32ND ANNUAL
INTERNAL MEDICINE BOARD REVIEW 2023

June 5-9, 2023
DISCLOSURE OF RELEVANT FINANCIAL RELATIONSHIP(S) WITH INDUSTRY

• Nothing to disclose

REFERENCES TO OFF-LABEL USAGE(S) OF PHARMACEUTICALS OR INSTRUMENTS

• Nothing to disclose

All relevant financial relationships have been mitigated.
LEARNING OBJECTIVES

- Identify risk factors for and presentation of congenital valve abnormalities, and choose appropriate management
- Outline risk factors for and recall the diagnosis, presentation, and management of aortic stenosis and hypertrophic cardiomyopathy
- Recognize the pathophysiology and presentation of mitral stenosis, select appropriate testing, and interpret the findings accurately
- Delineate risk factors for and recall the diagnosis and management of aortic regurgitation, mitral regurgitation, and tricuspid regurgitation
Valve disease and hypertrophic cardiomyopathy
OUTLINE

• Aortic valve disease
• Hypertrophic cardiomyopathy
• Mitral valve disease
• Tricuspid/pulmonary valve disease
• Pearls
QUESTION 1
A 91-year-old man with hypertension presents with new onset dyspnea. BP 150/85 mmHg, HR 76 bpm. Examination reveals a 3/6 systolic ejection murmur that is late peaking and reduced carotid upstrokes.

WHAT IS THE NEXT STEP IN MANAGEMENT?
1. Screen for hypertrophic cardiomyopathy
2. Refer for aortic valve replacement
3. Improve blood pressure control
4. Aortic balloon valvuloplasty
AORTIC STENOSIS (AS)
AORTIC STENOSIS
ETIOLOGY – AGE DEPENDENT

• <30 years old
  • Uni- or bi-cuspid valve
    • Bicuspid valve 1.8% population
    • Coexistent aortopathy

• 40-60 years old
  • Calcified bicuspid or rheumatic
    • Rheumatic more commonly affects MV

• >70 years old
  • Degenerative (calcific)
    • Most common cause
AORTIC STENOSIS
PRESENTATION

Angina

Syncope

Exertional dyspnea
AORTIC STENOSIS
NATURAL HISTORY

• Once severe and symptomatic, poor prognosis if untreated

• Life expectancy 2-5 years
AORTIC STENOSIS

• Listening posts for auscultation

- **AV** – 2\(^{nd}\) right intercostal (IC) space
- **PV** – 2\(^{nd}\) left IC space
- **TV** – 5-6\(^{th}\) left, parasternal IC space
- **MV** – 5-6\(^{th}\) left IC space, @ the apex

“All Patients Take Medicine”
ALL VALVE DISEASE TESTING
AORTIC STENOSIS
EXAMINATION

Stiff left ventricle

Later peak = more severe

Diminishes with ↑severity

Carotids: Parvus et tardus
AORTIC STENOSIS
SEVERITY

• The diagnosis of AS is made by auscultation on physical examination

• The assessment severity of AS is based on carotid delay
SEVERE AORTIC STENOSIS

TREATMENT

• Use caution with afterload reducing agents (beta-blockers, ACE-inhibitors)

• Operate when symptoms or ↓EF to <50% in asymptomatic

• Balloon valvuloplasty
  • Temporary
AORTIC STENOSIS
AORTIC VALVE REPLACEMENT

- No direct oral anticoagulants for mechanical valves
- Never too old, OK with low EF

Requires warfarin for life (INR 2.0-3.0), ± aspirin
Requires aspirin, last 10-15 years
TAVR (TAVI) – increasingly preferred option, 3-6 mo DAPT, then aspirin
AORTIC STENOSIS
MURMUR DIFFERENTIAL DIAGNOSIS

• **Hypertrophic cardiomyopathy** – normal carotids, increase with Valsalva

• **Pulmonary stenosis** – Increases with inspiration, normal carotids

• **Innocent murmur**
INNOCENT/FUNCTIONAL MURMUR

- Short duration, soft murmur
  - ≤ Grade 2 intensity
  - Upper sternal border
  - Systolic ejection pattern

