TRP 2021

Complex Valves

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Plan

- Review the major valvular heart disease
  - Case-based
  - Expectations for the “exam”
  - Tricks
- What we will cover
  - Diagnosis and indications/types of interventions
- What we will not cover
  - AS/TAVI (being covered by Dr. C. Glover in separate session)

Nomenclature – 2020 Guidelines

- Recall change in ACC/AHA wording from mild/moderate/severe, to at risk/progressive/severe
- Classification scheme
    - A – At risk
    - B – Progressive
    - C – Severe, **ASYMPTOMATIC**
    - D – Severe, Symptomatic

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

Valvular diseases to consider

- Aortic Stenosis
- Aortic Regurgitation
- Mitral Stenosis
- Mitral Regurgitation
- Right-sided valve failure
- Prosthetic valve
  - Valve type selection, treatment of complications
- IE prophylaxis/management
- VHD in pregnancy

Case 1

- 45F, from East Africa, otherwise well
- G1P0, 14 weeks pregnant
- Developing progressive dyspnea and orthopnea

- What is the diagnosis?
- What is the physical exam going to show?
- What precipitated her symptoms?

Mitral Stenosis

- Recommendations based on presumption of Rheumatic cause (ie. not MAC, SLE, etc)

- Considers the hemodynamics of the inflow gradient (*which is heavily dependent on volume status and heart rate*), but also subsequents effects on:
    - Left atrium
    - Pulmonary system
    - Clinical symptoms
    - Electrocardiographic symptoms

What defines severe MS?

- MVA ≤1.5 cm2 (MVA ≤1.0 cm2 with very severe MS)
- Diastolic pressure half-time ≥150 ms (Diastolic pressure half-time ≥220 ms with very severe MS)

- Severe LA enlargement
- Elevated PASP >30 mmHg

- Trans-mitral gradient
    - Heavily dependent on loading conditions, therefore not technically included, but tends to be >5-10 mmHg

- Medical therapy
  - Anticoagulation (if in AF), always VKA
  - HR control for those in AF, or those in sinus to increase DFP

Favourable for PMBC

Boston/Wilkins-Weyman/Mitral Valve score – components (leaflet thickening, leaflet mobility, calcification, and subvalvular involvement), scored from 1-4 (calcium can be 0), favourable score is ≤8

Commissural fusion present (usually best seen in TTE short axis MV)

  - 1) are **not** candidates for PMBC,
  - 2) have failed a previous PMBC,
  - 3) require other cardiac procedures, or
  - 4) do not have access to PMBC,
  - Mitral valve surgery (repair, commissurotomy, or replacement) is indicated

- Class IIa – NYHA I and favorable valve morphology with less than 2+ MR in the absence of LA thrombus who have elevated pulmonary pressures (pulmonary artery systolic pressure >50 mmHg), PMBC is reasonable

Older recommendations – Class IIb

- Severe MS, develops AF

- Severe MS, pulmonary artery wedge pressure >25 mm Hg or a mean mitral valve gradient >15 mm Hg during exercise

- NYHA III-IV, non-ideal anatomy for PMBC, and not candidates for surgery, PMBC could be considered

- Note: PMBC should be performed at a “Comprehensive Valve Center”

Secondary prevention – very important

What to use?

Until when?

