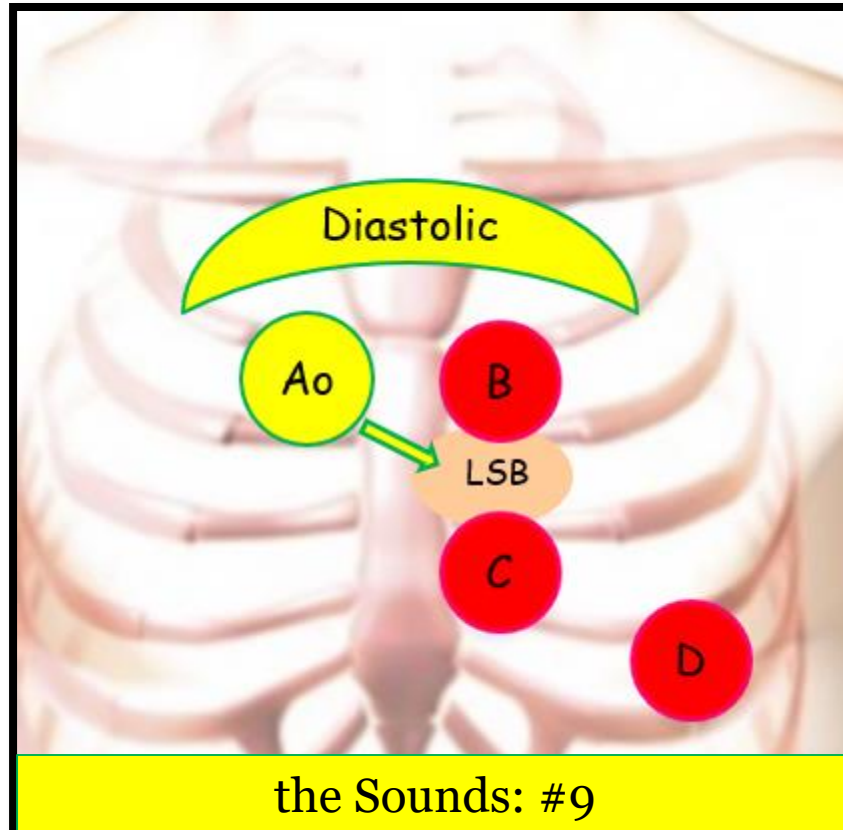
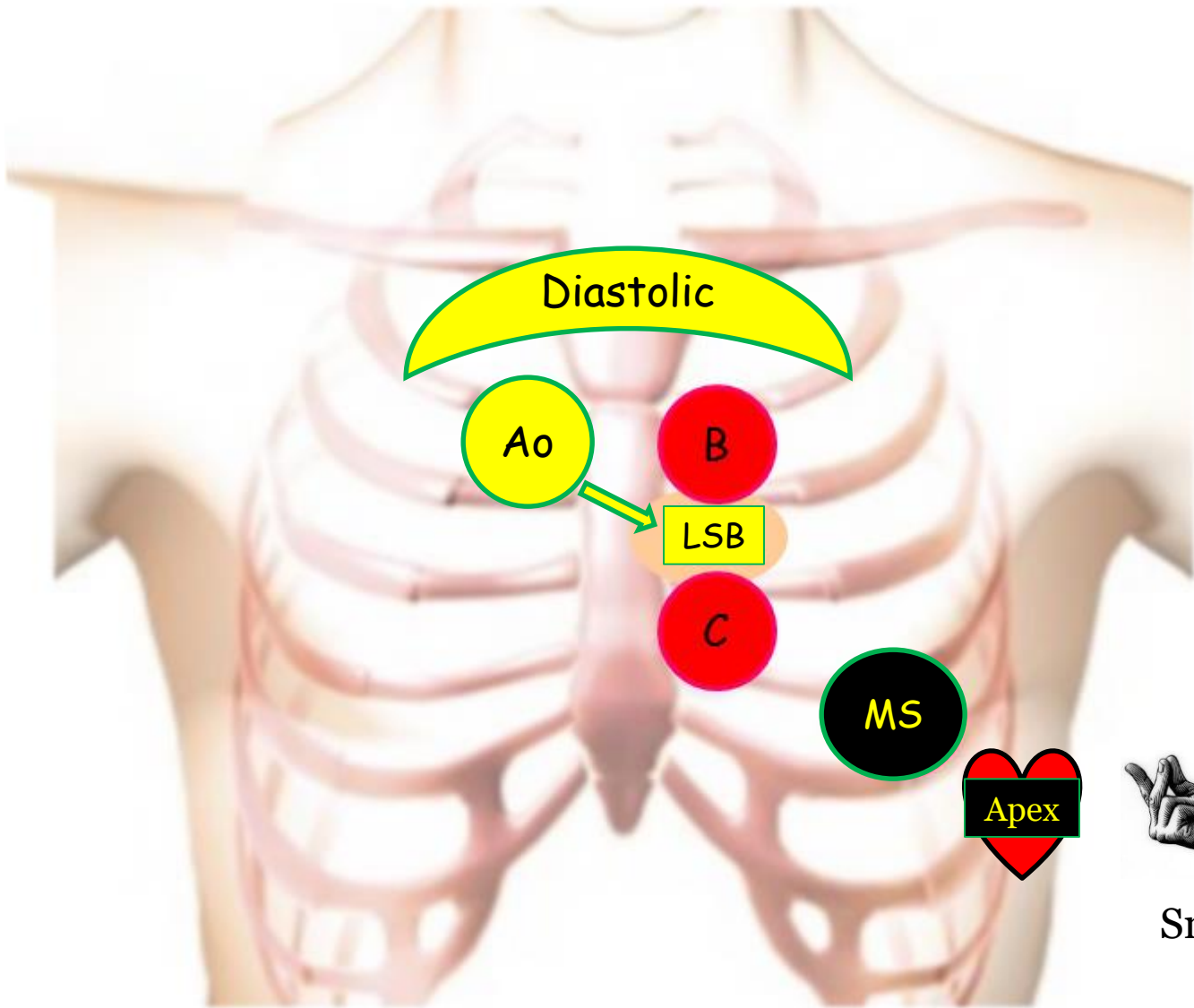