- Normal S2, no other abnormal sounds

- No left ventricular enlargement on exam or left ventricular hypertrophy on ECG

- Commonly seen in any high flow state
  - Anemia, pregnancy
QUESTION 1 – ANSWER AND RATIONALE
A 91-year-old man with hypertension presents with new onset dyspnea. BP 150/85 mmHg, HR 76 bpm. Examination reveals a 3/6 systolic ejection murmur that is late peaking and reduced carotid upstrokes.

WHAT IS THE NEXT STEP IN MANAGEMENT?
1. Screen for hypertrophic cardiomyopathy
   Carotid artery upstroke would be normal, age not classic
✓ 2. Refer for aortic valve replacement
   Late peak = late disease & symptoms; TAVR increasing utilized
3. Improve blood pressure control
   Lowering afterload could precipitate ischemia, not best choice
4. Aortic balloon valvuloplasty
   Not a durable therapy

Otto et al. Circulation. 2021;143:e72–e227
QUESTION 2
A 63-year-old asymptomatic woman with remote history of syphilis presents with cardiac enlargement on chest x-ray. She has no other medical history.

WHAT IS THE MOST LIKELY EXAMINATION FINDING?

1. Irregularly irregular rhythm
2. “V” wave on jugular venous pulse
3. Midsystolic click
4. Diastolic decrescendo murmur
5. Opening snap
AORTIC REGURGITATION (AR)
AORTIC REGURGITATION
ETIOLOGY

Chronic

• Bicuspid valve
• Rheumatic
• Root dilatation
  • Hypertension, syphilis, Marfan’s, aortopathies
• Leaflet damage: Endocarditis, drugs

Acute

• Aortic dissection
• Endocarditis
• Trauma
AORTIC REGURGITATION

PRESENTATION

• Acute AR → pulmonary edema

• Chronic AR
  • Dyspnea, fatigue, bounding pulses
  • Often well tolerated
  • Ventricular enlargement over time
AORTIC REGURGITATION
EXAMINATION

Underwhelming in acute AR

DIASTOLIC

Austin flint murmur
(apical diastolic rumble)

BP = ↑ Pulse pressure
AORTIC REGURGITATION
EXAMINATION – EPONYMS!

• **Water-Hammer pulse** – forceful peripheral pulses
• **Traube’s sign** – pistol-shot femoral bruit
• **Corrigan’s pulse** – prominent carotid pulse
• **Quinke’s sign** – pulsatile nail bed on compression
• **De Musset’s sign** – head bobbing
• **Muller’s sign** – uvula bobbing
• **Duroziez’s sign** – to-and-fro femoral artery murmur
• **Geske’s sign** – lame “dad joke” humor hidden in talks
AORTIC REGURGITATION

TREATMENT

• Acute severe AR → surgery

• Chronic AR
  • Treat hypertension with afterload reduction (ACE-inhibitors, vasodilators)
    • No benefit if not hypertensive

• Valve replacement when symptoms or asymptomatic EF falls to <55%
BICUSPID AORTOPATHY

• Ascending aorta dilatation, replace when:
  • 5.5 cm
  • ↑ 0.5 cm in 1 year

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QUESTION 2 – ANSWER AND RATIONALE
A 63-year-old asymptomatic woman with remote history of syphilis presents with cardiac enlargement on chest x-ray. She has no other medical history.

WHAT IS THE MOST LIKELY EXAMINATION FINDING?

1. Irregularly irregular rhythm
   Atrial fibrillation not related to syphilis, LV enlarges in AR, not LA
2. “V” wave on jugular venous pulse
   Finding of tricuspid regurgitation; no relationship to syphilis
3. Midsystolic click
   Bicuspid aortic valve; could have aortopathy but no relationship to syphilis
4. Diastolic decrescendo murmur
   Aortic regurgitation results from syphilitic aortopathy
5. Opening snap
   Finding of rheumatic mitral stenosis
OUTLINE

• Aortic valve disease
• Hypertrophic cardiomyopathy
• Mitral valve disease
• Tricuspid/pulmonary valve disease
• Pearls
QUESTION 3
A 46-year-old man presents for screening of hypertrophic cardiomyopathy following his sister’s recent diagnosis. Which examination finding would suggest hypertrophic cardiomyopathy?

