



“Every Little Thing She Does is Magic”:

# Cardiac Murmurs Demystified

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SBHPP 2024



# agenda

Review Cardiac Anatomy

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Auscultation Identification

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Murmur Severity

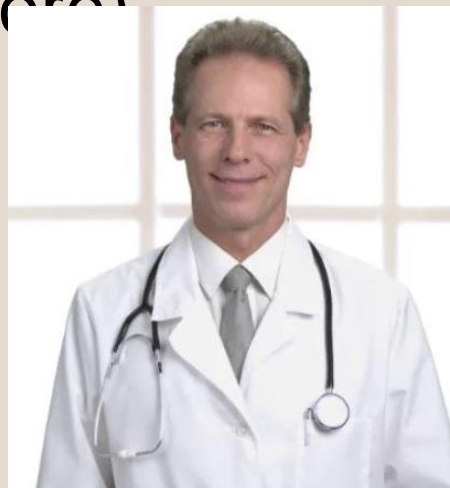
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Interventions

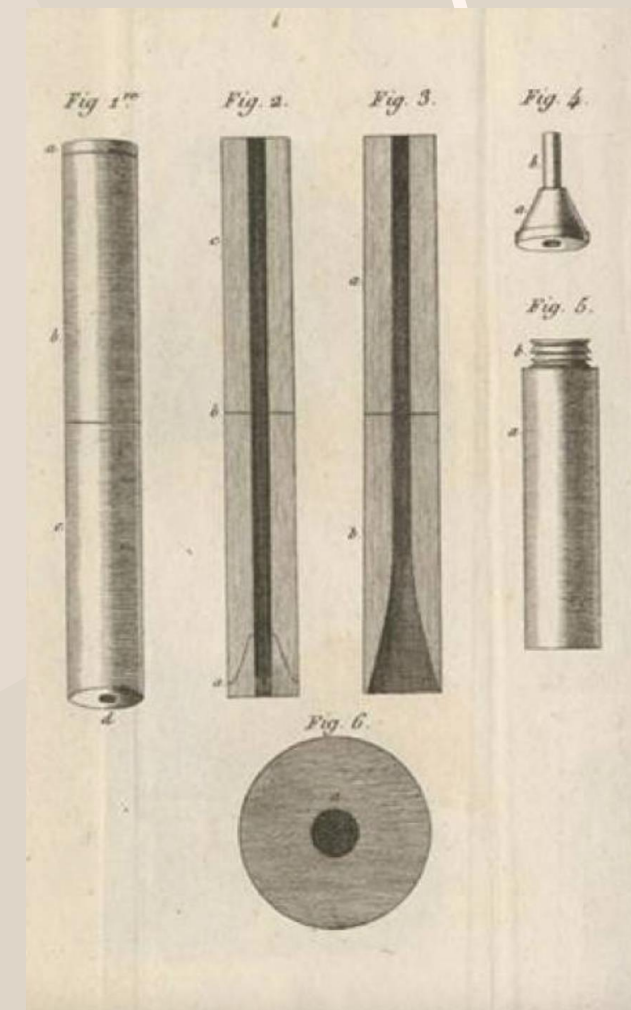
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# Anatomy of your stethoscope

- Fun fact: Rene Theophile Hyacinthe Laënnec (1781–1826) was a French physician who invented the stethoscope in 1816
  - Greek: *stethos* (chest) and *skopein* (to explore)



- Note: traditions vs new method
  - The “new” way was in part a fashion accessory borrowed from medical TV shows
  - Doctors used to wear their stethoscopes dangling down the front like a tie



# Modern Day Stethoscope...



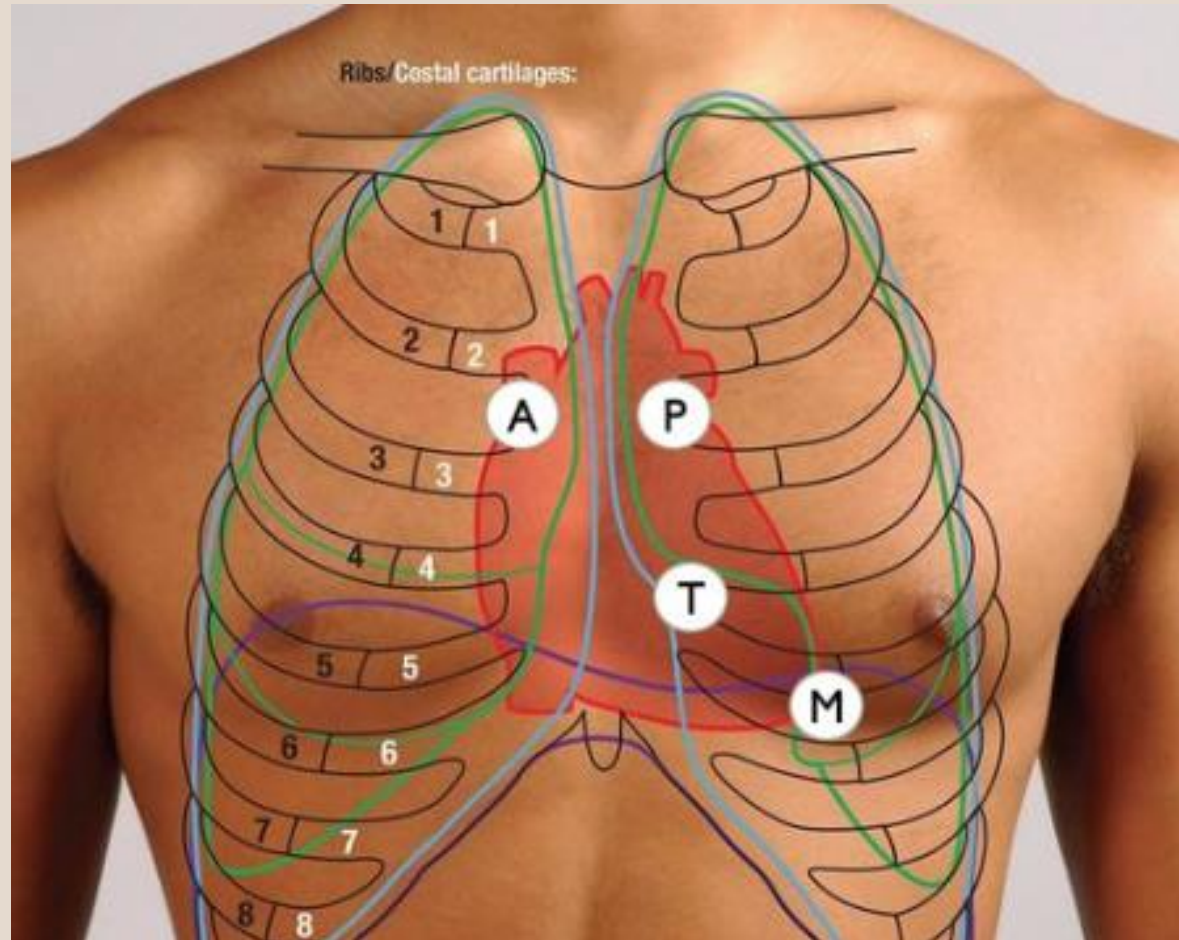
- Bell- better for lower-frequency sounds
- Diaphragm- better for higher frequencies.

1925

Bowles and Sprague

Combination of bell and a rigid diaphragm chest piece as used today

# Auscultation Locations- APT M



# Grading Murmurs

(thank you Samuel Levine (1891-1966), Cardiologist)

Levine's scale I-VI:

- I - lowest intensity: difficult to hear unless listening carefully
- II – faint, but usually audible with a stethoscope
- III – loud, easy to hear, no palpable thrill
- IV - loud, easy to hear WITH palpable thrill
- V – loud with thrill, can hear even with the the edge of the stethoscope touching the chest
- VI – loud with thrill, can hear even if the stethoscope is not touching the chest (just lifted above the chest)

# Sample question:

- You are seeing a patient in clinic and on palpitation notice a thrill. On auscultation you appreciate a loud murmur. How will you document this murmur?
  - A: 1/6
  - B: 2/6
  - C: 3/6
  - D: 4/6
  - E: 5/6
  - F: 6/6

