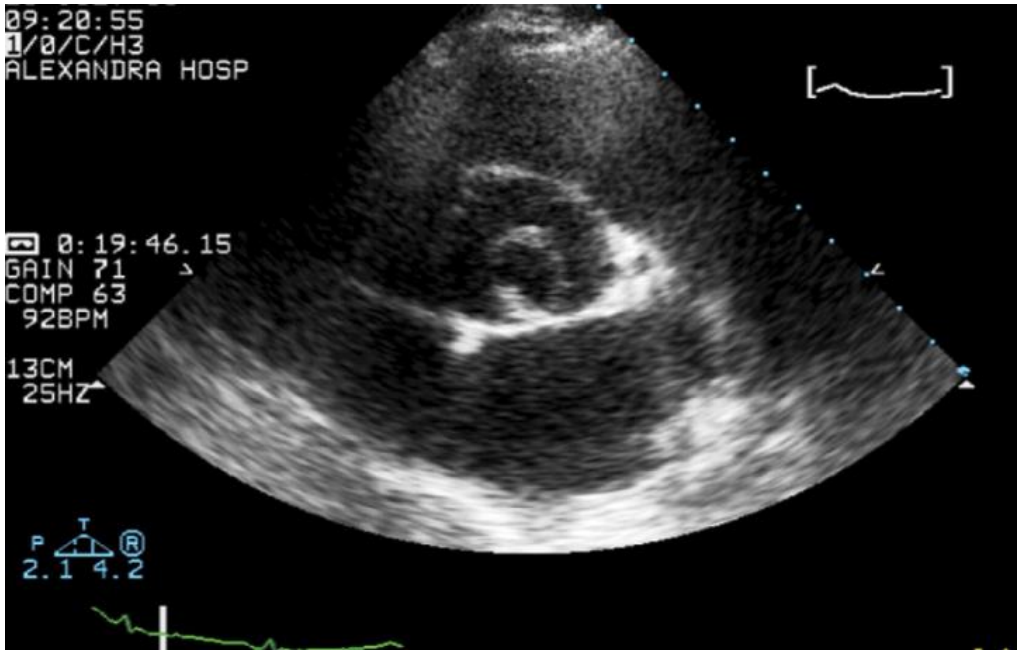
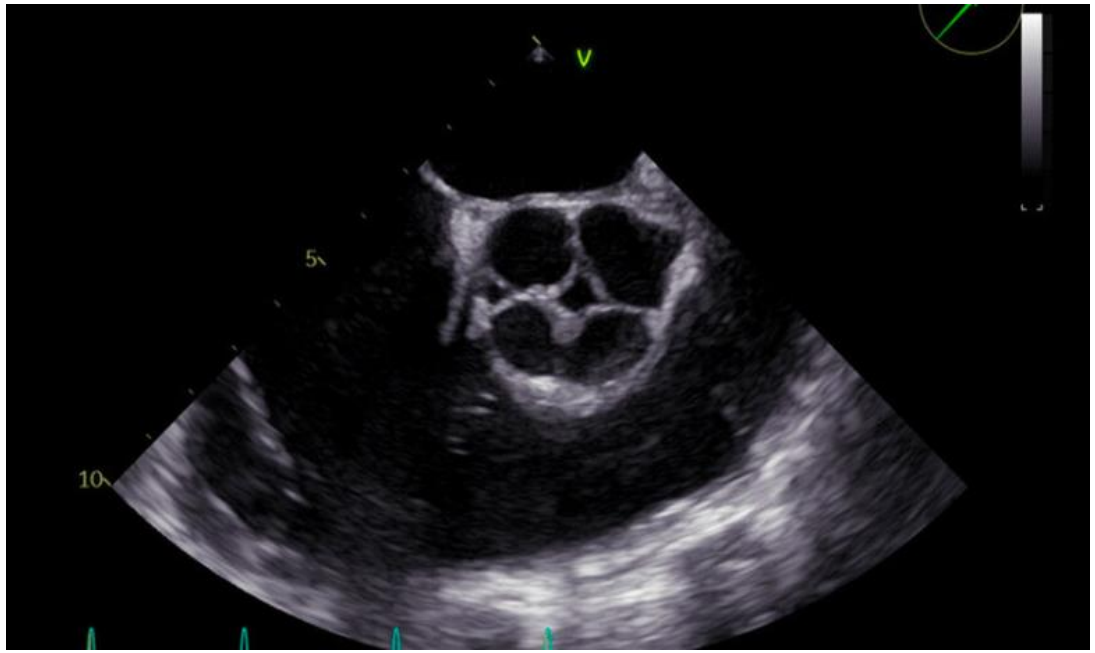
Congenital anomalies

Unicuspid



Quadricuspid



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Evaluation

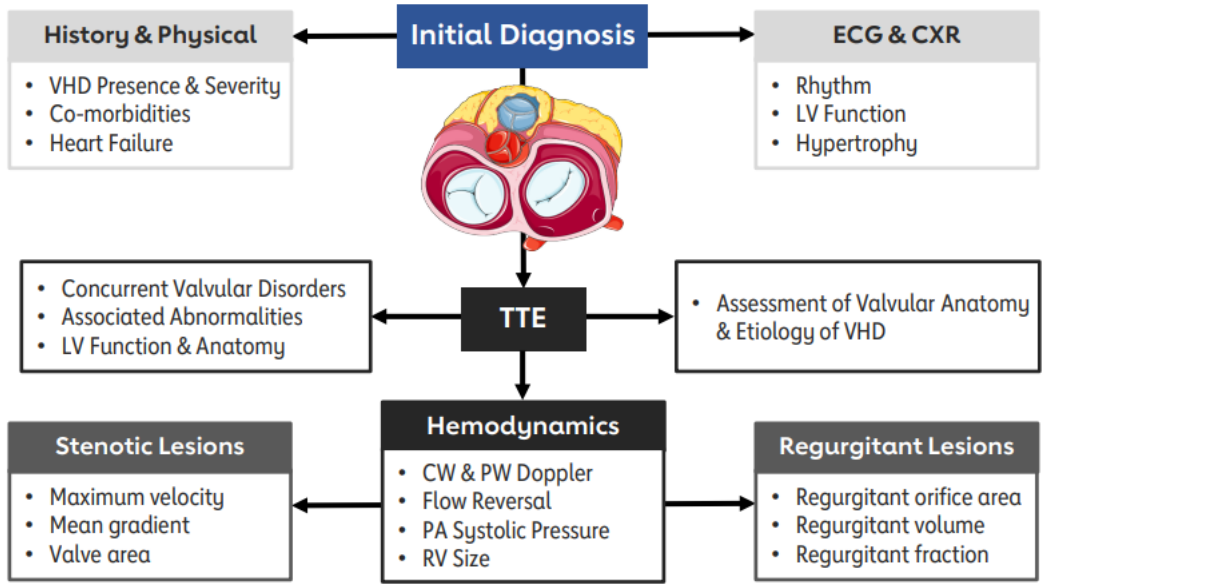
AS: MURMUR

- The hallmark finding is a **crescendo-decrescendo ejection murmur,** heard best with the diaphragm of the stethoscope at the right upper sternal border when a patient is sitting upright leaning forward.
- The murmur typically radiates to one or both carotid arteries and has a harsh or grating quality.
- The intensity of the systolic murmur does not correspond to the severity of AS; rather, **the timing of the peak and the duration of the murmur** corresponds to the severity of AS. The more severe the stenosis, the longer the duration of the murmur and the more likely it peaks at late systole.