Table 6. Secondary Prevention of Rheumatic Fever

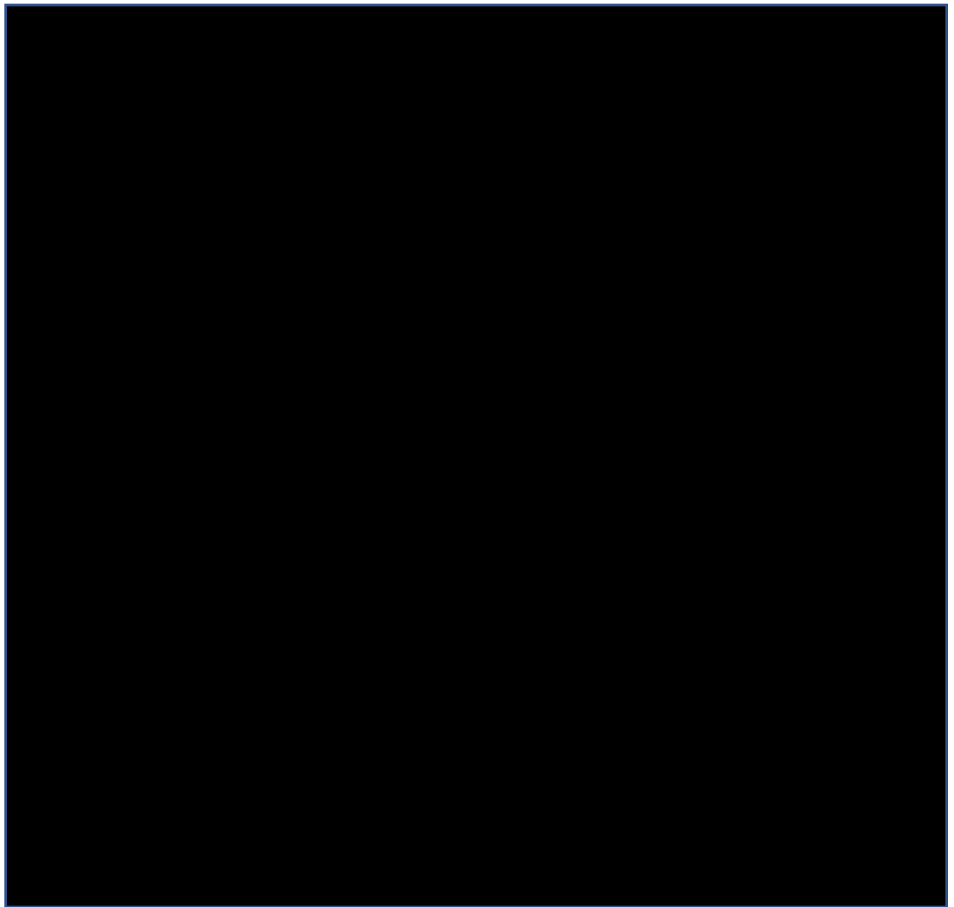
Antibiotics for Prevention	Dosage*
Penicillin G benzathine	1.2 million U intramuscularly every 4 wk†
Penicillin V potassium	200 mg orally twice daily
Sulfadiazine	1 g orally once daily
Macrolide or azalide antibiotic (for patients allergic to penicillin and sulfadiazine)‡	Varies

*In patients with documented valvular heart disease, the duration of rheumatic fever prophylaxis should be ≥10 y or until the patient is 40 y of age (whichever is longer). Lifelong prophylaxis may be recommended if the patient is at high risk of group A streptococcus exposure. Secondary rheumatic heart disease prophylaxis is required even after valve replacement.

†Administration every 3 wk is recommended in certain high-risk situations.

‡Macrolide antibiotics should not be used in persons taking other medications that inhibit cytochrome P450 3A, such as azole antifungal agent HIV protease inhibitors, and some selective serotonin reuptake inhibitors.

Adapted from Gerber et al.[1]



Case answered

- What is the diagnosis?
    - Severe MS
- What is the physical exam going to show?
    - Tachycardia, hypotension
    - Loud S1, loud P2, OS, diastolic rumble, RV heave, elevated JVP
    - Crackles in lung bases
- What precipitated her symptoms?
    - Volume overload of second trimester
    - Sinus tachycardia
    - Possible atrial arrhythmia

Case 2

- 59M, otherwise well
- Progressive dyspnea on exertion, worsened over last year
- Father had “valve surgery” when he was 50

- What is the diagnosis?
- What is the physical exam going to show?

Bicuspid aortic valve (BAV)

- Common, 0.5-2% of population
- 3:1 male:female
- 20-30% have a family history of aortopathy/BAV
- Watch for aortic aneurysms (20-40% of cases)

- Present with AS or AI as primary, fairly equally

- In young patients with aortic coarctation, need to rule out bicuspid aortic valve

Principles of monitoring/management

- In presence of aortic root > 4cm, need regular FU (even after isolated SAVR)
- Consider BB and ACEi/ARB in aortopathy > 4cm
    - 2006 guidelines, limited proof of concept data

- Intervention on aorta indicated at (cf Marfan/LD,etc):
    - >55mm
    - 50-55mm with additional risk factors
        - Family history, rapid growth >5mm/y, coarctation
        - Without additional risk factors is Class IIb
    - Going for SAVR and aorta ≥45mm

Case answered

- What is the diagnosis?
    - Bicuspid aortic valve stenosis

- What is the physical exam going to show?
    - All features of severe aortic stenosis
    - BAV-specific (ejection click)

Case 3

- 55F, longstanding history of palpitation NYD
- Acute onset of dyspnea 4 weeks ago, and now NYHA III (no chest pain)

- What is the diagnosis?
- What is the physical exam going to show?
- What precipitated her symptoms?