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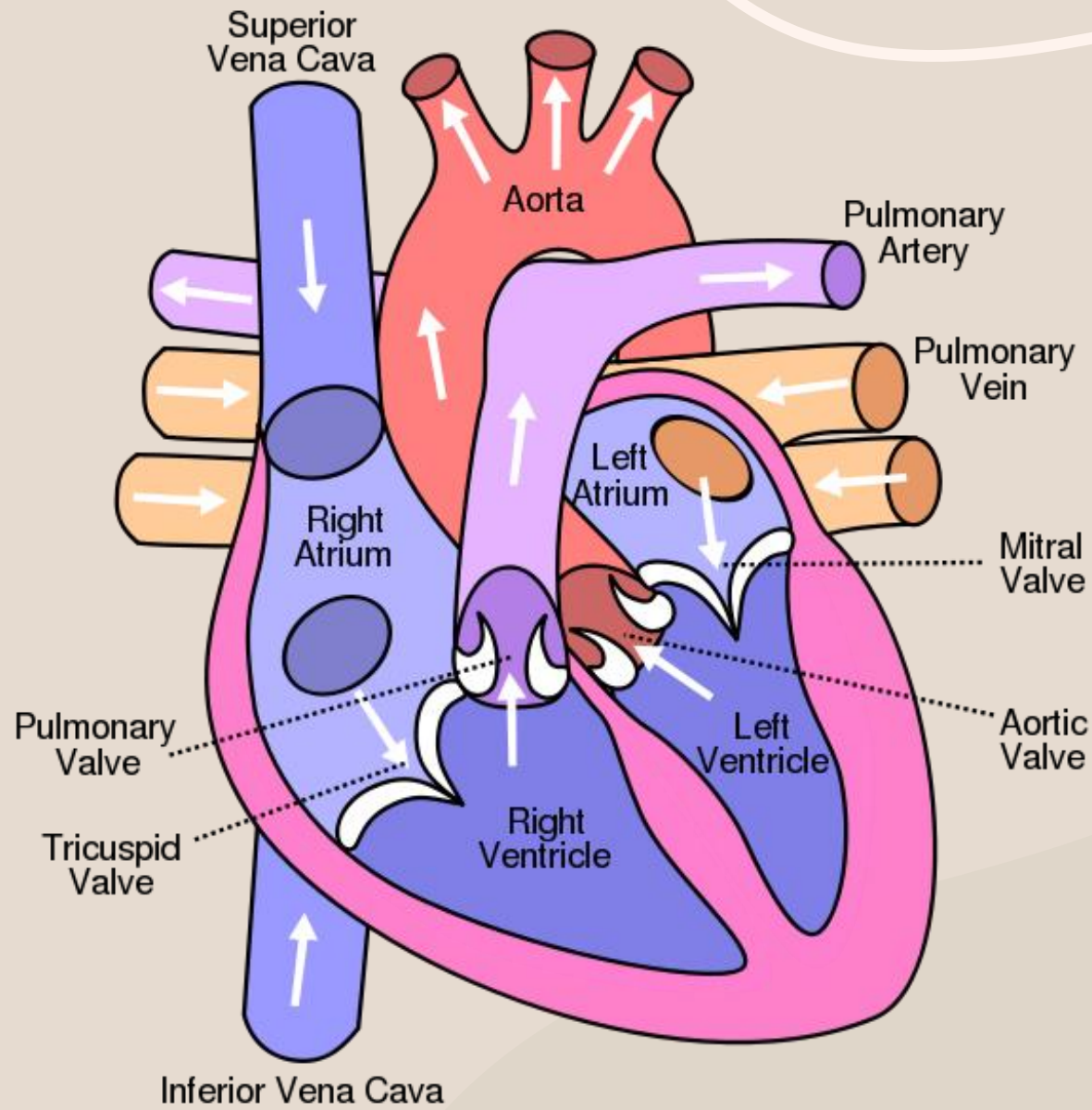
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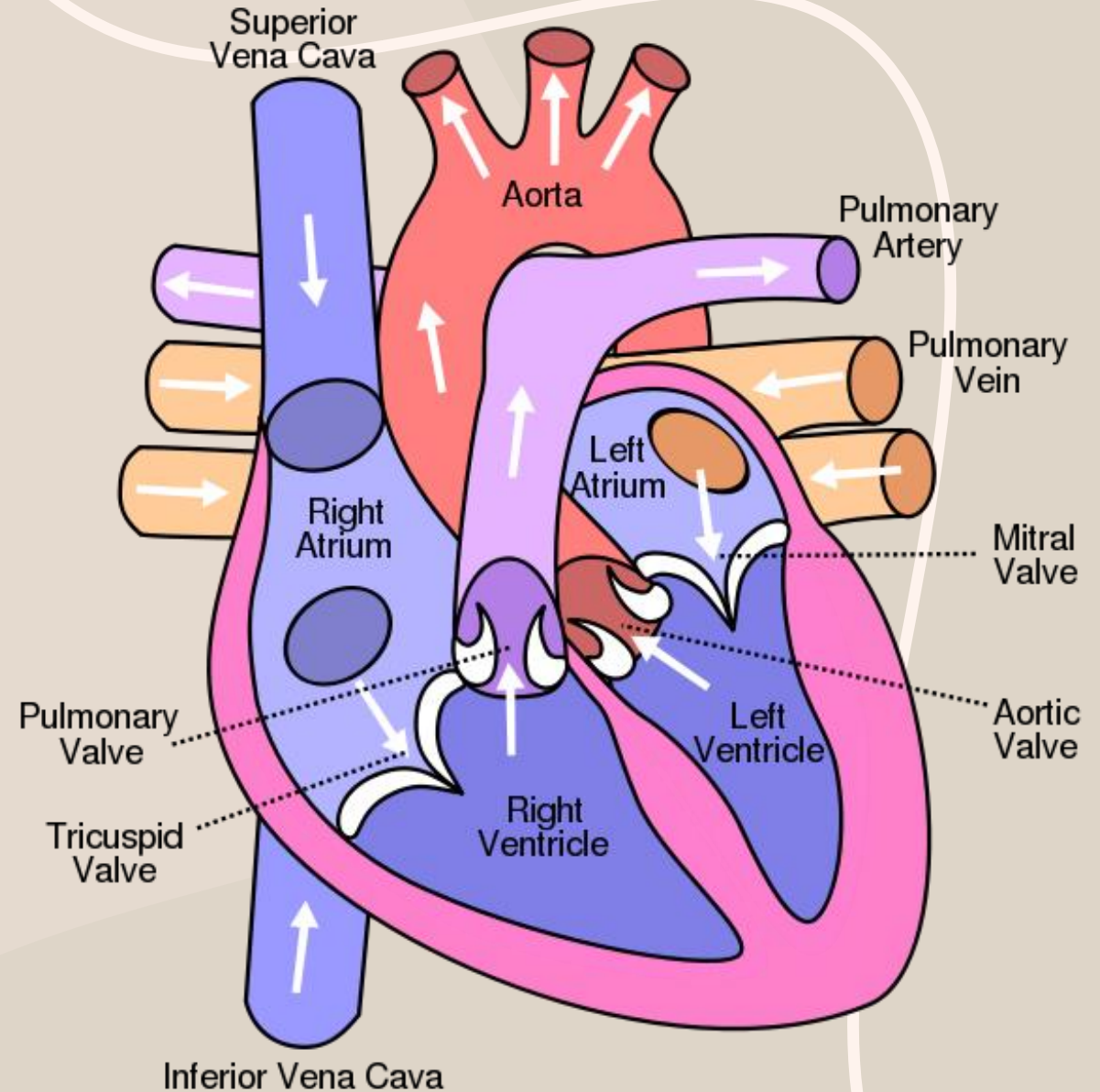
# Valvular Heart Disease: CDC Facts

- 2.5% of the U.S. population
- More common in elderly
  - >1 in 8 people >75 have moderate or severe valve disease
- Rheumatic heart disease- commonly affects MV or AV
  - 11% of VHD deaths in US due to RHD
- Bicuspid AV rare but greater risk for VHD
  - 1-2% population, M>F
- VHD deaths more commonly due to AV disease
- AS, MR, and TR are the most common valvular disorders
- Success with TAVI has increase interest in similar interventions for MV and TV conditions



# Systole and Diastole

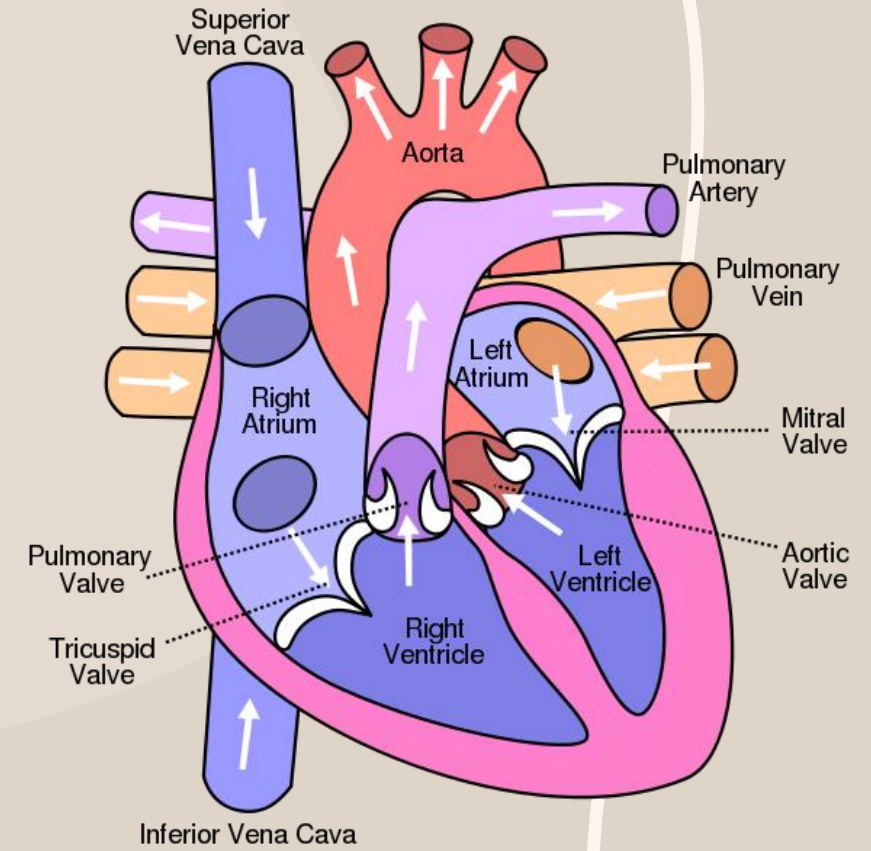
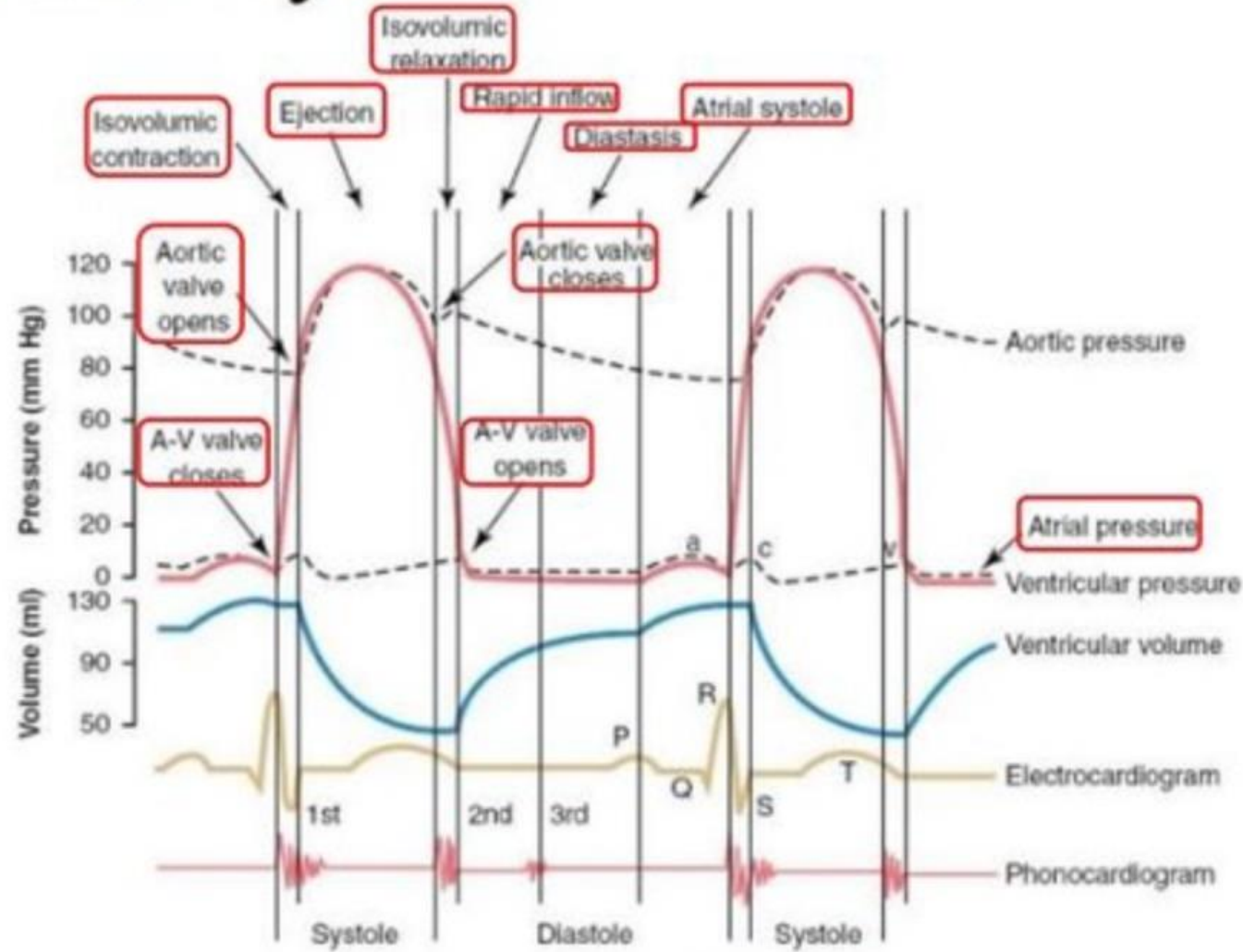
- Heart fills (think **Dilates**) during **Diaстole**
- Heart ejects (think **Squeezes**) in **Systole**
- 4 heart valves
  - 2 let blood in to ventricles (Mitral, Tricuspid)
  - 2 let blood out of ventricles (Aortic, Pulmonary)