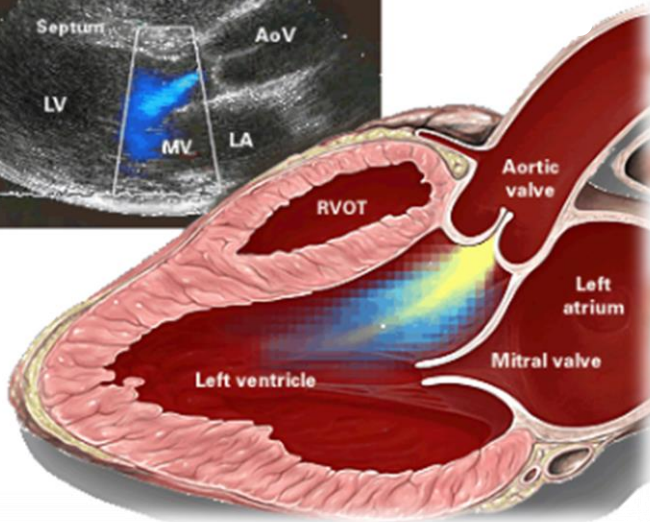
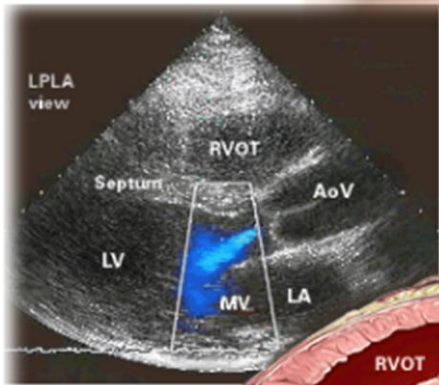
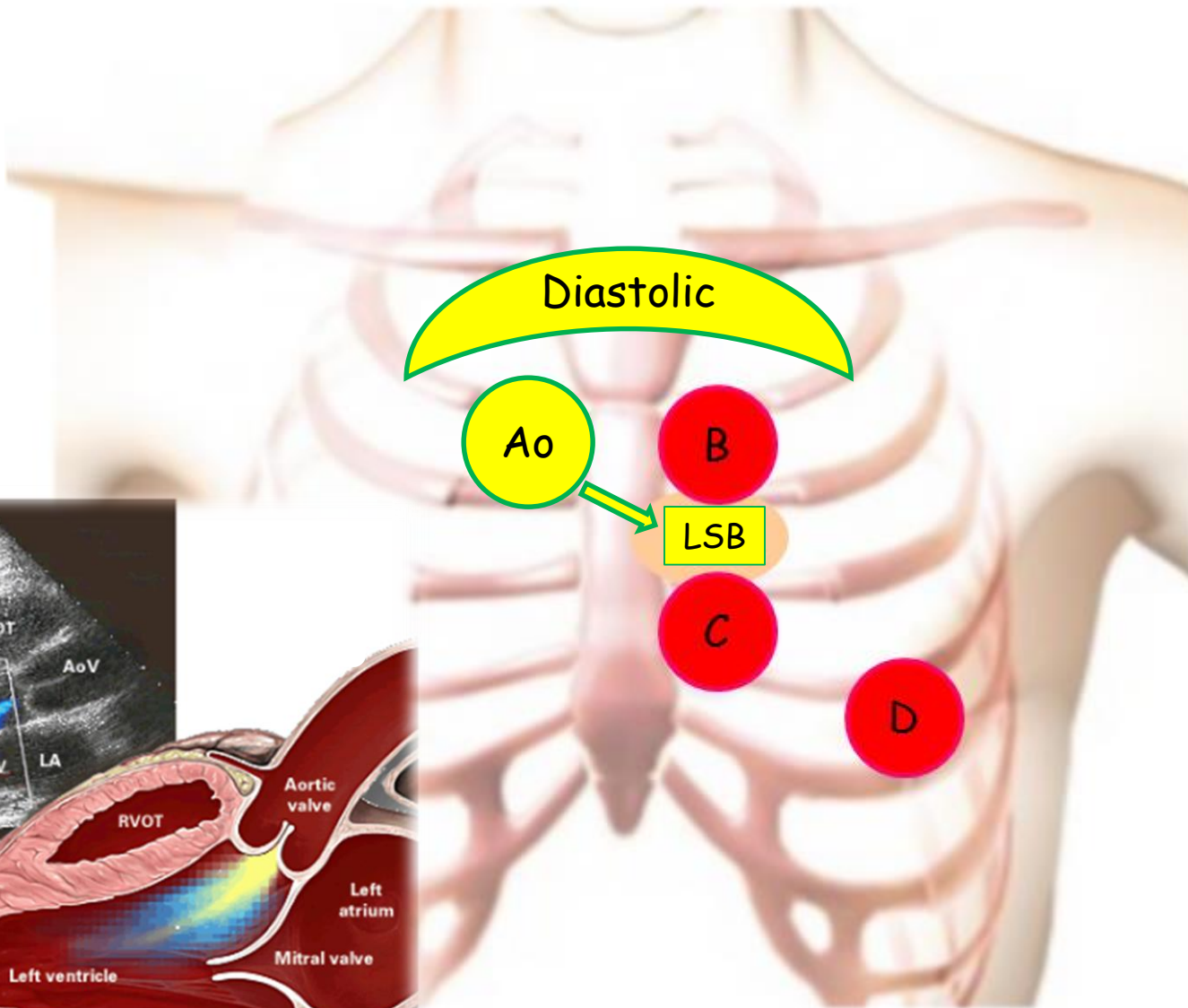
Aortic (Insufficiency) Regurgitation for the USMLE Step One Exam

