Valvular Heart Disease

No.7

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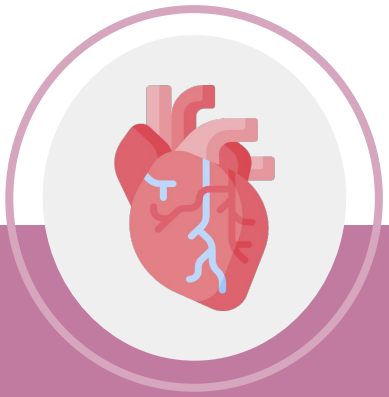

Objectives :

- ★ Describe the etiology, pathology, and natural history of valvular heart disease.
- ★ Describe the clinical symptoms and signs of valvular heart disease.
- ★ Explain the clinical examination findings of particular valvular problems.
- ★ Determine the role of echocardiograms in valvular heart disease, both in diagnosis and prognosis.
- ★ Discuss the long-term systemic consequences of valvular heart disease.
- ★ Describe the management and identify the indications of surgical intervention for particular valvular heart diseases.

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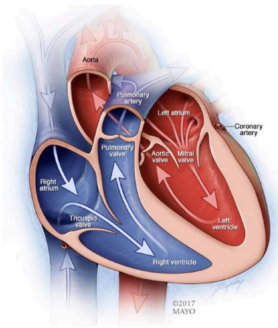
Valves and Heart sounds

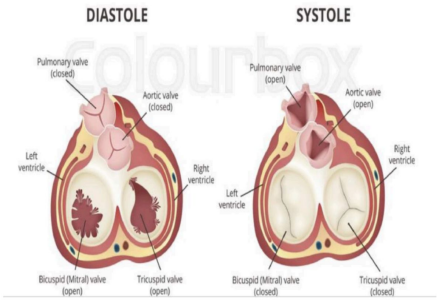
◄ What are heart valves ?

- Cardiac structures that maintain continuous free forward blood flow without backward leakage.
- There are four main cardiac valves divided into 2 groups:
- Atrioventricular valves :
  - Mitral valve
  - Tricuspid valve
- Semilunar valves:
  - Aortic valve
  - Pulmonic valve

◄ Characteristics of heart valves

Valve	Structure	Site of auscultation	Open in	Sound
Mitral valve	Bicuspid	Left 5th intercostal space at the midclavicular line (Apex)	Diastole	S1 (LUB)
Tricuspid valve	Tricuspid	Left 5th intercostal space at the sternal border		
Aortic valve	Semilunar	Right 2nd intercostal space at the sternal border	Systole	S2 (DUB)
Pulmonary valve	Semilunar	Left 2nd intercostal space at the sternal border		

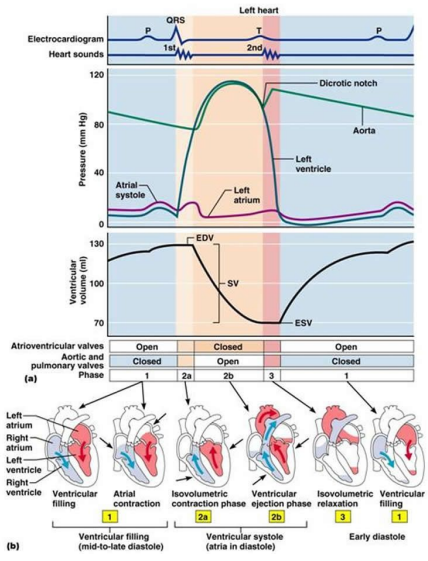


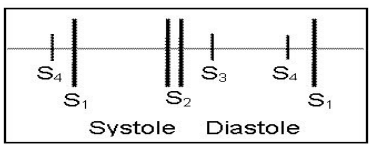


◄ Heart sounds

i 16.8 Normal and abnormal heart sounds

Sound	Timing	Characteristics	Mechanisms	Variable features
First heart sound (S1)	Onset of systole	Usually single or narrowly split	Closure of mitral and tricuspid valves	Loud: hyperdynamic circulation (anaemia, pregnancy, thyrotoxicosis); mitral stenosis Soft: heart failure; mitral regurgitation
Second heart sound (S2)	End of systole	Split on inspiration Single on expiration (p. 447)	Closure of aortic and pulmonary valve A_2 first P_2 second	Fixed wide splitting with atrial septal defect Wide but variable splitting with delayed right heart emptying (right bundle branch block) Reversed splitting due to delayed left heart emptying (left bundle branch block)
Third heart sound (S3)	Early in diastole, just after S2	Low pitch, often heard as 'gallop'	From ventricular wall due to abrupt cessation of rapid filling	Physiological: young people, pregnancy Pathological: heart failure, mitral regurgitation
Fourth heart sound (S4)	End of diastole, just before S1	Low pitch	Ventricular origin (stiff ventricle and augmented atrial contraction) related to atrial filling	Absent in atrial fibrillation A feature of severe left ventricular hypertrophy
Systolic clicks	Early or mid-systole	Brief, high-intensity sound	Valvular aortic stenosis Valvular pulmonary stenosis Floppy mitral valve Prosthetic heart sounds from opening and closing of normally functioning mechanical valves	Click may be lost when stenotic valve becomes thickened or calcified Prosthetic clicks lost when valve obstructed by thrombus or vegetations
Opening snap (OS)	Early in diastole	High pitch, brief duration	Opening of stenosed leaflets of mitral valve Prosthetic heart sounds	Moves closer to S2 as mitral stenosis becomes more severe. May be absent in calcific mitral stenosis

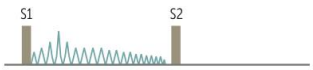




murmurs

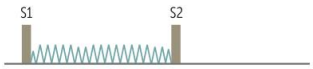
Systolic

Aortic Stenosis



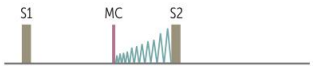
- **Crescendo-decrescendo systolic ejection murmur** same in HCM
- soft S2 (ejection click may be present).
- radiates to carotids (murmur in HCM doesn't radiate).
- "Pulsus parvus et tardus"—pulses are weak with a delayed peak.

Mitral/tricuspid regurgitation



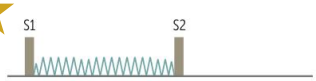
- **Holosystolic, high-pitched "blowing murmur"**
- Mitral—loudest at apex and radiates toward axilla
- Tricuspid—loudest at tricuspid area

Mitral valve prolapse



- **Late systolic crescendo murmur with midsystolic click (MC)** due to sudden tensing of chordae tendineae as mitral leaflets prolapse into the LA (chordae cause crescendo with click)
- Best heard over apex. Loudest just before S2

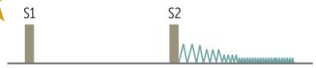
Ventricular septal defect



- **Holosystolic, harsh-sounding murmur**
- Loudest at tricuspid area. Larger VSDs have a lower intensity murmur than smaller VSDs.

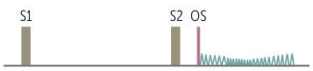
Diastolic

Aortic regurgitation



- **High-pitched "blowing" early diastolic decrescendo murmur**
- Best heard at base (aortic root dilation) or left sternal border (valvular disease)

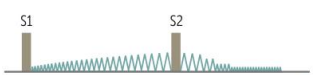
Mitral stenosis



- **Delayed rumbling mid-to-late diastolic murmur**
- Follows opening snap (OS; due to abrupt halt in leaflet motion in diastole, after rapid opening due to fusion at leaflet tips).
- (□interval between S2 and OS correlates with □ severity)

Continuous

Patent ductus arteriosus



- **Continuous machine-like murmur**
- Best heard at left infraclavicular area
- Loudest at S2

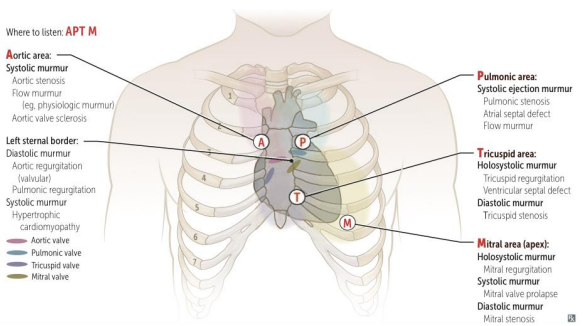
Other

Carotid bruit

- **continuous murmur in neck** that increases in intensity during systole
- The murmur disappears with pressing on the sides of the neck
- result of carotid artery stenosis which is a risk for stroke & transient ischemic attacks

Atrial septal defect

- **Mid-systolic murmur at the pulmonic region** with a **diastolic rumble along the left sternal border**.
- The second heart sound is split and fixed relative to respiration

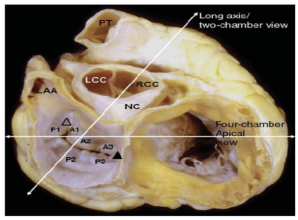


MANEUVER	CARDIOVASCULAR CHANGES	MURMURS THAT INCREASE WITH MANEUVER	MURMURS THAT DECREASE WITH MANEUVER
Standing Valsalva (strain phase)	↓ preload (↓ LV volume)	MVP (↓ LV volume) with earlier midsystolic click HCM (↓ LV volume)	Most murmurs (↓ flow through stenotic or regurgitant valve)
Passive leg raise	↑ preload (↑ LV volume)	Most murmurs (↑ flow through stenotic or regurgitant valve)	MVP (↑ LV volume) with later midsystolic click HCM (↑ LV volume)
Squatting	↑ preload, ↑ afterload (↑ LV volume)		
Hand grip	↑↑ afterload → ↑ reverse flow across aortic valve (↑ LV volume)	Most other left-sided murmurs (AR, MR, VSD)	AS (↓ transaortic valve pressure gradient) HCM (↑ LV volume)
Inspiration Opposite in expiration	↑ venous return to right heart, ↓ venous return to left heart	Most right-sided murmurs	Most left-sided murmurs

Introduction to VHDs

What is Valvular Heart Disease (VHD) ?