1. Systolic ejection murmur that becomes quieter with Valsalva maneuver
2. Diastolic rumble at the point of maximal impulse
3. Delayed carotid upstrokes
4. Paradoxically split S2
HYPERTROPHIC CARDIOMYOPATHY (HCM)

Thickening that is not secondary
HYPERTROPHIC CARDIOMYOPATHY

ETIOLOGY

- Most common heritable cardiomyopathy (1/500)
  - Autosomal dominant, incomplete penetrance, variable expression
  - Sarcomere genes
    - Beta-myosin heavy chain
    - Troponin T
    - Myosin binding protein C
- Screen 1st degree relatives
  - If gene known, can use to screen family
  - If gene unknown, use echocardiography
    - Annual in adolescence / sports
    - Every five years in adults
HYPERTROPHIC CARDIOMYOPATHY
PRESENTATION

• Benign/stable (normal longevity)
• Atrial fibrillation / stroke
• Heart failure
  • Exertional dyspnea, chest pain
  • Presyncope, syncope
• Sudden cardiac death
HYPERTROPHIC CARDIOMYOPATHY
OBSTRUCTION
HYPERTROPHIC CARDIOMYOPATHY
EXAMINATION

- Carotid upstrokes **NOT** delayed
- Paradoxically split S2
- Systolic ejection murmur
  - Sternal border
- Mitral regurgitation murmur
  - Systolic anterior motion of mitral valve
HYPERTROPHIC CARDIOMYOPATHY
MURMUR VS AORTIC STENOSIS

↑ HCM murmur with ↓ left ventricular volume

• Dehydration
• Squat to stand
• Valsalva maneuver
  • How to Valsalva?
MURMUR RESPONSE TO VALSALVA

**VALSALVA**

**HCM**

Systolic Ejection Murmur

*More narrow LVOT = louder*

**VALSALVA**

**AS**

Systolic Ejection Murmur

*Less blood through valve = softer*
HYPERTROPHIC CARDIOMYOPATHY
TREATMENT

• Beta-blockers, Ca-channel blockers are mainstay
• Avoid dehydration, vasodilators
• Shared decision-making for competitive athletics
• Prophylactic ICD for high-risk patients
• Septal reduction therapy for medically-refractory patients
HYPERTROPHIC CARDIOMYOPATHY
SEPTAL REDUCTION THERAPY

Surgical septal myectomy

Alcohol septal ablation

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HYPERTROPHIC CARDIOMYOPATHY
SEPTAL REDUCTION THERAPY – SIMPLIFIED

Surgical septal myectomy

Alcohol septal ablation

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QUESTION 3 – ANSWER AND RATIONALE
A 46-year-old man presents for screening of hypertrophic cardiomyopathy following his sister’s recent diagnosis. Which examination finding would suggest hypertrophic cardiomyopathy?

1. Systolic ejection murmur that becomes quieter with Valsalva maneuver
   Valsalva decreases preload; HCM $\rightarrow$ louder murmur, AS $\rightarrow$ quieter murmur

2. Diastolic rumble at the point of maximal impulse
   Finding of mitral stenosis, no relationship to HCM

3. Delayed carotid upstrokes
   Carotid upstrokes are normal in HCM, carotid tardus = AS

✓ 4. Paradoxically split S2
   LVOT obstruction delays A2 component of S2 $\rightarrow$ paradoxical splitting

Ommen SR et al. Circulation. 2020;142:e558–e631
OUTLINE

• Aortic valve disease
• Hypertrophic cardiomyopathy
• Mitral valve disease
• Tricuspid/pulmonary valve disease
• Pearls
QUESTION 4
A 52-year-old man has rheumatic mitral stenosis. What is an indication to refer for balloon valvuloplasty?