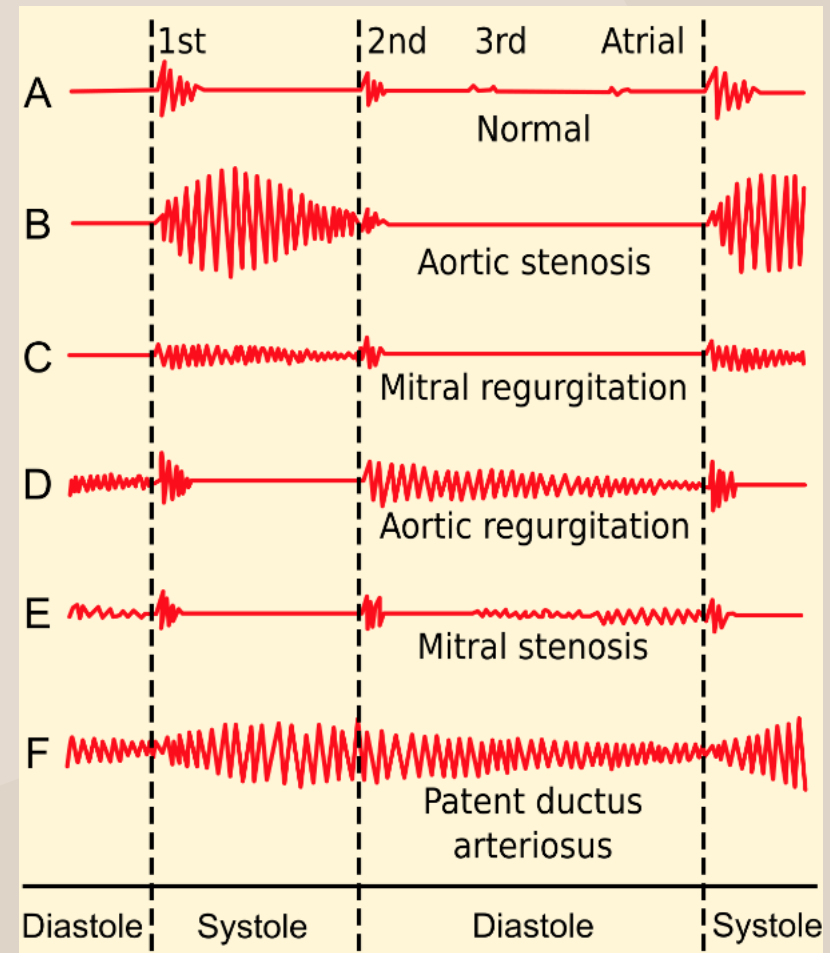
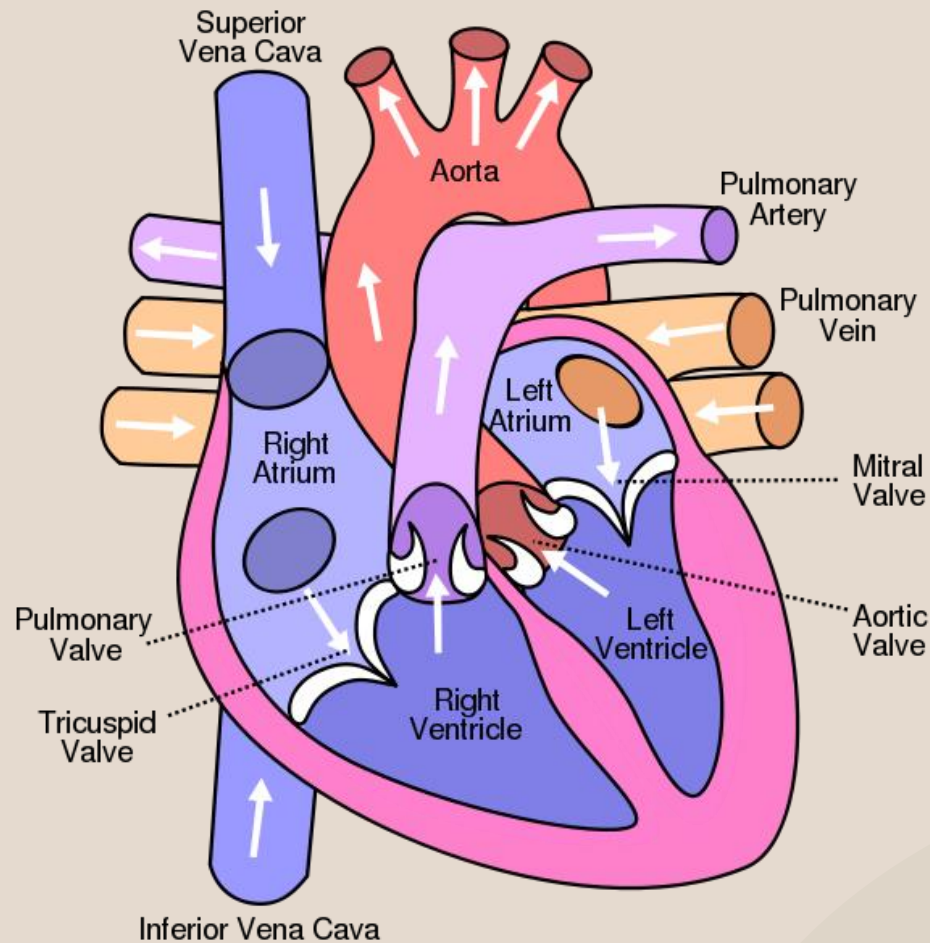
# Auscultation tips

- Normal heart sounds and abnormal, or pathological heart sounds are caused by turbulent blood flow
  - Example: the closing of heart valves makes a sound
- Laminar flow does not make noise and is silent
- Turbulent flow does make noise and can be auscultated
- Sometimes, this can be so pronounced that it can be palpated (more on this later)
  - This is called a “thrill”

# Cardiac Cycle



# Understanding murmurs



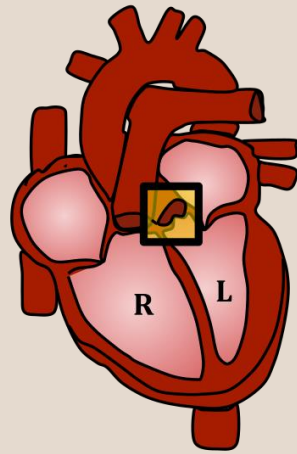
[http://commons.wikimedia.org/wiki/File:Diagram\\_of\\_the\\_human\\_heart\\_\(cropped\).svg](http://commons.wikimedia.org/wiki/File:Diagram_of_the_human_heart_(cropped).svg)

[https://en.wikipedia.org/wiki/Systolic\\_heart\\_murmur](https://en.wikipedia.org/wiki/Systolic_heart_murmur) - NOTE: these 2 figures are used throughout this presentation

# Aortic Stenosis Frequency

- Most common primary valve lesion requiring surgery or transcatheter intervention in Europe/North America
- 2<sup>nd</sup> most common valvular lesion in USA
- Uncommon if <65 y.o.
- Increasing frequency with age
- Approximate rates:
  - 0.2% in the 50–59-year group
  - 1.3% in the 60–69-year group
  - 3.9% in of the 70–79-year group
  - 9.8% in those aged 80–89 years
  - new AS: 5 per 1,000 per year, mean age 60