- Acquired or congenital cardiac abnormality of the heart valves that interfere with their normal function.



Surgeon view[1]

Valvular heart diseases (VHDs) Classification

- **VHD**
  - **Systolic**
    - Aortic/Pulmonic stenosis
    - Mitral/Tricuspid regurgitation
  - **Diastolic**
    - Aortic/Pulmonic regurgitation
    - Mitral/Tricuspid stenosis

Hemodynamic consequences (Important)

Hemodynamic consequences of VHD[2]

- **Pressure overload**
  - Aortic stenosis → Leads to **LV** hypertrophy[3]
  - Mitral stenosis → Leads to **LA** hypertrophy and dilation
- **Volume overload[3]**
  - Chronic mitral regurgitation → Leads to dilation of **LA** & LV
  - Aortic regurgitation → Leads to dilation of **LV** with high systolic blood pressure and low diastolic pressure due to peripheral vasodilation
  - Chronic Tricuspid Regurgitation → Leads to dilation of **RA** & RV

Investigations[4]

- **ECG**[5]
- **CXR**
- ★ **Echocardiogram:** **(Best initial test for all VHDs)**
  - M mode, 2D ,3D, 4D,TEE, Doppler.
- **24hrs monitor for heart rhythm**
- **MRI**
- **Cardiac catheterization**[6] **(Most accurate)**
- **Exercise test.**

1- It is crucial that you know the anatomical relations of each valve
2- Volume overload⟶ LV dilation , Pressure overload ⟶ LV hypertrophy
3- Regurgitation is Volume overload, eventually high volume will affect your pressure somehow, but initial pathology is that there is a huge volume that is coming back to a chamber.
4- depend on the presentation, If I want to confirm whether there is a valve pathology or not your test is echo.
5- ECG define which chamber is enlarged. Eg: Lt. Axis deviation means LV is enlarged or hypertrophied or that there's a Left Bundle Branch Block (LBBB). Rt. Axis deviation means RV enlarged or hypertrophied or that there's a Right Bundle Branch Block (RBBB
6- 2 Types. Right heart catheterization: Gives the physician the mean pulmonary capillary pressure, which is a reflection of the left arterial pressure. Left heart catheterization: Gives the pressure in the left ventricle.

Introduction to VHDs

◀ Types of pathology

Stenosis : Narrowing that leads to obstruction of flow

Regurgitation : Backward leakage of blood

◀ Stages of VHD

Stage	Definition	Description
A	At risk	• Patients with risk factors for development of VHD.
B	Progressive	• Patients with progressive VHD (Mild-Moderate) (Asymptomatic)
C	Asymptomatic severe	• Asymptomatic but reached the criteria of severe VHD: **C1:** Asymptomatic with compensated cardiac function. **C2:** Asymptomatic but decompensated cardiac function.
D	Symptomatic severe	• Developed symptoms secondary to VHD

◀ Types of presentations

Acute	Chronic
e. g Acute mitral regurgitation due to eg acute myocardial infarction acute chordae tendineae rupture	e.g Chronic mitral regurgitation due to eg RHEUMATIC fever . Mitral valve Prolapse . e.g Chronic aortic regurgitation due to eg Bicuspid Aortic valve

◀ Etiology of VHD

Stenosis	Regurgitation
congenital	Congenital
Rheumatic	Rheumatic
Degenerative / Senile	Degenerative e.g myxomatous, calcification
Drugs	Infective endocarditis
Radiation	valve ring dilatation e.g Dilated Cardiomyopathy
	infection e.g syphilis
	Traumatic
	Ischemia

◀ Etiology of VHD

Congenital	Acquired
• Bicuspid or unicuspid • Subvalvular or supravalvular	• Rheumatic • Degeneration: myxomatous and calcification • Ischaemic • Infective Endocarditis • Valve ring dilatation

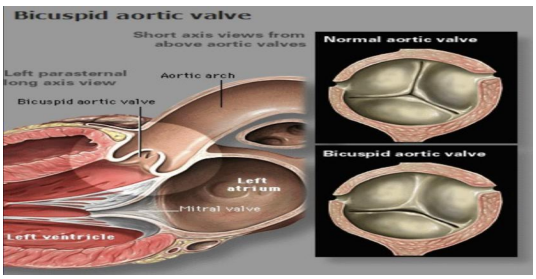
◀ Symptoms and signs of VHD

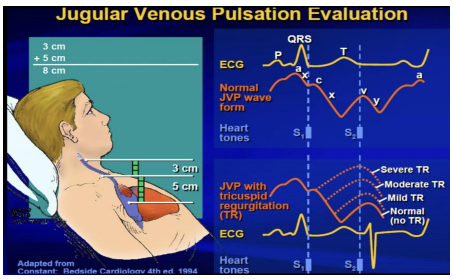
Symptoms	Signs
• Dyspnea, paroxysmal nocturnal dyspnea orthopnea • Palpitation • Chest pain • Dizziness, pre fainting, syncope • Oedema, Ascites • Cough • Fatigue • Hemoptysis • Symptoms of thromboembolic complication	• Abnormal look (mitral facies) • Abnormal pulse (Atrial fibrillation) • Abnormal JVP • Apex beat abnormality • Sternal or parasternal heave • Thrill • Abnormal heart sound • MURMURS • Systolic or Diastolic

◀ Investigations

- ECG, CXR, TEE, Doppler, 24 hours monitor for heart rhythm, MRI .
- Echo cardiology. M mode, 2D, 3D, 4D.
- Cardiac catheterization.
- Cardiac complication.

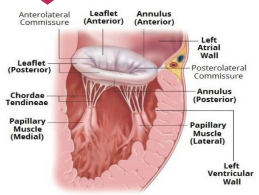
◀ Pictures



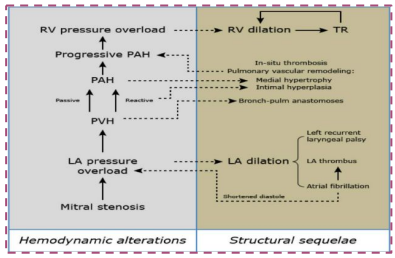


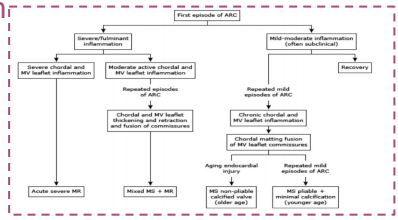
1- Mitral stenosis (MS)

◀ Definition



- It is the **restriction and narrowing** of the Mitral valve with impairment of left ventricular filling.
- **Etiology:**
  - **Almost always due to rheumatic heart disease.**
    - 25% alone, 40% with MR, 35% with AV, 6% with TV
  - **Other causes include:** Bacterial Endocarditis, Congenital mitral stenosis (Shone syndrome) , Systemic Lupus Erythematosus (with libman sacks endocarditis), Rheumatoid Arthritis, Atrial Myxoma[3], Malignant carcinoid with lung metastasis or patent foramen ovale, Drug induced (Methysergide), Radiation induced, Calcific (Especially in old people), Fabry's disease, Whipple's disease, Mucopolysaccharidosis.
  - Rheumatic Fever which is related to streptococcus infections, causing damage to the mitral valve and leading to mitral stenosis later in life.





◀ Pathophysiology

- In rheumatic mitral stenosis, the mitral valve orifice is slowly diminished by progressive **fibrosis**, **calcification** of the valve leaflets, and **fusion** of the cusps and subvalvular apparatus.
- The mitral valve orifice is normally about 5 cm^2 in diastole but can be reduced to <1 cm^2 in severe mitral stenosis. **The patient is usually asymptomatic until the orifice is < 2 cm^2.**

01 Increase in left atrial pressure (Hallmark of MS):

A. As stenosis progresses, left ventricular filling becomes more dependent on left atrial contraction. Mitral valve stenosis → increase in left atrial pressure[1] →backup of blood into lungs → increased pulmonary capillary pressure → cardiogenic **pulmonary edema** → pulmonary hypertension → backward heart failure, right ventricular hypertrophy and secondary tricuspid regurgitation (LV is protected)

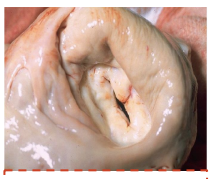
★ **B.** **Atrial fibrillation**[2] is very common due to progressive **dilatation of the LA.**

02 Limited LV filling & Cardiac output

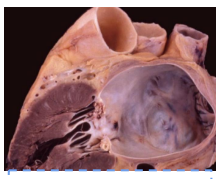
A. Mitral valve stenosis → obstruction of blood flow into the left ventricle (LV) → limited diastolic filling of the LV (↓ end-diastolic LV volume) → decreased stroke volume → decreased cardiac output

◀ Integrity of the valve in mitral stenosis

1. **Cusps thicken**
2. **Calcium deposits form**
3. **Commissures fused together**
4. **Chordae tendineae becomes thickened and shortened**



Fish mouth appearance due to fusion of the commissures



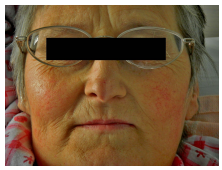
Pressure overload :LA, RV, RA & pulmonary tree LV protected

1- Situations that demand an increase in cardiac output, such as pregnancy and exercise, also increase left atrial pressure and are poorly tolerated.
2- Its onset often precipitates pulmonary oedema because the accompanying tachycardia and loss of atrial contraction (↓ Atrial kick) lead to marked haemodynamic deterioration (↓LV filling) and a rapid rise in left atrial pressure.
3- It's a benign tumor that arises from the atrial septum blocking the mitral valve

1- Mitral stenosis *(cont.)*

◀ Signs & Symptoms

- It's a progressive lifelong disease.
- Slow and stable initially then progressive acceleration years later
- Long latent period post RF (Symptoms onset ~ 10 years after RHD)
- All signs and symptoms will increase with exercise and during pregnancy.