Mitral regurgitation

- Primary (degenerative)
  - Disease of the valve apparatus
    - MVP/Barlow
    - IE
    - Connective tissue disorders
    - Rheumatic heart disease
    - Cleft mitral valve
    - Radiation heart disease.
- Secondary (functional)
  - Disease of the LA and/or LV

Stages of chronic, **primary**, MR

Central jet MR >40% LA or holosystolic eccentric jet MR

Vena contracta ≥0.7 cm

Regurgitant volume ≥60 mL

Regurgitant fraction ≥50%

ERO ≥0.40 cm2

Angiographic grade 3+ to 4+

Moderate or severe LA enlargement

LV enlargement

Pulmonary hypertension may be present at rest or with exercise

C1: LVEF >60% and LVESD <40 mm

C2: LVEF ≤60% and/or LVESD ≥40 mm

Intervention (chronic primary MR)

- Symptomatic
- Asymptomatic
  - LV systolic dysfunction (LVEF ≤60%, LVESD ≥40 mm) (Stage C2), mitral valve surgery is recommended
  - Mitral valve repair is recommended in preference to mitral valve replacement when the anatomic cause of MR is degenerative disease, if a successful and durable repair is possible
  - Normal LV systolic function (LVEF ≥60% and LVESD ≤40 mm) mitral valve repair is reasonable when the likelihood of a successful and durable repair without residual MR is >95% with an expected mortality rate of <1%, when it can be performed at a Comprehensive Valve Center
- Severely symptomatic patients (NYHA class III or IV) and high or prohibitive surgical risk, transcatheter edge-to-edge repair (TEER) is reasonable if mitral valve anatomy is favorable for the repair procedure and patient life expectancy is at least 1 year

Stages of chronic, **secondary**, MR

Stage	Definition	Valve Anatomy	Valve Hemodynamics*	Associated Cardiac Findings	Symptoms
A	At risk of MR	Normal valve leaflets, chords, and annulus in a patient with CAD or cardiomyopathy	No MR jet or small central jet area <20% LA on Doppler Small vena contracta <0.30 cm	Normal or mildly dilated LV size with fixed (infarction) or inducible (ischemia) regional wall motion abnormalities Primary myocardial disease with LV dilation and systolic dysfunction	Symptoms attributable to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy
B	Progressive MR	Regional wall motion abnormalities with mild tethering of mitral leaflet Annular dilation with mild loss of central coaptation of the mitral leaflets	ERO <0.40 cm^2† Regurgitant volume <60 mL Regurgitant fraction <50%	Regional wall motion abnormalities with reduced LV systolic function LV dilation and systolic dysfunction attributable to primary myocardial disease	Symptoms attributable to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy
C	Asymptomatic severe MR	Regional wall motion abnormalities and/or LV dilation with severe tethering of mitral leaflet Annular dilation with severe loss of central coaptation of the mitral leaflets	ERO ≥0.40 cm^2† Regurgitant volume ≥60 mL‡ Regurgitant fraction ≥50%	Regional wall motion abnormalities with reduced LV systolic function LV dilation and systolic dysfunction attributable to primary myocardial disease	Symptoms attributable to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy
D	Symptomatic severe MR	Regional wall motion abnormalities and/or LV dilation with severe tethering of mitral leaflet Annular dilation with severe loss of central coaptation of the mitral leaflets	ERO ≥0.40 cm^2† Regurgitant volume ≥60 mL‡ Regurgitant fraction ≥50%	Regional wall motion abnormalities with reduced LV systolic function LV dilation and systolic dysfunction attributable to primary myocardial disease	HF symptoms attributable to MR persist even after revascularization and optimization of medical therapy Decreased exercise tolerance Exertional dyspnea

Intervention (chronic secondary MR)

- GDMT and consideration for HF specialist
- No Class I recommendations!