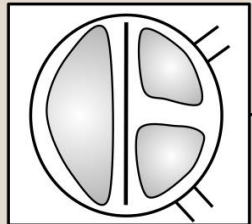
# Bicuspid Aortic Valve



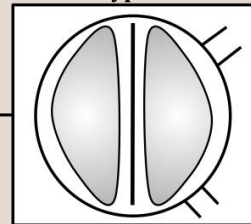
Normal Aortic Valve



Bicuspid Aortic Valve  
Type 1



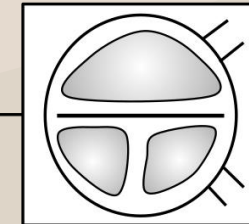
Bicuspid Aortic Valve  
Type 2



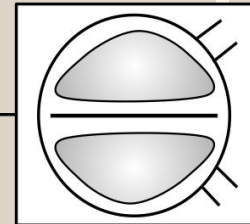
Bicuspid Aortic Valve  
Type 3



Bicuspid Aortic Valve  
Type 4



Bicuspid Aortic Valve  
Type 5

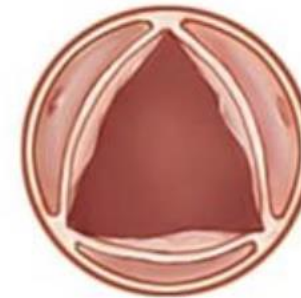




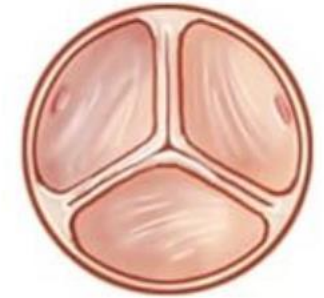
# Aortic Stenosis: Etiology

- Due to thickening and calcification of the aortic valve
  - May see more frequently if bicuspid AV
  - Smoking
  - Hypertension
  - Chemo/radiation
  - Less commonly from scarring after endocarditis infection or rheumatic heart disease in USA
- Normal aortic valve area: 3 cm<sup>2</sup>
  - AS symptoms usually once valve area is <1 cm<sup>2</sup>
- Symptoms:
  - Angina
  - DOE
  - Syncope
  - Heart failure

Healthy aortic valve (top view)

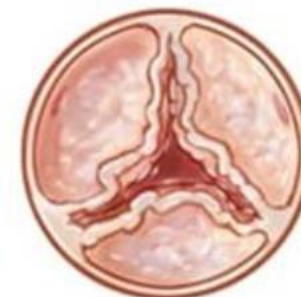


Open



Closed

Aortic valve stenosis (top view)



Open



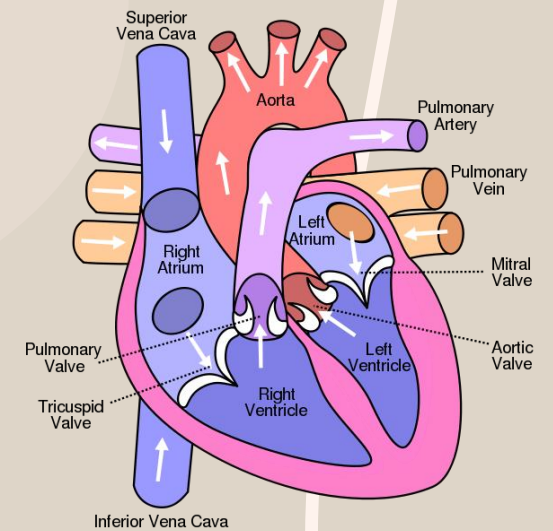
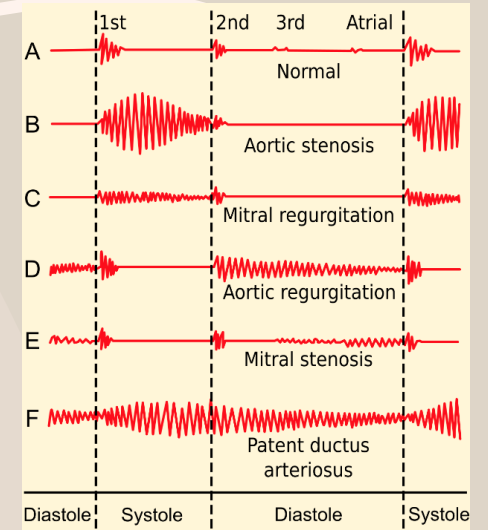
Closed

# Aortic Stenosis: description

- High-pitched
- Systolic ejection murmur
- Heard loudest over the aortic valve
- Crescendo-decrescendo (diamond shaped) quality
- Often radiates to the carotid arteries

## Aortic Stenosis Auscultation:

- <https://www.youtube.com/watch?v=cDXknORsJXw>
- <https://www.youtube.com/watch?v=Fb8E7dr6g0A>

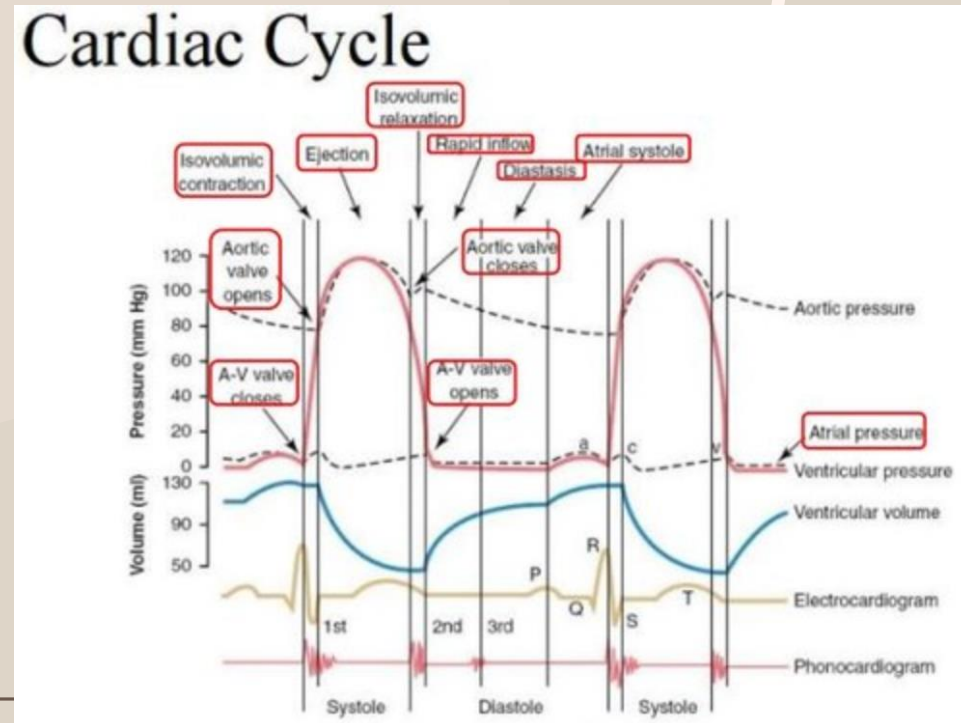
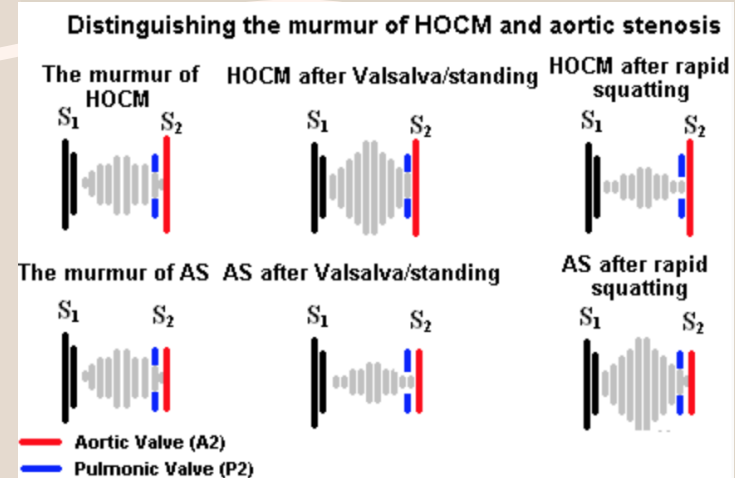
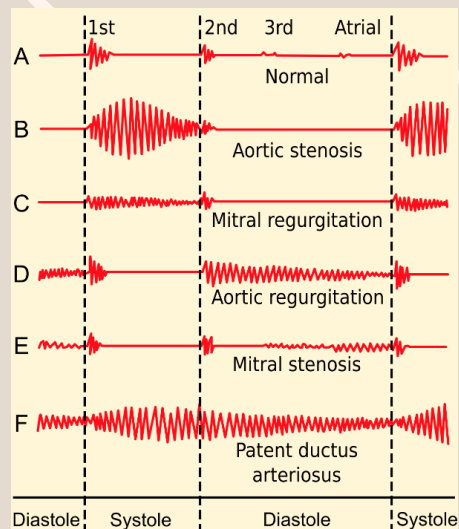


# Aortic Stenosis 2.0 (severity)

- Carotid arteries assessment
- "pulsus parvus et tardus"
  - Weak (parvus) pulse
  - Is it weak?
    - Palpate your own carotid artery while palpating the patient's
  - Delayed (tardus) carotid upstroke
  - Is it delayed?
    - Listen for patient's S2 heart sound while palpating carotid upstroke
    - S2 and carotid upstroke should take place nearly at same time
    - If carotid upstroke is delayed after S2, this suggests severe AS

# Aortic Stenosis 2.0

- Auscultation @ apex may appear midsystolic or holosystolic (you might think MR)
  - AS typically radiates to carotids
- HOCM can also mimic AS
  - How to tell if AS or HCM?
  - Valsalva decreases AS and increases HCM murmur
- Split S2 in AS
  - Why? Delayed AV closure (need more time to complete LV systole)
  - As AS worsens, leaflets become less mobile and S2 intensity will decrease
  - When S2 cannot be heard, AS is more severe
- S4 occurs in severe LVH which is a consequence of AS
  - This also suggests more severe AS



# AS: what to consider next

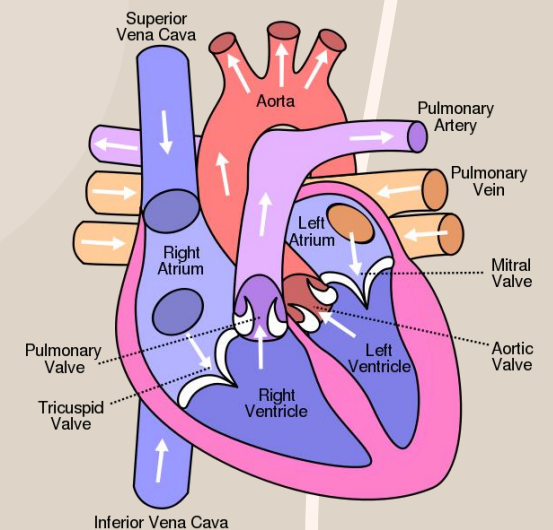
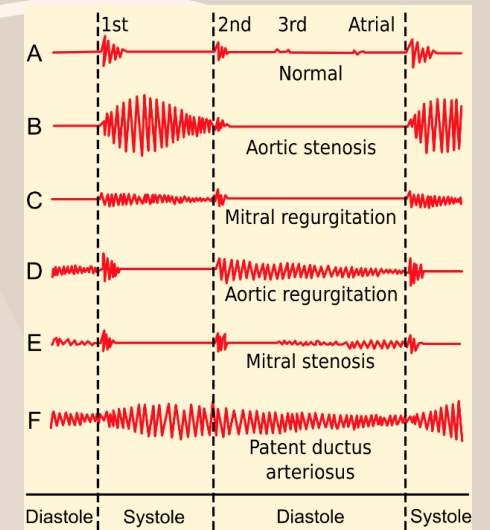
- Echocardiography, stress imaging, CT
- Surgery (if concerns of poor prognosis without intervention, low EF, symptoms, may be indicated if another surgery required)
- Transcatheter aortic valve implantation-TAVI
- Surgical aortic valve replacement-SAVR
- Medical therapy: “No medical therapies influence the natural history of aortic stenosis”
  - Still treat HF/HTN if present (with meds like ACEi), avoid vasodilators to avoid hypotension