Inspection: Carotid pulse

- The quality of the arterial pulse reflects the obstruction to blood flow into the peripheral arterial circulation.
- The arterial pulse :as "**parvus and tardus**", ie, it is small or weak and rises slowly.
- Best appreciated in the **carotid artery** where the pulse is **reduced in amplitude and delayed in occurrence**.
- The delay can be appreciated by simultaneous palpation of the apex (PMI) and the carotid artery.
- There may be :an associated carotid artery thrill or coarse vibration ("shuddering")→ due to the marked turbulence of blood flow across the stenotic valve.

Evaluation of the Patient With Known or Suspected Native VHD



Abbreviations: CW indicates continuous wave; LV, left ventricle; PASP, pulmonary artery systolic pressure; PW, pulsed wave; RV, right ventricle; TTE, transthoracic echocardiography; and VHD, valvular heart disease.

American Heart Association.

Otto, CM et al. 2020 ACC/AHA. Guideline for the Management of Patients With Valvular Heart Disease *Circulation*.

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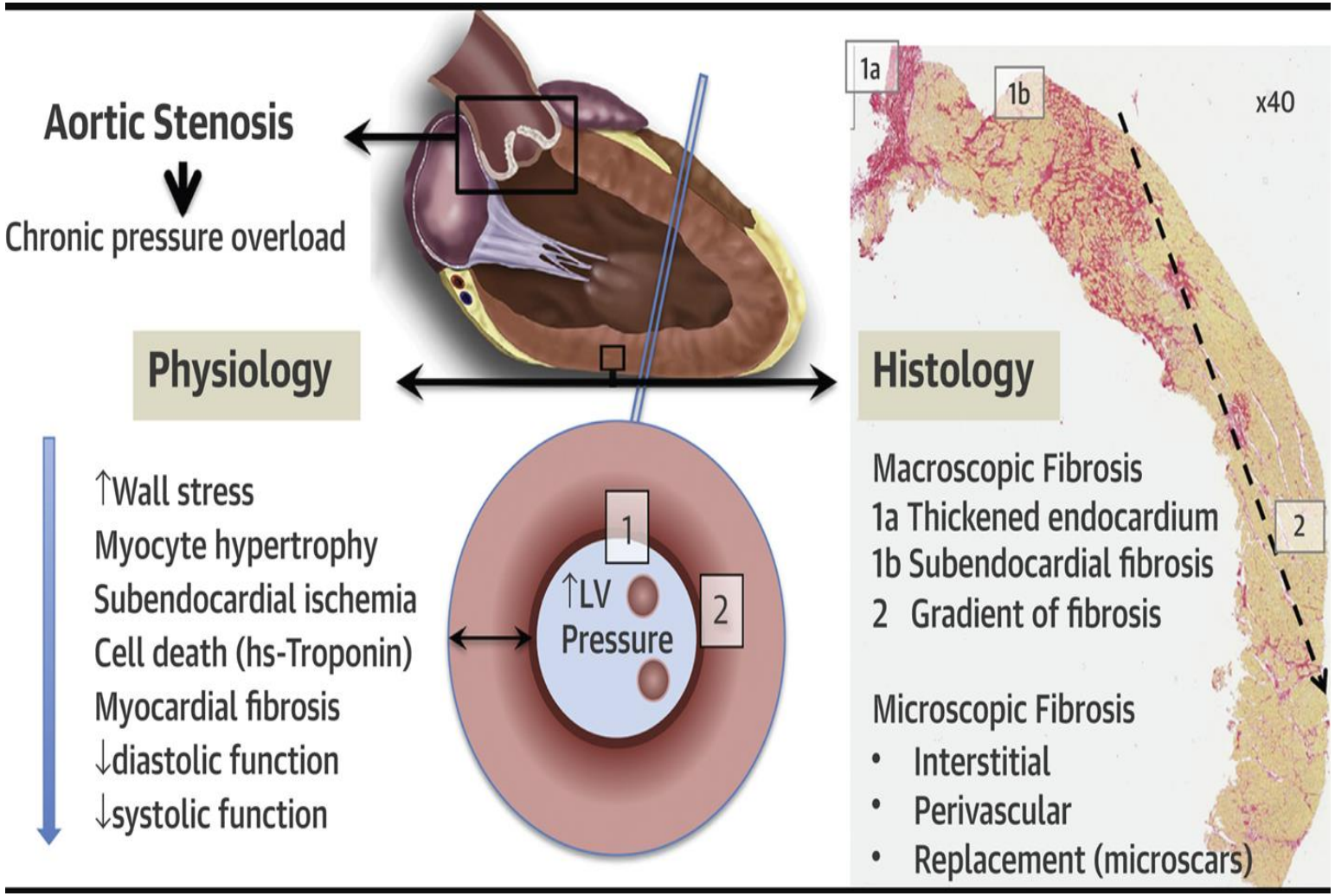
Symptoms

- The classic symptoms due to AS are **heart failure (HF), syncope, and angina.** However, these "classic" symptoms reflect **end-stage disease**.
- Now, with earlier diagnosis by echocardiography and prospective followup of patients, the most common presenting symptoms are:

1. Dyspnea on exertion or decreased exercise tolerance
2. Exertional dizziness
3. Exertional angina

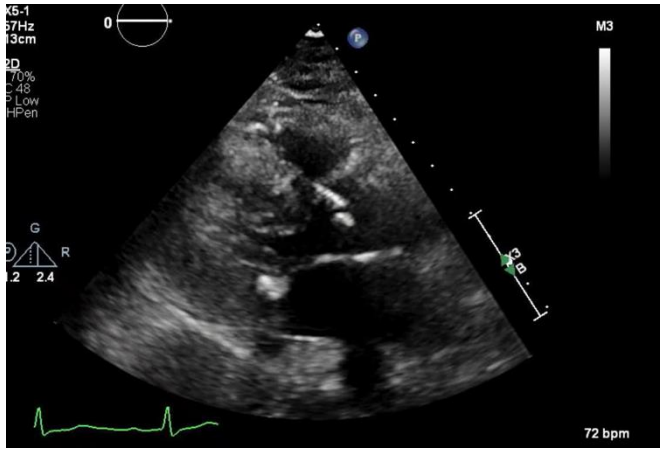
Physiologic sequalae

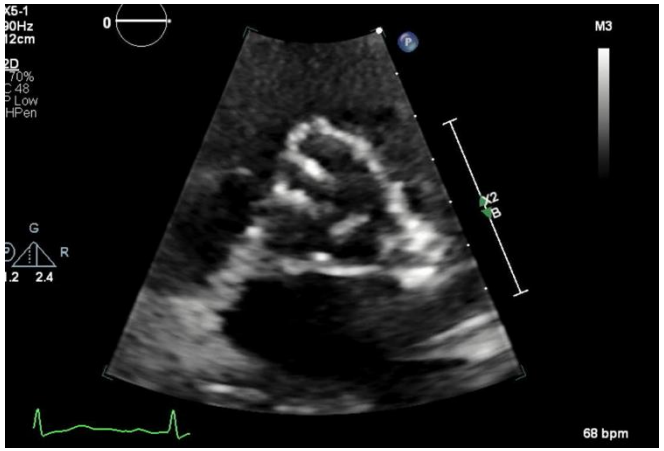


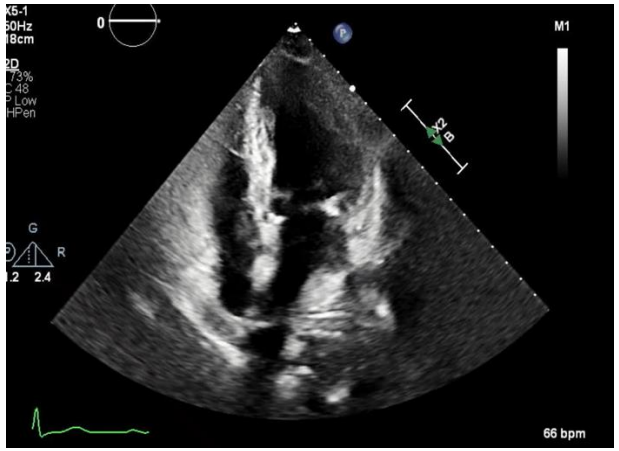
- LVH
- Reduction in coronary flow reserve
- Subendocardial ischemia
- Apoptosis
- Myocardial fibrosis (interstitial vs replacement)
- Diastolic dysfunction
- Pulmonary HTN
- Systolic dysfunction

