Valvular Heart Disease

ACP Board Review Course 7/16/26

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Key Points

- Aortic Stenosis
  - Severe: ≥4 m/s, ≥40 mmHg, AVA <1 cm^2
  - LFLG: small AVA, but not meeting other requirements for severe criteria -> DSE
  - Balloon valvuloplasty, medical therapy are not definitive treatments for AS
- Murmur patterns
- Mitral regurgitation
  - Repair preferred over replacement
- Intervention even w/o sx
  - Severe MR, EF <60%
  - Severe AR, EF <55%
  - Severe AS, EF <50%
- Clinical scenarios
  - MI -> acute severe MR
  - Acute AR -> avoid IABP, BB
- Prosthetic valves
  - Younger pts -> mechanical valves
  - Older pts -> bioprosthetic valves
  - Prosthetic valves need endocarditis ppx
  - Valve dysfxn/endocarditis -> TEE
  - Bridging (all mech MV, mech AV w/risk factors)
- Anticoagulation
  - Mechanical valves: warfarin
  - Mitral stenosis/Afib: warfarin

ABIM Exam Blueprint

– *High Relevance: Topics are very likely to appear on the assessment*

– *Medium Relevance: Topics are moderately likely to appear on the assessment*

– *Low Relevance: Topics will not appear on the assessment*

LF – ***Low Frequency***: *No more than 18% of questions will address topics with this designation, regardless of task or importance.*

CARDIOVASCULAR DISEASE *continued…* *(15% of exam)*	**Diagnosis/ Testing**	**Treatment/ Care Decisions**	**Risk Assessment/ Prognosis/ Epidemiology**	**Pathophysiology/ Basic Science**
VALVULAR HEART DISEASE *(<2% of exam)*				
Aortic stenosis	HIGH	HIGH	HIGH	MEDIUM
Aortic regurgitation	HIGH	MEDIUM	MEDIUM	MEDIUM
Mitral regurgitation	HIGH	HIGH	MEDIUM	MEDIUM
Mitral stenosis LF	HIGH	MEDIUM	MEDIUM	MEDIUM
Prosthetic heart valve	HIGH	HIGH	MEDIUM	MEDIUM

Outline

- Stages of valvular heart disease
- Aortic Stenosis/Mitral Stenosis
- Aortic Regurgitation/Mitral Regurgitation
- Treatment options for VHD
- Anticoagulation strategies
- Valve Surveillance
- Endocarditis
- Wrap-up

Stages of Valvular Heart Disease

TABLE 4 Stages of VHD

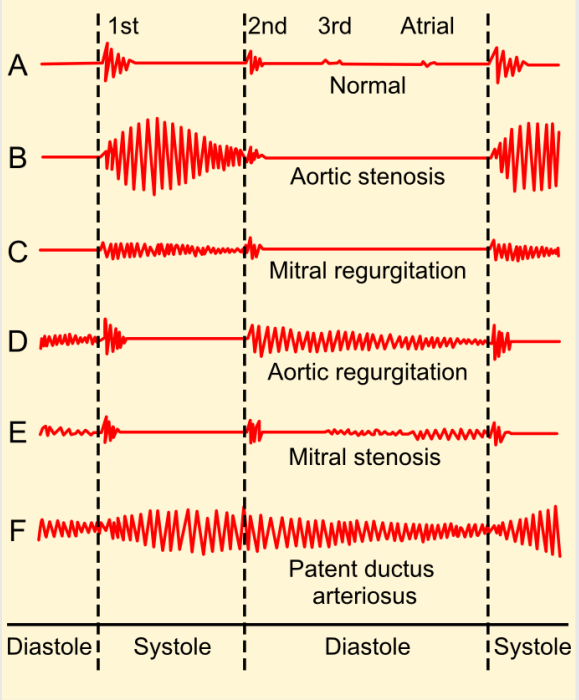
Stage	Definition	Description
A	At risk	Patients with risk factors for development of VHD
B	Progressive	Patients with progressive VHD (mild to moderate severity and asymptomatic)
C	Asymptomatic severe	Asymptomatic patients who have the criteria for severe VHD:
		C1: Asymptomatic patients with severe VHD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

LV indicates left ventricle; RV, right ventricle; and VHD, valvular heart disease.

Murmurs

- Aortic stenosis
  - Crescendo-decrescendo, RUSB, radiating to carotids
- Mitral regurgitation
  - Holosystolic, apex, radiating to axilla/back
- Mitral stenosis
  - Diastolic rumble, low-pitched, decrescendo, opening snap after S2
  - Apex
- Aortic regurgitation
  - Diastolic, decrescendo
  - LLSB, RLSB
  - Displaced apical impulse, bounding pulses
  - Wide pulse pressure
- Mitral Valve Prolapse
  - Mid-systolic click -> systolic murmur
- HOCM
  - Louder murmur w/valsalva
  - Softer murmur w/handgrip

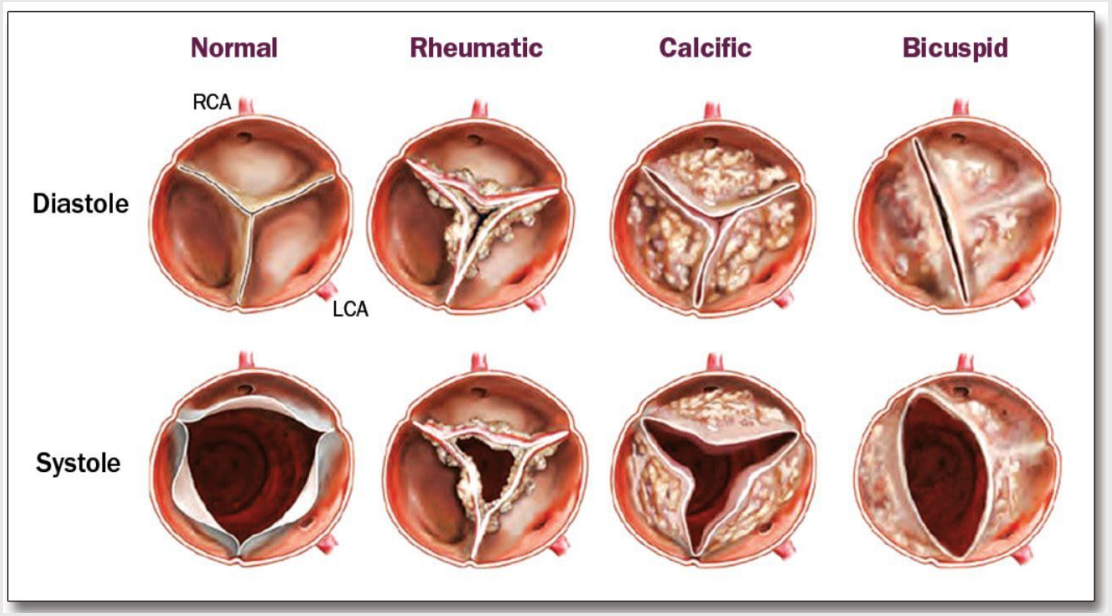
- Demographics
  - **Older pt** – think AS
  - **Younger pt** – consider BAV, rheumatic
  - **Hx Rheumatic fever** - MS



https://geekymedics.com/heart-murmurs/

Aortic/Mitral Stenosis

Aortic Stenosis



- Presentation
  - Crescendo/decrescendo murmur
  - Radiating to carotids
  - Signs of severe AS:
    - Late peaking, diminished S2
    - Paradoxical split S2
    - Pulsus parvus et tardus
- Demographic
  - Calcific AS older population
  - BAV younger population

Aortic Stenosis Stages

Stage	Definition	Valve Anatomy	Hemodynamics	Symptoms
A	At Risk for AS	Bicuspid Aortic Valve Aortic Sclerosis	Aortic V_{max} <2.0 m/sec	None
B	Progressive AS	Mild-moderate leaflet calcification with reduced systolic motion Rheumatic valve changes with commissural fusion	Mild AS - Aortic V_{max} 2.0 - 2.9 m/sec or mean ΔP <20 mm Hg Moderate AS - Aortic V_{max} 3.0 - 3.9 m/sec or mean ΔP 20 - 39 mm Hg	None
C Asymptomatic Severe AS				
C1	Asymptomatic Severe AS	Severe leaflet calcification with reduced opening	Aortic V_{max} ≥4.0 m/sec or mean ΔP ≥40 mm Hg AVA typically ≤1.0 cm^2, LVEF normal	None
C2	Asymptomatic Severe AS with reduced EF	Severe leaflet calcification with reduced opening	Aortic V_{max} ≥4.0 m/sec or mean ΔP ≥40 mm Hg AVA typically ≤1.0 cm^2, LVEF <50%	None
D Symptomatic Severe AS				
D1	Symptomatic severe high gradient AS	Severe leaflet calcification with reduced opening	Aortic V_{max} ≥4.0 m/sec or mean ΔP ≥40 mm Hg AVA typically ≤1.0 cm^2, LVEF normal	Decreased exercise tolerance Dyspnea on exertion Heart failure Angina Exertional presyncope Syncope
D2	Symptomatic severe low-flow, low-gradient AS with reduced LVEF	Severe leaflet calcification with reduced opening	Aortic V_{max} <4.0 m/sec or mean ΔP <40 mm Hg AVA ≤1.0 cm^2, LVEF <50%, DSE = Aortic V_{max} >4.0 m/sec, AVA <1.0 cm^2 at any flow rate	
D3	Symptomatic severe low-flow, low-gradient AS with normal LVEF	Severe leaflet calcification with reduced opening	Aortic V_{max} <4.0 m/sec or mean ΔP <40 mm Hg AVA ≤1.0 cm^2, Indexed AVA <0.6 cm^2/m^2, Stroke volume index <35 ml/m^2, LVEF ≥50%	

Stage A – At Risk
Stage B – Mild/moderate

Stage C 1 – severe, asx, preserved EF
Stage C 2 – severe, asx, reduced EF

Stage D1 – severe, sx, high gradient
Stage D2 – LFLG w/reduced EF
Stage D3 - LFLG w/preserved EF

Low Flow, Low Gradient AS

- Occurs when AVA <1 or suspicion for severe AS but Vmax, gradient do not meet criteria, and the EF is reduced.
- Need a strong pump in order to generate forward pressure
- If the pump fails, it cannot generate enough force to create a high pressure gradient
- How can we distinguish if the valve disease is the primary cause of the weak pump?

- Dobutamine stress echo
  - Make the heart pump stronger w/dobutamine.
  - If heart function improves and the gradient is still low then you know the valve is not the issue.
  - If heart function improves and now you have an elevated gradient then it is due to the valve
- Paradoxical LFLG AS
  - EF is preserved but still reduced stroke volume

Question 1

- 72 y/o man with pmh HTN, HLD presents with progressive dyspnea on exertion. He is on lisinopril 20mg at home. He has a blood pressure of 158/90. Physical exam is notable for a systolic 3/6 crescendo-decrescendo murmur radiating to the carotids. His echocardiogram shows EF of 60% with an aortic valve velocity of 4.1 m/s and a mean gradient of 44 mmHg. What's the next best step?

A. Surveillance, repeat echo in 6 mos to re-assess EF

B. Increase lisinopril

C. Refer for aortic valve replacement

D. Refer for balloon valvuloplasty, then re-check TTE

*No role for balloon valvuloplasty or medical therapy as definitive therapy for aortic stenosis.

Question 2

- 76 y/o man with pmh HLD, hypothyroidism, on atorvastatin 40mg daily who notes worsening shortness of breath w/climbing stairs over the last two months. Denies chest pain. His echocardiogram shows an EF of 35%, with a calcified aortic valve and a mean gradient of 36 mmHg. What is the next best step?

A. TEE to better assess valve and hemodynamics
B. Treadmill stress
C. Dobutamine stress echo
D. Surveillance, f/u in 6 mos

*Do not do treadmill stress test in severe symptomatic AS – can precipitate sudden cardiac death.