1. Left atrial appendage thrombus
2. Asymptomatic pulmonary hypertension
3. Loud S3
4. Moderate mitral regurgitation
MITRAL STENOSIS (MS)
MITRAL STENOSIS
ETIOLOGY

• Almost always **rheumatic**
  • Commissural fusion
• Calcified mitral annulus
• Drug-induced (same as AS)
MITRAL STENOSIS
PRESENTATION

• Increased left atrial pressure
  • Huge atria → Atrial fibrillation
  • Pulmonary hypertension

• Dyspnea on exertion, orthopnea

• Fatigue
MITRAL STENOSIS
NATURAL HISTORY

- Long plateaus
- Adverse prognosis once NYHA III/IV symptoms
MITRAL STENOSIS

EXAMINATION

• Palpable RV lift
• Opening snap*
• Diastolic rumble
• Loud S1*

What heart sound can’t you get with significant MS?

*S3

*Pliable MV


MITRAL STENOSIS
TREATMENT

• Gradient is heart rate dependent
  • Beta blockers

• Warfarin for all patients with atrial fibrillation
  • CHADS$_2$/CHADS$_2$Vasc doesn’t apply!

• Avoid inotropes – whipping the ventricle won’t help the cardiac output
SEVERE MITRAL STENOSIS
MITRAL BALLOON VALVULOPLASTY

- Consider for:
  - NYHA III-IV, or
  - Atrial fibrillation, or
  - Pulmonary hypertension

- Need pliable valve
  - Exam, echo

- Contraindicated: Moderate+ mitral regurgitation, left atrial thrombus
MITRAL STENOSIS
MITRAL VALVE REPLACEMENT

Requires warfarin for life (INR 2.5-3.5), ± aspirin

Requires aspirin, last 10-15 years
QUESTION 4 – ANSWER AND RATIONALE
A 52-year-old man has rheumatic mitral stenosis. What is an indication to refer for balloon valvuloplasty?

1. Left atrial appendage thrombus
   Intracardiac thrombus is a contraindication given stroke risk
2. Asymptomatic pulmonary hypertension
   NYHA III/IV symptoms, atrial fibrillation, or pulmonary hypertension
3. Loud S3
   Impossible in mitral stenosis (unable to rapidly fill LV)
4. Moderate mitral regurgitation
   Valvuloplasty may worsen MR; pursue valve replacement instead

Otto et al. Circulation. 2021;143:e72–e227
QUESTION 5
A 65-year-old woman presents with severe mitral regurgitation in the setting of a flail mitral valve. What is the lower limit of a normal ejection fraction in this patient?

1. 70%
2. 60%
3. 50%
4. I skip board questions that have lots of numbers
MITRAL REGURGITATION (MR)
MITRAL REGURGITATION
ETIOLOGY

Chronic
• Primary
  • Degenerative - #1 cause
    • Prolapse, flail segment
  • Rheumatic
  • Endocarditis

• Secondary (“functional”)
  • Ventricular problem (dilated, infarct)

Acute
• Ischemic complication (papillary muscle rupture)
• Endocarditis
MITRAL REGURGITATION
FLAIL POSTERIOR LEAFLET
MITRAL REGURGITATION
PRESENTATION

• Increased left atrial pressure
  • Atrial fibrillation
  • Pulmonary hypertension

• Dyspnea on exertion, orthopnea

• Fatigue
MITRAL REGURGITATION
EXAMINATION

Chronic
• Holosystolic murmur
• Diffuse, tapping apical impulse
• ± Pulmonary congestion
• ± Palpable S3

Acute
• Murmur may be subtle
• Sitting upright, ill-appearing
MITRAL REGURGITATION
EXAMINATION

Chronic severe MR

Acute MR

Diastolic rumble does not mean MS
MITRAL VALVE PROLAPSE

Late systolic murmur

S1

Click

S2

RV

LV

LA

Ao

S1

Click

S2

Courtesy of William Edwards, MD Mayo Clinic
MITRAL VALVE PROLAPSE

Shorter patient $\rightarrow$ shorter murmur

$\uparrow$ LV volume (squat) $\rightarrow$ Less valve redundancy & late click

$\downarrow$ LV volume (stand) $\rightarrow$ More valve redundancy & early click
MITRAL REGURGITATION
TREATMENT

Chronic MR
- Treat hypertension
- Surgery for severe disease
  - Operate for symptoms or EF <60%
    - May be “too late” – early repair?