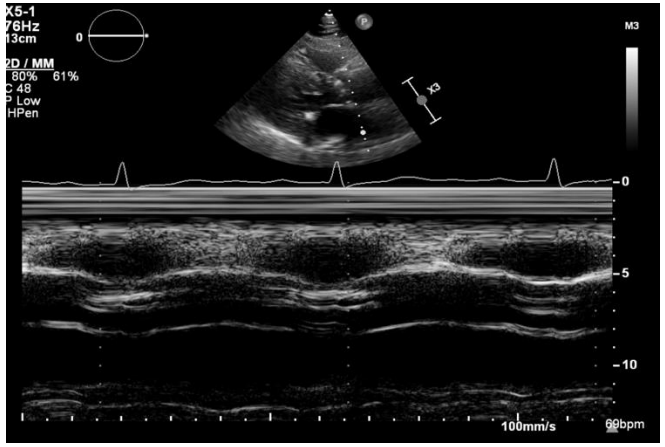
Treibel T, et al. J Am Coll Cardiol Img. 2019; 12 (8): 1532-48

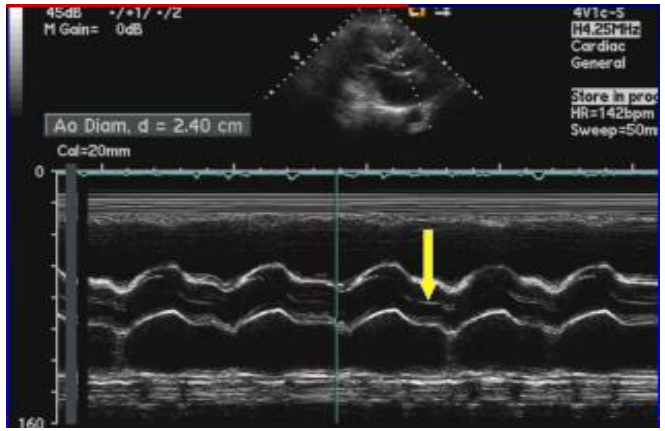
Echo evaluation











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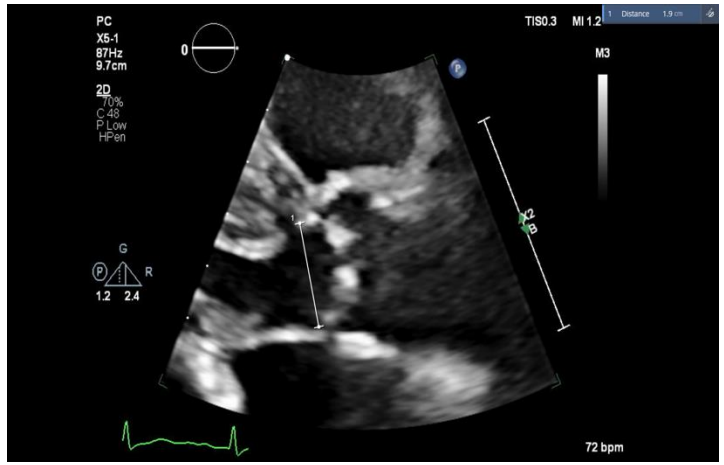
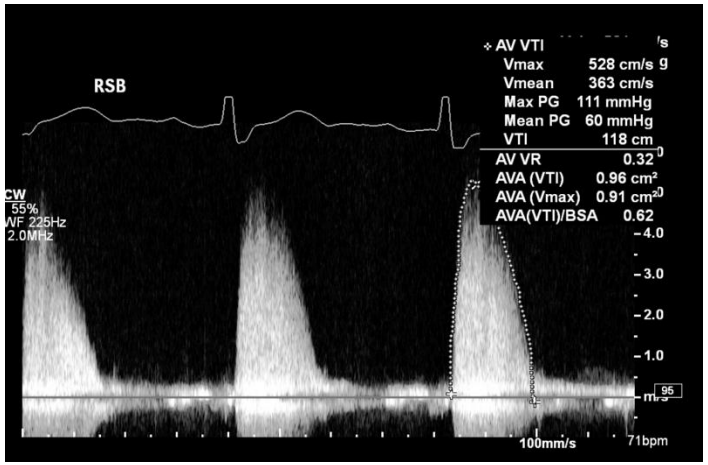
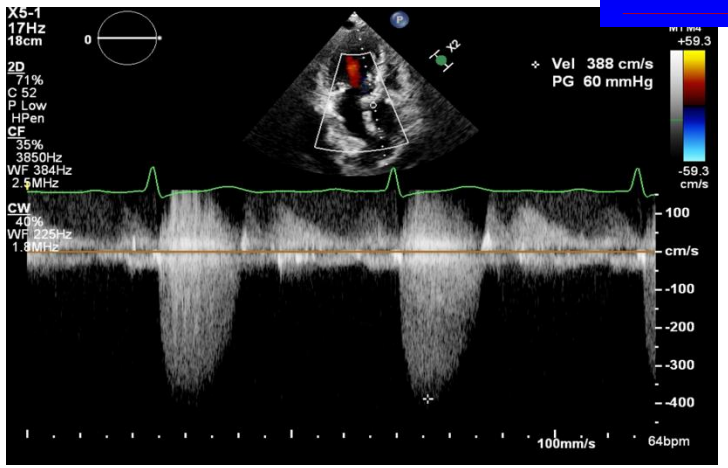
AVA