Prognosis in Severe Aortic Stenosis

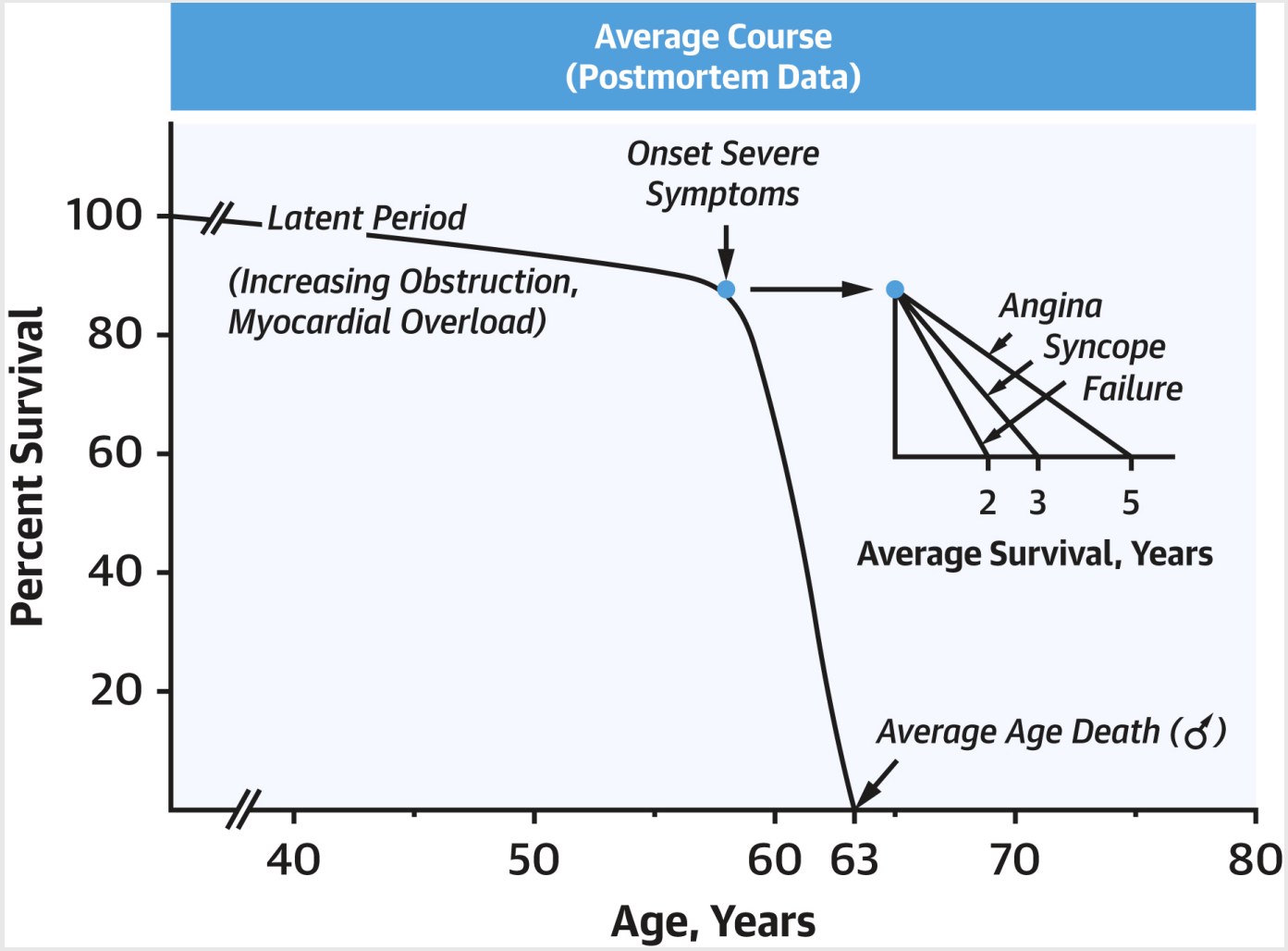
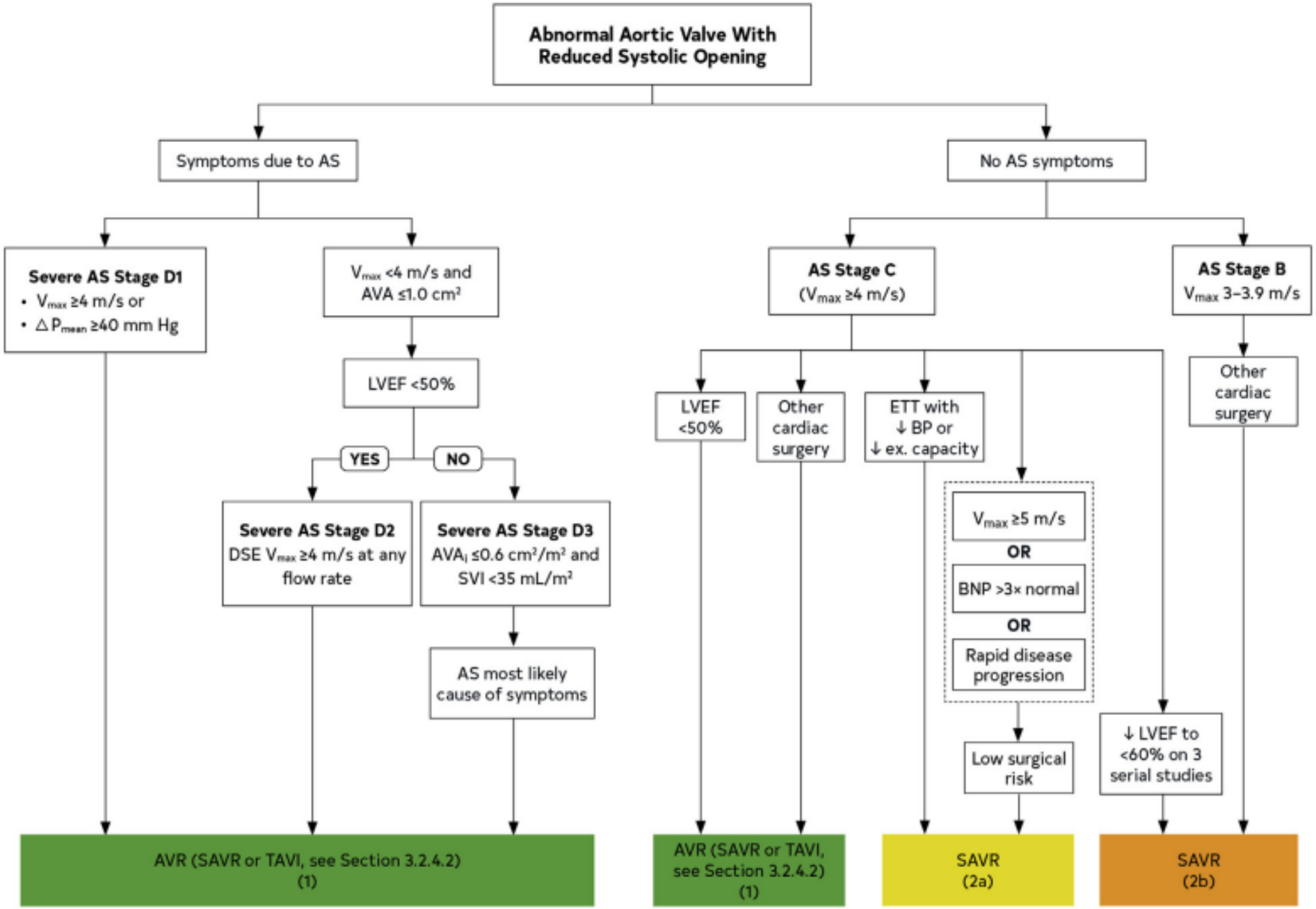


FIGURE 2 **Timing of intervention for AS**



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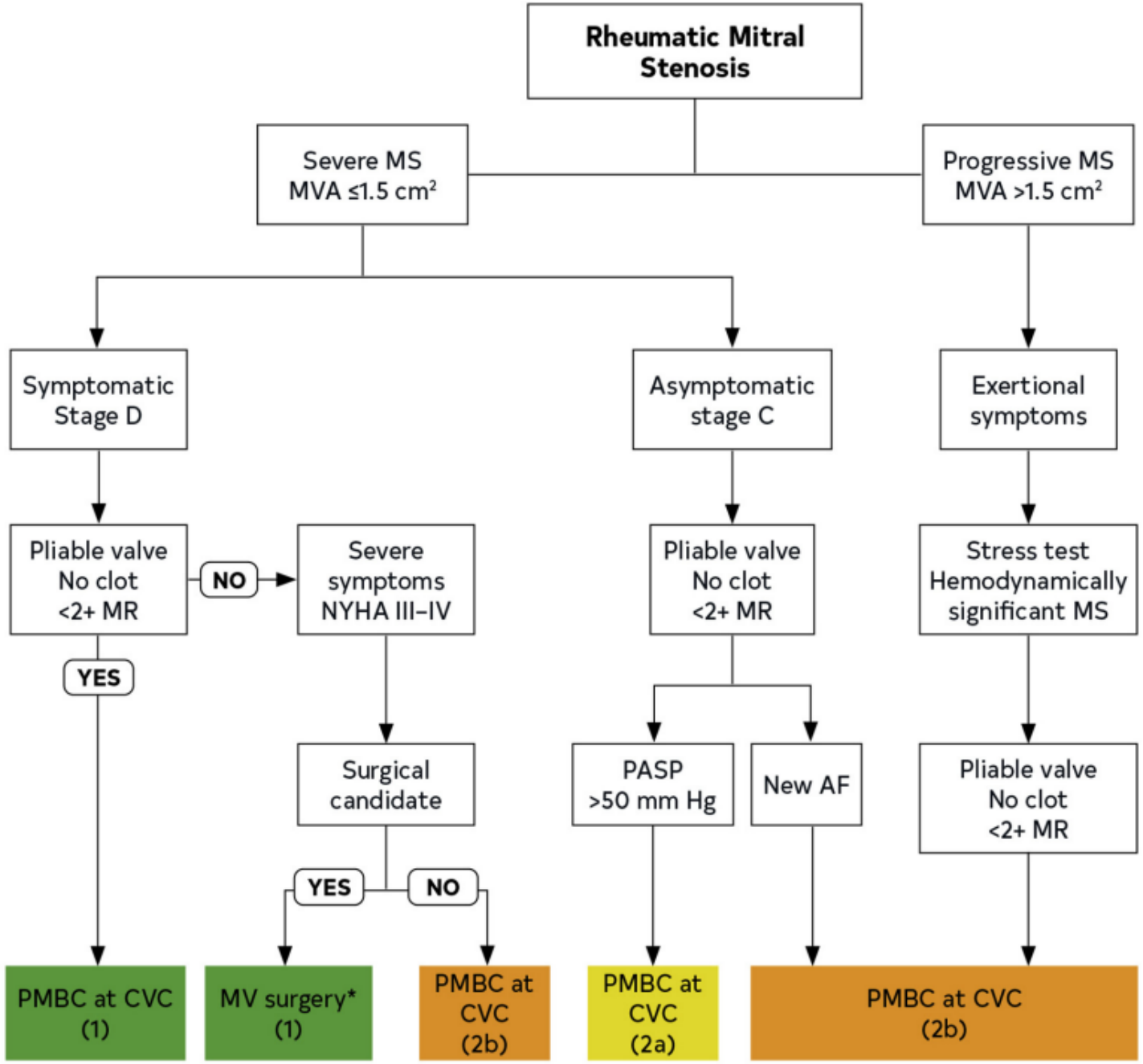
Mitral Stenosis

Mitral Stenosis

- Classification
  - Severe: Mitral valve area <1.5 cm^2
- Etiology
  - MCC: Rheumatic fever
    - Occurs 20-40 years after the illness
  - Can also be caused by calcific disease, prior valve intervention
- Treatment
  - Balloon commissurotomy
  - Wilkins score
  - Contraindications: concurrent MR, left atrial thrombus
  - Medical therapy: Heart rate control
  - Frequently with Afib
    - Need VKA for anticoagulant therapy, CHA2DS2VASc score is not applicable