- NYHA II-IV, EF <50%, TEER is reasonable in patients with appropriate anatomy as defined on TEE and with LVEF between 20% and 50%, LVESD ≤70 mm, and pulmonary artery systolic pressure ≤70 mm Hg (in other words, severe MR with mildly dilated LV)
- Severely symptomatic, can undergo MVR when undergoing concomitant CABG

- NYHA III-IV, atrial annular dilation with preserved LV systolic function (LVEF ≥50%) despite therapy for HF and therapy for associated AF or other comorbidities, mitral valve surgery may be considered
- NYHA III-IV, MR related to LV systolic dysfunction (LVEF <50%) while on optimal GDMT for HF, mitral valve surgery may be considered
- NYHA III-IV, related to LV systolic dysfunction (LVEF <50%), chordal-sparing mitral valve replacement may be reasonable to choose over downsized annuloplasty

Case answered

- What is the diagnosis?
    - Mitral valve prolapse/primary MR
- What is the physical exam going to show?
    - Volume overload, elevated JVP
    - Mid-systolic click, followed by murmur of MR, presence of S3
    - Loud P2, RV heave
- What precipitated her symptoms?
    - Papillary cord rupture/break

Case 4

- 24M, IVDA, EtOH
- Progressive weakness and noting dyspnea, rash, and pedal edema over 6 weeks

- What is the diagnosis?
- What is the physical exam going to show?

Tricuspid valve disease

Primary	Secondary
Rheumatic Infective endocarditis Iatrogenic (device leads, endomyocardial biopsy) Congenital (eg, Ebstein's, levo-transposition of the great arteries) Other (eg, trauma, carcinoid, drugs, irradiation)	Pulmonary hypertension with RV remodeling (primary or secondary to left-sided heart disease) Dilated cardiomyopathy Annular dilation (associated with AF)* RV volume overload (shunts/high output)

*Isolated TR is associated with AF and has LVEF >60%, pulmonary artery systolic pressure <50 mm Hg, and no left-sided valve disease, with normal-appearing tricuspid valve leaflets.

AF indicates atrial fibrillation; LVEF, left ventricular ejection fraction; RV, right ventricular; and TR, tricuspid regurgitation.

Diagnosis

- TTE to evaluate presence/severity of TR, determine etiology, measure sizes of right-sided chambers and IVC, assess RV systolic function, estimate RVSP, and rule in/out left-sided heart disease
  - Normal
    - TAPSE (tricuspid annular plane systolic excursion >16 mm)
    - Tricuspid valve systolic annular velocity >10.0 cm/s,
    - RV end-systolic area <20.0 cm2 or fractional area change >35%

- Invasive measurement (CO/CI, right-sided and pulmonary pressures, PAWP, TPG/PVR) can be useful when clinical and non-invasive data are discordant or inadequate

Severity

Stage	Definition	Valve Hemodynamics	Hemodynamic Consequences	Clinical Symptoms and Presentation
B	Progressive TR	Central jet <50% RA Vena contracta width <0.7 cm ERO <0.40 cm^2 Regurgitant volume <45 mL	None	None
C	Asymptomatic severe TR	Central jet ≥50% RA Vena contracta width ≥0.7 cm ERO ≥0.40 cm^2 Regurgitant volume ≥45 mL Dense continuous wave signal with triangular shape Hepatic vein systolic flow reversal	Dilated RV and RA Elevated RA with "c-V" wave	Elevated venous pressure No symptoms
D	Symptomatic severe TR	Central jet ≥50% RA Vena contracta width ≥0.7 cm ERO ≥0.40 cm^2 Regurgitant volume ≥45 mL Dense continuous wave signal with triangular shape Hepatic vein systolic flow reversal	Dilated RV and RA Elevated RA with "c-V" wave	Elevated venous pressure Dyspnea on exertion, fatigue, ascites, edema

c-V wave indicates systolic positive wave; ERO, effective regurgitant orifice; RA, right atrial; RV, right ventricular; and TR, tricuspid regurgitation.

When to intervene?