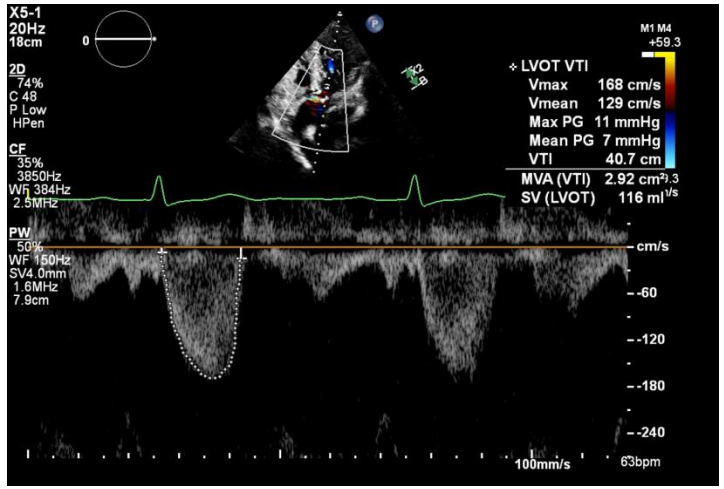
Calculating Aortic Valve Area

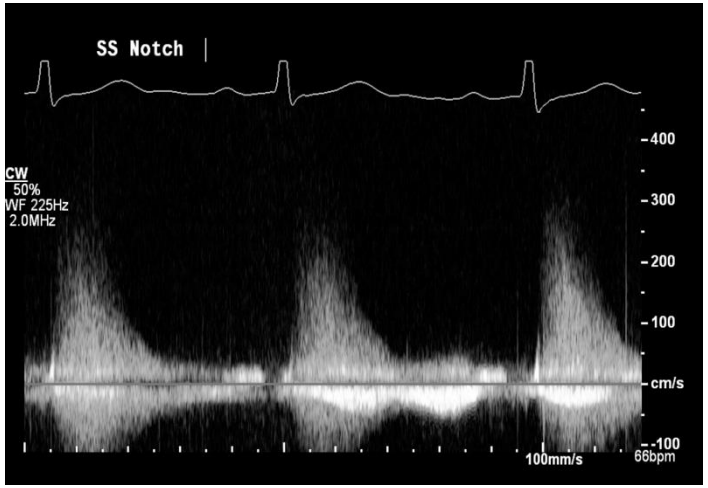
- $AVA = \frac{(Diameter_{LVOT} / 2)^2 \times \pi \times VTI_{LVOT}}{VTI_{AV}}$
- $AVA = \frac{(2.1\ cm / 2)^2 \times 3.14 \times 19\ cm}{85\ cm}$
- **AVA = 0.7 cm²**

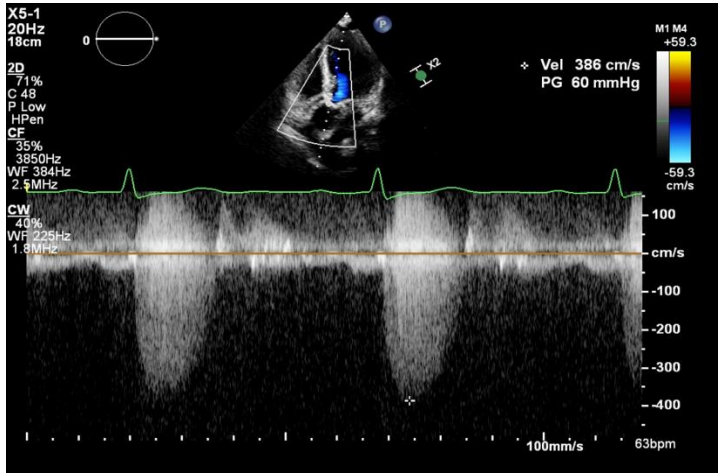












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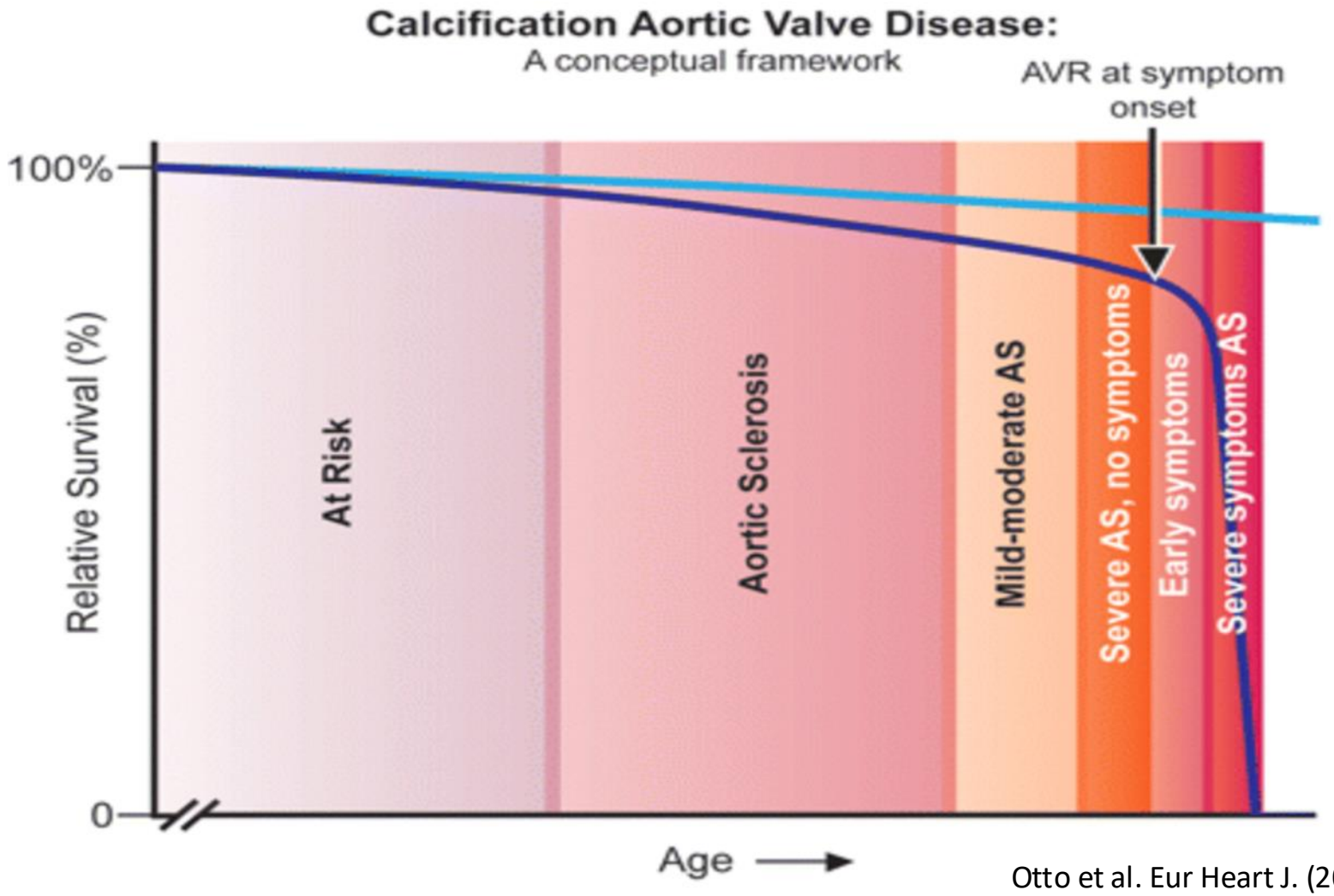
Severity grading

	Aortic sclerosis	Mild	Moderate	Severe
Peak velocity (m/s)	≤2.5 m/s	2.6–2.9	3.0–4.0	≥4.0
Mean gradient (mmHg)	–	<20	20–40	≥40
AVA (cm^2)	–	> 1.5	1.0–1.5	<1.0
Indexed AVA (cm^2/m^2)	–	>0.85	0.60–0.85	<0.6
Velocity ratio	–	> 0.50	0.25–0.50	<0.25