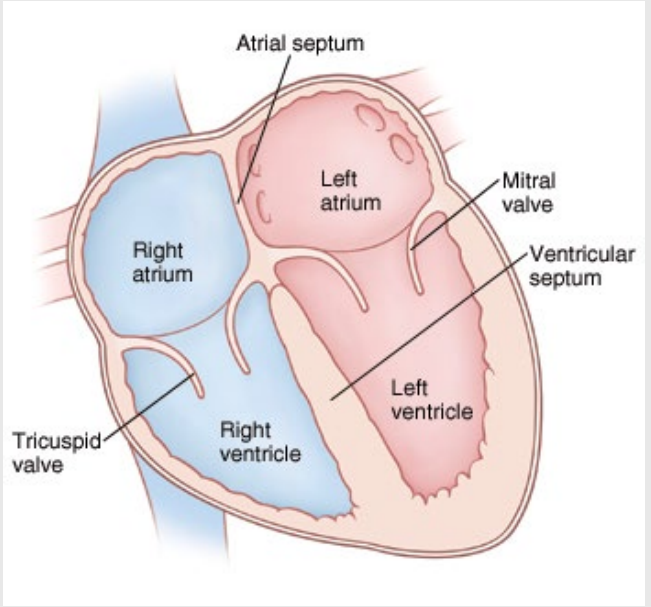
FIGURE 7 Intervention for MS



Question 3

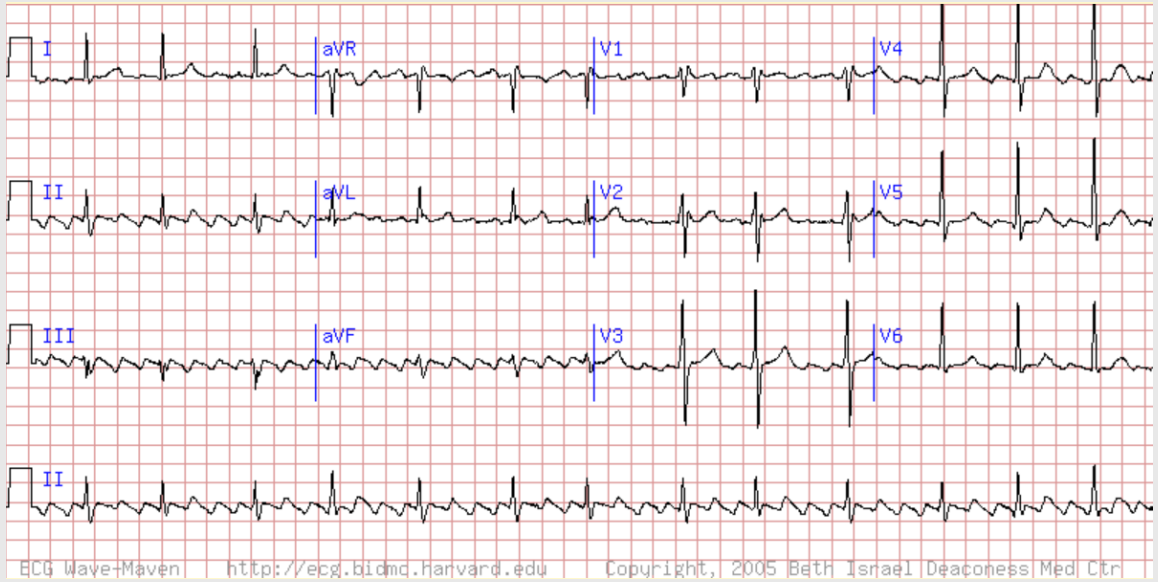
- 44 y/o with pmh rheumatic fever, stroke who presents for a first-time visit. She reports some shortness of breath with doing housework but is otherwise feeling well. Exam is notable for a facial droop, and an opening snap followed by diastolic rumble, best heard at the apex. What is the next best step?

A. Transthoracic echocardiogram
B. Transesophageal echocardiogram
C. Chest x-ray
D. MRI brain
E. 30d Remote monitor



Question 4

- 66 y/o woman with history of HTN, HLD, with a 2v CABG and left atrial appendage ligation 10 years ago presents to clinic with worsening lower extremity edema and shortness of breath. Her ECG is below. Her echo shows an EF of 65%, and a mitral valve with restricted leaflet motion and a mitral valve area of 1.0 cm^2. Her CHADSVASC is 4. What is the next best step?



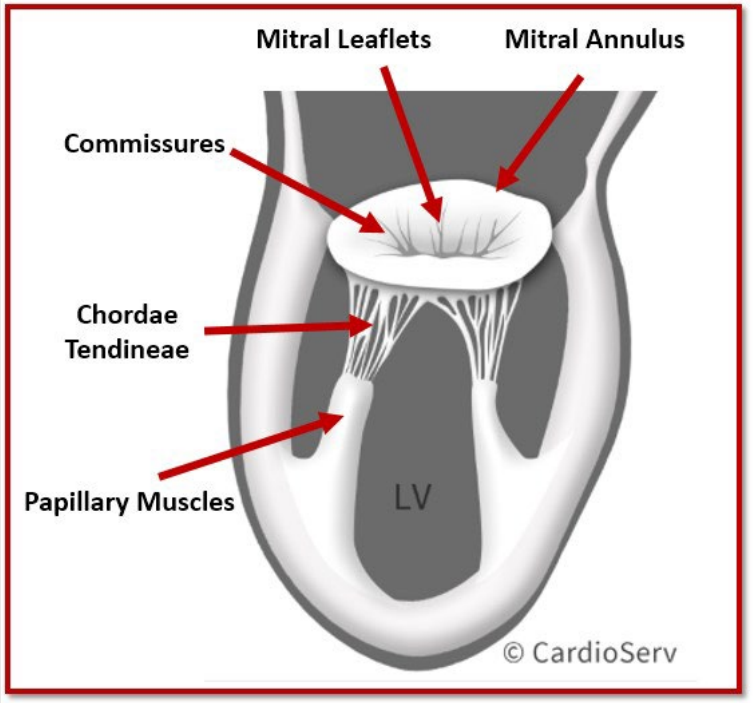
A. Start anticoagulation with apixaban
B. Start anticoagulation with warfarin
C. Check TEE
D. No anticoagulation is indicated as she has had a left atrial appendage ligation

Aortic/Mitral Regurgitation

Mitral Regurgitation

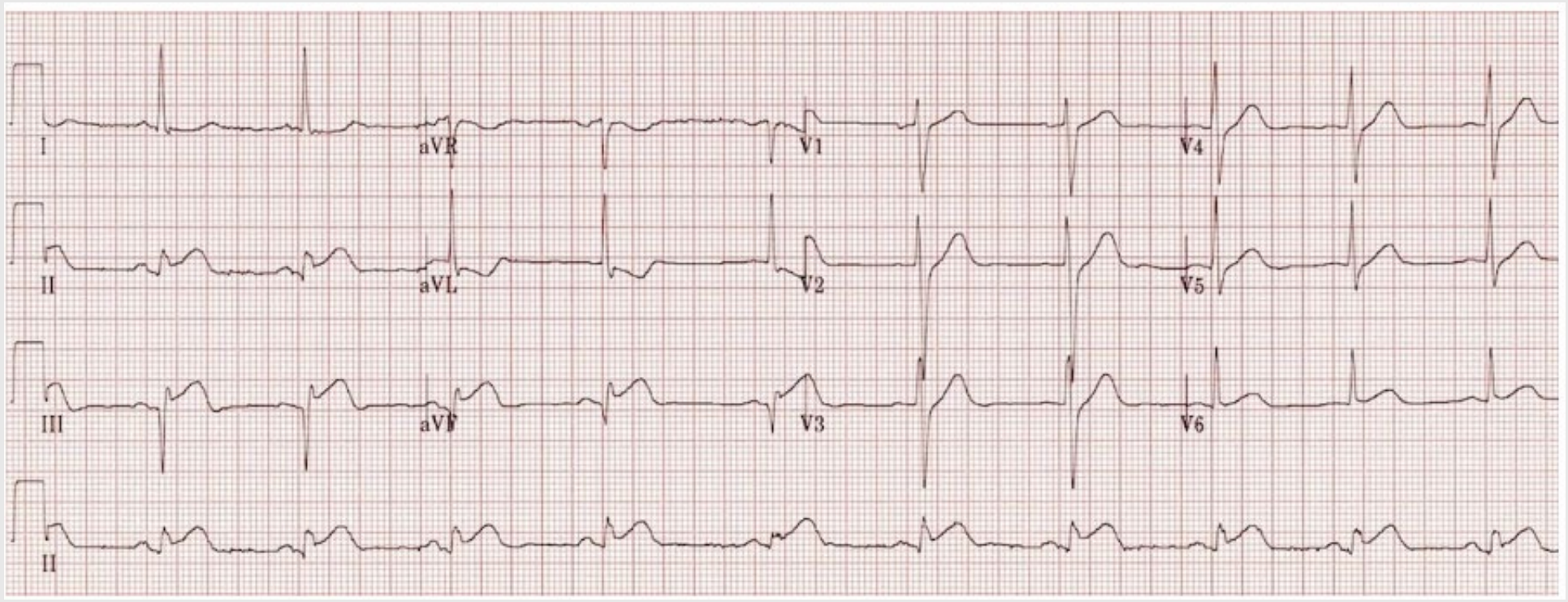
Mitral Regurgitation

- Etiology
  - Primary vs secondary
  - Common causes: ischemia, endocarditis, HCM, dilated LV
- Replacement indications
  - Symptoms
  - Asx with EF <60% or LVESD >40 mm
- In general, repair is preferred over replacement
  - Done surgically
  - M-TEER (e.g. Mitraclip) also an option in select cases (e.g. low EF, dilated LV)



Question 5

- A 68 y/o male with a 25 pack year smoking hx presents with chest pain. His ECG shows the following:



Question 5

- He is taken to the cath lab emergently where he has a 100% occlusion of the right coronary artery, for which he undergoes placement of a drug-eluting stent.
- On the day of discharge, he is noted to have increased work of breathing. Vitals are notable for an O2 sat of 88% on room air, BP 100/64, HR 102. Chest x-ray shows pulmonary edema. ECG shows q waves but no new ST segment elevations. What is the next best step?

A. CTA chest

B. BNP

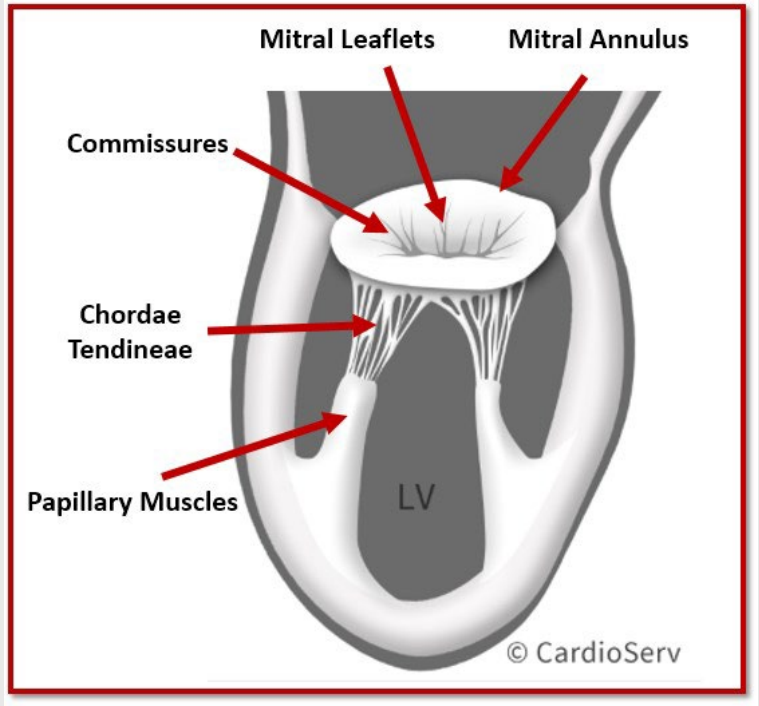
C. Echocardiogram

D. Tilt table test

Question 5

- The posterior mitral valve leaflet has only a single blood supply from the posterior coronary circulation (PDA) and is prone to rupture in the setting of ischemia
  - Anterior leaflet has dual blood supply (anterior and posterior) so is less vulnerable
  - Can present with acute pulmonary edema (may be unilateral) sometime after an acute MI.