**TABLE 1. Prevalence of AR in the Framingham Offspring Study**

	<b>26–39</b>	<b>40–49</b>	<b>50–59</b>	<b>60–69</b>	<b>70–83</b>
<b>Men</b>	(n=91)	(n=352)	(n=433)	(n=359)	(n=91)
None	96.7%	95.4%	91.1%	74.3%	75.6%
Trace	3.3%	2.9%	4.7%	13.0%	10.0%
Mild	0%	1.4%	3.7%	12.1%	12.2%
≥Moderate	0%	0.3%	0.5%	0.6%	2.2%
<b>Women</b>	(n=93)	(n=451)	(n=515)	(n=390)	(n=90)
None	98.9%	96.6%	92.4%	86.9%	73.0%
Trace	1.1%	2.7%	5.5%	6.3%	10.1%
Mild	0%	0.7%	1.9%	6.0%	14.6%
≥Moderate	0%	0%	0.2%	0.8%	2.3%

# Aortic Regurgitation: description

- AR has the highest frequency sound (~ 400 Hz)
- Decrescendo blowing diastolic murmur
- Best heard at cardiac base
- Corrigan's Pulse
  - <https://www.youtube.com/watch?v=Cb-EXdLIGGs> (start at 4:58)
- Wide pulse pressure ("water hammer peripheral pulse")
- Nail bed pulsation ("Quincke pulse")
  - <https://www.youtube.com/watch?v=ZzwoYTYVHSI>
  - [https://www.youtube.com/watch?v=9m\\_0RAQDFHM](https://www.youtube.com/watch?v=9m_0RAQDFHM)
- Popliteal brachial blood pressure difference > 20 mm Hg
- Murmur:
  - <https://www.youtube.com/watch?v=k5u933Blbo>
  - <https://www.youtube.com/watch?v=uZysrKXHJMM>



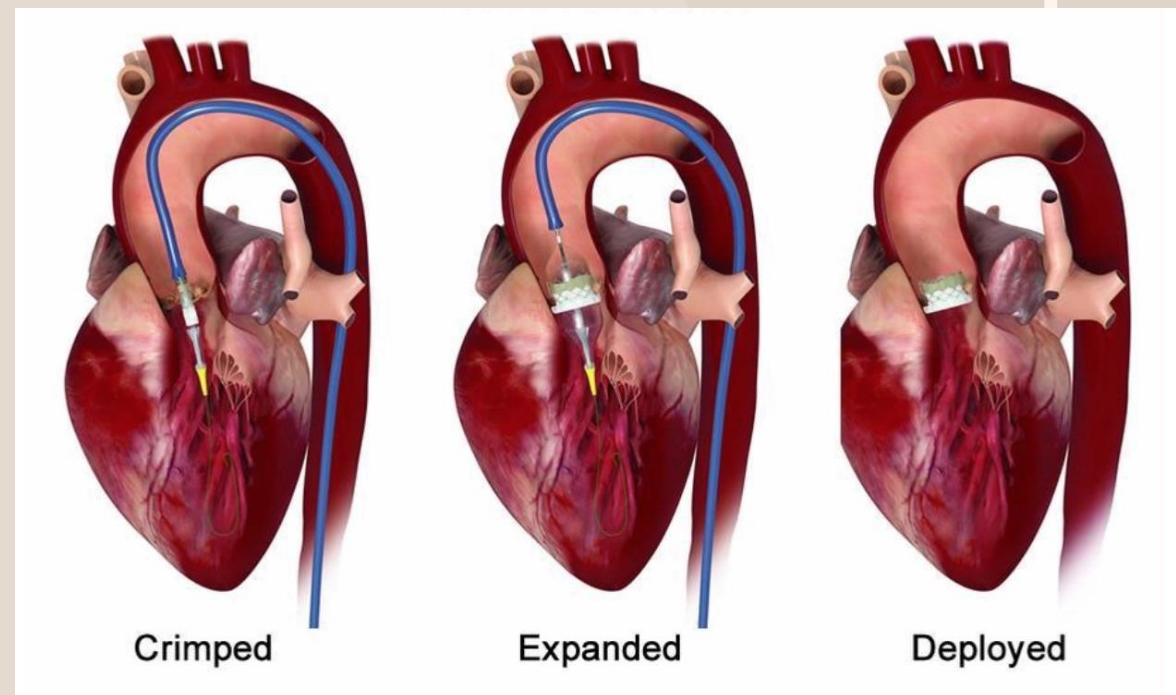
# Aortic Regurgitation: Etiology

- High-income countries:
  - ~2/3 of AR due to degenerative tricuspid and bicuspid aortic regurgitation
- Other etiologies:
  - Endocarditis (infective and rheumatic)
  - Connective tissue disease
  - Right heart disease
  - Autoimmune disease
  - Rheumatic heart disease (especially in lower income countries)
  - Genetics
- Acute AR etiology:
  - Infective endocarditis>>aortic dissection



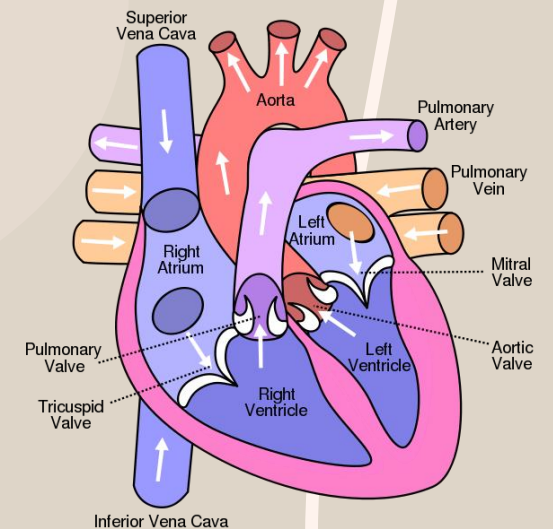
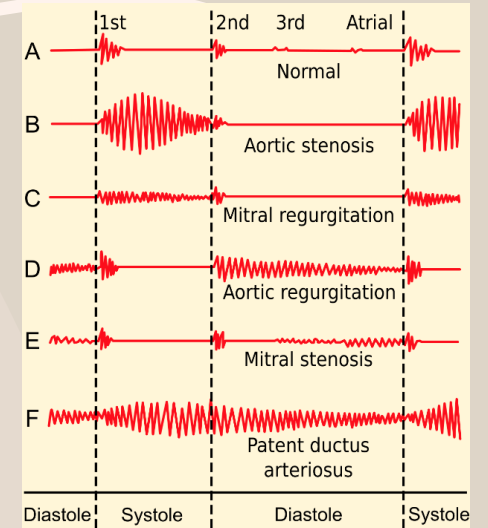
# AR: what to consider next...

- Echocardiography (could do CT, MRI)
- Surgery (if significant- aorta enlargement, large LVEDD, low EF, symptoms, may be indicated if another surgery required (CAD))
- TAVI, SAVR, valve, others
- Medical therapy:
  - ACEi or dihydropyridines (CCB- nifedipine, others)
  - If surgery and still HF consider ARB, BB



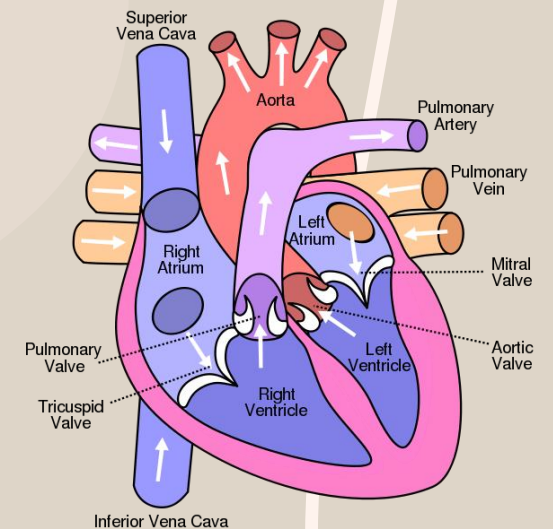
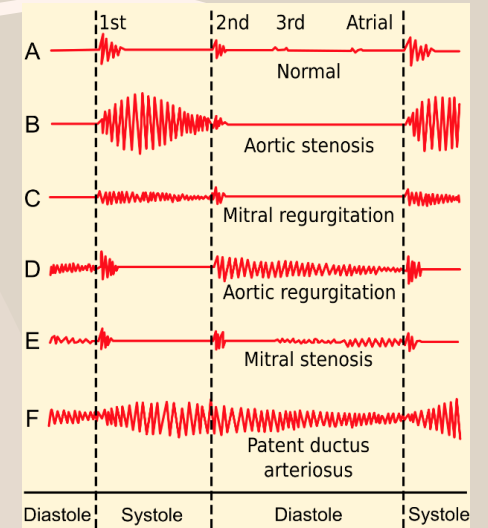
# Mitral Regurgitation: frequency and etiology

- 3<sup>rd</sup> most common form of valvular heart disease
- Degenerative causes (higher income countries)
- Rheumatic heart disease (lower income countries)
- **MVP** (most commonly diagnosed valvular heart disease)
  - 3-5% of population
  - Midsystolic click followed by midsystolic murmur
  - Handgrip increases intensity
  - Valsalva maneuver increases intensity
  - [https://www.youtube.com/watch?v=sH\\_KmHIHR70](https://www.youtube.com/watch?v=sH_KmHIHR70)
- Endocarditis
- Papillary muscle rupture