- Class I – going for surgery for left-sided disease
- Class II
  - Progressive (Stage B) undergoing left-sid… surgery can be beneficial in the c… annular dilation (tricuspid … …ter >4.0 cm) or 2) prior signs and …
  - Signs and s… …and severe primary TR (Stage D), is… …eficial to reduce symptoms and …ns of right-sided HF and severe isolated …R attributable to annular dilation (in absence of …monary hypertension or left-sided disease) who are poorly responsive to medical therapy (Stage D), isolated TV surgery can be beneficial to reduce symptoms and recurrent hospitalizations

Asymptomatic, going for left-sided surgery and severe right-sided HF failing medical to reduce hospitalizations

Table 1. Modified Duke Criteria for the Clinical Diagnosis of Infective Endocarditis.*

Major clinical criteria

Positive blood culture

- Typical microorganisms (*Staphylococcus aureus*, viridans streptococci, *Streptococcus gallolyticus*, HACEK [haemophilus species, aggregatibacter (formerly actinobacillus) species, cardiobacterium species, *Eikenella corrodens*, and kingella species], and community-acquired enterococci in the absence of a primary focus) consistent with infective endocarditis from two separate blood cultures
- Microorganisms consistent with infective endocarditis from persistently positive blood cultures, defined as ≥2 positive cultures from blood samples drawn >12 hr apart or all of 3 or a majority of ≥4 separate cultures of blood (with first and last sample drawn at least 1 hr apart)
- Single positive blood culture for *Coxiella burnetii* or phase I IgG antibody titer >1:800

Positive echocardiography

- Vegetation (defined as an oscillating intracardiac mass on a valve or supporting structure), abscess, or new partial dehiscence of a prosthetic valve

New valvular regurgitation (an increase or change in preexisting murmur is not sufficient)

Minor clinical criteria

Presence of predisposing cardiac condition or intravenous drug use

Temperature ≥38.0°C (100.4°F)

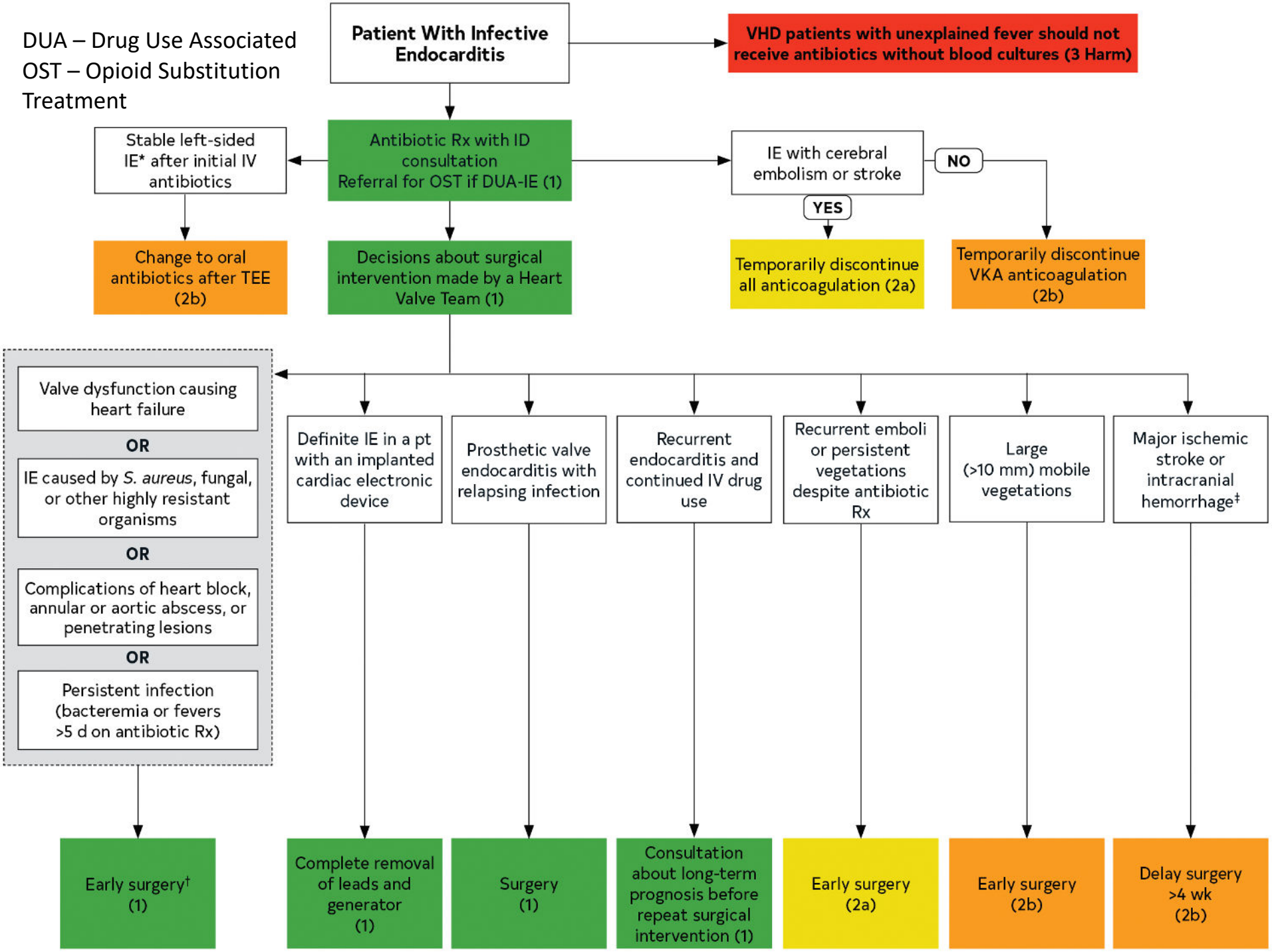
Vascular phenomena such as systemic arterial emboli, septic pulmonary emboli, mycotic aneurysm, intracranial hemorrhage, conjunctival hemorrhages, or Janeway lesions