- Acute MR vs VSD
  - VSD will have loud murmur, MR may not
  - MR will have pulmonary edema, VSD may not



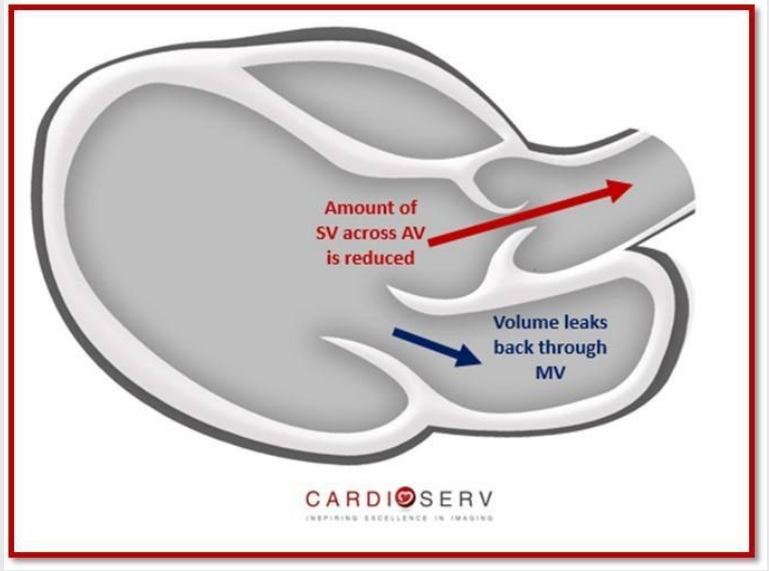
Question 6

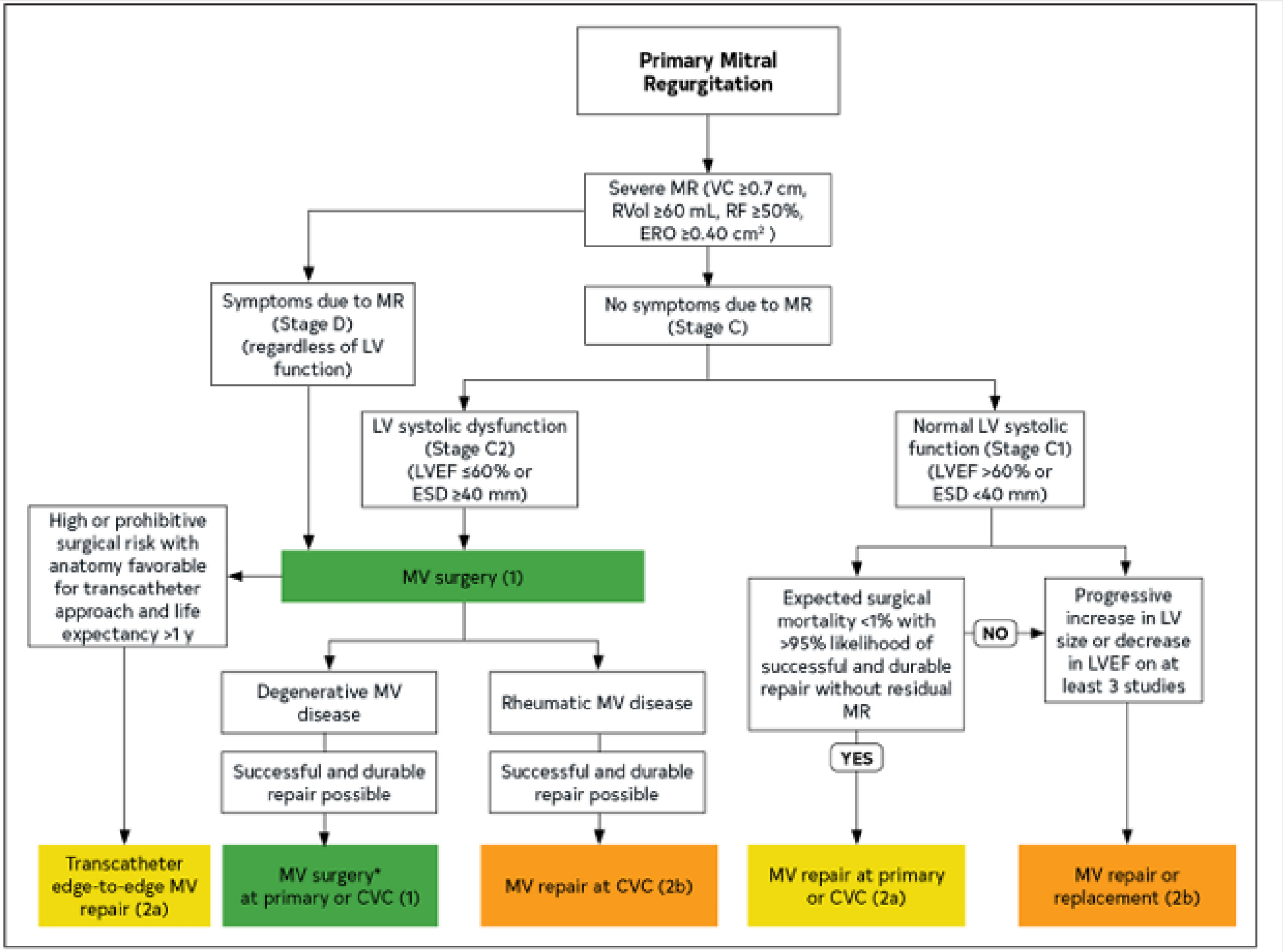
- A 77 y/o man with pmh HTN, HLD, non-obstructive CAD presents for worsening shortness of breath. Blood pressure is 156/88, HR 68. His exam is notable for a 2/6 holosystolic murmur at the apex. An echocardiogram shows severe mitral regurgitation, EF 65%. What is the next best step?

A. Start losartan
B. Start metoprolol
C. Transesophageal echo
D. Refer for mitral valve intervention

- Symptomatic, severe MR would warrant mitral valve intervention – regardless of EF

- Asx, severe MR would warrant intervention if EF <60%



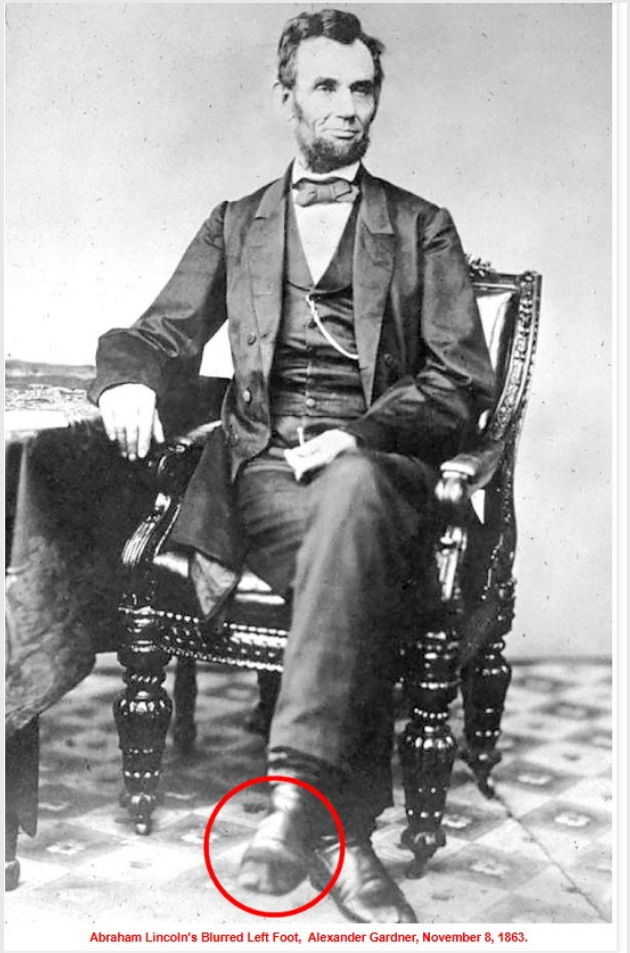

Primary Mitral Regurgitation
Severe MR (VC ≥0.7 cm, RVol ≥60 mL, RF ≥50%, ERO ≥0.40 cm²)
Symptoms due to MR (Stage D) (regardless of LV function)
No symptoms due to MR (Stage C)
LV systolic dysfunction (Stage C2) (LVEF ≤60% or ESD ≥40 mm)
Normal LV systolic function (Stage C1) (LVEF >60% or ESD <40 mm)
High or prohibitive surgical risk with anatomy favorable for transcatheter approach and life expectancy >1 y
MV surgery (1)
Degenerative MV disease
Rheumatic MV disease
Expected surgical mortality <1% with >95% likelihood of successful and durable repair without residual MR
NO
Progressive increase in LV size or decrease in LVEF on at least 3 studies
Successful and durable repair possible
Successful and durable repair possible
YES
Transcatheter edge-to-edge MV repair (2a)
MV surgery* at primary or CVC (1)
MV repair at CVC (2b)
MV repair at primary or CVC (2a)
MV repair or replacement (2b)

Aortic Regurgitation

Aortic Regurgitation

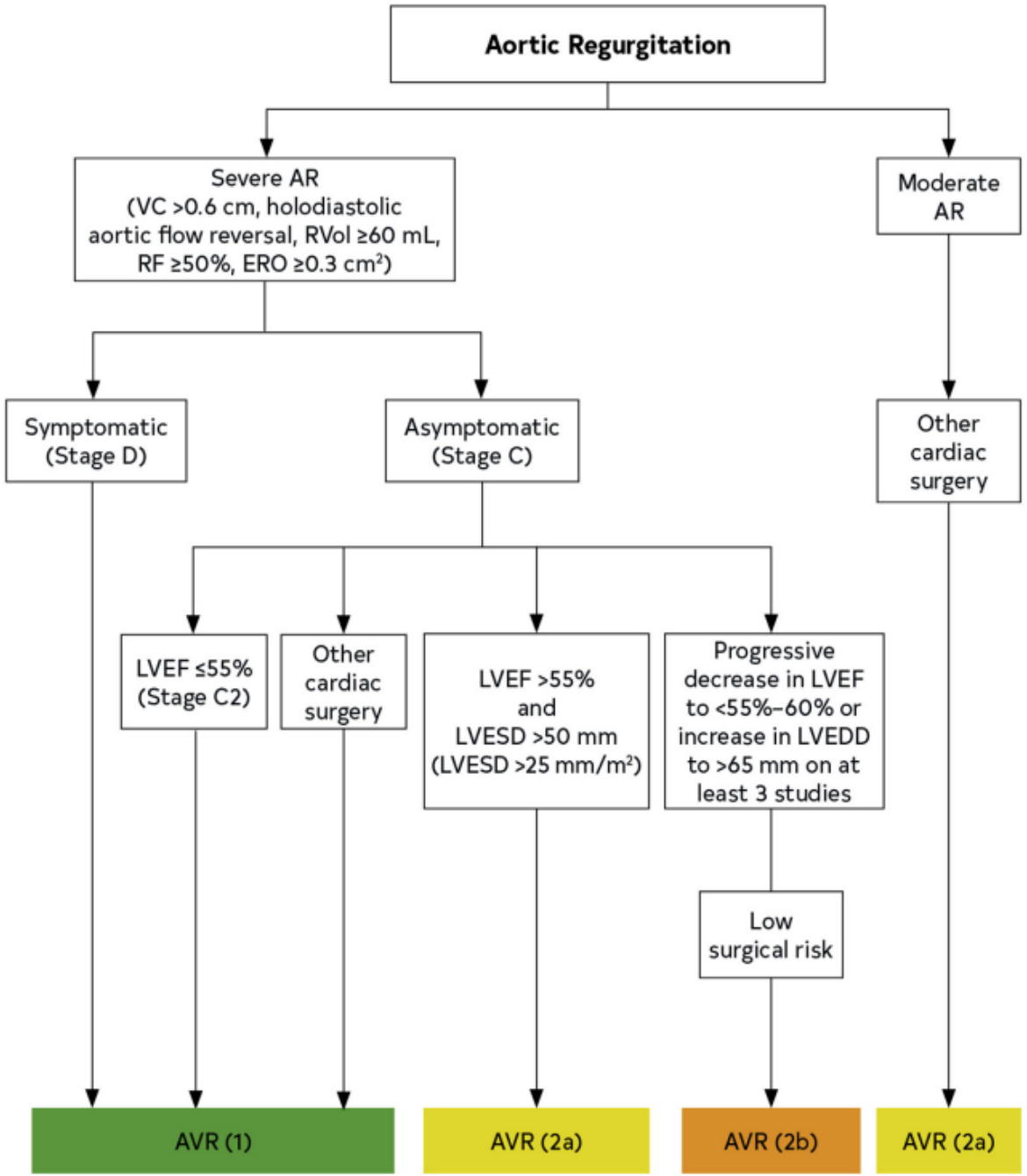
- Signs to look out for
  - Widened pulse pressure
  - Diastolic murmur after A2 along the LSB
  - LVH on ECG
  - Aortic root dilation, cardiomegaly on CXR
- Acute aortic regurgitation
  - Seen in dissection, endocarditis
  - Warrants emergent surgical intervention
  - Nitroprusside, IV diuretics can be used as adjunct
  - Avoid IABP, BB
- Chronic aortic regurgitation
  - Seen with ascending aortic aneurysm, HTN, BAV, rheumatic disease, Marfan's
  - Avoid beta blockers to limit time in diastole
  - Control blood pressure

- Lincoln Sign



Abraham Lincoln's Blurred Left Foot, Alexander Gardner, November 8, 1863.