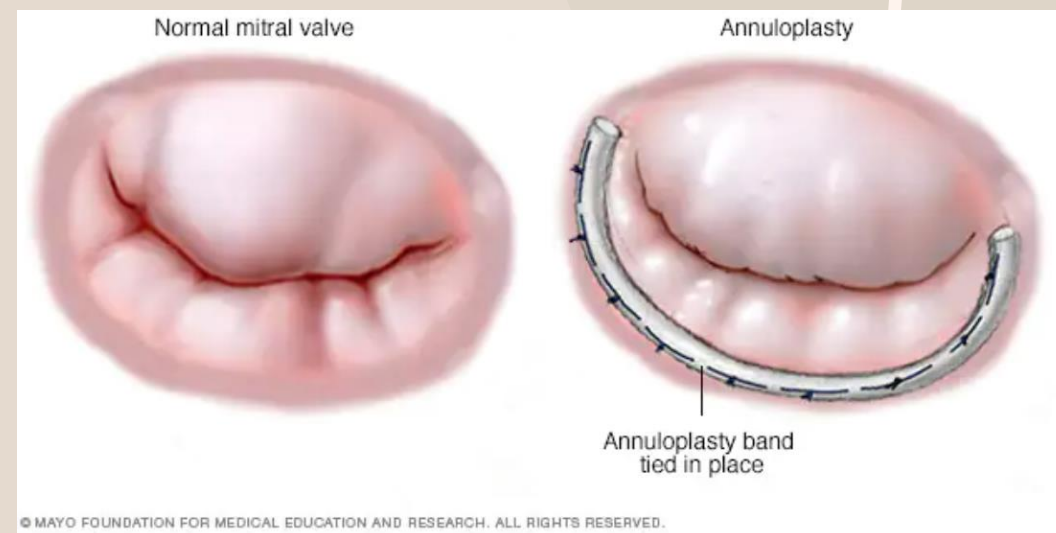
# Mitral Regurgitation: Description

- Holosystolic
- “blowing” sound
- Best heard at the cardiac apex
- Radiation to the **axilla**
  - (vs. AS- recall: radiates to the carotids)
- S3 = severe MR, systolic heart failure
- <https://www.youtube.com/watch?v=JKT9dQxBJqs>



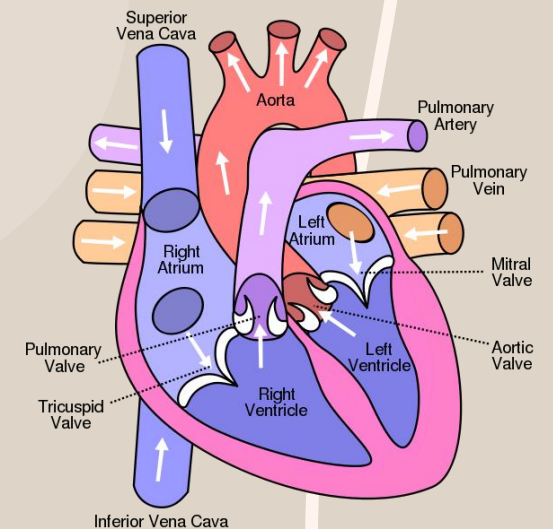
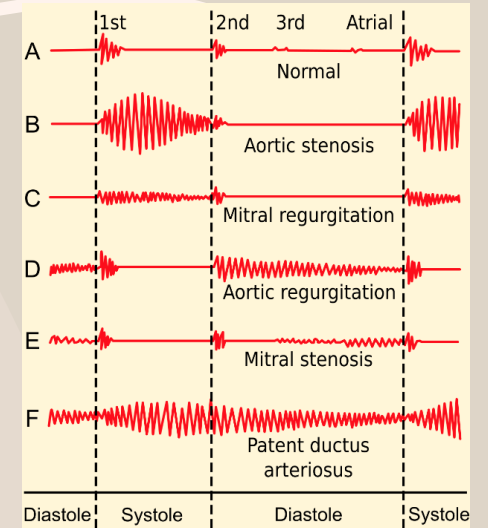
# MR: what to consider next

- Echocardiography (could add exercise)
- Intervention (if significant- aorta enlargement, large LVEDD, low EF, high PA pressure, AF, symptoms, may be indicated if another surgery required (CAD))
- Repair vs. replacement
  - Transcatheter implant may be successful in some patients (transcatheter edge-to-edge repair- TEER)
  - Annuloplasty
  - Mitraclip
- Medical therapy:
  - Acute: nitrates, diuretics
  - Chronic: prophylactic vasodilators not indicated, just treat underlying HF



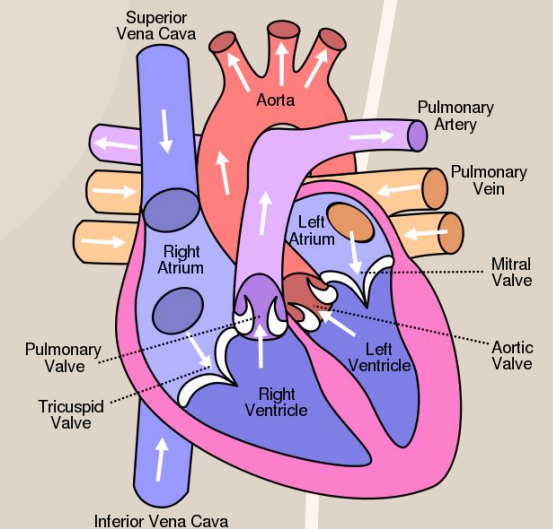
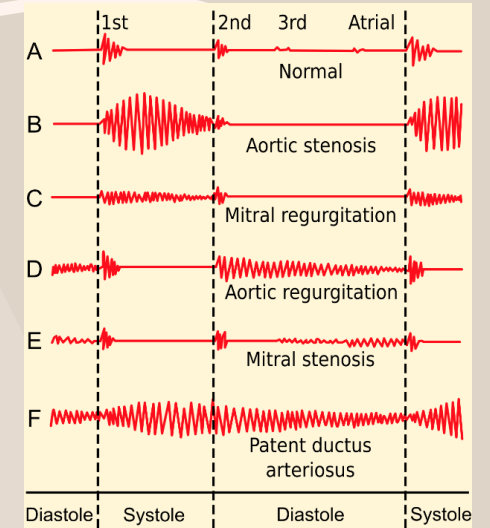
# Mitral Stenosis: frequency and etiology

- Frequency: 1 in 100,000
- Onset is between 3<sup>rd</sup>/4<sup>th</sup> decades of life
- Degenerative
- Rheumatic (most common worldwide- less so in higher income countries)- will occur 20-40 years after
- F>M
- Will see progression of HF with MS



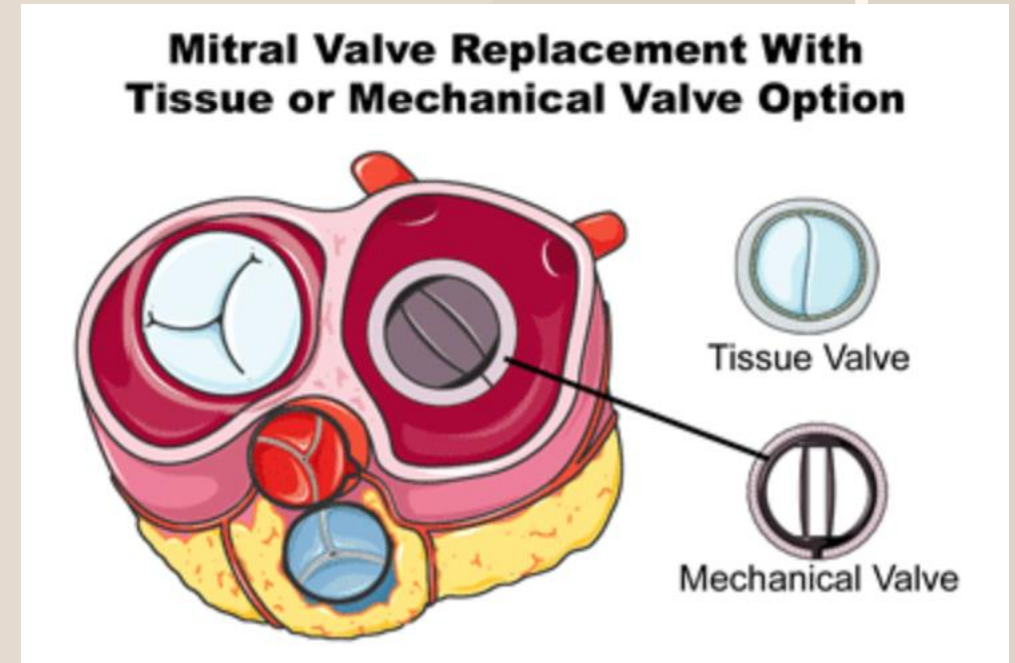
# Mitral Stenosis: Description

- Low frequency/low pitched (use the BELL)- less than 100 Hz
- Opening snap (OS) (forceful opening of MV)
- Mid-diastolic
- Rumbling
- Presystolic accentuation is heard after the opening snap
- Loud 1<sup>st</sup> sound (increased force to close MV)- sometimes palpable
- Louder in left lateral decubitus position
- Louder with isometric exercise
- May also see: left parasternal heave, tapping apical beat
- <https://www.youtube.com/watch?v=wsY8cqGfawk>
- <https://www.youtube.com/watch?v=KK70reK7syg> (start at 0:41)