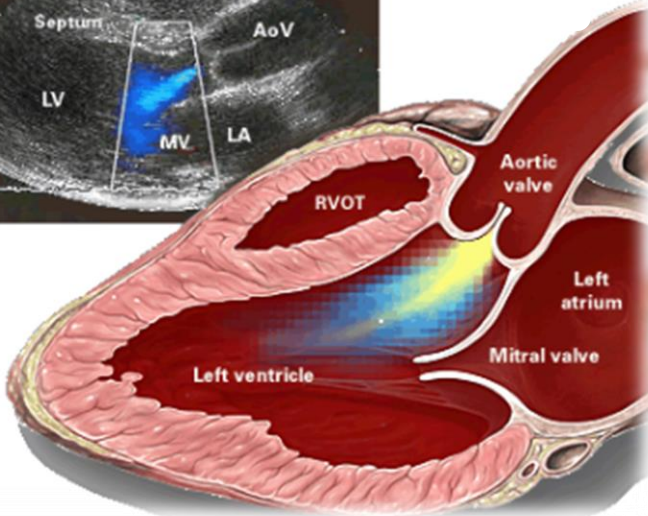
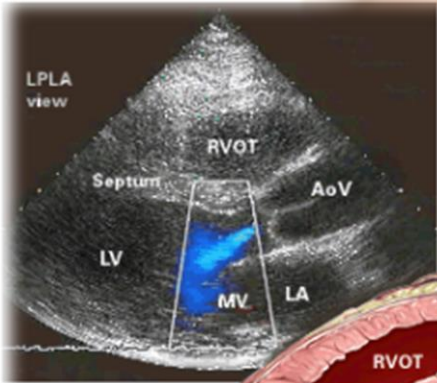
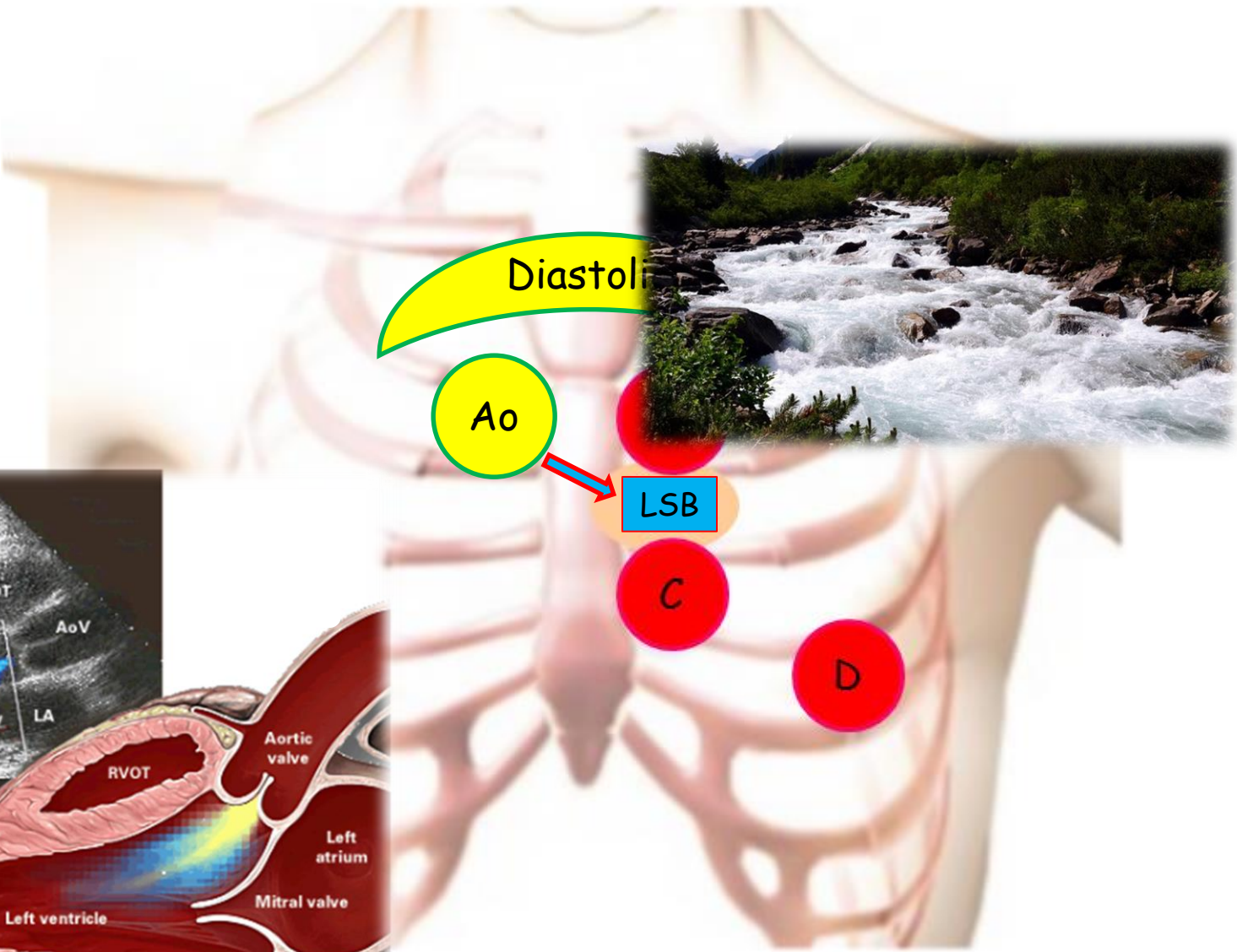