Immunologic phenomena such as glomerulonephritis, Osler nodes, Roth spots, or rheumatoid factor

Positive blood cultures that do not meet major criteria, or serologic evidence of active infection with organism consistent with infective endocarditis

* Adapted from Li et al.[6] A definite diagnosis is based on two major criteria, five minor criteria, or one major criterion plus three minor criteria. Possible endocarditis is based on three minor criteria or one major criterion plus one minor criterion. If criteria for either definite or possible endocarditis are not met, the diagnosis of infective endocarditis is rejected.

DUA – Drug Use Associated
OST – Opioid Substitution Treatment



Chronic Aortic Regurgitation

B	Progressive AR	Mild to moderate calcification of a trileaflet valve BAV (or other congenital valve anomaly) Dilated aortic sinuses Rheumatic valve changes Previous IE	Mild AR: Jet width <25% of LVOT Vena contracta <0.3 cm Regurgitant volume <30 mL/beat Regurgitant fraction <30% ERO <0.10 cm² Angiography grade 1	Normal LV systolic function Normal LV volume or mild LV dilation	None
C					None; exercise testing is reasonable to confirm symptom status
D		Previous IE with abnormal leaflet closure or perforation	Regurgitant volume ≥60 mL/beat Regurgitant fraction ≥50% ERO ≥0.3 cm² Angiography grade 3 to 4 In addition, diagnosis of chronic severe AR requires evidence of LV dilation	Moderate to severe LV dilation is present	Exertional dyspnea or angina or more severe HF symptoms

Moderate AR:

- Jet width 25%–64% of LVOT
- Vena contracta 0.3–0.6 cm
- Regurgitant volume 30–59 mL/beat
- Regurgitant fraction 30% to 49%
- ERO 0.10–0.29 cm²
- Angiography grade 2

When to intervene, chronic AI

- Medical therapy for HTN and GDMT for LV dysfunction

- SAVR in:
  - Symptomatic, regardless of LV systolic function
  - Asymptomatic
    - LVEF ≤55%, if no other cause of systolic dysfunction
    - Undergoing cardiac surgery for other indications
    - Normal LV systolic function (LVEF >55%), when the LV is severely enlarged (LVESD >50 mm or indexed LVESD >25 mm/m2)

    - Moderate AR (Stage B) who are undergoing cardiac or aortic surgery for other indications
    - Normal LV systolic function at rest (LVEF >55%; Stage C1) and low surgical risk, SAVR may be considered when there is progressive decline in LVEF on at least 3 serial studies to the low–normal range (LVEF 55% to 60%) or a progressive increase in LV dilation into the severe range (LV end-diastolic dimension [LVEDD] >65 mm)