FIGURE 4 Timing of intervention for AR



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Valve Interventions

Valve Interventions

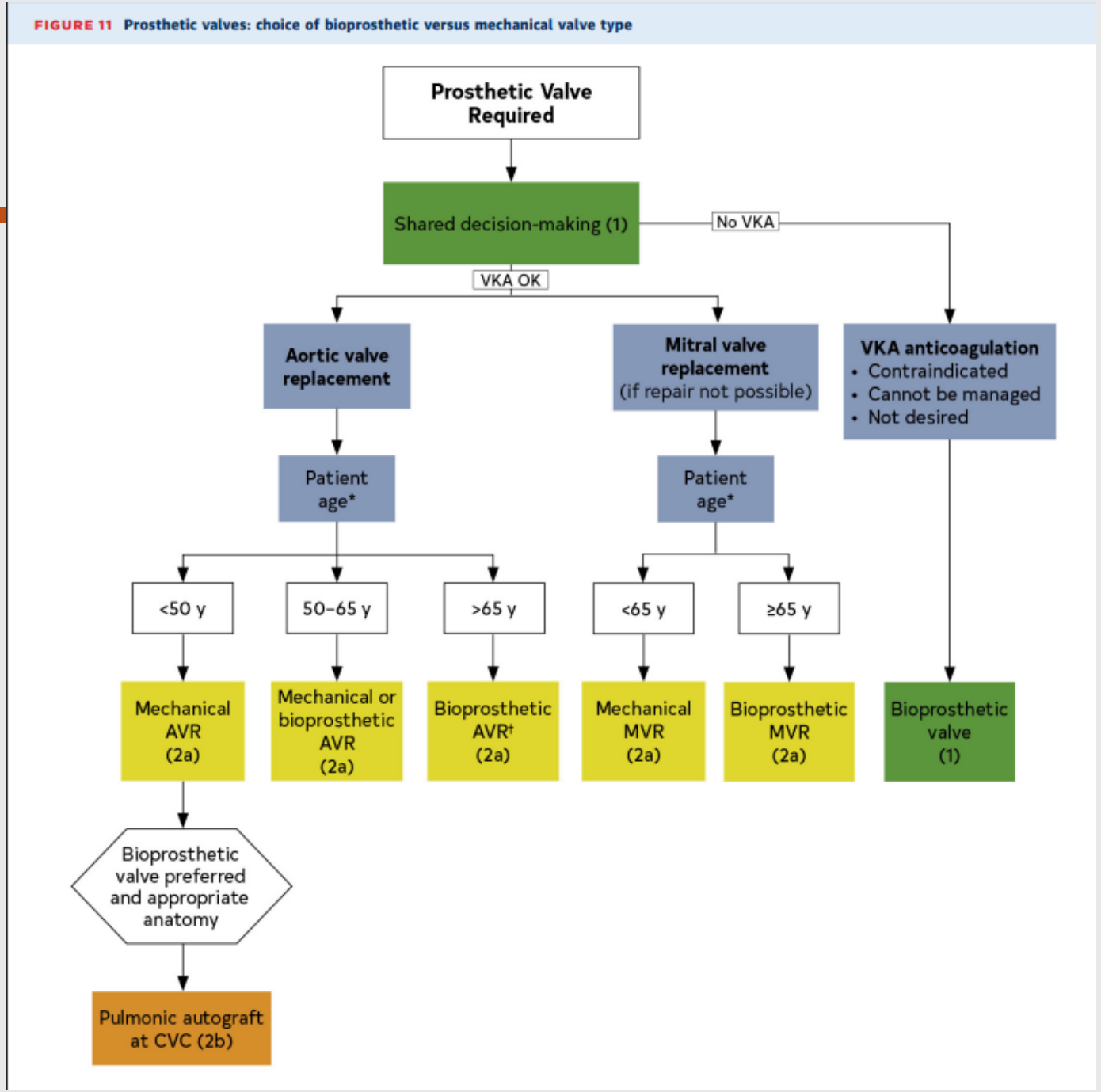
On-X Bileaflet Mechanical Valve

- Bioprosthetic
  - Life span: 10-15 years
  - Can be placed surgically or transcatheter
  - Favored in older patients or those high risk for surgery
  - Xenograft
    - Sapien: bovine pericardium
    - Evolut: porcine pericardium

- Mechanical
  - Life span: 35+ years
  - Can only be placed surgically
  - Favored in younger patients
  - Required to be on VKA anticoagulation
    - No DOACS!
  - INR target 2.5 vs 3.0
    - On-X valve is a specific type of valve that targets a lower INR (1.5-2)

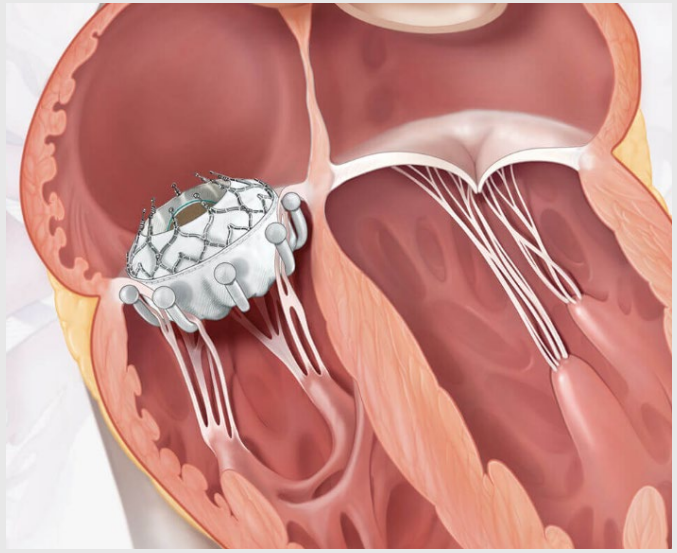
Which Valve to Choose?

- Age
- Anticoagulation candidate
- Surgical candidate
  - STS score
- Need for other procedures
  - Need LHC prior to any valve replacement to r/o obstructive coronary disease

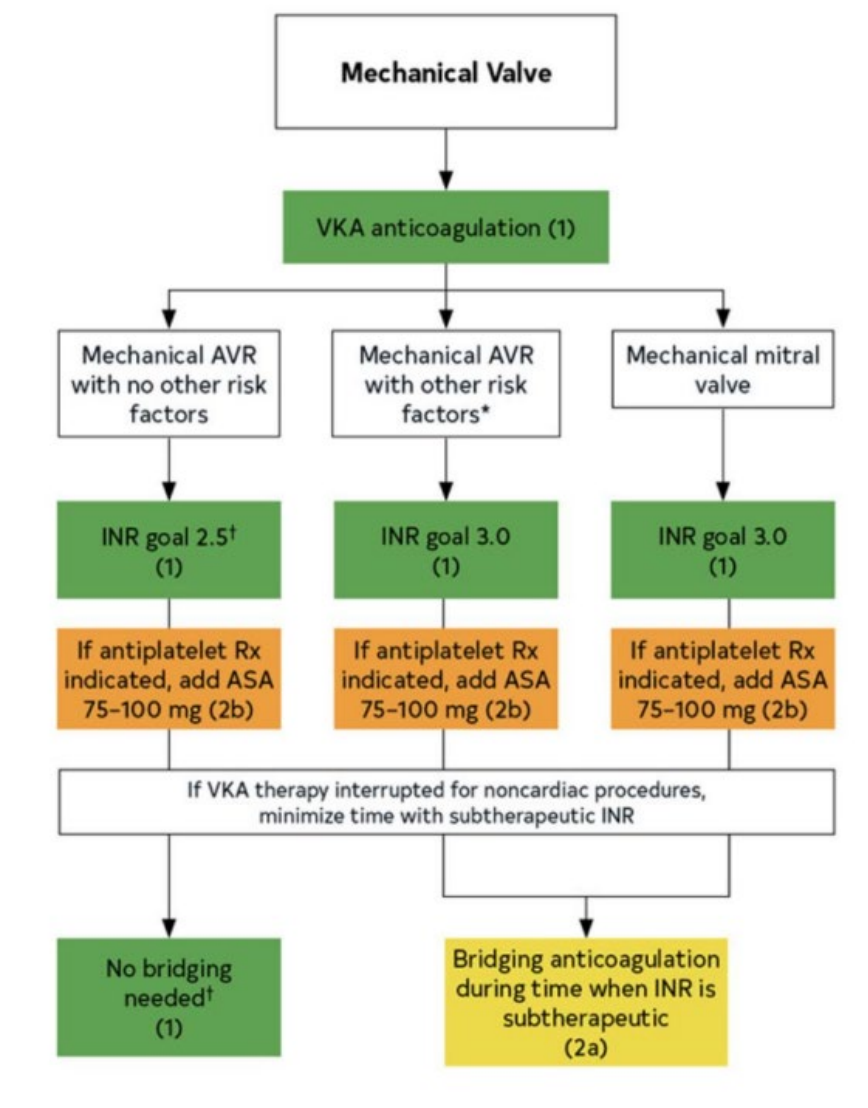


Transcatheter Therapies

- M-TEER
  - Clipping together of mitral valve segments
  - Mitraclip, Pascal
  - More for patients with low EF, dilated LV, high surgical risk
- T-MVR
  - Transcatheter MV replacement
- T-TEER
  - Triclip
- T-TVR
  - An option for severe TR



Anticoagulation



- "Thromboembolic risk factors include an older-generation valve, AF, previous thromboembolism, hypercoagulable state, and LV systolic dysfunction."

- **For bioprosthetic valves,** aspirin is a class 2a indication ("is reasonable") – ACC 2020 VHD Guidelines

Question 7

- Which famous doctor is on the patent for the Mitraclip?