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Snap



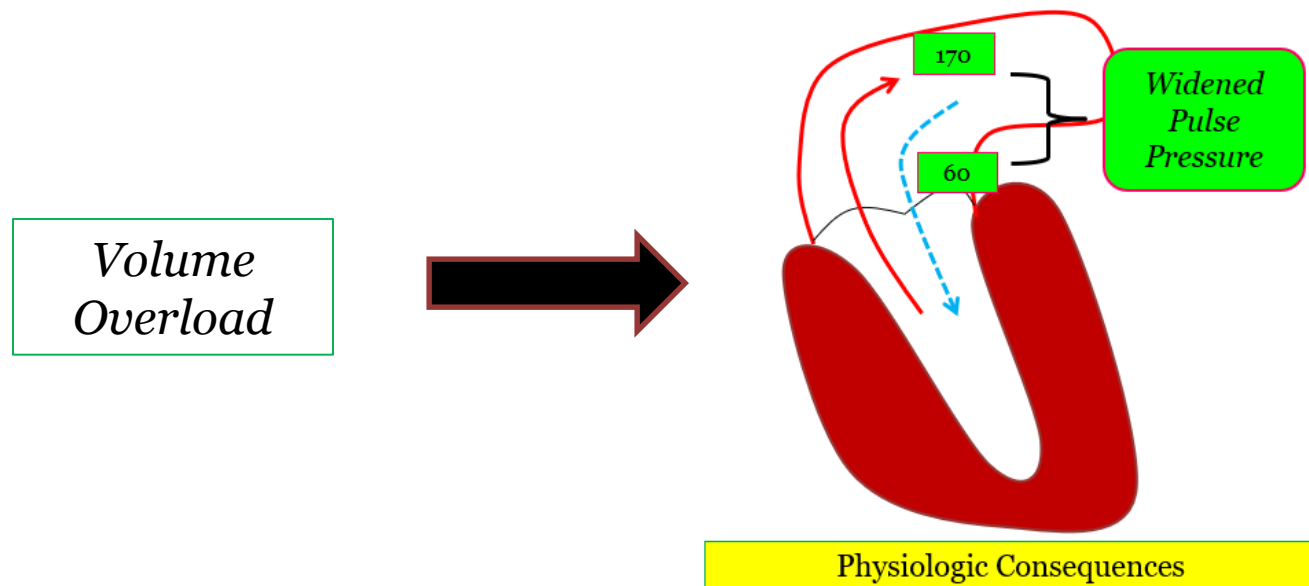


Aortic Regurgitation: *the Curriculum*

- Background
- *Physiology Consequences* ($\rightarrow \uparrow EDV$)
 - Pulse pressure
 - Aorta: limited compliance ($C = \Delta V / \Delta P$)
 - Eccentric hypertrophy
 - Hemodynamic curves (cardiac cycle, pressure-volume loop)
- Physical Exam: *the Murmur*
 - Chronic AI: *Decrescendo at mid-LSB*
 - Squatting maneuver $\rightarrow \uparrow$ intensity
- Demographics
 - Endocarditis
 - Rheumatic fever, acute
 - Aortitis/Dissection

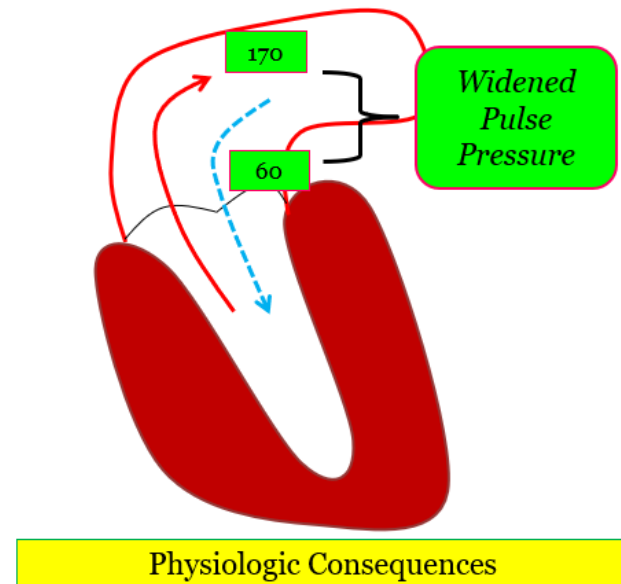
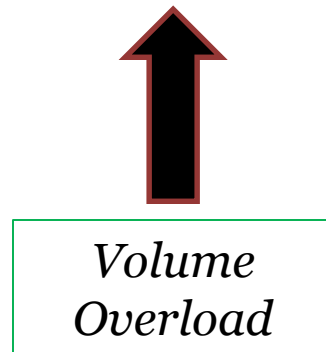
Aortic Regurgitation: *the Curriculum*

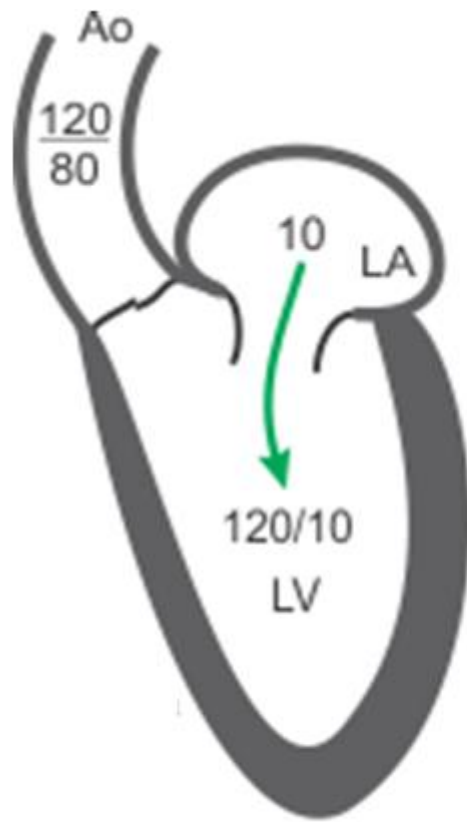
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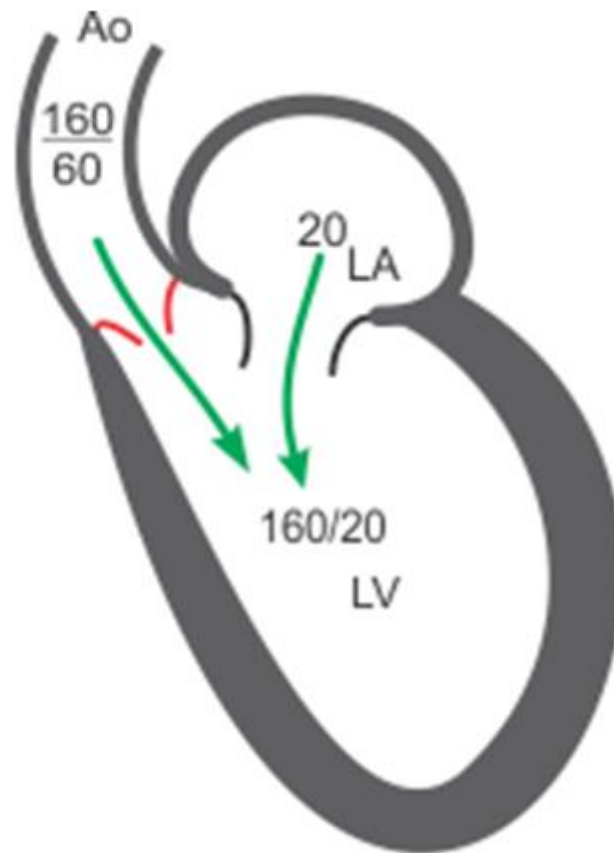
Aortic Regurgitation: *the Curriculum*