Very severe/ critical AS: Peak velocity > 5.0 m/s



Otto et al. Eur Heart J. (2009), 30 (16), 1940-2

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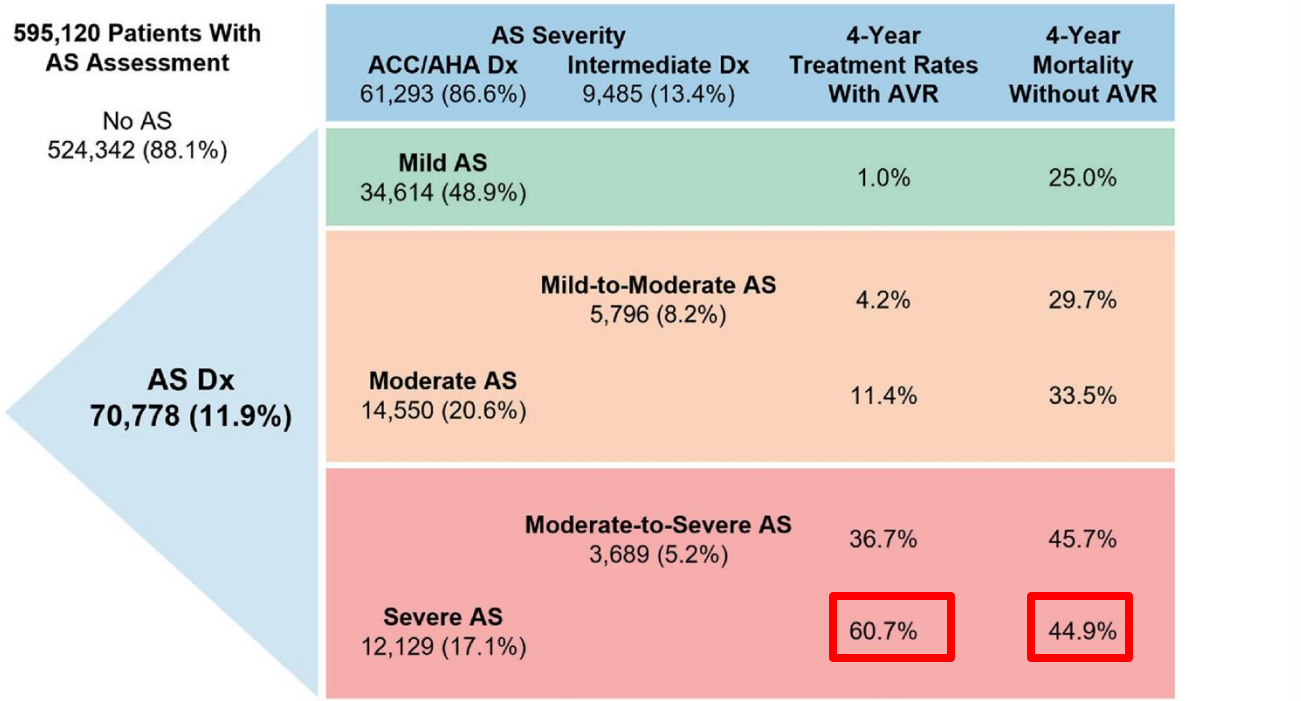
Mortality associated with untreated aortic stenosis

CENTRAL ILLUSTRATION: Mortality Associated With Untreated Aortic Stenosis



Généreux P, et al. J Am Coll Cardiol. 2023;82(22):2101-2109.

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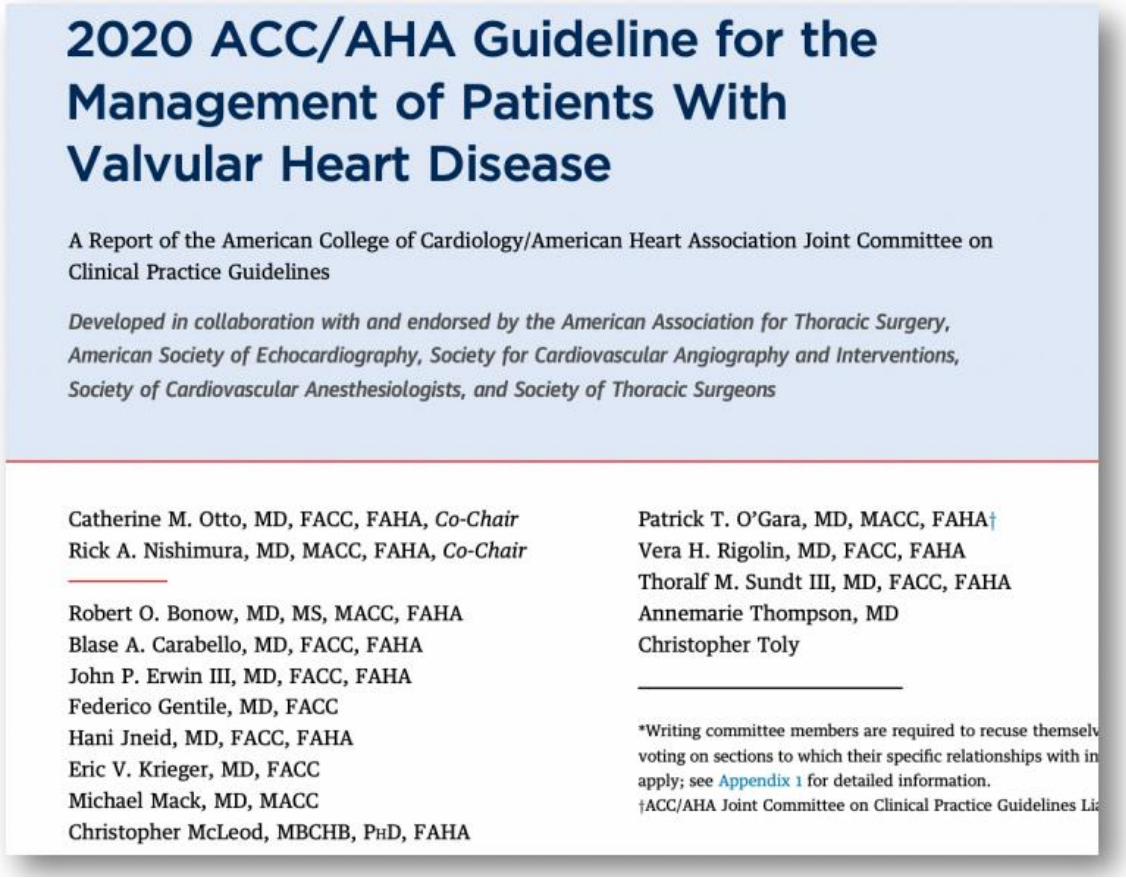
ACC/AHA guidelines



2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease

A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Developed in collaboration with and endorsed by 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

Catherine M. Otto, MD, FACC, FAHA, *Co-Chair*
Rick A. Nishimura, MD, MACC, FAHA, *Co-Chair*

Robert O. Bonow, MD, MS, MACC, FAHA
Blase A. Carabello, MD, FACC, FAHA
John P. Erwin III, MD, FACC, FAHA
Federico Gentile, MD, FACC
Hani Jneid, MD, FACC, FAHA
Eric V. Krieger, MD, FACC
Michael Mack, MD, MACC
Christopher McLeod, MBCHB, PHD, FAHA

Patrick T. O'Gara, MD, MACC, FAHA†
Vera H. Rigolin, MD, FACC, FAHA
Thoralf M. Sundt III, MD, FACC, FAHA
Annemarie Thompson, MD
Christopher Toly

*Writing committee members are required to recuse themselv
voting on sections to which their specific relationships with in
apply; see Appendix 1 for detailed information.
†ACC/AHA Joint Committee on Clinical Practice Guidelines Li