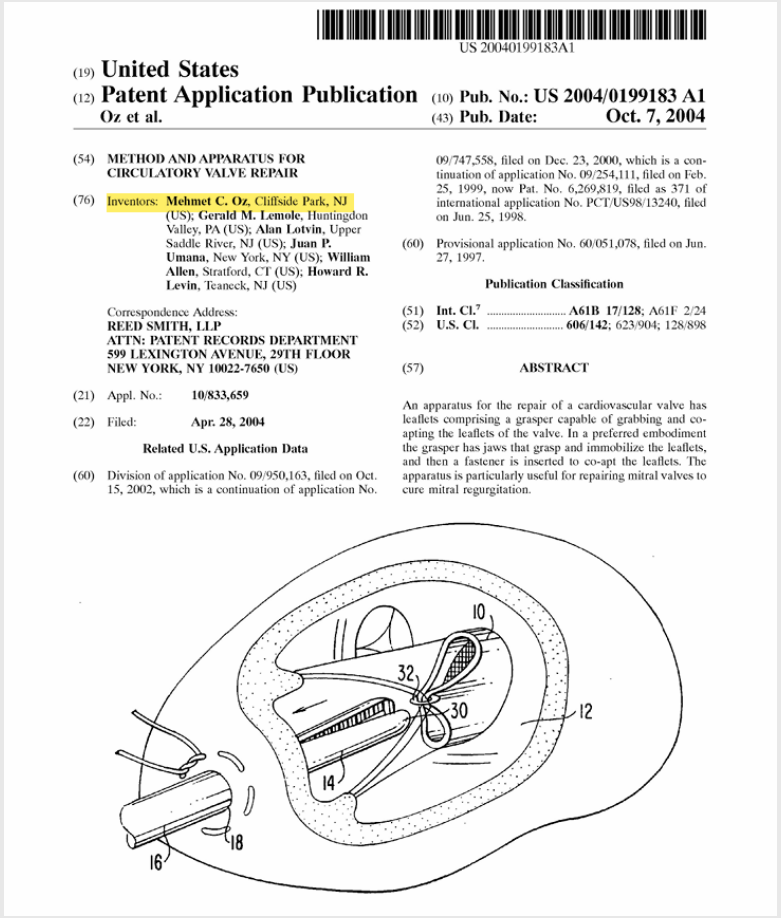
A. Dr. Neil deGrasse Tyson

B. Dr. Phil

C. Dr. Oz

D. Dr. Sanjay Gupta

E. Dr. Glaucomflocken



US 20040199183A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2004/0199183 A1**

Oz et al. (43) **Pub. Date: Oct. 7, 2004**

(54) **METHOD AND APPARATUS FOR CIRCULATORY VALVE REPAIR**

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NEW YORK, NY 10022-7650 (US)

(21) Appl. No.: **10/833,659**

(22) Filed: **Apr. 28, 2004**

Related U.S. Application Data

(60) Division of application No. 09/950,163, filed on Oct. 15, 2002, which is a continuation of application No. 09/747,558, filed on Dec. 23, 2000, which is a continuation of application No. 09/254,111, filed on Feb. 25, 1999, now Pat. No. 6,269,819, filed as 371 of international application No. PCT/US98/13240, filed on Jun. 25, 1998.

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(52) **U.S. Cl.** **606/142**; 623/904; 128/898

(57) **ABSTRACT**

An apparatus for the repair of a cardiovascular valve has leaflets comprising a grasper capable of grabbing and co-apting the leaflets of the valve. In a preferred embodiment the grasper has jaws that grasp and immobilize the leaflets, and then a fastener is inserted to co-apt the leaflets. The apparatus is particularly useful for repairing mitral valves to cure mitral regurgitation.

Valve surveillance

- Valve disease
  - **Mild:** 3-5 years
  - **Moderate:** 1-2 years
  - **Severe:** 6-12 mos
    - Can do earlier timeline in severe AS

- Valve replacement
  - **Transcatheter** -> annually
  - **Mechanical valve** -> none
  - **Bioprosthetic surgical** -> year 5, year 10, then annually

- If there is concern for prosthetic valve dysfunction, TEE is diagnostic procedure of choice.

Question 8

- 88 y/o woman with pmh of HTN, HLD, moderate aortic stenosis presents for a clinic f/u. She has trouble climbing hills, which is something she could do six mos ago. Her last echocardiogram was 1 year prior and showed an EF of 55%, Vmax of 3.8 m/s, mean gradient of 36 mmHg, and a valve area of 1.5 cm^2. What's the next best step?

A. Echocardiogram

B. Treadmill stress test

C. Dobutamine stress echo

D. Surveillance

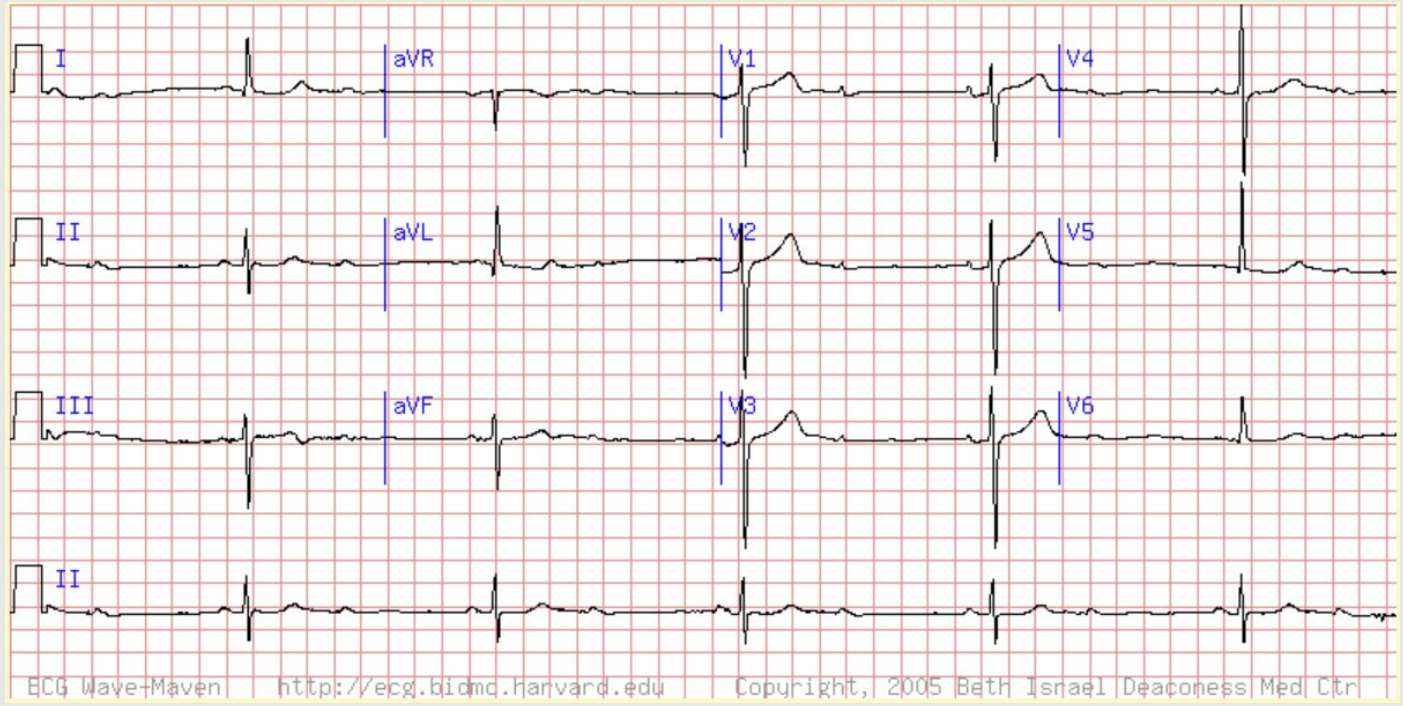
Endocarditis

- Prophylaxis
  - Recommended for patients with prosthetic material undergoing manipulation of gingival tissue or the periapical region of the teeth, or perforation of oral mucosa
  - Prosthetic valves, prosthetic material used for valve repair (annuloplasty rings, chords), unrepaired cyanotic congenital heart disease, repaired congenital lesions w/residual defects at prosthetic site, transplant with valvular regurgitation.
- If c/f endocarditis with bioprosthetic valve, opt for TEE as test of choice.

- Medications
  - PO
    - Amoxicillin 2g
  - Unable to take PO
    - Ampicillin 2g IM/IV
    - Cefazolin or CTX 1gm IM/IV
  - Penicillin/ampicillin allergy (PO)
    - Cephalexin 2g
    - Clindamycin 600mg
    - Azithromycin or clarithromycin 500mg
  - Penicillin/ampicillin allergy and cannot take PO
    - Cefazolin or CTX 1g IM/IV
    - Clindamycin 600mg IV
  - Take medications 30-60 min prior to appt.

Question 9

- 70 y/o with hx of severe AS with prior bioprosthetic valve (place 5 years ago), chronic lower extremity venous insufficiency, HTN, HLD and uncontrolled DM is admitted with cellulitis of the lower extremity. He is febrile, and blood cultures are positive for MSSA. A murmur is auscultated on exam. Below is his ECG. What's the next best step?



A. TEE

B. Pharmacologic stress test

C. Coronary CTA

D. TTE

Outline

- ~~Stages of valvular heart disease~~
- ~~Aortic Stenosis/Mitral Stenosis~~
- ~~Aortic Regurgitation/Mitral Regurgitation~~
- **Treatment options for VHD**
- **Anticoagulation strategies**
- **Valve Surveillance**
- **Endocarditis**
- Wrap-up

Outline

- ~~Stages of valvular heart disease~~
- ~~Aortic Stenosis/Mitral Stenosis~~
- ~~Aortic Regurgitation/Mitral Regurgitation~~
- ~~Treatment options for VHD~~
- ~~Anticoagulation strategies~~
- ~~Valve Surveillance~~
- ~~Endocarditis~~
- **Wrap-up**

Key Points

- Aortic Stenosis
  - Severe: ≥4 m/s, ≥40 mmHg, AVA <1 cm^2
  - LFLG: small AVA, but not meeting other requirements for severe criteria -> DSE
  - Balloon valvuloplasty, medical therapy are not definitive treatments for AS
- Murmur patterns
- Mitral regurgitation
  - Repair preferred over replacement
- Intervention even w/o sx
  - Severe MR, EF <60%
  - Severe AR, EF <55%
  - Severe AS, EF <50%
- Clinical scenarios
  - MI -> acute severe MR
  - Acute AR -> avoid IABP, BB
- Prosthetic valves
  - Younger pts -> mechanical valves
  - Older pts -> bioprosthetic valves
  - Prosthetic valves need endocarditis ppx
  - Valve dysfxn/endocarditis -> TEE
  - Bridging (all mech MV, mech AV w/risk factors)
- Anticoagulation
  - Mechanical valves: warfarin
  - Mitral stenosis/Afib: warfarin

Question 10

- A 66 y/o with pmh CAD, HTN, HLD is admitted from the ED with worsening dyspnea on exertion, lower extremity edema, orthopnea, and weight gain for the last 3 mos. He recently had an episode of loss of consciousness while getting out of his car. Exam is notable for 3+ BLEE, JVD of 18 cm, and bl crackles at lung bases. Labs are notable for a sodium of 130, Cr 1.5, BNP 1300. He is started on IV furosemide with improvement in edema and symptoms.
- An echocardiogram is ordered which demonstrates an EF of 20%, mild mitral regurgitation, a calcified aortic valve with an AVA of 0.9 cm^2, with a mean gradient of 30 mmHg. He undergoes a left heart catheterization which shows no obstructive coronary disease.
- What is the next best test?

A. Transesophageal echocardiogram
B. Dobutamine stress echo
C. Pharmacologic stress test
D. Repeat BNP
E. 30d remote monitor

Question 11

- After diuresis, he undergoes a dobutamine stress test, which shows an increase in his stroke volume to 44 mL/m^2 and an aortic valve gradient of 44 mmHg with an AVA of 0.9 cm^2. What is the most likely diagnosis?

A. Ischemic cardiomyopathy
B. Low flow, low gradient aortic stenosis
C. Paradoxical low flow, low gradient aortic stenosis
D. Pseudo-aortic stenosis
E. Familial cardiomyopathy

Question 12

- A 56 y/o man with a pmh of HTN, HLD presents with worsening shortness of breath. His exam is notable for a 3/6 holosystolic murmur at the apex, radiating to the axilla. What is the most likely valve pathology?

A. Aortic stenosis
B. Mitral stenosis
C. Aortic regurgitation
D. Mitral regurgitation

Question 13

- A 44 y/o with hx of bicuspid aortic valve is found to have severe aortic stenosis. He has no other medical problems and no contraindications to long-term anticoagulation. What option would be the best choice of valve replacement?

A. Bioprosthetic valve
B. Mechanical valve
C. Balloon valvuloplasty
D. No intervention

Question 14

- An 87 woman with a history of a mechanical mitral valve is being evaluated prior to a knee replacement surgery. She is on warfarin and follows with anticoagulation clinic, with her most recent INR of 3.2. What should be the recommendation regarding perioperative anticoagulation?

A. Stop warfarin 4-5d prior to surgery
B. Stop warfarin 4-5d prior to surgery and bridge with IV heparin
C. Stop warfarin 4-5d prior to surgery, and switch to apixaban 2.5mg bid
D. Stop warfarin 4-5d prior to surgery, and switch to apixaban 5mg bid.