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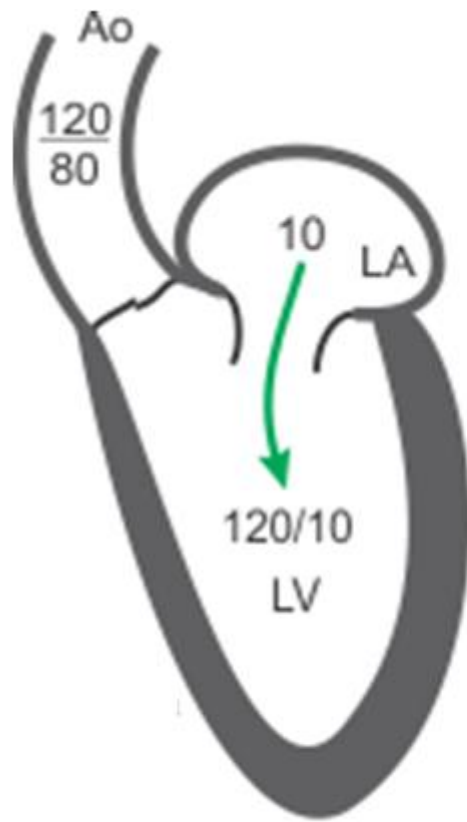
Normal



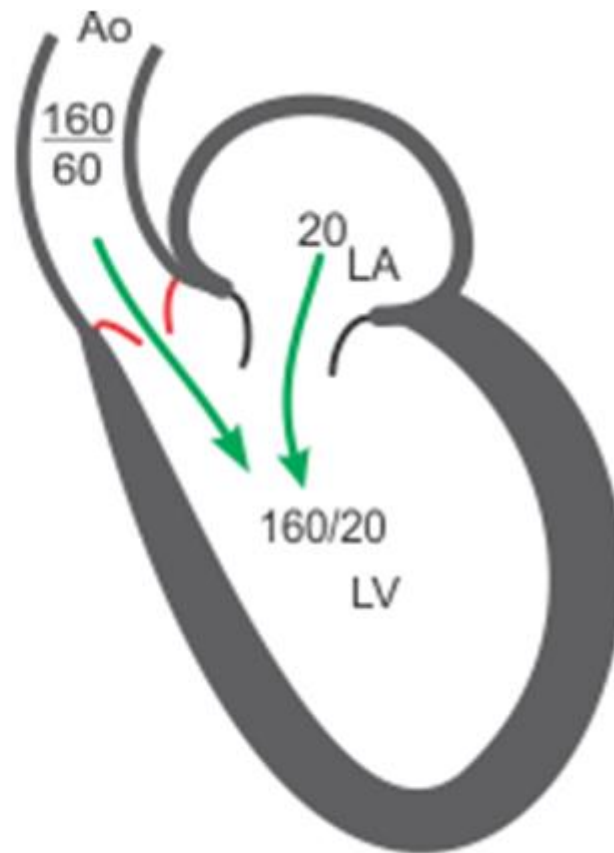
Aortic Regurgitation

Why does the Pulse Pressure (Systolic - Diastolic) widen?
[normal = <50 mm Hg]

This is a key pathophysiologic hallmark



Normal

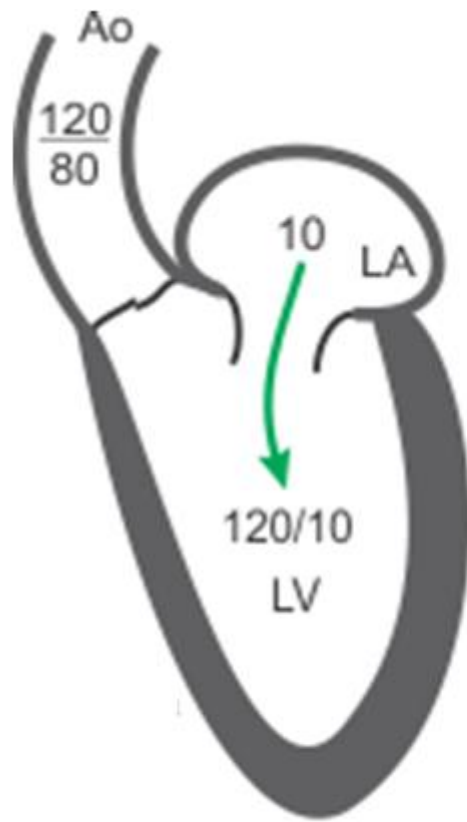


Aortic Regurgitation

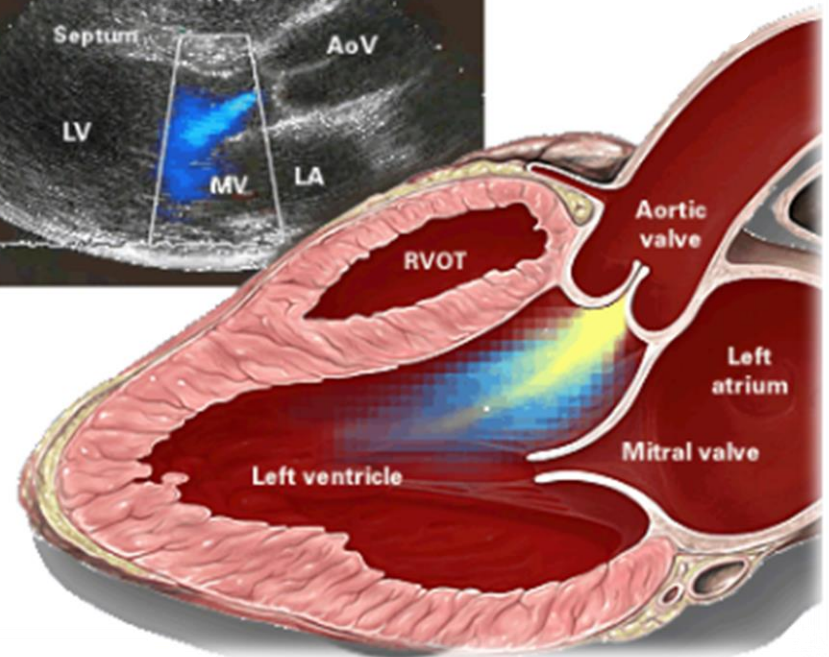
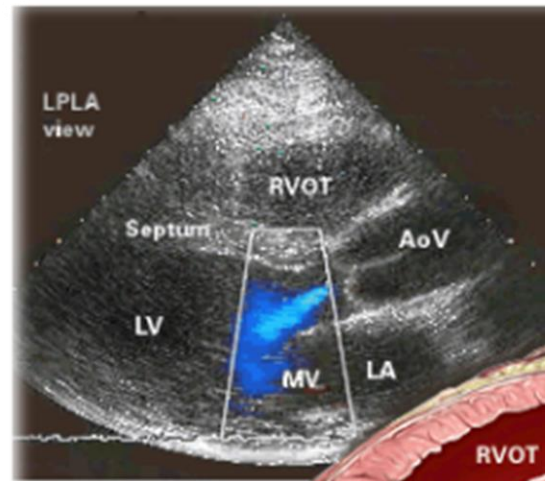
Why does the Pulse Pressure (Systolic - Diastolic) widen?