STENOSis

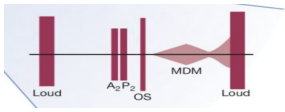
Symptoms

- **Hallmark: Increased LA pressure (**Afib, Pulmonary hypertension**)**
- **Dyspnea on exertion**[3] and Poor exercise tolerance
- **Fatigue, syncope** (Due to↓ cardiac output).
- **Odema & Ascites:** Inability to tolerate the increased volume
- **Pulmonary edema:** develops when there's a sudden ↑ in flow rate across a markedly narrowed mitral orifice.
- **Orthopnea, PND** and **Palpitation** (Due to AF which is caused by LA Enlargement)
- **PHT symptoms:** Right HF, hemoptysis(10%) (Due to rupture of thin dilated bronchial veins)
- **Stroke or peripheral Embolism secondary to Atrial fibrillation (AF)**
- **Ortner's syndrome:** which is hoarseness due to left recurrent laryngeal nerve compression by the dilated LA.
- **Peripheral edema**

Heart failure signs and symptoms

Signs

- **Face (Cyanosis): Mitral facies** (Malar flush) pink purple plaques on cheeks (due ↑ Systemic vasoconstriction)
- **Pulse:** Regular (sinus), Irregularly irregular with AF, Low volume.
- **JVP:** Prominent a wave in sinus rhythm **(Absent in AF)**



- **Heart sounds:** loud 1st heart sound only with mitral and tricuspid stenosis
  - **Loud S1**[1,5] Pliable MV when leaflets are still pliable, can be palpable (Tapping apex beat)
  - **Loud P2** (due to pulmonary hypertension) which is followed by an opening snap
  - **Opening snap**[1] Pliable MV of the mitral valve after a Normal S2: A high frequency, early diastolic sound that can mimic a split second heart sound. Caused by thickened valve leaflets as they open (Earlier OS indicates severe MS)[2]
- **Murmur:** Low pitched **mid-diastolic rumble** at the apex with presystolic accentuation[4] . **The murmur is localised and does not radiate!**
- **S3 CANNOT BE HEARD IN MITRAL STENOSIS**
- Right ventricular heave (lift) "Parasternal heave" due to pulmonary hypertension
- Signs of pulmonary hypertension. (Due to back of the pressure)
- What Heart Sound can't you get with significant MS? S3

◀ Complications

ABCD

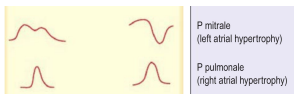
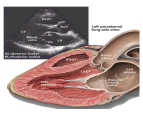
- **A**trial fibrillation & **C**lots with systemic embolization
- P(**B**)ulmonary hypertension & Lung congestion
- **C**ongestive heart failure (CHF)
- **D**ysphagia (Due to compression of the esophagus by LA)

1- However, the first heart sound and opening snap may be inaudible if the valve is heavily calcified.
2- What indicates severe MS? Presence of pulmonary HTN, Shorter interval between S2 and opening snap, Prolonged mid diastolic murmur.
3- First bouts of dyspnea in patients with MS are usually precipitated by exercise, emotional stress, infection, or Atrial fibrillation all of which increase the rate of blood flow across the mitral orifice and result in further elevation of left atrial pressure → pulmonary venous congestion.
4- Typically heard best at the 5th left intercostal space at the midclavicular line (the apex). Heard loudest with the bell of stethoscope when the patient is lying on his/her side (left lateral decubitus position). The murmur is accentuated by exercise and during atrial systole (pre-systolic accentuation). Since it's low pitched it Increases with squatting/leg raising and decreases with standing/valsalva maneuver. If there was coexisting MR there will be a pansystolic murmur that radiates to axilla.
- **Orthopnea, SOB, PND:** backward pressure symptoms due to elevated pressure of the LA, PCWP, Pulmonary HTN
5- This occurs because the increased left atrial pressure in early mitral stenosis forces the mobile portion of the mitral valve leaflets far apart. At the onset of ventricular systole, they are forced closed from a relatively far distance, resulting in a loud S1.

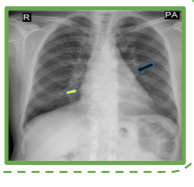
1- Mitral stenosis *(cont.)*

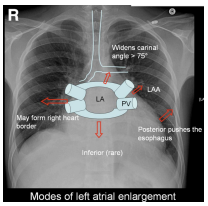
◀ Diagnosis

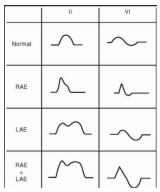
Right ventricular enlargement -> epigastric pulsation
Left atrial enlargement -> obstruction in the esophagus

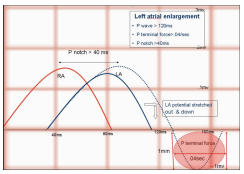
Investigation	Findings / notes
Clinical	• Clinical evaluation of Mitral Stenosis begins with an in-depth history and physical exam. • Bloods, FBCs, U&Es, Cholesterol, clotting, ECG exercise testing and echodoppler
ECG & ECG exercise stress testing	• **Atrial fibrillation (AF), right atrial enlargement**[1] (P pulmonale), signs of right ventricular hypertrophy (Sokolow-Lyon index). RV enlargement will cause right axis deviation • **left atrial enlargement (P mitrale): Broad notched (bifid) p waves.** 
★ **Echo (Gold standard)**	• Thickened immobile cusps, decreased mitral valve area, enlarged left atrium, Reduced rate of diastolic filling of left ventricle. • Hockey stick appearance: classic for MS 
Cardiac cath	• **Required if surgery or valvuloplasty is being considered**, to screen for coexisting conditions such as CAD.
CXR	• **Left atrial enlargement (LAE):** straightening of the left heart border & a double shadow(because it'll be enlarged) • **Late in the course:** Pulmonary congestion (Kerley B lines) and prominent PA, Calcified MV. • Dorsal displacement of the esophagus (visible in barium swallow test) 
Other	• 2D Echocardiogram, Doppler Study and TransEsophageal Echocardiography

We see mitralization (ruler sign): Straightening of the left heart border as well as pushed "right atrial deviation" to the side on a CXR due to prominence of the left atrial appendage or the pulmonary outflow tract. **A double shadow** reflecting how big the atrium is.









◀ Management

- Patients with **mild symptoms can be treated medically** but intervention by balloon valvuloplasty, mitral valvotomy or mitral valve replacement should be considered if the patient remains symptomatic **despite medical treatment or if pulmonary hypertension develops**.

Treatment of symptomatic mitral stenosis

1- Medical therapy (Treat the symptoms)

1. **Treatment of HF: ONLY** Diuretics[2] and Na restriction
2. **AF control:** (More details in arrhythmias lecture)
   a. ★ Digoxin (Digitalis), Beta[3] & Ca channel blockers, Antiarrhythmic, Anticoagulation (Warfarin).
3. **Endocarditis prophylaxis:** to prevent endocarditis (No longer routinely recommended)
4. Antibiotics

2- Surgical therapy (Treat the cause)

if the valve area < 1 cm^2 we should do open heart surgery

You choose according to the severity of the condition[4]:

1. **First line: Percutaneous mitral Balloon commissurotomy (PMBC) AKA. mitral valvuloplasty** if the following criteria are fulfilled:
   a. Mobile, non calcified valve on echo
   b. No LA thrombus
   c. No or mild mitral regurgitation

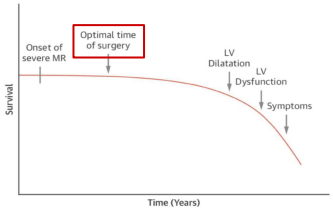
   PERCUTANEOUS TRANSVENOUS MITRAL COMMISSUROTOMY (PTMC)
2. **Alternatives: Open surgical Commissurotomy[4], Mitral Valve Replacement[4]**

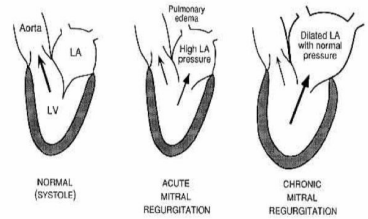
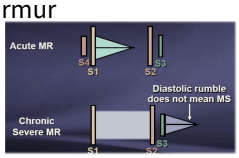
1- Eventually because of Tricuspid regurgitation. Continuous wave (CW) Doppler can be used to estimate of pulmonary artery pressure through measurement of the degree of tricuspid regurgitation.
2- ACE inhibitors and other afterload-reducing drugs are contraindicated because they cause dilation of peripheral blood vessels, which may lead to cardiovascular decompensation! Also In pregnant women it is better to do PMBC because diuretics can cause intrauterine growth retardation.
3- beta blockers : medication of choice, because you want to prolonged diastol > so to give enough time for blood in the atrium to go to the left ventricle.
4- Asses severity by Doppler echocardiography: (Always check for LA thrombus with TEE prior to surgery)
- Good leaflet morphology, no calcification → **Valvuloplasty** (the Wilkins score can also be used to determine if the valve is suitable for PMBC.)
- Leaflet/chordal thickening, Mild valve calcification → **Open commissurotomy**
- Severely scarred leaflets, moderate - severe calcification (cannot be re-opened without producing significant regurgitation), presence of mitral regurgitation or LA thrombus despite anticoagulation→ **Mitral valve replacement**

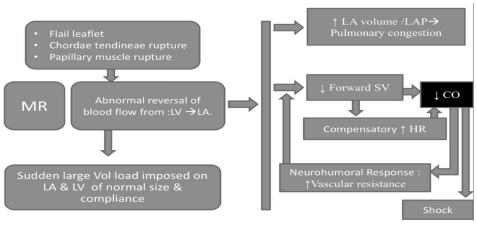
2- Mitral Regurgitation (MR)

◀ Definition & Types

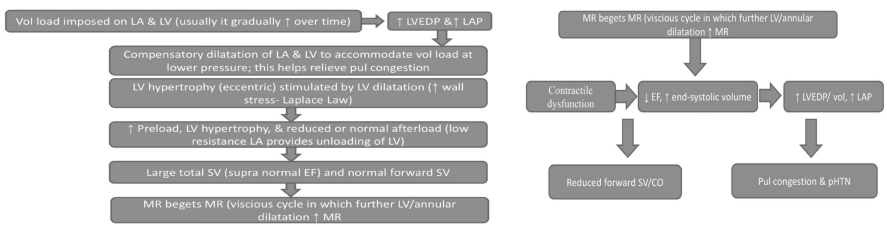
◆ Backflow of blood from the left ventricle into the left atrium, due to inadequate functioning (**insufficiency**) of the mitral valve.