Acute MR
- Acute papillary muscle rupture → surgical emergency
- Endocarditis → Operate if heart failure
MITRAL REGURGITATION

MITRAL VALVE INTERVENTION

Repair preferred, dependent on surgeon skill

Requires warfarin for life (INR 2.5-3.5), ± aspirin

Requires aspirin, last 10-15 years

High risk patients, both primary and secondary MR
QUESTION 5 – ANSWER AND RATIONALE
A 65-year-old woman presents with severe mitral regurgitation in the setting of a flail mitral valve. What is the lower limit of a normal ejection fraction in this patient?

1. 70%
   - ↑preload and ↓afterload often result in hyperdynamic EF

✓ 2. 60%
   - EF drops when correcting MR, so a higher cutoff is used for normal

3. 50%
   - This is a normal lower limit for EF

4. I skip board questions that have lots of numbers
   - We can still be friends

Otto et al. Circulation. 2021;143:e72–e227
OUTLINE

• Aortic valve disease
• Hypertrophic cardiomyopathy
• Mitral valve disease
• Tricuspid/pulmonary valve disease
• Pearls
TRICUSPID REGURGITATION (TR)

Blood leaking back into right atrium
TRICUSPID REGURGITATION

ETIOLOGY

• Rheumatic
• Endocarditis (IV drug use)
• Carcinoid
• Annular dilatation
• Pacemaker lead mediated
• Ebstein’s anomaly
TRICUSPID REGURGITATION
PRESENTATION = RIGHT HEART FAILURE

Congestive hepatopathy

Edema

Ascites
TRICUSPID REGURGITATION
EXAMINATION

- Holosystolic murmur
  - How tell not MR?
    - Increases with inspiration

- Right ventricular lift
- Jugular venous distention, v-wave
- Pulsatile liver
TRICUSPID REGURGITATION

TREATMENT

Medical

• Observe asymptomatic disease
• Diuresis

Surgical

• Often can repair instead of replace (annuloplasty band)
• Repair moderate+ TR if other cardiac surgeries
THE REST...

• Pulmonary regurgitation
  • Pulmonary hypertension, endocarditis, carcinoid
  • Post-operative Tetralogy of Fallot

• Tricuspid stenosis
  • Rare, think carcinoid

• Pulmonary stenosis
  • Congenital heart disease, in adult → carcinoid
  • Treatment = Balloon valvuloplasty
PROPHYLACTIC ANTIBIOTICS

1. Prosthetic valves
2. Prior endocarditis
3. Complex congenital heart disease
4. Transplant recipients who develop valvulopathy

EVERYONE ELSE?
OUTLINE

• Aortic valve disease
• Hypertrophic cardiomyopathy
• Mitral valve disease
• Tricuspid/pulmonary valve disease
• Pearls
PEARLS

• Exam is important

• Symptoms in AS are chest pain, dyspnea and syncope; never too old to correct severe AS

• AR can be valvular or related to the aorta; treat hypertension

• HCM is hereditary; 1st line therapy = beta-blockers or Ca-blockers

• MS is rheumatic; slow heart rate; anticoagulate for AFib

• Operate for severe MR with any symptoms or EF <60%; consider early repair

• TR→right heart failure; 1st line therapy = diuretics
THANK YOU
THANK YOU FOR JOINING US IN THIS COURSE

Rochester, Minnesota
Phoenix, Arizona
Jacksonville, Florida