Main contributor

↑ SYSTOLIC: Increased EDV (LA + Regurg Vol) → ↑ SV



Normal

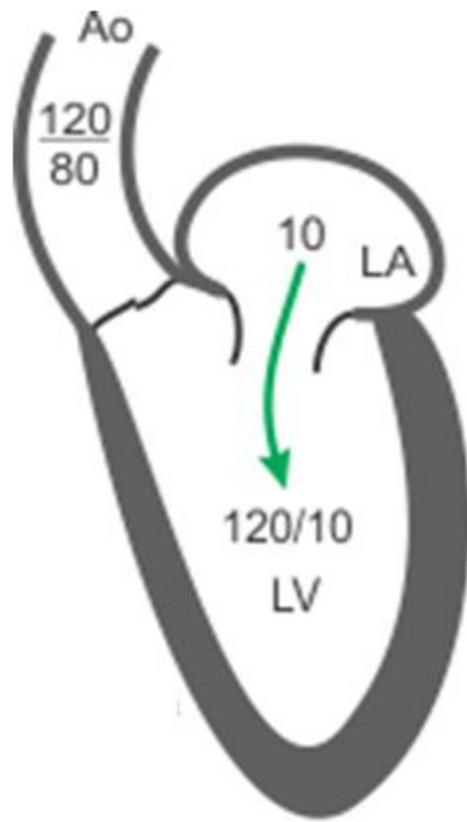


Aortic Regurgitation

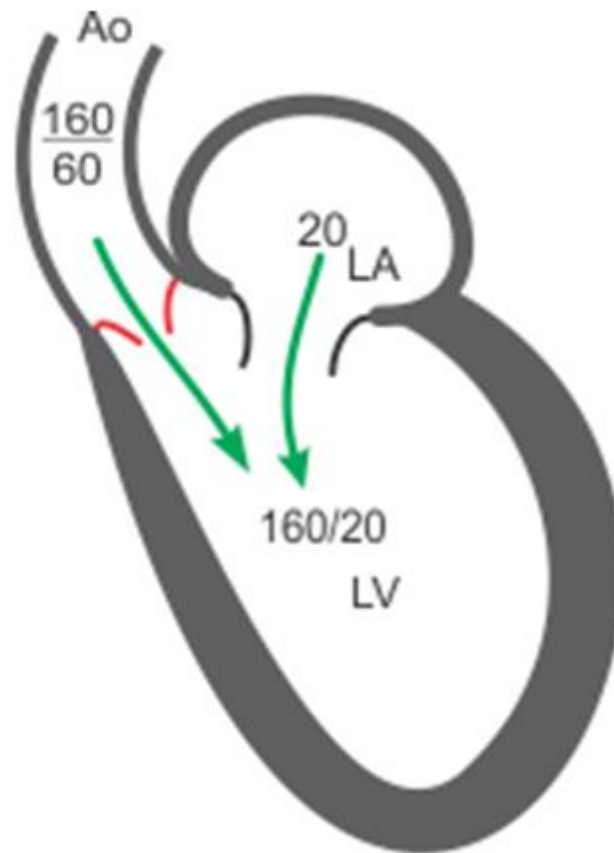
Why does the Pulse Pressure (Systolic - Diastolic) widen?

↑ SYSTOLIC: Increased *EDV* (LA + Regurg Vol) ⇒

↑ *Stroke Volume*



Normal



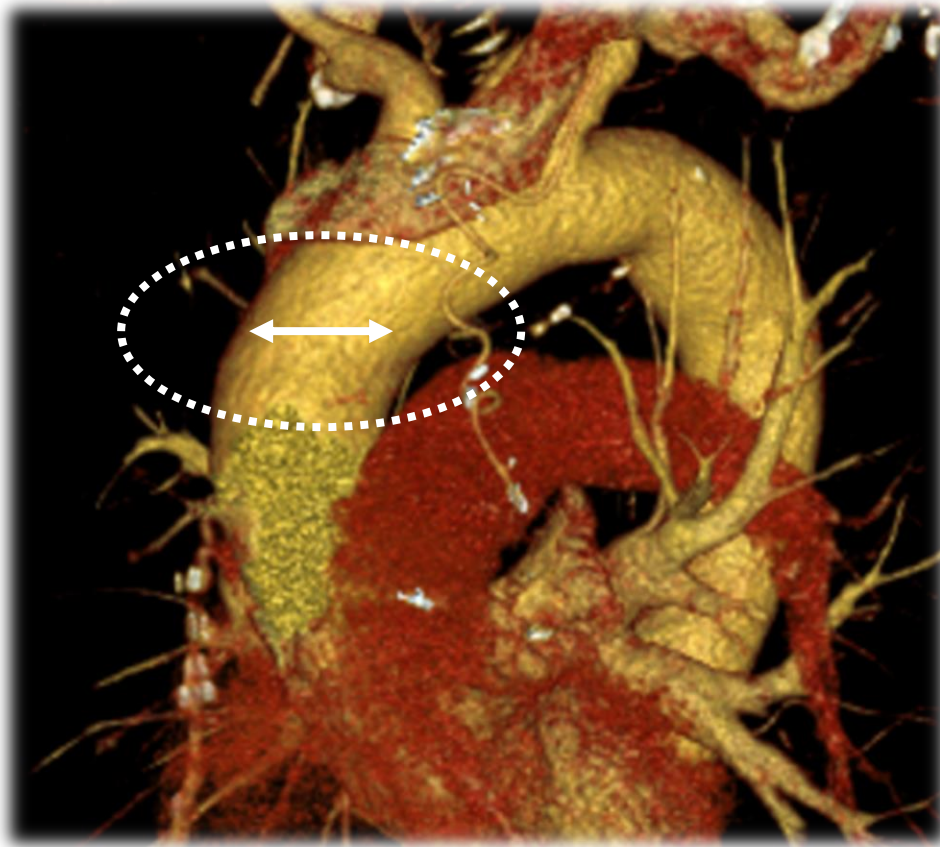
Aortic Regurgitation

Why does the Pulse Pressure (Systolic - Diastolic) widen?