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CLINICAL PRACTICE GUIDELINE: FULL TEXT

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

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FIGURE 2 **Timing of intervention for AS**

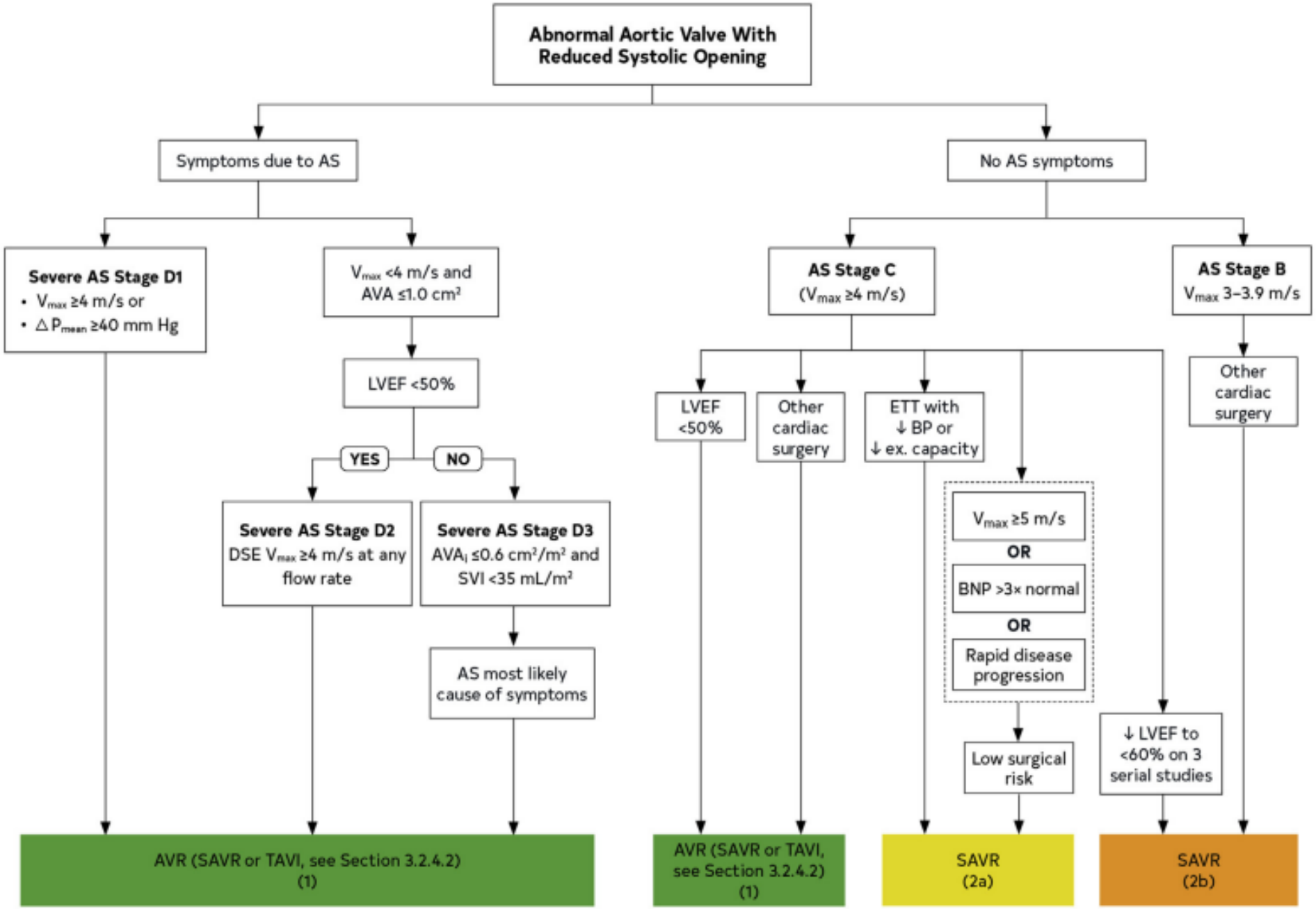
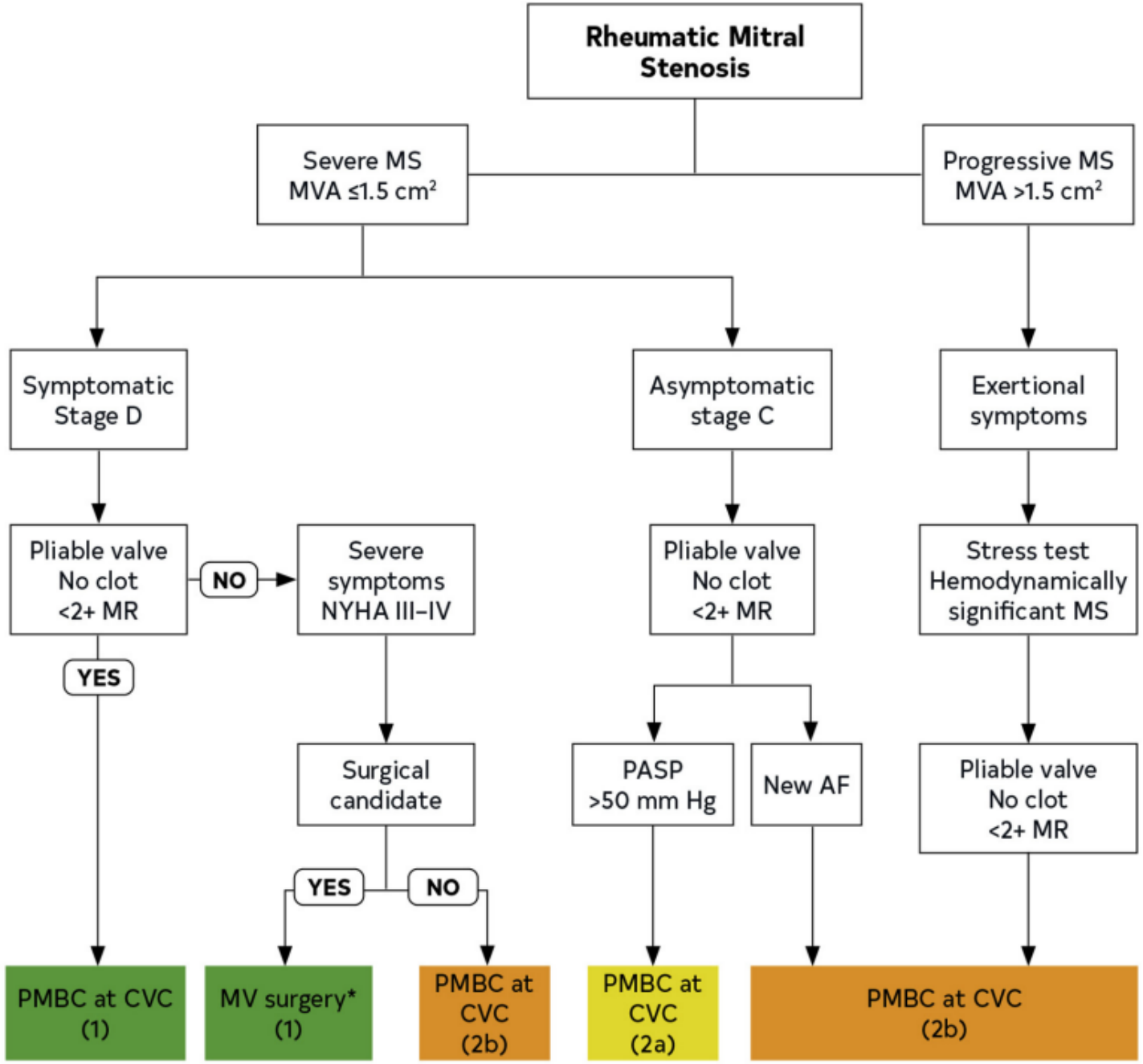


FIGURE 7 Intervention for MS



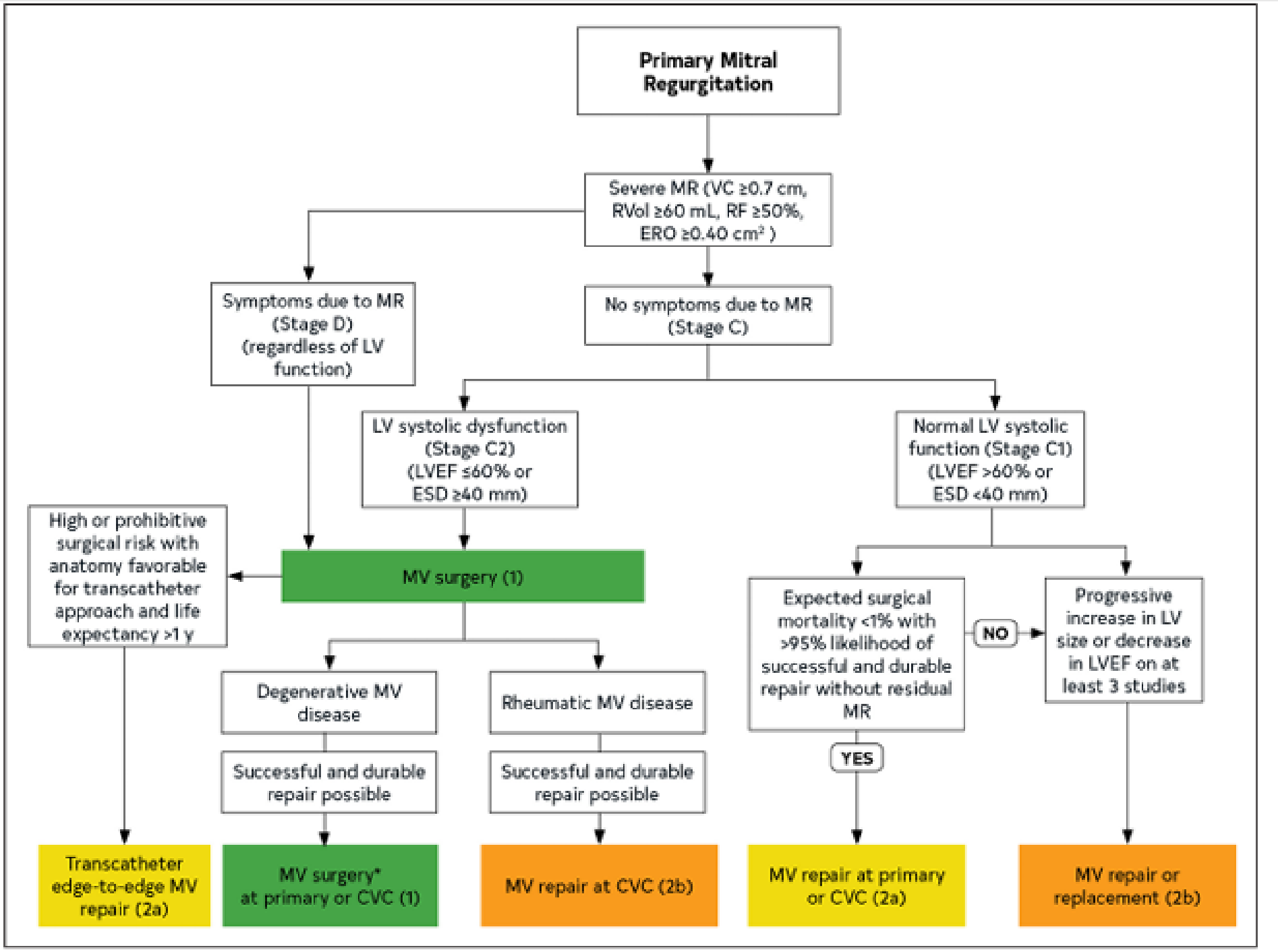

Primary Mitral Regurgitation
Severe MR (VC ≥0.7 cm, RVol ≥60 mL, RF ≥50%, ERO ≥0.40 cm²)
Symptoms due to MR (Stage D) (regardless of LV function)
No symptoms due to MR (Stage C)
LV systolic dysfunction (Stage C2) (LVEF ≤60% or ESD ≥40 mm)
Normal LV systolic function (Stage C1) (LVEF >60% or ESD <40 mm)
High or prohibitive surgical risk with anatomy favorable for transcatheter approach and life expectancy >1 y
MV surgery (1)
Degenerative MV disease
Rheumatic MV disease
Expected surgical mortality <1% with >95% likelihood of successful and durable repair without residual MR
NO
Progressive increase in LV size or decrease in LVEF on at least 3 studies
YES
Successful and durable repair possible
Successful and durable repair possible
Transcatheter edge-to-edge MV repair (2a)
MV surgery* at primary or CVC (1)
MV repair at CVC (2b)
MV repair at primary or CVC (2a)
MV repair or replacement (2b)