	Acute MR	Chronic MR
Etiology	• **Infective Endocarditis** • **Papillary muscle rupture (post MI, Myocarditis)** • acute myocardial infarction • acute chordea tendineae rupture • Trauma • Chordal rupture/leaflet flail 	**Primary (Organic)** • **Myxomatous (Mitral Valve Prolapse)**[1] ★ **Rheumatic heart disease** Rheumatic fever • Endocarditis (healed) • Mitral annular calcifications • Congenital (cleft, AV canal/HOCM with SAM) • Radiation. Connective tissue disorders: SLE and collagen abnormalities: Marfan's syndrome **Secondary (Functional)** • **Ischemic (LV remodeling)** & Hypertensive heart disease • Cardiomyopathy (dilated,hypertrophic) **Note:** The abnormal & dilated LV causes Papillary muscle displacement which in turn results in leaflet tethering with associated annular dilation that prevents coaptation.
Symptoms	• Decompensated HF symptoms: **Dyspnea, orthopnea, PND**) • Low cardiac output state • **Cardiogenic shock**: due to the heart's inability to accommodate the fast changes	• Initially asymptomatic • HF symptoms (**Dyspnea,orthopnea, PND**, LL edema) • Decreased exercise tolerance • Palpitation with AF if present • PHTN symptoms if present
Signs	• Large volume collapsing pulse and prominent V wave on JVP • Tachycardia, Tachypnea, Hypotension. • Soft & Short early systolic decrescendo murmur • S4 heart sound 	• Large volume collapsing pulse and prominent V wave on JVP • Normal HR (Sinus AF may be present) • Normal/High BP • Laterally displaced (forceful) diffuse tapping apical impulse (PMI) +/- ★ palpable systolic thrill • **Normal/Soft (muffled) S1 heart sound** due the inability of mitral valve leaflets to close "while in MS it is loud" • S2 physiology or wide split due to premature AV closure • S3 (Prominent) in advanced stages of disease (Bc of the vibration of chordae tendineae) ★ S4 may be heard in functional MR • **High pitched holosystolic (pansystolic) murmur** (Louder at the apex and **radiates to left axilla**)[2]



Acute MR pathophysiology[3]



Chronic MR pathophysiology[4]

1- often associated with Marfan's syndrome which is an autosomal dominant connective tissue disorder that affects the microfibrils and elastin in connective tissue throughout the body. MFS is associated with disorders of the cardiovascular system (e.g., mitral valve prolapse, aortic aneurysm, and dissection), the musculoskeletal system (e.g., tall stature with disproportionately long extremities, joint hypermobility), and the eyes (e.g., subluxation of the lens of the eye).

★ 2- Louder with squatting or expiration (& that is a way to differentiate between MR and MVP since they have similar murmurs, but MVP gets better (fainter) with squatting and expiration) Heard loudest with the bell of stethoscope when the patient is lying on his/her side (left lateral decubitus position).

3- Acute mitral regurgitation causes a rapid rise in left atrial pressure (because left atrial compliance is normal) and marked symptomatic deterioration.

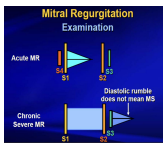
4- Chronic mitral regurgitation causes gradual dilatation of the LA with little increase in pressure and therefore relatively few symptoms. Nevertheless, the LV dilates slowly and the left ventricular diastolic and left atrial pressures gradually increase as a result of chronic volume overload of the LV

2- Mitral Regurgitation *(cont.)*

◄ Diagnosis

Investigation	Findings/notes
Clinical evaluation	**Acute:**[1] sitting upright, you can hear rales (wet lungs) and the murmur can be subtle. **Chronic:** diffuse, tapping apical impulse. May have pulmonary findings. S3 +/- palpable.
ECG	• LA enlargement (bifid P wave), AF and PHT findings • LV hypertrophy
Echo (Gold standard)	• Dilated left atrium and left ventricle • Dynamic left ventricle (unless myocardial dysfunction predominates) • Structural abnormalities of mitral valve Note: Consider Cardiac MRI if the findings of both TTE and TEE are inconclusive.
Cardiac cath	• Helpful for confirmation and prior to surgical intervention. • Needed if the patient is old/ suspected ischemic MR.

Other tests: Bloods, FBCs, U&Es, Cholesterol, clotting and ECG exercise testing



◄ Management

- **Surgical/percutaneous intervention is the gold standard for management**

Type	Treatment
Acute MR	**Surgical (Repair, replace)[2]:** All patients with acute MR should undergo surgery. **Medical:** Only temporarily while surgery is planned. The aim is to reduce symptoms: • **HF if present:** Diuretics, Vasodilators e.g. Nitrates, ACEI. • **Hypotension if present:** Inotropes e.g. Dobutamine • **AF if present:** Digoxin and anticoagulants (Details in arrhythmias lecture)
Chronic MR	**Medical:** Initiated in all patients to optimize cardiac function but surgery is the definitive Tx: • **Identify and treat the underlying cause** • **HF if present:** Diuretics, BB, Vasodilators e.g. Nitrates, ACEI. • **AF if present:** Digoxin and anticoagulants (Details in arrhythmias lecture) **Surgical (Repair "MitralClip" or replace)[2]: When is it indicated?[3]**

Management of mitral regurgitation

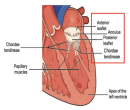
- Evidence of progressive cardiac enlargement generally warrants early surgical intervention by either mitral valve repair or replacement .
- Treatment with ACE inhibitors, diuretics and possibly anticoagulants .

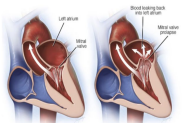
1- Check ECG and troponin in Acute MR to rule out MI.
2- Mitral valve **repair** is now the treatment of choice for severe mitral regurgitation, even in asymptomatic patients, because results are excellent and early repair prevents irreversible left ventricular damage, Do not wait for left ventricular end systolic diameter (LVESD) to become too large because the damage will be irreversible.
3- Surgery is **indicated in** patients with **symptomatic severe mitral regurgitation**, **left ventricular ejection fraction >30%** and **end-diastolic dimension of <55 mm,** and in **asymptomatic patients with left ventricular dysfunction (end-systolic dimension >45mm and/or ejection fraction of <60%).** Surgery should also be considered in patients with **asymptomatic severe mitral regurgitation with preserved left ventricular function and atrial fibrillation and/or pulmonary hypertension**.

3- Mitral valve prolapse (MVP)

◀ General characteristics

- Prolapsing (billowing) mitral valve. This is also known as Barlow syndrome or floppy mitral valve.
- It is due to excessively large mitral valve leaflets, an enlarged mitral annulus, abnormally long chordae or disordered papillary muscle contraction.
- **It's the most common cause of Mitral Regurgitation in developed countries[1].**
- **Etiology:**
  - Mostly idiopathic but it is associated with Connective tissue disorders (e.g. **Marfan's syndrome,** Ehlers-Danlos syndrome, Osteogenesis imperfecta) , thyrotoxicosis, rheumatic or ischaemic heart disease and autosomal dominant PKD





◀ Pathophysiology

- The most common underlying pathology in the case of mitral valve prolapse is **myxomatous degeneration** (deposition of glycosaminoglycan such as dermatan sulfate) of the mitral valve due to a primary disease or connective tissue disorder:
  - Long, floppy mitral valve leaflets with excessive valvular tissue → the mitral annulus becomes dilated and the chordae tendineae become elongated (and may rupture) → prolapse of one or both mitral valve leaflets into the left atrium during systole → Papillary muscle traction & Activation of stretch receptors → Papillary muscle and subendocardial ischemia → MR, Pain & Ventricular arrhythmias

◀ Signs & Symptoms

- **Mitral valve prolapse associated with severe mitral regurgitation has a risk of sudden cardiac death.**

Symptoms	★ **Most patient are asymptomatic for their entire live.** • **Atypical chest pain** is the most common symptom if any were present. • **Palpitations** may be experienced because of the abnormal ventricular contraction or because of the **atrial and ventricular arrhythmias** • Sudden cardiac death due to fatal ventricular arrhythmias is a very rare but recognized complication. Mitral valve prolapse + severe mitral regurgitation -> a risk of sudden cardiac death.
Signs	• **Mitral valve prolapse click:** High frequency, **Mid-systolic click** (**most common sign**) Produced by the sudden prolapse of the valve and the tensing of the chordae tendineae that occurs during systole. best heard at the mitral region, Increases with standing and valsalva maneuver but decreases with squatting • Followed by a Late systolic murmur that is best heard at mitral region and may radiate to axilla. (if associated with MR). • **If present with severe MR:** S3 may be heard (especially in left decubitus position)

For the diagnosis: Echocardiography is the test of choice[2]

◀ Treatment

No treatment is required in most cases. Just Beta blockers for the atypical chest pain and palpitations