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Clinical stage of AS

STAGE	VALVE ANATOMY	VALVE HEMODYNAMICS	SYMPTOMS
A At risk of AS	• Bicuspid aortic valve or other congenital valve anomaly • Aortic valve sclerosis	• Aortic V_{max} <2 m/s with normal leaflet motion	None
B Progressive AS	• Mild to moderate leaflet calcification • Fibrosis of a bicuspid or trileaflet valve with reduction in systolic motion • Rheumatic valve changes with commissural fusion	• **Mild AS:** V_{max} 2-2.9 m/s or mean ΔP <20 mmHg • **Moderate AS:** V_{max} 3-3.9 m/s or mean ΔP 20-39 mmHg	None
C Asymptomatic Severe AS	• **C1:** Asymptomatic severe AS • **C2:** Asymptomatic severe AS with left ventricular systolic dysfunction (LVEF <50%) • **Both C1 and C2 may show:** – Severe leaflet calcification/fibrosis – Congenital stenosis with severely reduced leaflet opening	• **C1 and C2:** V_{max} ≥4 m/s or mean ΔP ≥40 mmHg, AVA typically ≤1 cm^2 (or AVAi 0.6 cm^2/m^2) but not required to define severe AS • **Very severe AS:** V_{max} ≥5 m/s or mean ΔP ≥60 mmHg	**C1:** None; exercise testing reasonable to confirm symptom status **C2:** None
D Symptomatic Severe AS	• **D1:** Symptomatic severe high-gradient AS • **D2:** Symptomatic severe low-flow low-gradient AS with reduced LVEF (<50%) • **D3:** Symptomatic severe low-gradient AS with normal LVEF (>50%) or paradoxical low-flow severe AS • **D1, D2, and D3 may show:** – Severe leaflet calcification/fibrosis with reduced leaflet motion	• **D1:** V_{max} ≥4 m/s or mean ΔP ≥40 mmHg, AVA typically ≤1 cm^2 (or AVAi 0.6 cm^2/m^2) but may be larger with mixed AS/AR • **D2:** AVA ≤1 cm^2 with V_{max} <4 m/s or mean ΔP <40 mmHg; dobutamine stress echocardiography shows AVA ≤1 cm^2 with V_{max} ≥4 m/s at any flow rate • **D3:** AVA ≤1 cm^2 with V_{max} <4 m/s or mean ΔP <40 mmHg AND stroke volume index <35 mL/m^2 measured in a normotensive patient	Exertional dyspnea, angina, syncope or presyncope, heart failure, exercise intolerance

Abbreviations: AR indicates aortic regurgitation; AS aortic stenosis; AVA, aortic valve area circulation; AVAi, aortic valve area indexed to body surface area; LVEF, left ventricular ejection fraction; ΔP, pressure gradient between the left ventricle and aorta; and V_{max}, maximum velocity.

American Heart Association.

Otto, CM et al. 2020 ACC/AHA. Guideline for the Management of Patients With Valvular Heart Disease *Circulation*.

Clinical Stage	Definition	
A	At Risk	
B	Progressive Mild/Moderate	
C	Asymptomatic Severe	
	C1	Normal LVEF ≥ 50%
	C2	Abnormal LVEF < 50%
D	Symptomatic Severe	
	D1	Severe High Gradient
	D2	Low Flow/Low Gradient EF < 50%
	D3	Low Flow/Low Gradient EF ≥ 50%

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Patient

- LVEF 68%, peak velocity 4.5 m/s, mean gradient 54 mmHg, AVA 0.7cm2

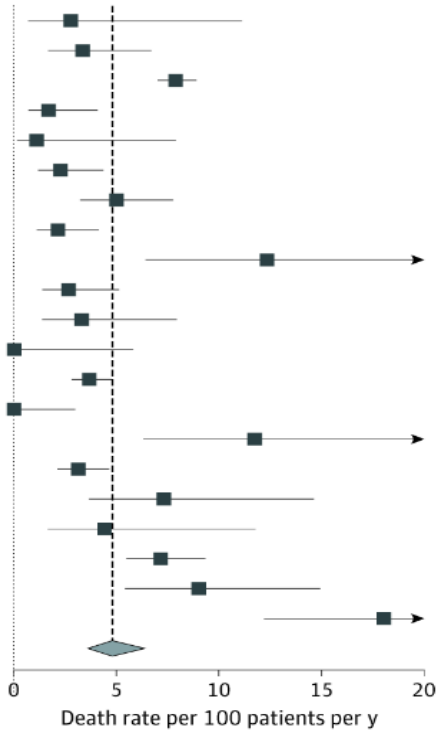
No symptoms

Stage C1

Natural History of Asymptomatic Severe Aortic Stenosis treated conservatively

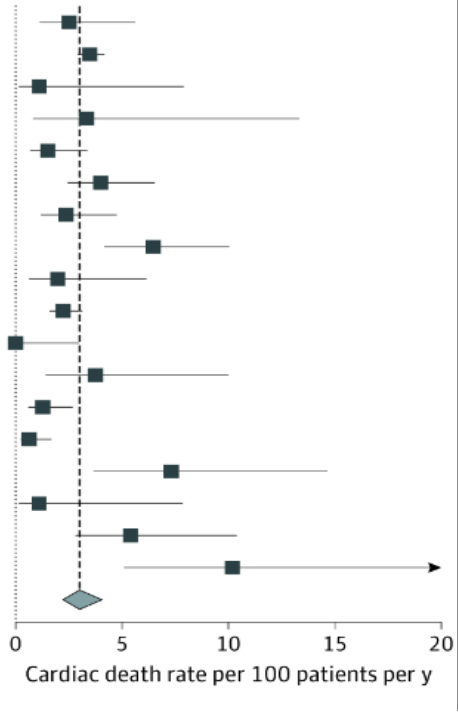
A All-cause death

Source	No. of deaths/ No. of patients	Death rate
Pierri et al,[41] 2000	2/72	2.8 (0.7-11.1)
Rosenhek et al,[42] 2000	8/239	3.4 (1.7-6.7)
Pellikka et al,[50] 2005	265/3359	7.9 (7.0-8.9)
Weisenberg et al,[37] 2008	5/295	1.7 (0.7-4.1)
Hristova-Antova et al,[35] 2009	1/90	1.1 (0.2-7.9)
Rosenhek et al,[34] 2010	9/396	2.3 (1.2-4.4)
Cioffi et al,[33] 2011	20/400	5.0 (3.2-7.8)
Kitai et al,[32] 2011	9/418	2.2 (1.1-4.1)
Perera et al,[31] 2011	9/73	12.3 (6.4-23.7)
Lancellotti et al,[30] 2012	9/338	2.7 (1.4-5.1)
Yingchoncharoen et al,[28] 2012	5/151	3.3 (1.4-7.9)
Cho et al,[27] 2013	0/52	0 (0-5.8)
Jander et al,[24] 2014	56/1523	3.7 (2.8-4.8)
Levy et al,[26] 2014	0/100	0 (0-3.0)
Zuern et al,[25] 2014	10/85	11.7 (6.3-21.8)
Maréchaux et al,[20] 2016	25/796	3.1 (2.1-4.6)
Todaro et al,[22] 2016	8/109	7.3 (3.7-14.6)
Christensen et al,[17] 2017	4/90	4.4 (1.7-11.8)
González Gómez et al,[16] 2017	54/755	7.2 (5.5-9.3)
Zilberszac et al,[18] 2017	15/167	9.0 (5.4-14.9)
Suzuki et al,[14] 2018	25/139	18.0 (12.2-26.7)
Overall: $\tau^2 = 0.29$; 95% PI, 1.5-15.5		4.8 (3.6-6.4)