FIGURE 4 Timing of intervention for AR

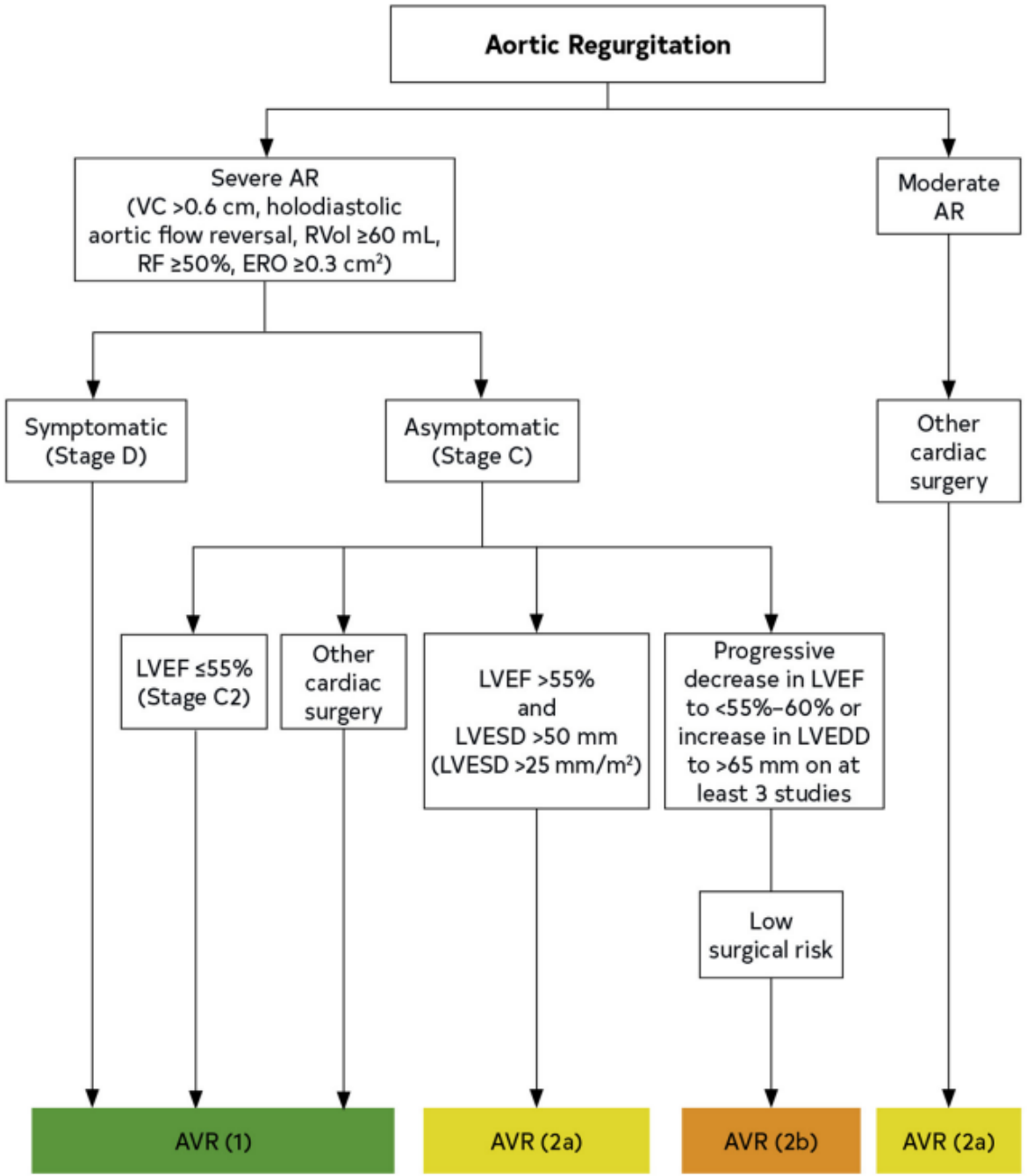
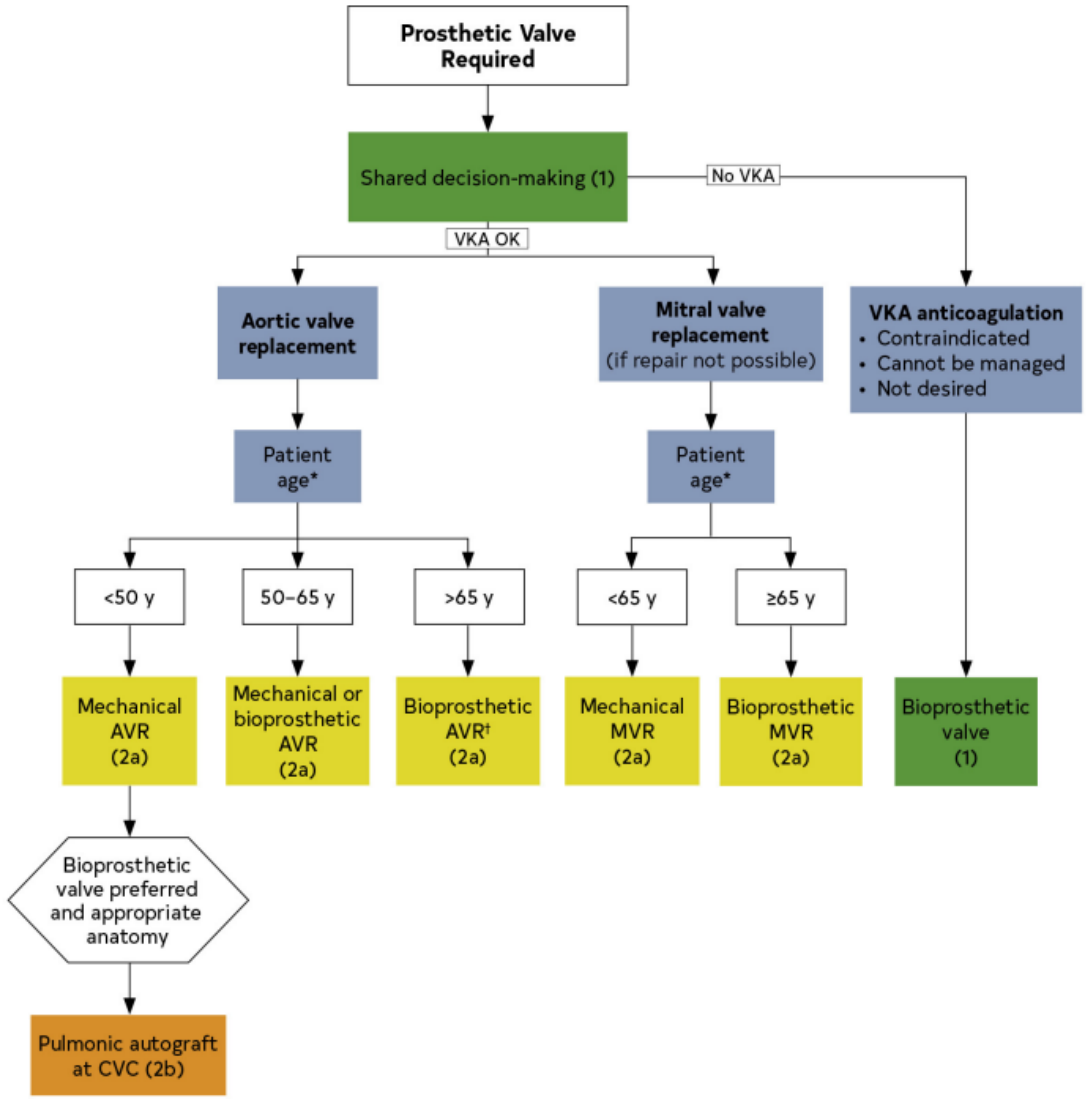
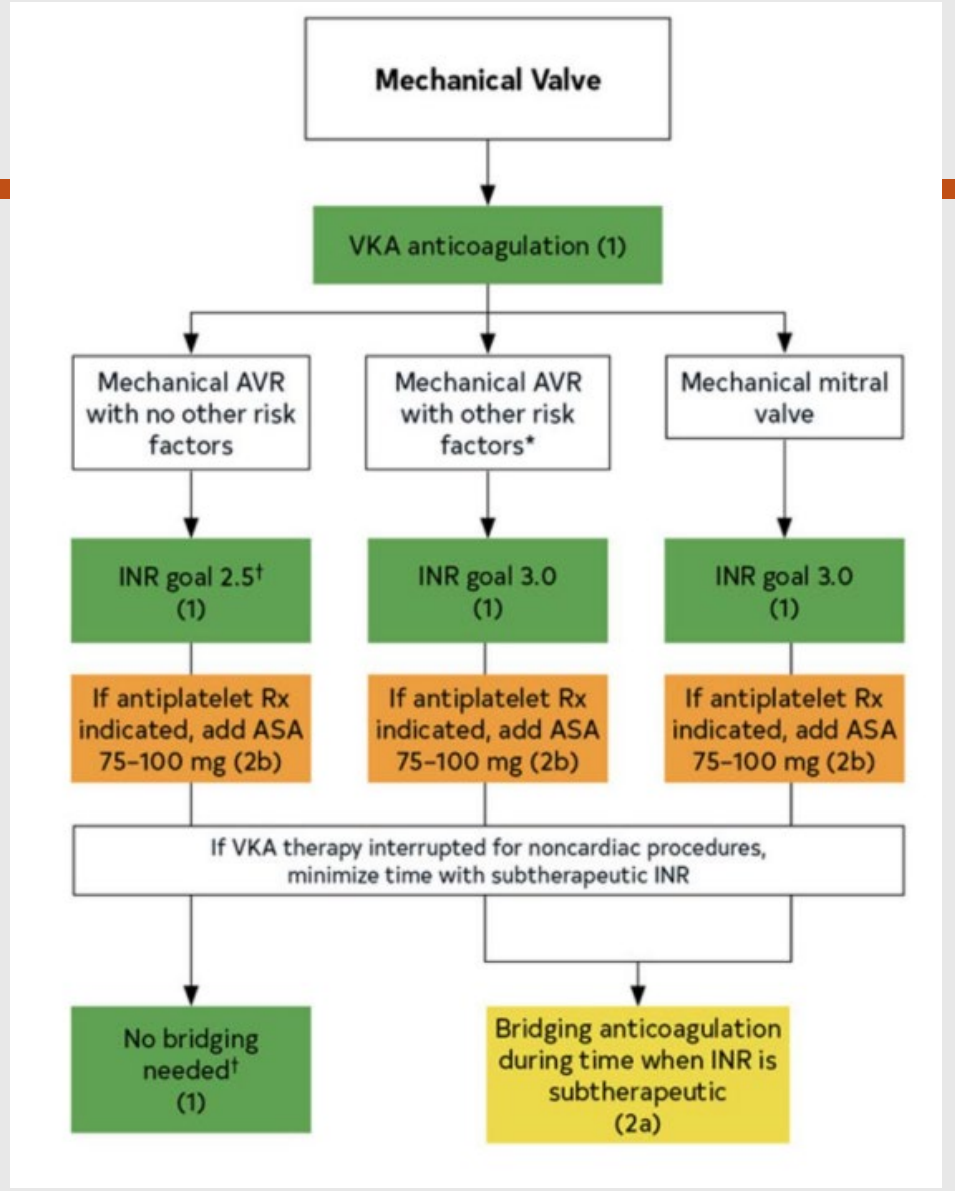


FIGURE 11 Prosthetic valves: choice of bioprosthetic versus mechanical valve type





Answer Key

1. C
2. C
3. A
4. B
5. C
6. D
7. C
8. A
9. A
10. B
11. B
12. D
13. B
14. B