- **Surgery is rarely required, this condition is benign. When is surgery required?**
  For patients with severe MR, mitral valve surgery (repair favoured over replacement) is indicated.
- **Treatment of complications if present:**
  - **Ventricular ectopics:** Avoid caffeine and give B-Blockers for symptoms relief
  - **IE**: MVP patient with past history of IE require IE prophylaxis
  - **Atrial fibrillation (AF):** Anticoagulation is advised to prevent thromboembolism.
  - **Transient ischemic attacks (TIA) and/or stroke:** Prophylactic aspirin

1- While 70% of patients with MVP have some form of mitral regurgitation, only 4% of patients with MVP have severe mitral regurgitation.
2- Echocardiographic definition of MVP: displacement of the mitral valve during systole by more than 2 mm above the mitral valve annulus in the parasternal long-axis view

Mitral S/R Cases

◀ Case study 1

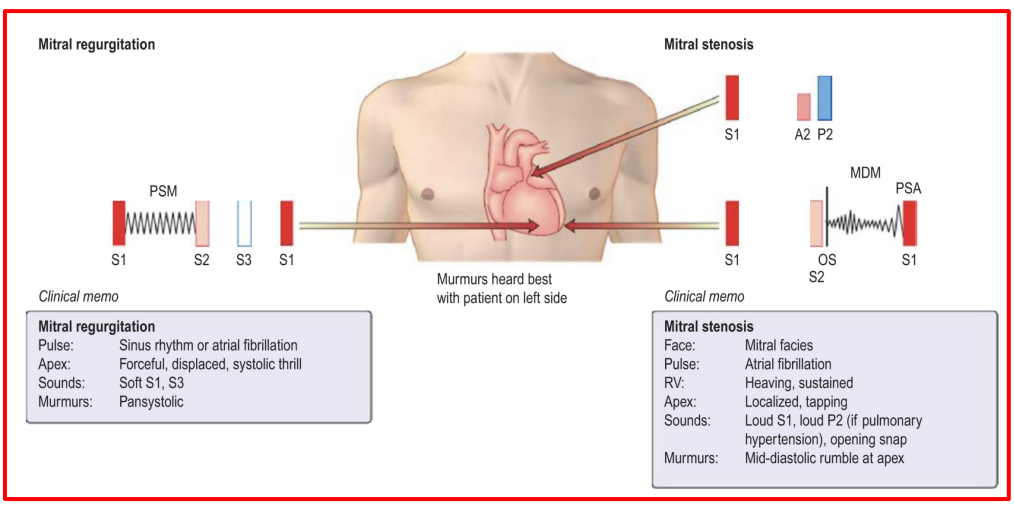
A 36-year-old woman who is 22 weeks pregnant presents with dyspnea and palpitations. Her dyspnea began at 16 weeks of pregnancy but has progressed to the point where she is dyspneic at rest. She sleeps upright in a chair. On examination, her heart rate is 108 beats per minute with an irregularly irregular rhythm. Her blood pressure is 90/64 mm Hg. the first heart sound is louder than the second heart sound at the base. here is a high-pitched, snapping, discrete, early diastolic sound that follows the second heart sound. here is a diastolic rumbling murmur heard over the apex with the patient positioned in the left lateral decubitus position. Pulmonary auscultation reveals bibasilar wet rales. he patient's jugular venous pressure is 16 cm H2O.

- **What is the diagnosis?** Mitral stenosis
- **What's the best initial test for this case?** Echocardiography to confirm the diagnosis as well as to appropriately stage the disease (measuring ventricular diameter, flow velocities, extent of regurgitation, etc.).
- **Echocardiography was performed and it showed a mobile, non calcified valve with no LA thrombus. The patient was given medical treatment initially but symptoms didn't go, what's the best next step in managing this patient?** Percutaneous mitral Balloon commissurotomy (PMBC)
- **What findings will most likely present on ECG?** Biphasic p wave in V1 (sign of LA enlargement) and others mentioned previously

◀ Case study 2

A 69-year-old woman with a history of hypertension and rheumatic heart disease in childhood presents to the clinic complaining of worsening shortness of breath with exertion, fatigue, and occasional palpitations. On physical examination, she appears in no acute distress, and her vital signs include a temperature of 37.0°C (98.6°F), blood pressure of 140/80 mm Hg, pulse rate of 80/min, respiratory rate of 12/min, and oxygen saturation of 99% on room air. Her physical examination is remarkable for mild crackles in both lung fields bilaterally, a laterally displaced point of maximum impulse, a diminished S1, and a 3/6 holosystolic murmur heard best at the apex and radiating to the axilla. The murmur is reduced with Valsalva maneuver.

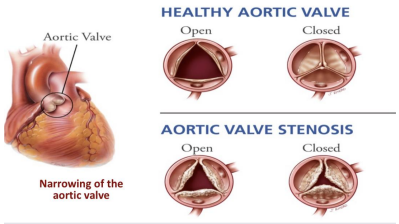
- **What is the diagnosis?** Mitral regurgitation
- **What medical management option exist?** Patients with symptoms of mitral regurgitation benefit from acute vasodilator therapy (which reduces preload on the left ventricle, thereby reducing the "stretching" pressure on the mitral valve orifice) or β-blockers, calcium channel blockers, hydralazine, or diuretics to reduce afterload and encourage forward flow. Additionally, patients with **rheumatic** MR and atrial fibrillation, or history of systemic embolization should receive anticoagulation. Patients with **nonrheumatic** MR should also receive anticoagulation, if they have atrial fibrillation or a history of embolization.
- **What surgical management option exist?** The surgical options in mitral regurgitation include mitral valve repair (also known as mitral valve annuloplasty) and mitral valve replacement. Repair has been shown to have better outcomes than replacement



4- Aortic stenosis (AS)

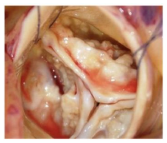
◀ Definition

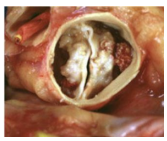
- It is a chronic progressive disease that produces obstruction to the left ventricular stroke volume leading to symptoms of chest pain, breathlessness, syncope and presyncope and fatigue.
- In contrast to patients with mitral stenosis, which tends to progress very slowly, patients with aortic stenosis typically remain asymptomatic for many years but deteriorate rapidly when symptoms develop; if otherwise untreated, they usually die within 3–5 years of presentation.
- **Differential diagnosis:** AS should be distinguished from these
  - Supravalvular obstruction (Murmur R carotid, ↑A_2)[1]
  - Subvalvular stenosis (Often leads to AR)[2]
  - Hypertrophic cardiomyopathy (HCM)[3]

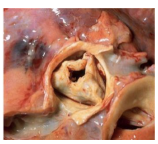


◀ Etiology

Age Sx appear	Etiology
★ >65 years old >70 years old	**Calcification and degeneration** of a normal valve **(Most common cause 80%)**. **Risk factors:** old age, male gender, elevated lipoprotein(a) and LDL, hypertension, diabetes and smoking.
< 65 years old	Congenital **Bicuspid Aortic valve*** (Most common in young)
30-60 years old	Rheumatic heart disease **Note:** Key feature here is that the mitral valve will be affected not only aortic Differential Diagnosis: Supravalvular - murmur R carotid, high A2. Subvalvular - often leads to AR, HCM


Degenerative[4]


Bicuspid[5]


RHD[6]

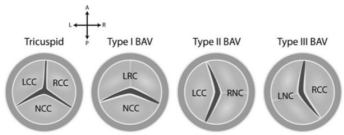
Other causes: CTD e.g. Rheumatoid

*Bicuspid Aortic Valve (BAV):

- Most common congenital abnormality of the heart with **males** being affected more than females.
- **1-2%** of the population Dr said that this is important, 1.8% of the population
- 70-80% of cases are due to fusion of the right & left coronary and non-coronary leaflets while 20-30% of cases are due to fusion of the right & non-coronary leaflets
- Sx presents on equal or less than 60 years old

Note: Fusion of the non coronary & left coronary leaflets is rare.

- Associated aortopathy (Medial degeneration) : aneurysm, dissection, coarctation and root dilation. So, they should have regular follow-up echo.
- Requires annual imaging if aorta > 4.5cm
- Beta blockers in absence of significant AI
- **Ask a replacement if:**
  - Aorta >5.5cm
  - Aorta >5cm with risk factors for dissection (e.g. FHX or progression of 0.5cm/y)
  - Aorta >4.5cm If AVR is indicated

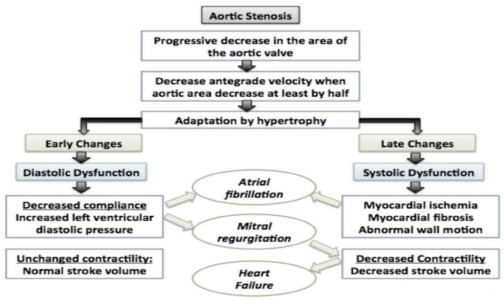


1- A congenital fibrous diaphragm above the aortic valve, often associated with mental retardation and hypercalcaemia (Williams syndrome)
2- A congenital condition in which a fibrous ridge or diaphragm is situated immediately below the aortic valve.
3- how to differentiate? Murmur in HCM gets better (fainter) with squatting/expiration, but worse with AS.
4- the leaflets themselves are thickened, with inflammatory degenerative changes and heavy calcification.
5- fusion between two cusps making only two cusps seen, calcification and degenerative changes.
6- Classical appearance in rheumatic: commissures got fused, one whole valve with no clear leaflet demarcations

4- Aortic stenosis *(cont.)*

◀ Pathophysiology

- Obstructed left ventricular emptying → ↑ left ventricular pressure (**pressure overload**) → compensatory left ventricular **concentric** hypertrophy (reduce wall stress, reduce ventricular Compliance, ↑ LVEDp & ↑ LAp, **Cardiac output is reduced**[1])★
- Forceful atrial contraction augments filling at the thick, non compliant ventricle and generates a prominent S4 gallop that elevates the left ventricular end-diastolic pressure.