B Cardiac death

Source	No. of cardiac deaths/No. of patients	Death rate
Rosenhek et al,[42] 2000	6/239	2.5 (1.1-5.6)
Pellikka et al,[40] 2005	117/3359	3.5 (2.9-4.2)
Hristova-Antova et al,[35] 2009	1/90	1.1 (0.2-7.9)
Lafitte et al,[36] 2009	2/60	3.3 (0.8-13.3)
Rosenhek et al,[34] 2010	6/396	1.5 (0.7-3.4)
Cioffi et al,[33] 2011	16/400	4.0 (2.5-6.5)
Lancellotti et al,[30] 2012	8/338	2.4 (1.2-4.7)
Saito et al,[29] 2012	20/309	6.5 (4.2-10.0)
Yingchoncharoen et al,[28] 2012	3/151	2.0 (0.6-6.1)
Jander et al,[24] 2014	34/1523	2.2 (1.6-3.1)
Levy et al,[26] 2014	0/100	0 (0-3.0)
Nagata et al,[23] 2015	4/107	3.8 (1.4-10.0)
Nishimura et al,[19] 2016	7/548	1.3 (0.6-2.7)
Shibayama et al,[21] 2016	4/633	0.6 (0.2-1.7)
Todaro et al,[22] 2016	8/109	7.3 (3.7-14.6)
Christensen et al,[17] 2017	1/90	1.1 (0.2-7.8)
Zilberszac et al,[18] 2017	9/167	5.4 (2.8-10.4)
Wu et al,[15] 2018	8/79	10.2 (5.1-20.4)
Overall: $\tau^2 = 0.24$; 95% PI, 1.0-8.8		3.0 (2.2-4.1)



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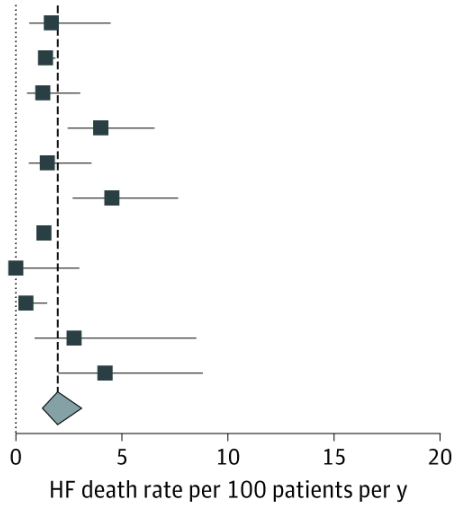
C HF death

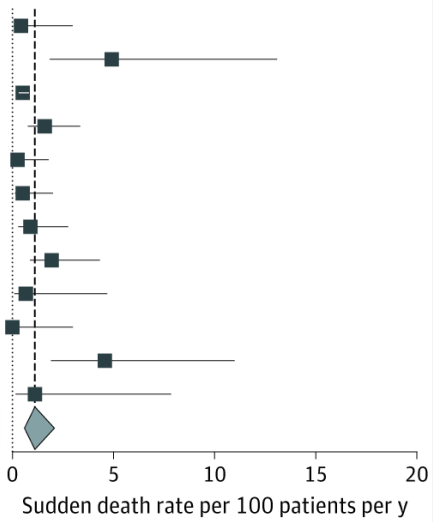
Source	No. of HF deaths/ No. of patients	Death rate
Rosenhek et al,[42] 2000	4/239	1.7 (0.6-4.5)
Pellikka et al,[50] 2005	47/3359	1.4 (1.1-1.9)
Rosenhek et al,[34] 2010	5/396	1.3 (0.5-3.0)
Cioffi et al,[32] 2011	16/400	4.0 (2.5-6.5)
Lancellotti et al,[30] 2012	5/338	1.5 (0.6-3.6)
Saito et al,[29] 2012	14/309	4.5 (2.7-7.7)
Yingchoncharoen et al,[28] 2012	2/151	1.3 (0.3-5.3)
Levy et al,[26] 2014	0/100	0 (0-3.0)
Shibayama et al,[21] 2016	3/633	0.5 (0.2-1.5)
Todaro et al,[22] 2016	3/109	2.7 (0.9-8.5)
Zilberszac et al,[18] 2017	7/167	4.2 (2.0-8.8)
Overall: $\tau^2 = 0.36$; 95% PI, 0.5-8.4		2.0 (1.3-3.1)



HF indicates heart failure; PI, prediction interval.

D Sudden death

Source	No. of sudden deaths/No. of patients	Death rate
Rosenhek et al,[42] 2000	1/239	0.4 (0.1-3.0)
Amato et al,[6] 2001	4/81	4.9 (1.8-13.1)
Pellikka et al,[50] 2005	17/3359	0.5 (0.3-0.8)
Avakian et al,[38] 2008	7/439	1.6 (0.8-3.3)
Rosenhek et al,[34] 2010	1/396	0.3 (0.0-1.8)
Cioffi et al,[33] 2011	2/400	0.5 (0.1-2.0)
Lancellotti et al,[30] 2012	3/338	0.9 (0.3-2.8)
Saito et al,[29] 2012	6/309	1.9 (0.9-4.3)
Yingchoncharoen et al,[28] 2012	1/151	0.7 (0.1-4.7)
Levy et al,[26] 2014	0/100	0 (0-3.0)
Todaro et al,[22] 2016	5/109	4.6 (1.9-11.0)
Christensen et al,[17] 2017	1/90	1.1 (0.2-7.8)
Overall: $\tau^2 = 0.73$; 95% PI, 0.1-8.5		1.1 (0.6-2.1)



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- Patients with asymptomatic severe aortic stenosis have deaths that are mostly cardiac but not only sudden