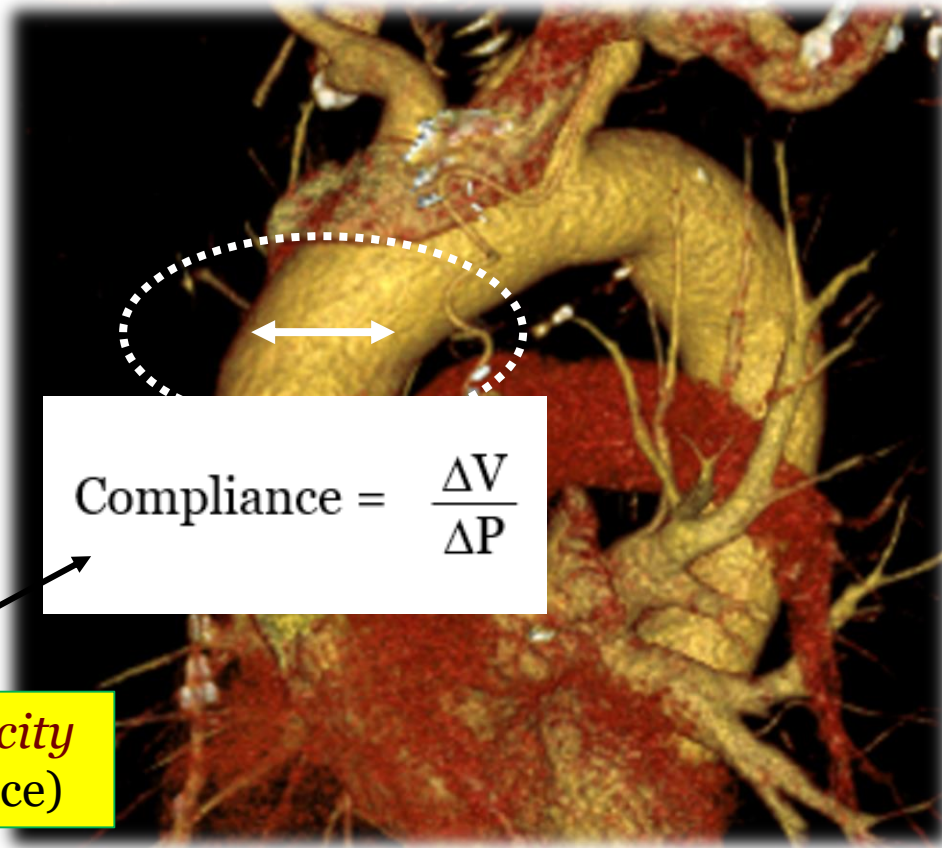
Main contributor

↑ SYSTOLIC: Increased EDV (LA + Regurg Vol) → ↑ SV
 ↓ DIASTOLIC: Regurgitant Volume

↑ **Stroke Volume** → ↑ **Systolic pressure** as the aorta has a finite capacity (i.e. limited compliance) to accommodate the volume.



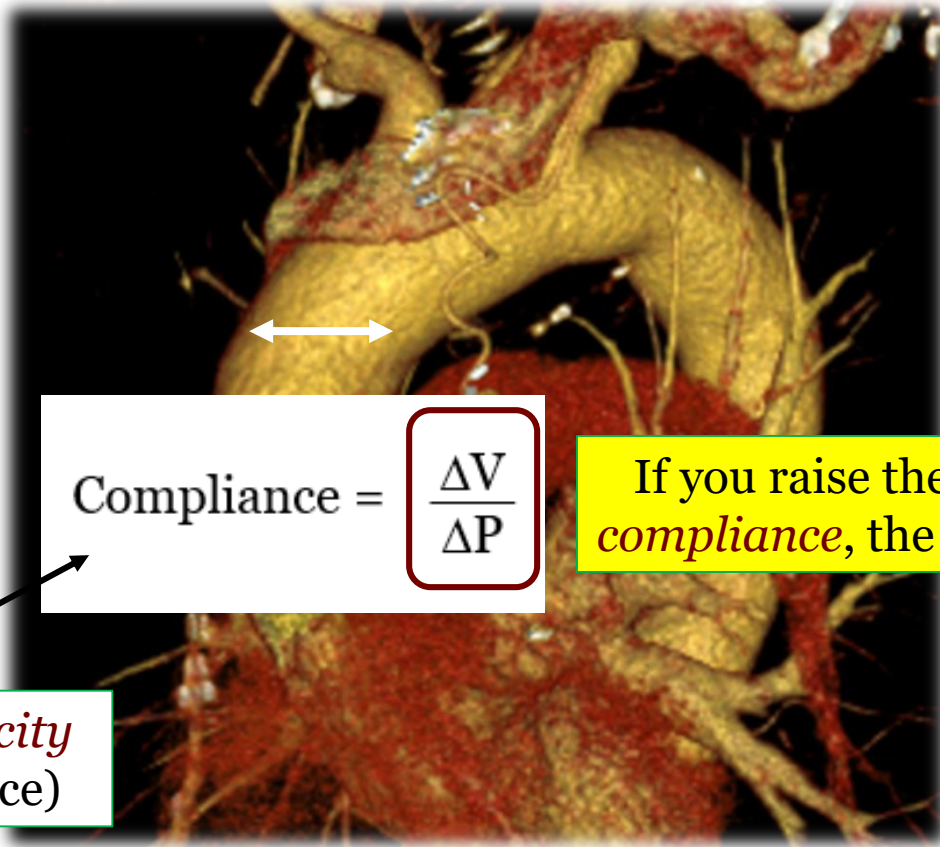
↑ **Stroke Volume** → ↑ **Systolic pressure** as the aorta has a finite capacity (i.e. limited compliance) to accommodate the volume.



$$\text{Compliance} = \frac{\Delta V}{\Delta P}$$

Aorta, *Fixed Capacity*
(limited compliance)

↑ **Stroke Volume** → ↑ **Systolic pressure** as the aorta has a finite capacity (i.e. limited compliance) to accommodate the volume.