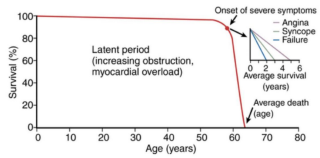


◀ Signs & Symptoms

- Aortic stenosis is commonly picked up in asymptomatic patients at routine clinical examination.
- Symptoms typically present on exertion, unless AS is severe (when valve area is < 1cm2)
- When symptoms develop the prognosis is poor

Symptoms

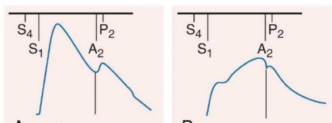
- **Classical triad (SAD): Syncope (exertional), Angina, Dyspnea (important)**
- **Angina** (most common) → imbalance between supply & demand → 5 yrs survival.
  - ↑ LVEDp → leads to ↓ coronary perfusion.
  - Myocardial hypertrophy → ↑ O2 demand.
- **Syncope** with exertion → 3 yr survival
- **Dyspnea**
- ★**Congestive heart failure** (CHF) → 2 yrs survival (the **worst**).

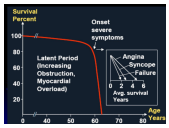


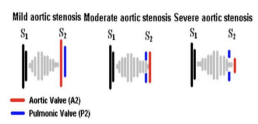
Survival is 6 months if you develop atrial fibrillation

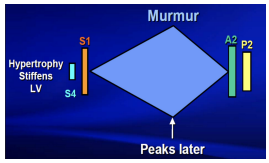
Signs

- **Pulses:**
  - ★**Pulsus Parvus et Tardus:** Low volume, slow rising, delayed upstroke carotid pulse
    - Narrow pulse pressure
    - Brachioradial delay.
- **Apex:** Sustained Bifid LV impulse (from LVH). (Not displaced PMI)
- ★Presence of a palpable systolic thrill at the base of the heart
- **Auscultation:**
  - ★**Harsh Crescendo-decrescendo (Diamond shape)[2,3], mid-to-late systolic ejection** murmur that **radiates bilaterally to the carotids.** (best heard in the aortic area)
    - **Gallavardin phenomenon:** High-pitched musical components of the murmur of aortic stenosis heard at the apex (the musical murmur).
  - ★**Soft S2** (When AV is immobile)**, reversed splitting** (Splitting of S2 on expiration)**, single S2 (soft or absent A2)**
    - **Prominent S4 gallop** (Caused by atrial contraction) → it is heard unless co-existing mitral stenosis prevent this. (Best heard at the apex)
  - ★Early systolic ejection click (due to abrupt stop of the leaflets upon opening) → It is heard unless the valve has become immobile and calcified









1-Initially CO is maintained but later the decreased distensibility of the LV reduces CO → Backflow into pulmonary veins → pulmonary venous congestion → Higher afterload (pulmonic pressure) on the right heart → Right HF → CHF

2- The murmur is often likened to a saw cutting wood and may (especially in older patients) have a musical quality like the 'mew' of a seagull.

★3- If the murmur's peak (The top of the diamond) is late → means severe disease. When early it is mild disease

4- Aortic stenosis *(cont.)*

◀ Investigations[1]

Test	Findings/notes
ECG	• **Signs of LVH**: **Deep S-waves** in V1 and V2, **Tall R-waves** in V5 and V6 and **Down-sloping ST segments** and **T inversion** ("strain pattern") • Normal axis or LAD • **Signs of left atrial enlargement:** Bifid & wide p wave • **ECG exercise stress testing:** May be used in asymptomatic patients. A positive test may be indicated by the onset of symptoms, ECG changes, or an abnormal BP response. **Note:** Nonspecific for AS (helpful but not diagnostic, so absent LVH doesn't rule out AS!)
CXR	• Typically demonstrates a small heart; cardiomegaly occurs if heart failure develops. • Dilated ascending aorta. • LV enlargement, rounded heart apex and calcification of Aortic valves 
Echo (Gold standard)	• Allow assessment the valve area, ejection fraction and ventricular hypertrophy.  • Calcification and narrowing of the aortic valve • Concentric hypertrophy and increased mean pressure gradient across the aortic valve.
Cardiac cath	• Most accurate test, used when echo is inconclusive • Mainly to identify associated CAD

Other tests: CBC, U&Es, lipids, coagulation profile and cardiac MRI

◀ Management

Symptoms are a good index of severity

Symptomatic

1. **Surgical therapy** (Treat the cause):
   a. **Aortic valve replacement (AVR)**[2] is the **only truly effective therapy for AS**, either with Bioprosthetic or Mechanical[3] AVR. **2 possible approaches:**
      i. **Surgical AVR:** Pts with low surgical risk
      ii. **Transcatheter AVR (Transfemoral, Transapical):** Pts with high surgical risk or contraindication
      TAVR: Transfemoral (TF) and Transapical (TA)
2. **Medical therapy** (Treat symptoms)
   a. Anticoagulants are required only in patients who have AF or those who have had a valve replacement with a mechanical prosthesis.
   b. **Hypertension is common:** Cautious use of vasodilators due to afterload reduction.[3]

Asymptomatic

1. Under **regular review for assessment** of symptoms and echocardiography
2. Surgical intervention for asymptomatic people with severe aortic stenosis is recommended in those with:
   a. symptoms during an exercise test or with a drop in blood pressure or an LVEF of <50%
   b. Those undergoing cardiac surgery

1- cardiac MRI, cardiac catheterization and ECG exercise stress test are "special tests" only done when you are not sure about the symptoms of the patient (e.g.: the patient has other underlying conditions) or patients with severe AS, and only done under supervision.
2- Delay exposes the patient to the risk of sudden death or irreversible deterioration in ventricular function. Old age is not a contraindication to valve replacement and results are very good in experienced centres, even for those in their eighties. Without definite treatment (surgery), more than 50% of the symptomatic patients with severe aortic stenosis will die within the first 2 years of diagnosis!
2- Which type of valve to use, mechanical or bioprosthetic? **Mechanical valves**, in general, result in better outcomes; they are preferred in patients with expected long life spans, those with a preexisting mechanical valve in a different location, those already requiring warfarin therapy due to thromboembolism risk factors, and those < 65 years old. A **bioprosthetic valve**, however, is preferred in patients who cannot or will not take warfarin and those > 65 years old who have no thromboembolic risk factors
3- because you might reduce their pressure a lot and exaggerate the gradient that they get between the ventricle and aorta > drop their pressure dramatically.

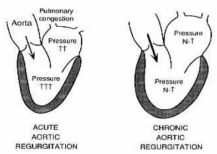
5- Aortic Regurgitation/Insufficiency (AR/AI)

◀ Definition

- Aortic Regurgitation (AR) is the **leaking of the aortic valve** of the heart that causes blood to flow from Aorta to the LV during diastole.
- This condition can result from either disease of the aortic valve cusps, infection, trauma or dilatation of the aortic root[2].
- Usually presents 4th-6th decades of life with males affected 3 time more than females.

Etiology

Valvular (aortic valve cusps)	Non-valvular (aortic root)
Infectious: IE, RF	Marfan
Congenital: BAV, Marfan	syphilis
Inflammatory: SLE, RA, Behcet	Ankylosing spondylitis
Degenerative: Myxomatous AV, calcific AV	Idiopathic aortitis
Trauma	Ehler danlos syndrome
Postaortic valvuloplasty	Aortic dissection
Drug induced: Fenfluramine	Trauma
	VSD

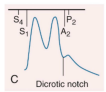
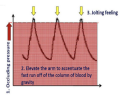


◀ Acute vs Chronic AR/AI

	Acute AR	Chronic AR
General info	• A medical emergency • The compensatory changes. seen in chronic disease do not have time to develop	• Patients may remain **asymptomatic** for many decades • Develops slowly with compensatory changes
Consequences	• Reduced coronary flow - the coronaries fill predominantly during diastole, regurgitant flow at this time reduces filling. Results in angina or in severe cases myocardial ischaemia. • Increased EDP- causes increased pulmonary pressures with resulting **pulmonary oedema** and dyspnoea. In severe cases, **cardiogenic shock** may occur.	• Increase in the left ventricular end-diastolic volume (essentially the preload). • Increased stroke volume compensating for regurgitant flow supported by the ventricular hypertrophy to maintain ejection fraction, with a greater preload leading to greater contractility (frank-starling law) • Eventually further increases in preload cannot be met by greater contractility and heart failure develops.
Causes	**Aortic root:** • **Aortic dissection** (ascending aorta) ★ **Valvular (Aortic valve cusps):** • **Infective endocarditis** • Chest trauma → Rupture of leaflet • Failure of prosthetic heart valve • Acute RF **Others:** Ruptured sinus valsalva aneurysm	**Aortic root:** • Hypertension (severe) • Connective tissue disorders e.g. **Marfan syndrome,** Ehlers-Danlos syndrome, osteogenesis imperfecta • Idiopathic Aortitis **Valvular (Aortic valve cusps):** • **Bicuspid aortic valve:** Most common cause of AR in young adults and developed countries • **Rheumatic heart disease:** Most common cause of AR in developing countries • Calcific degeneration **Others:** Tertiary syphilis, Arthritides (Reiter's syndrome, Ankylosing spondylitis and Rheumatoid arthritis) Aortic endocarditis
Symptoms	• Sudden, severe dyspnea • Chest pain • Symptoms of low CO & HF	• Exertional dyspnea • Chest pain

1- Best heard to the left of the sternum during held expiration
2- usually in pt who had syphilis, aneurysm, atherosclerosis, aortic dissection, Marfan syndrome