- TAVI is NOT recommended in primary/isolated AI

Prosthetic valve selection

Favor Mechanical Prosthesis	Favor Bioprosthesis
Age <50 y Increased incidence of structural deterioration with bioprosthesis (15-y risk: 30% for age 40 y, 50% for age 20 y) Lower risk of anticoagulation complications	Age >65 y Low incidence of structural deterioration (15-y risk: <10% for age >70 y) Higher risk of anticoagulation complications
Patient preference (avoid risk of reintervention)	Patient preference (avoid risk and inconvenience of anticoagulation)
Low risk of long-term anticoagulation	High risk of long-term anticoagulation
Compliant patient with either home monitoring or close access to INR monitoring	Limited access to medical care or inability to regulate VKA
Other indication for long-term anticoagulation (eg, AF)	Access to surgical centers with low reoperation mortality rate
High-risk reintervention (eg, porcelain aorta, prior radiation therapy)	Access to transcatheter ViV replacement
Small aortic root size for AVR (may preclude ViV procedure in future)	TAVI valves have larger effective orifice areas for smaller valve sizes (avoid patient–prosthesis mismatch)

General Principles

Risk of Surgical Intervention

Table 10. Median Operative Mortality Rates for Specific Surgical Procedures (STS Adult Cardiac Surgery Database, 2019)

Procedure	Mortality Rate (%)
AVR	2.2
AVR and CABG	4
AVR and mitral valve replacement	9
Mitral valve replacement	5
Mitral valve replacement and CABG	9
Mitral valve repair	1
Mitral valve repair and CABG	5

2x

2x

AVR indicates aortic valve replacement; CABG, coronary artery bypass graft surgery; and STS, Society of Thoracic Surgeons.

IE prophylaxis (which patients?)

- Prophylaxis against IE is reasonable before dental procedures that involve manipulation of gingival tissue, manipulation of the periapical region of teeth, or perforation of the oral mucosa in patients with:
    - Prosthetic cardiac valves, including transcatheter-implanted prostheses and homografts.
    - Prosthetic material used for cardiac valve repair, such as annuloplasty rings and chordae
    - Previous IE
    - Unrepaired cyanotic congenital heart disease or repaired congenital heart disease, with residual shunts or valvular regurgitation at the site near or adjacent to the site of a prosthetic patch or prosthetic device.
    - Cardiac transplant with valve regurgitation due to a structurally abnormal valve.

All Class IIa

Follow-up

Table 5. Frequency of Echocardiograms in Asymptomatic Patients With VHD and Normal LV Function

Stage	Type of Valve Lesion			
	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 3–5 y (mild severity)	Every 3–5 y (MV area >1.5 cm^2)	Every 3–5 y (mild severity)
	Every 1–2 y moderate severity; V_{max} 3.0–3.9 m/s)	Every 1–2 y (moderate severity)		Every 1–2 y (moderate severity)
Severe asymptomatic (Stage C1)	Every 6–12 mo (V_{max} ≥4 m/s)	Every 6–12 mo	Every 1–2 y (MV area 1.0–1.5 cm^2)	Every 6–12 mo
		Dilating LV: More frequently	Every year (MV area <1.0 cm^2)	Dilating LV: More frequently

Patients with mixed valve disease may require serial evaluations at intervals earlier than recommended for single-valve lesions. These intervals apply to most patients with each valve lesion and do not take into consideration the etiology of the valve disease.

*With normal stroke volume.

LV indicates left ventricle; MV, mitral valve; VHD, valvular heart disease; and V_{max}, maximum velocity.

Tricks

- Watch for stem suggestions (but be keen of locked-in biases)
  - Young women (MS, MVP, pregnancy)
  - Young person (TV, IE)
  - Middle age male (BAV, AI)
  - Older person (AS)
  - Radiation (MS, AS)
  - Immigrant patient (MS)

- Know severe indices (MR, MS, AI, AS, etc)
- Know “dimensions” for intervention (MR LVESD $\geq$40mm, AI LVESD $\geq$50mm, etc)

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Good luck

Any questions?