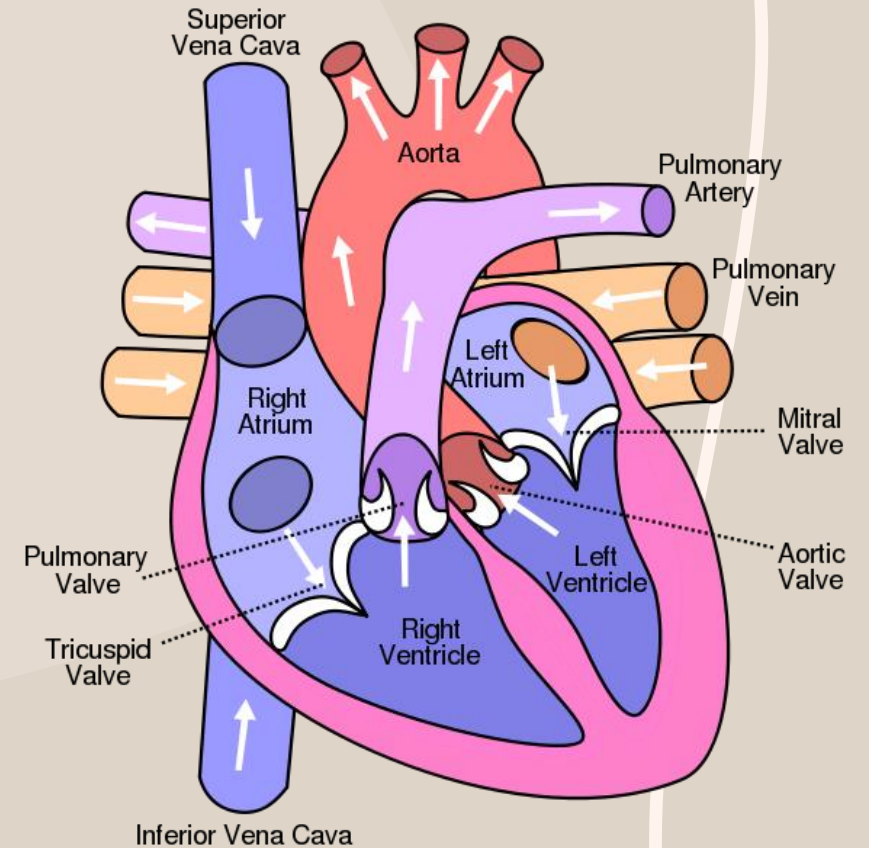
# MS: what to consider next

- Echocardiography
- Intervention (if symptoms, high risk without surgery)
- Surgery vs. percutaneous balloon valvuloplasty/percutaneous mitral commissurotomy
- Medications (to improve sx): Diuretics, beta-blockers, digoxin, non-dihydropyridine calcium channel blockers, ivabradine



# Tricuspid Regurgitation: Etiology

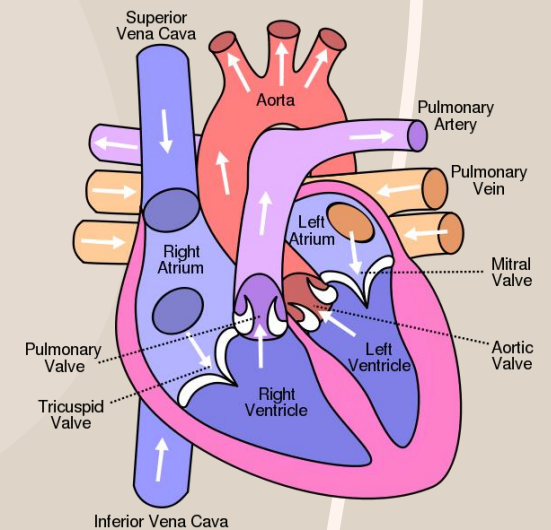
- IV drug use
  - infective endocarditis
- Rheumatic heart disease
- Carcinoid syndrome
- Myxomatous disease
- Endomyocardial fibrosis
- Underlying congenital valve concerns
- Thoracic trauma
- TV damage



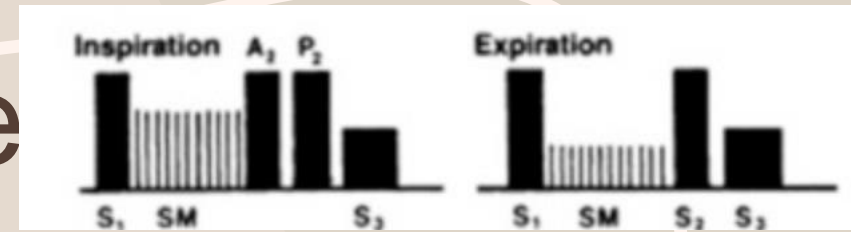


# Tricuspid Regurgitation: Frequency

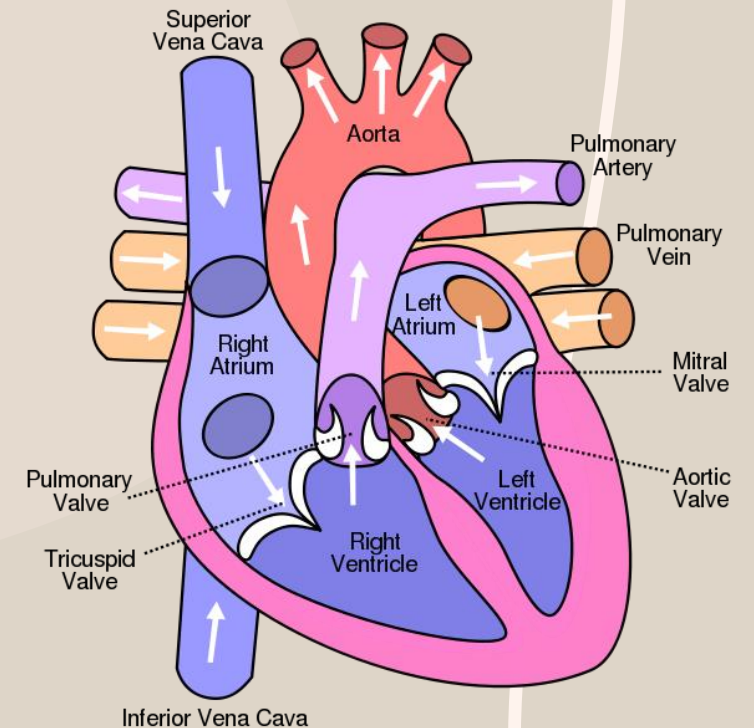
- Least common primary valvular pathology
  - But high mortality
- 0.55% of the general population
- prevalence increases with age
- 4% of the patients  $\geq 75$
- Secondary etiology most common ( $\geq 90\%$ )
  - RV/RA dilatation, large TV annulus d/t chronic AF
  - Left-sided valvular dysfunction
  - Myocardial dysfunction
  - Development after left-sided valve surgery



# Tricuspid Regurgitation: De



- Presentation: RHF (JVD, hepatojugular reflex, LE edema, ascites)
- S3 gallop
- Pansystolic murmur
- High pitched
- Loudest in 4<sup>th</sup> intercostal space (tricuspid region)
- Loudest during inspiration
- Parasternal region
- Increase intensity with: inspiration, exercise, leg raising
- Decrease intensity with: standing, Valsalva
- <https://www.youtube.com/watch?v=UtbHrIWFRo>
- C-V waves (“Lancisi Sign”) can be seen if severe TR:
  - <https://www.youtube.com/watch?v=2VKP81EnSgg>

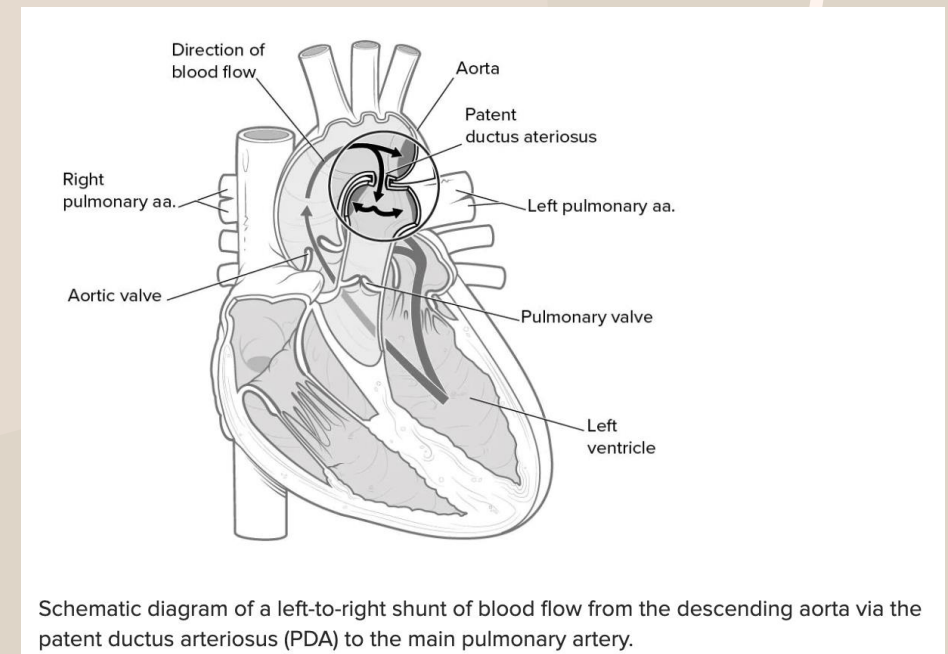
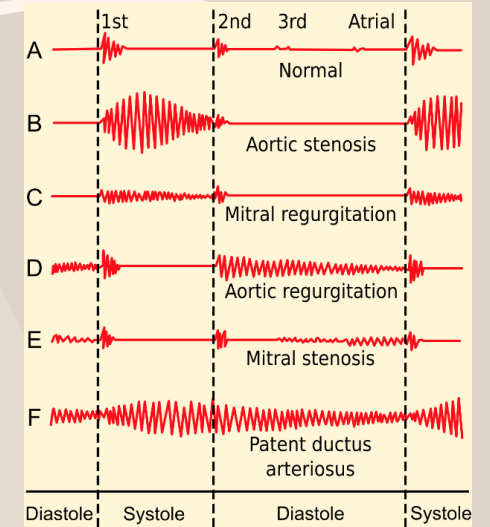


# TR: what to consider next

- Echocardiography (could do MRI)
- Surgery (if significant, symptoms, RV dilation/dysfunction, consider if left sided surgery)
- Repair vs. replacement (annuloplasty preferred)
- Medical therapy: diuretics to treat underlying RHF