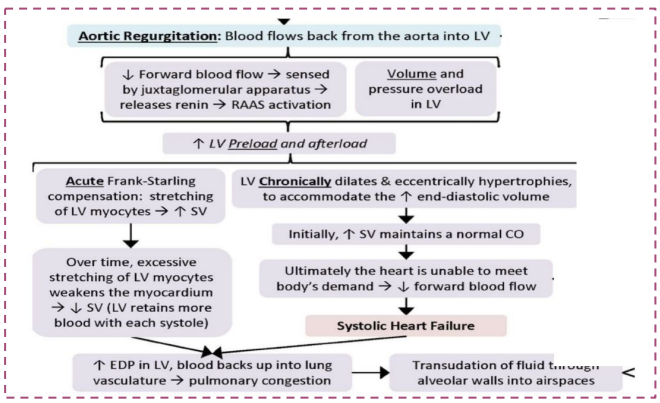
5- Aortic Regurgitation *(cont.)*

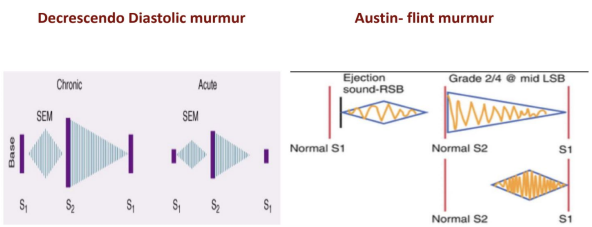
	Acute AR	Chronic AR
Signs	• **Cardiogenic shock & Heart failure:** Hypotension, tachycardia, elevated JVP...etc • Peripheral signs of chronic AI are usually absent because the body did not have time to develop the compensatory changes seen in chronic AI • S3+ Murmur is early, short, faint and may be absent • Very faint, short, non-compliant LV • May have few signs, Murmur .underwhelming **Note:** The classical signs of aortic regurgitation in such patients may be masked by tachycardia and an abrupt rise in left ventricular end-diastolic pressure. The pulse pressure may also be normal or near-normal and the diastolic murmur may be short or even absent.	**Murmurs:** ○ **Diastolic decrescendo blowing murmur (most typical)[1]** ★ **Austin Flint Murmur[2]:** soft Mid-diastolic murmur • **Point of maximal impulse (PMI):** displaced inferolaterally • Diffuse, and hyperdynamic LV • **BP:** High (150/50) with widened pulse pressure • **Pulse:** Pulsus bisfeirens/collapsing/waterhammer pulse • **HS:** Soft S1,2 (with S4, S3 Gallop in advanced AI) **Peripheral signs of AR[3]: Wide pulse pressure**   1. **De Musset's -** systolic nodding of the head. 2. **Quincke's -** capillary pulsation of nail beds. 3. **Corrigan's sign –** abrupt distension with prominent pulse then rapid collapse. 4. **Traube's (pistol shot femoral) –** systolic & diastolic bruit in the femoral artery 5. **Duroziez's - systolic** bruit in the femoral artery with **proximal** compression and **diastolic** sound with **distal** compression using the stethoscope. 6. **Müller's -** systolic pulsation of uvula. 7. **Hill's sign –** SBP in legs > 20 mmHg higher than SBA in arms.

◄ Pathophysiology[4]

- **Widened pulse pressure** → ↑ systolic BP and ↓Diastolic BP (collapsing pulse) Seen in hyperdynamic circulation (pregnancy, anemia, infection, thyrotoxicosis)
  - Stroke volume increased → (high Systolic BP).
  - Regurgitant volume increased → (Low Diastolic BP).
- **Imbalance between myocardial supply and demand:**
  - ↓ Diastolic BP → ↓ perfusion pressure → ↓ supply.
  - ↑ LV size (thus ↑ wall stress) → ↑ demand.

Note: If mitral regurgitation ensues, left ventricular failure develops, leading to a rise in left ventricular end-diastolic pressure and pulmonary oedema.





1- AR due to valvular disease is best heard in the left third and fourth intercostal spaces and along the left sternal border (Erb point) because the flow goes down unlike aortic stenosis which goes up. Whereas AR due to aortic root disease (e.g., aortic dissection) is best heard along the right sternal border. In more severe stages, there might be a harsh, crescendo-decrescendo mid-systolic murmur that resembles the ejection murmur heard in aortic stenosis

2- it resembles stenosis but it is NOT! (Because the 1st heart sound is normal). it is functional stenosis

3- The relevance of these signs in clinical practice today is questionable. They are used less and less nowadays because patients are not left long enough before treatment to develop these signs

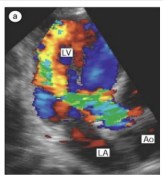
4- they will develop tachycardia as a compensatory mechanism, so if you give them beta blockers to reduce the HR, the diastol will prolongs and aortic regurgitation is a diastolic phenomena > increase regurgitation. So, they need this tachycardia to keep going and avoid long time of regurgitation.

5- Aortic Regurgitation *(cont.)*

◀ Investigations

Test	Findings/notes
ECG	• Left ventricular hypertrophy (deep S-waves in V1 and V2, tall R-waves in V5 and V6). • Left ventricular strain may be seen in severe disease.
CXR	• Cardiomegaly, calcifications, prominent aortic root/arch (Due to dilated aorta)
Echo (Gold standard)	• Allows visualisation of the origin of regurgitant jet & its width. Assess LV size and function. • Look for dilated aortic root and reversal of blood flow in aorta • in echo -> mosaic appearance indicates turbulent blood flow
Cardiac cath	• Dilated LV and aortic root

Other tests: CBC, U&Es, lipids, coagulation profile, cardiac MRI and ECG stress test



◀ Management

Acute AR (Usually symptomatic)	**Surgical therapy:** • Aortic valve replacement (AVR)[1] is indicated when symptoms develop **Medical therapy:** Vasodilators and inotropes

Chronic AR (Usually asymptomatic)	**Surgical therapy:**
	• Aortic valve replacement (AVR) is indicated in
	  ○ Symptomatic patients with chronic severe AR
	  ○ In asymptomatic with LVEF ≤ 50%
	  ○ Asymptomatic with LVEF >50% but with a dilated LV (end-diastolic dimension >70mm or systolic dimension >50mm)
	  ○ In those undergoing CABG or surgery of the ascending aorta.
	  ○ If aortic root dilatation is the cause of aortic regurgitation, as can occur in Marfan's syndrome, aortic root replacement is usually necessary.
	Medical therapy:
	• **Treat HTN:** Vasodilators (Nifedipine, ACE-I)
	• ACE inhibitors/ARBs are reasonable in patients with severe symptomatic AR and/or LV dysfunction when surgery is not performed because of comorbidities.
	• SBE (Subacute bacterial endocarditis) Prophylaxis

Treatment: Aortic valve replacement

- Because symptoms do not develop until the myocardium fails and because the myocardium does not recover fully after surgery, operation is performed before significant symptoms occur.
- The timing of the operation is best determined according to haemodynamic, echocardiographic or angiographic criteria

1- Both mechanical prostheses and tissue valves are used. Tissue valves are preferred in the elderly and when anticoagulants must be avoided, but are contraindicated in children and young adults because of the rapid calcification and degeneration of the valves.

6- Right sided VHDs[1]

Tricuspid valve (Same as mitral)	Pulmonary valve (Same as aortic)
Stenosis	**Stenosis**
• Characterized by obstruction of blood flow from the right atrium into the right ventricle during diastole due to impaired opening of the valve. Extremely rare and is most commonly caused by infective endocarditis (especially in IV drug users), carcinoid tumors, or rheumatic fever. • **Murmur:** Mid-Delayed diastolic rumbling murmur localised in the tricuspid area with a decrescendo. First heart sound is also loud • Symptoms? like RHF: Increase JVP, Congested and pulsating liver & lower limb edema	• Characterized by obstruction of blood outflow from the right ventricle into the pulmonary arteries during systole. Usually congenital or RHD (rare), echo is used to confirm and assess the severity of the stenosis. • **Murmur:** Crescendo-decrescendo ejection systolic murmur maximum at the pulmonary area that radiates to the back (to the lung not to the carotid as AS). • **Treatment:** Transcatheter dilatation of the pulmonary valve by balloon pulmonary valvuloplasty or replacement by surgery • Symptoms: Low CO
Regurgitation	**Regurgitation**
• Characterized by retrograde blood flow from the right ventricle into the right atrium during systole due to insufficient closure of the valve. Extremely rare and can be caused by infective endocarditis (especially IV drug users), rheumatic fever, or right ventricular heart failure. • **Murmur:** Soft Holosystolic murmur in the tricuspid area radiates to the apex (not axilla)	• Characterized by retrograde blood flow from the pulmonary artery into the right ventricle during diastole due to insufficient closure of the valve. Could be due to RHD • **Murmur[2]:** Graham Steel murmur: high-frequency decrescendo diastolic murmur • Symptoms: High CO • Treatment: if severe → valve replacement

1- All right-sided heart murmur increase in intensity and duration with inspiration (While all left-sided heart murmur increase with expiration). This is helpful to differentiate between Mitral vs Tricuspid OR Aortic vs Pulmonary
2- Early-diastolic murmur over the pulmonary area & the second heart sound will be less