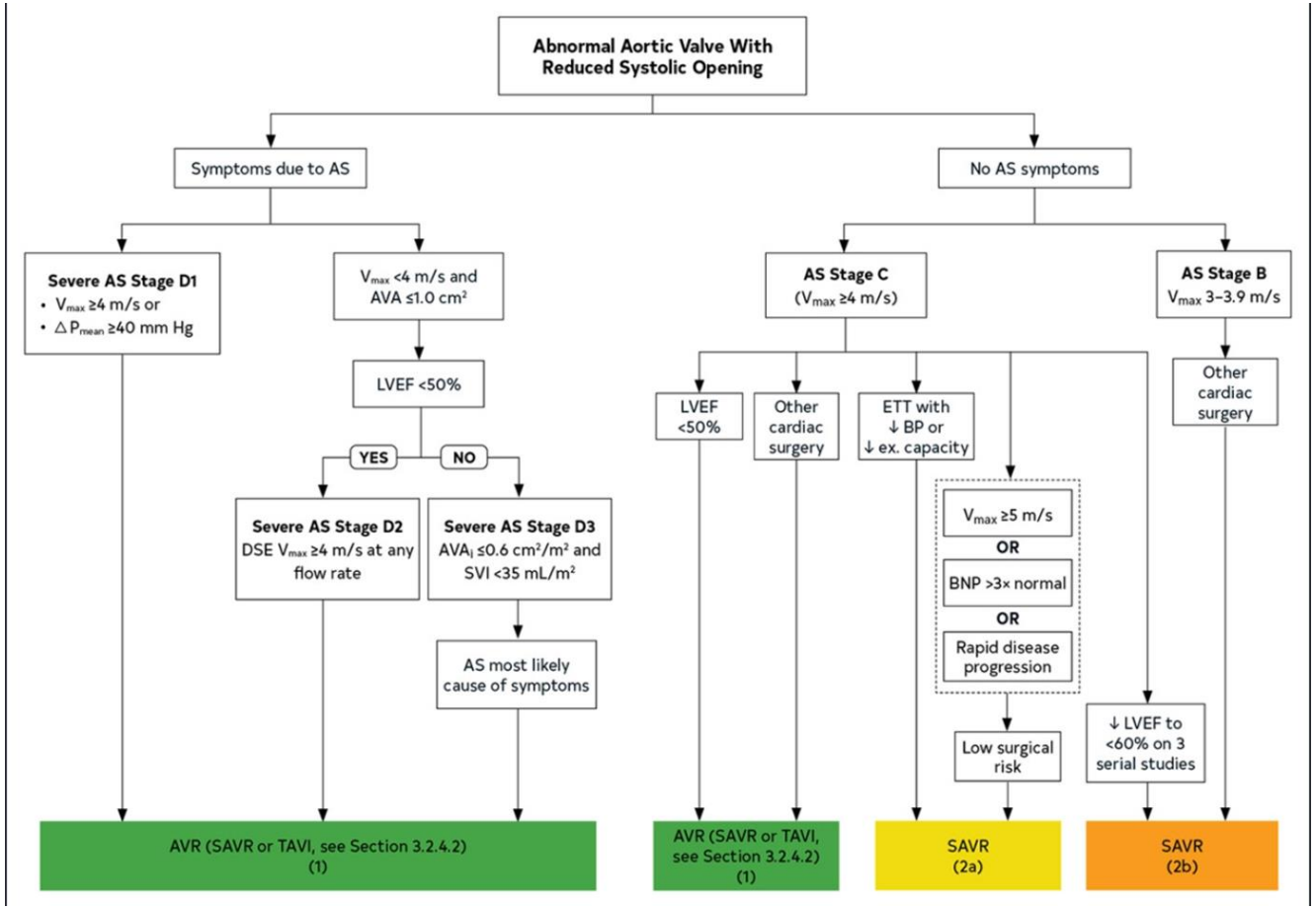
Goals of therapy

–Alleviate symptoms

–Reduce risk for heart failure

–Prolong life

Aortic stenosis management guidelines



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Patient

- LVEF 68%, peak velocity 4.5 m/s, mean gradient 54 mmHg, AVA 0.7cm2
- No planned cardiac surgery

No class 1 indication for AVR

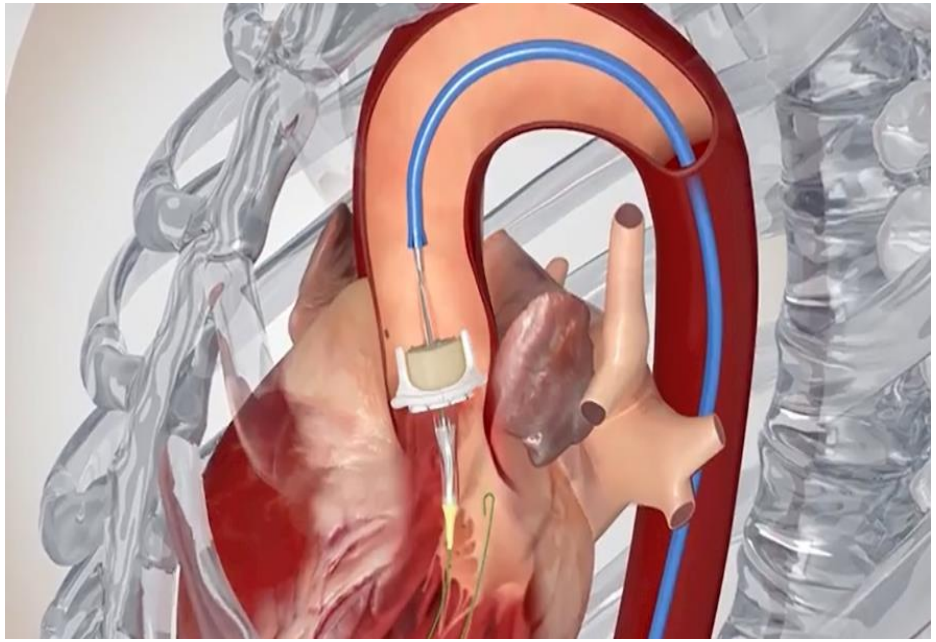
- Risk stratification tools

Patient

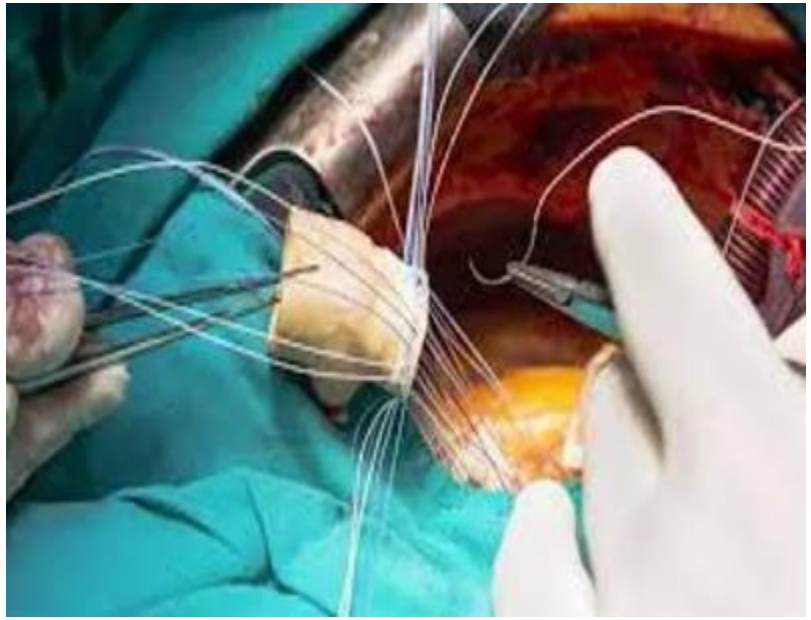
- No ETT : Degenerative OA hip
- BNP: < 3x ULN
- 6-month F/U: No significant echo changes, mild dyspnea with 1 mile walk
- TAVR performed

TAVR vs SAVR

TAVR



SAVR



TAVR vs SAVR

	Favors SAVR	Favors TAVI	Favors Palliation
Noncardiac conditions		• Severe lung, liver, or renal disease • Mobility issues (high procedural risk with sternotomy)	• Symptoms likely attributable to noncardiac conditions • Severe dementia • Moderate to severe involvement of ≥2 other organ systems
Frailty	• Not frail or few frailty measures	• Frailty likely to improve after TAVI	• Severe frailty unlikely to improve after TAVI
Estimated procedural or surgical risk of SAVR or TAVI	• SAVR risk low • TAVI risk high	• TAVI risk low to medium • SAVR risk high to prohibitive	• Prohibitive SAVR risk (>15%) or post-TAVI life expectancy <1 year
Procedure-specific impediments	• Valve anatomy, annular size, or low coronary ostial height precludes TAVI • Vascular access does not allow transfemoral TAVI	• Previous cardiac surgery with at-risk coronary grafts • Previous chest irradiation	• Valve anatomy, annular size, or coronary ostial height precludes TAVI • Vascular access does not allow transfemoral TAVI

AV management

- **Aortic balloon valvuloplasty** is useful in congenital aortic stenosis but is of **no value** in **older patients with calcific aortic stenosis.**

Gloria.Ayuba@utsouthwestern.edu

UT Southwestern
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