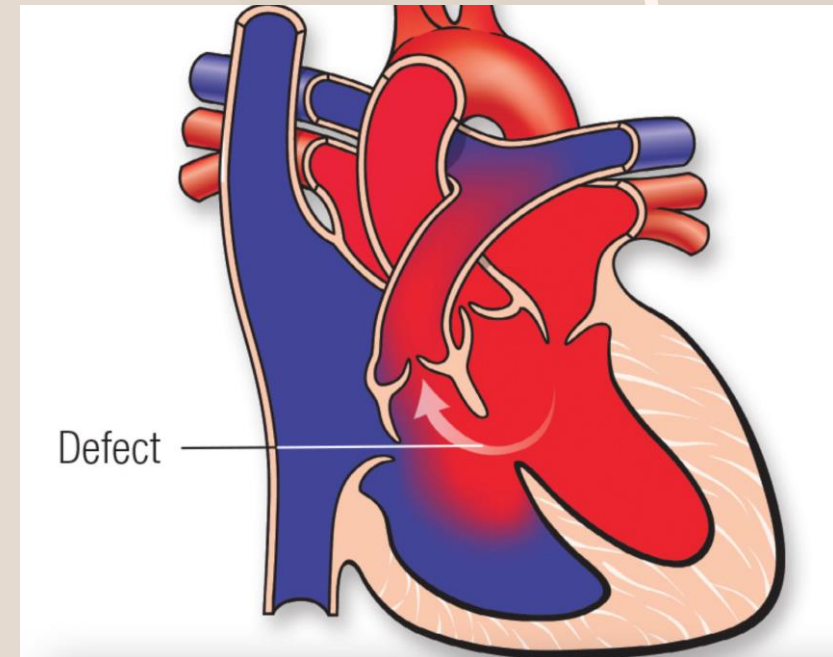
# PDA (left-to-right shunt)

- Can occur in premature infants
  - Low rate if born at term: 0.02% and 0.006%
  - Premature: 20% in premature infants > 32 weeks, up to 60% in those < 28 weeks' gestation
- Up to 30% of low birth weight infants
- F>M
- Murmur description:
  - Diastolic
  - Continuous machine-like murmur
  - Crescendo decrescendo
- Normally ductus arteriosus closes with 10-18 hours of birth
- Closure:
  - IV indomethacin
  - Catheter closure
  - Surgical ligation
- <https://www.youtube.com/watch?v=Fm5xgS1xOOc>

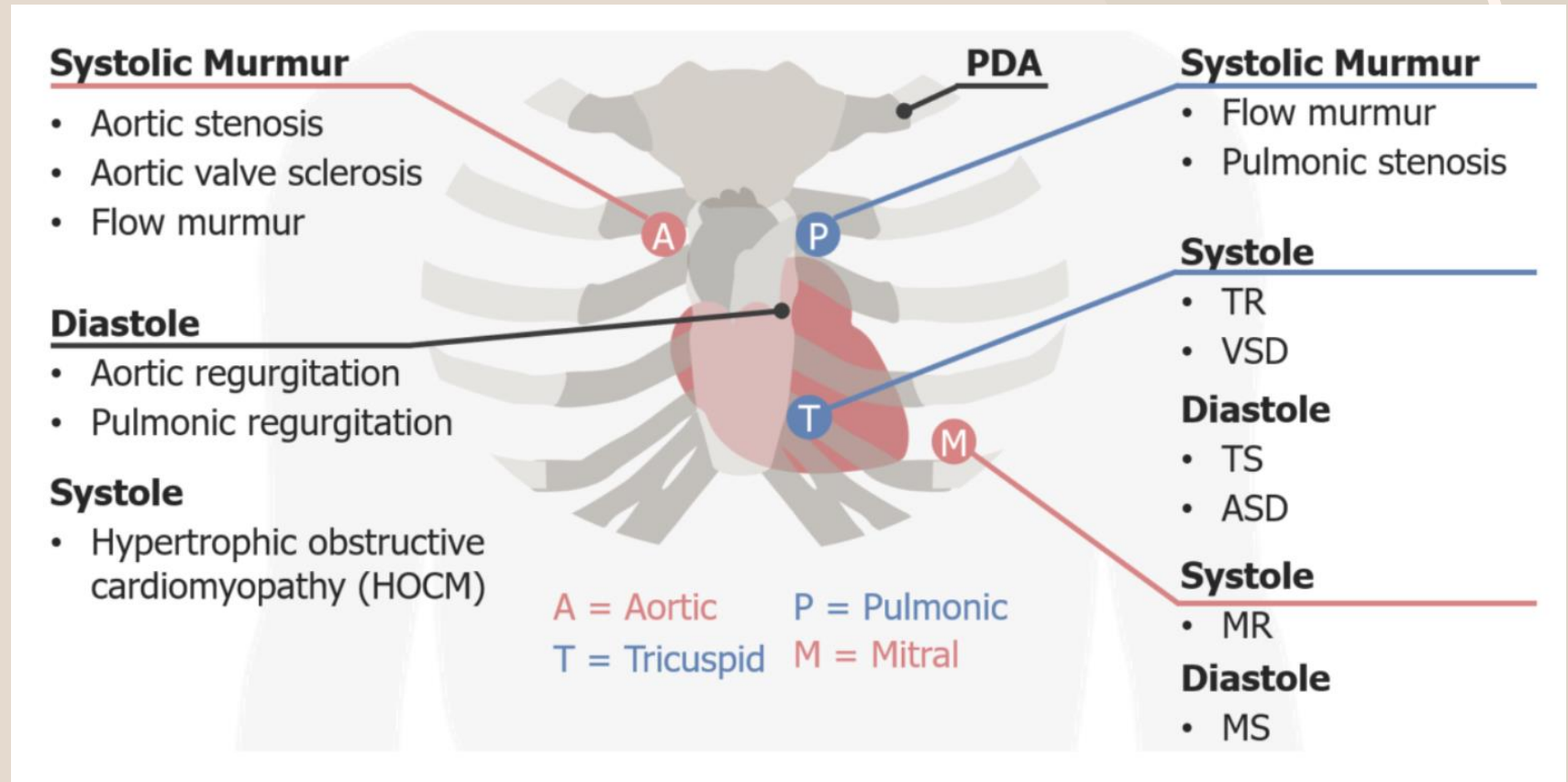


# VSD

- Most common pathological murmur in children
- Occurs with congenital heart disease most commonly
- Frequently will close spontaneously during 1<sup>st</sup> year
  - Surgical closure if large defect
- Left to right shunt
- Harsh and loud (if small defect), softer/less harsh if large
- Pan-systolic
- best heard at left lower sternal border
- Handgrip increases intensity
- Example: <https://www.youtube.com/watch?v=cVR0pybjRxM>
- Example in adult: [https://www.youtube.com/watch?v=joXtfE\\_iqU4](https://www.youtube.com/watch?v=joXtfE_iqU4)



# Review



# Review

Physiologic changes	Maneuver	Murmurs that increase with maneuver	Murmurs that decrease with maneuver
Increased <u>preload</u> (on the right)	<u>Inspiration</u>	Most right-sided murmurs	Most left-sided murmurs
Increased <u>preload</u>	<ul style="list-style-type: none"> <li>• Lying supine</li> <li>• Passive <u>leg</u> raise</li> <li>• Squatting</li> </ul>	Most murmurs	<ul style="list-style-type: none"> <li>• HOCM</li> <li>• <u>Mitral valve</u> prolapse</li> </ul>
Decreased <u>preload</u>	<ul style="list-style-type: none"> <li>• Valsalva (straining)</li> <li>• Abrupt standing</li> </ul>	<ul style="list-style-type: none"> <li>• HOCM</li> <li>• <u>Mitral valve</u> prolapse</li> </ul>	Most murmurs
Increased <u>afterload</u>	Handgrip	Most murmurs, especially <u>AR</u> , <u>MR</u> , <u>VSD</u>	<ul style="list-style-type: none"> <li>• AS</li> <li>• HOCM</li> </ul>

- Standing abruptly
  - Decreases preload
  - Same effects as Valsalva.

# Systolic Murmurs

Type	Cardiac cycle	Pattern	Location	Additional description
<u>Aortic stenosis</u>	Systolic	Crescendo-decrescendo murmur	Right 2nd ICS (aortic)	<ul style="list-style-type: none"> <li>Paradoxical <u>splitting</u> of S2 (A2 decreased)</li> <li>S4</li> </ul>
<u>Pulmonic stenosis</u>	Systolic	Crescendo-decrescendo murmur	Left 2nd ICS (pulmonic)	<ul style="list-style-type: none"> <li>Click often present</li> <li>↑ With <u>inspiration</u></li> </ul>
<u>Mitral valve prolapse</u>	Systolic	Click, crescendo into S2 (can vary with severity)	Left 4th ICS (mitral)	Mid-to-late systolic click
<u>Mitral regurgitation</u>	Systolic	Uniform (holosystolic)	Left 4th ICS (mitral)	<ul style="list-style-type: none"> <li>Holosystolic, high pitched</li> <li>Radiates to <u>axilla</u></li> </ul>
<u>Tricuspid regurgitation</u>	Systolic	Uniform (holosystolic)	LLSB (tricuspid)	<ul style="list-style-type: none"> <li>Holosystolic, high pitched</li> <li>↑ With <u>inspiration</u></li> </ul>
VSD	Systolic	Uniform (holosystolic)	LLSB (tricuspid)	Harsh, loud murmur



# Diastolic Murmurs

Type	Cardiac cycle	Pattern	Location	Additional description
<u>AR</u>	Diastolic	Decrescendo	Erb's point	<ul style="list-style-type: none"> <li>• S3 in acute <u>AR</u></li> <li>• High pitched</li> </ul>
<u>Pulmonary regurgitation</u>	Diastolic	Decrescendo	Erb's point	↑ With <u>inspiration</u>
<u>Mitral stenosis</u>	Diastolic	<u>Opening snap</u> followed by decrescendo-crescendo murmur	Left 4th ICS (mitral)	<ul style="list-style-type: none"> <li>• <u>Opening snap</u></li> <li>• Low-pitched, rumbling, mid-to-late diastolic murmur</li> </ul>
<u>Tricuspid stenosis</u>	Diastolic	Frequently with <u>MS</u> (but softer and shorter than <u>MS</u> )	LLSB (tricuspid)	<ul style="list-style-type: none"> <li>• Very rare</li> <li>• Low pitched</li> <li>• ↑ With <u>inspiration</u></li> </ul>
<u>Patent ductus arteriosus</u>	Continuous	Crescendo-decrescendo murmur	Left 1st and 2nd ICS	Continuous machinery-like murmur

The background features a light gray base with several abstract elements: a large, solid reddish-brown shape on the left side; a large, solid olive-green shape on the right side; and a white outline of a leafy branch in the upper left corner.

# thank you

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