Aortic S/R Case summary

◀ Case study 1

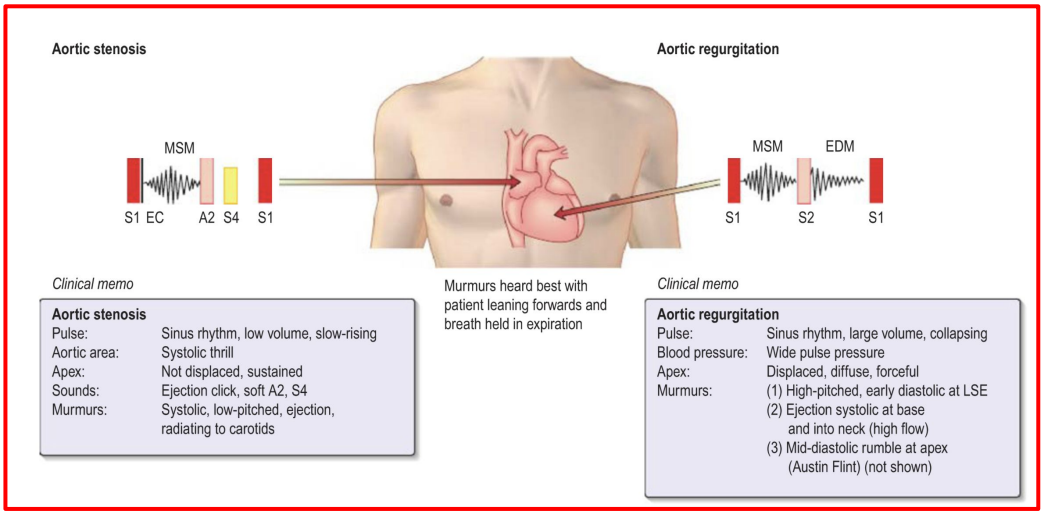
A 75-year-old man with a history of Marfan's syndrome presents to his physician complaining of a 6-month history of shortness of breath. He says his exercise tolerance has gradually decreased from 10 blocks on level ground to about 1 block and is limited by shortness of breath. He also reports shortness of breath at night, as well as generalized fatigue, occasional palpitations, and feeling like his heart is "pounding," especially when he lies on his left side. On physical examination, he appears in no acute distress and is a tall, thin man with a marfanoid body habitus. Vital signs include a temperature of 37.0° C (98.6°F), blood pressure of 160/50 mm Hg, pulse rate of 80/min, respiratory rate of 12/min, and oxygen saturation of 99% on room air. He has a laterally displaced point of maximum impulse; distant heart sounds; a high-pitched, blowing early diastolic murmur heard best at the left sternal border that is decreased by the Valsalva maneuver; clear lungs; and peripheral pulses with sharp upstrokes and downstrokes.

- **What is the diagnosis?** Aortic regurgitation
- **What's the best initial test for this case?** An echocardiogram is essential and will confirm the diagnosis by evaluating the degree of valvular dysfunction and myocardial compensation.
- **What are the next steps in management?** Initial management includes vasodilation, diuresis, and possibly digoxin, depending on systolic function. Once medical therapy is begun, workup for causes and assessment of need for valve surgery should be undertaken. In asymptomatic patients with severe AR who have left ventricular enlargement and normal LV systolic function, surgery may be forgone for vasodilator therapy, which reduces afterload and effectively shunts a greater proportion of the ejection fraction into the systemic circulation. In this patient with Marfan's syndrome, the most important determinant of the need for surgery is the diameter of the aortic root, as aortitis of any cause (syphilis, rheumatologic diseases) can dilate the aorta and cause aortic insufficiency.

◀ Case study 2

A 72-year-old man with a history of peripheral vascular disease presents to the clinic complaining of having shortness of breath for the past month. He had previously been able to climb two flights of steps with little difficulty, but now cannot climb one flight without severe shortness of breath. On further questioning, he reports occasional chest pain on heavy exertion, and says 1 week earlier he fainted after climbing the stairs from his basement. He denies a history of heart or lung problems, high cholesterol, diabetes, smoking, or family history of heart or lung disease. On physical examination, he appears in no acute distress, and his vital signs include a temperature of 37.0° C (98.6° F), blood pressure of 140/80 mm Hg, pulse rate of 80/min, respiratory rate of 12/min, and oxygen saturation of 99% on room air. There is a slow rise of the carotid upstroke, a sustained apical impulse, and a quiet S2, as well as a 3/6 harsh systolic ejection murmur heard best at the second intercostal space at the right sternal border

- **What is the diagnosis?** Aortic stenosis
- **What's the best initial test for this case?** An echocardiogram is an essential diagnostic tool that can assess the degree of valvular stenosis and the peak and mean gradients across the valve, which can help calculate the valve area.
- **What are the next steps in management?** Aortic valve replacement



Summary

VHDs (Remember Echo is the gold standard test for all VHDs) (Remember all murmurs get louder with squatting/leg raising and fainter with standing/valsalva except MVP and HOCM which get louder with standing/valsalva and fainter with squatting/leg raising)		
MS	**Etiology**	Rheumatic fever
	S&S	STENOSis
	Murmur	Opening snap and mid-diastolic murmur at the apex with loud S1
	Treatment	Antiarrhythmics (β-blockers, digoxin, or CCBs) and warfarin for AF. Mitral balloon valvotomy and valve replacement are effective for severe cases
MR	**Etiology**	Primarily 2° to rheumatic fever or chordae tendineae rupture after MI, Myxomatous degeneration due to mitral valve prolapse, Infective endocarditis]
	S&S	Patients present with dyspnea, orthopnea, PND, and fatigue
	Murmur	Acute MR: Soft & Short early systolic decrescendo murmur Chronic MR: High pitched holosystolic (pansystolic) murmur (radiates to left axilla)
	Treatment	Mitral valve repair or replacement is the definitive treatment
AS	**Etiology**	Most often seen in the elderly (senile calcific aortic stenosis).
	S&S	May be asymptomatic for years despite significant stenosis. Classical triad (SAD): Syncope (exertional), Angina, Dyspnea
	Murmur	**Harsh crescendo-decrescendo systolic ejection murmur** that radiates to carotid.
	Treatment	Aortic valve replacement (surgical or transcatheter methods)
AR	**Etiology**	Acute: Infective endocarditis, aortic dissection, chest trauma, MI Chronic: Valve malformations, rheumatic fever, connective tissue disorders (ie, Marfan syndrome), syphilis, inflammatory disorders
	S&S	Acute: Rapid onset of pulmonary congestion, cardiogenic shock, and severe dyspnea Chronic: Slowly progres- sive onset of dyspnea on exertion, orthopnea, and PND. Uncomfortable heart pounding when lying on left side
	Murmur	Early blowing **decrescendo** diastolic murmur at the left sternal border, mid-diastolic rumble (Austin Flint murmur)
	Treatment	Acute MR: AVR Chronic: Vasodilator therapy (e.g. ACEIs) until symptoms become severe enough to warrant valve replacement.

Lecture Quiz

Q1: You are called to see a 21-year-old man in the emergency room with new onset of slurred speech and left hemiparesis. On auscultation the patient has a systolic murmur at the pulmonic region with a diastolic rumble along the left sternal border. The second heart sound is split and fixed relative to respiration. What is the likely cause of patient's symptom?

A-Ventricular septal defect
B-Atrial septal defect
C-Patent ductus arteriosus
D-Aortic insufficiency
E-Coarctation of the aorta

Q2: A 70-year-old male is seen in the office for chest pain. He reports that he is getting substernal chest pain, without radiation, when he mows his lawn. The pain resolves with 10–15 minutes of rest. He has never had pain at rest. He has no other cardiac complaints and his review of systems is otherwise negative. He has an unremarkable medical history and takes only a baby aspirin a day. On examination, his blood pressure is 160/70, pulse 85, and respiratory rate 16. His cardiac examination is notable for a harsh, 3/6 systolic ejection murmur along the sternal border that radiates to the carotid arteries. His carotid pulsation is noted to rise slowly and is small and sustained. His lungs are clear. The remainder of his examination is normal. Subsequent workup confirms the diagnosis of critical aortic stenosis. Which of the following treatments would be most appropriate at this time?

A- Beta-blocker
B- ACEI
C- Aortic valve replacement
D- Mitral valve replacement

Q3: A 48-year-old man presents to the ED with a 4-hour history of new-onset shortness of breath, difficulty breathing while supine, and nonproductive cough. Medical history reveals he had rheumatic fever as a child. Vital signs are within normal limits, and oxygen saturation is 97% on room air. On examination there is a low-pitched diastolic rumble as well as an opening snap, both best auscultated at the apex. Rales and musical rhonchi are auscultated on inspiration in both lung fields. ECG shows an irregularly irregular rhythm. Creatine kinase–myocardial bound fraction, troponin T, and troponin I are negative 6 hours after the onset of symptoms. Testing reveals the thyroid- stimulating hormone level is normal. Which of the following is the most likely cause of the patient's pulmonary edema?

A- Acute aortic stenosis
B- Acute mitral regurgitation
C- Mitral stenosis
D- MI

Q4: A 32-year-old woman attends her GP for a routine medical examination and is noted to have a mid-diastolic murmur with an opening snap. Her blood pressure is 118/71mmHg and the pulse is regular at 66 beats per minute. She is entirely asymptomatic and chest x-ray and ECG are normal. What would be the most appropriate investigation at this point?

A- Anti-streptolysin O titre
B- Blood culture
C- Echocardiography
D- Cardiac catheterization

Q5: A 76-year-old male is brought to accident and emergency after collapsing at home. He has recovered within minutes and is fully alert and orientated. He says this is the first such episode that he has experienced, but describes some increasing shortness of breath in the previous six months and brief periods of central chest pain, often at the same time. On examination, blood pressure is 115/88mmHg and there are a few rales at both bases. On ECG there are borderline criteria for left ventricular hypertrophy. Which of the following might you expect to find on auscultation??

A- Mid-diastolic murmur best heard at the apex
B- Crescendo systolic murmur best heard at the right sternal edge
C- Diastolic murmur best heard at the left sternal edge
D- Pan-systolic murmur best heard at the apex

Q6: A 59-year-old man presents for a well person check. A cardiovascular, respiratory, gastrointestinal and neurological examination is performed. No significant findings are found, except during auscultation a mid systolic click followed by a late systolic murmur is heard at the apex. The patient denies any symptoms. The most likely diagnosis is:

A- Austin flint murmur
B- Graham steell murmur
C- Barlow syndrome
D- Carey coombs murmur

Answers: Q1:B | Q2:C | Q3:C | Q4:C | Q5:B | Q6:C

Answers Explanation File!

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Special thanks to Mohammed Alorayyidh and Arwa Alghamdi for the amazing first page theme!