Compliance = $\frac{\Delta V}{\Delta P}$

If you raise the *volume* against fixed *compliance*, the *pressure* must also rise

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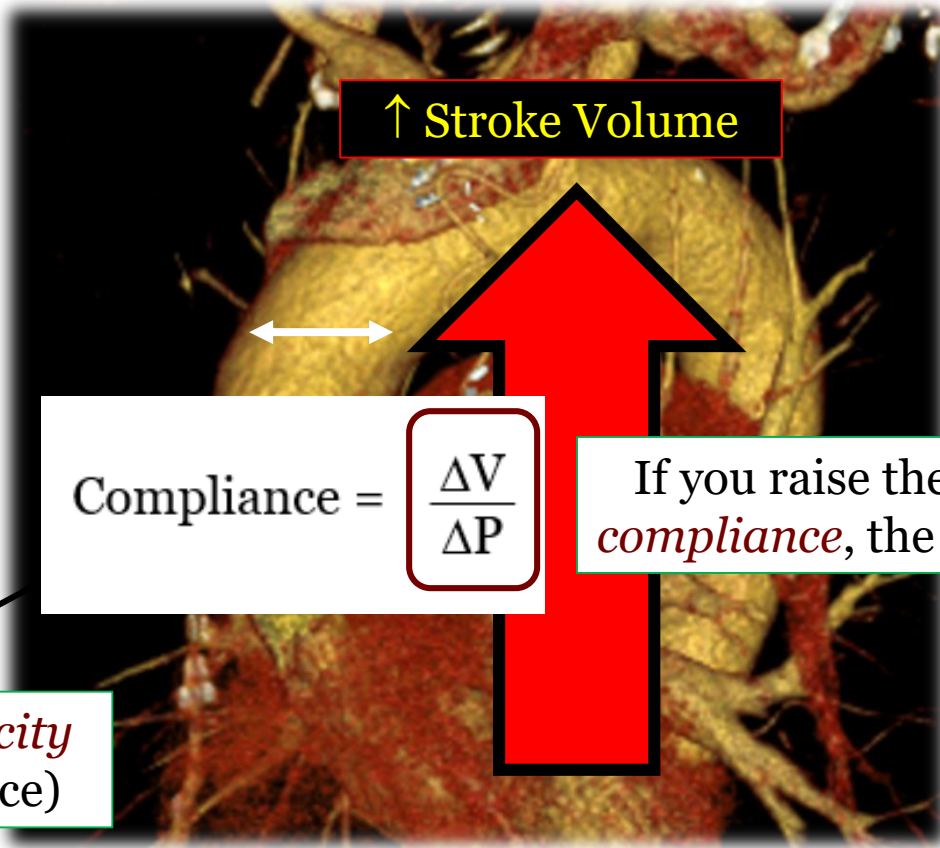
↑ **Stroke Volume**

Compliance =

$$\frac{\Delta V}{\Delta P}$$

If you raise the *volume* against fixed *compliance*, the *pressure* must also rise

Aorta, *Fixed Capacity*
(limited compliance)

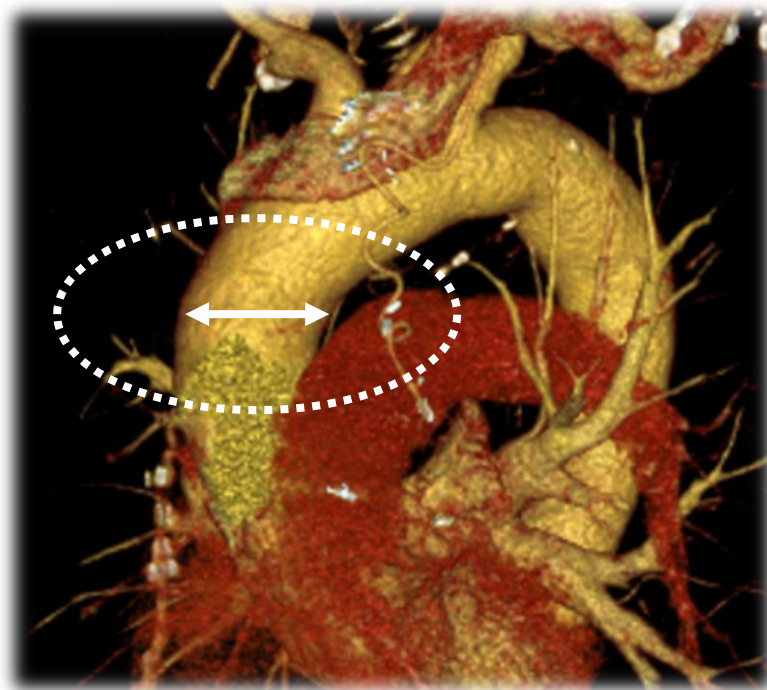


↑ Stroke Volume → ↑ Systolic pressure as the aorta has a finite capacity (i.e. limited compliance) to accommodate the volume.

This is also observed in anemia.

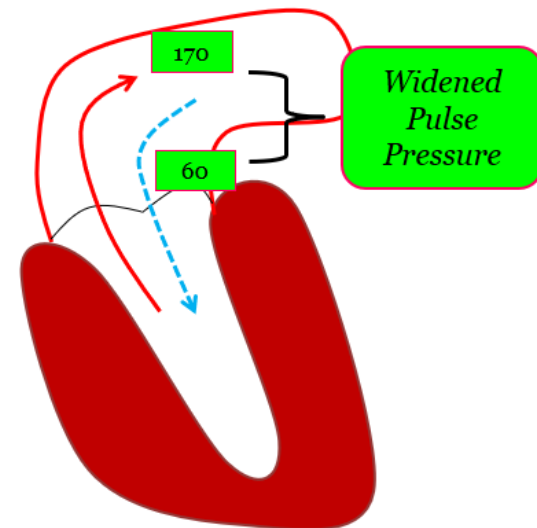
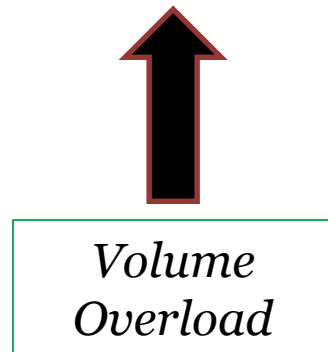
Decreased oxygen delivery → vasodilation → ↓ afterload → ↑ SV

Result: *Widened pulse pressure*

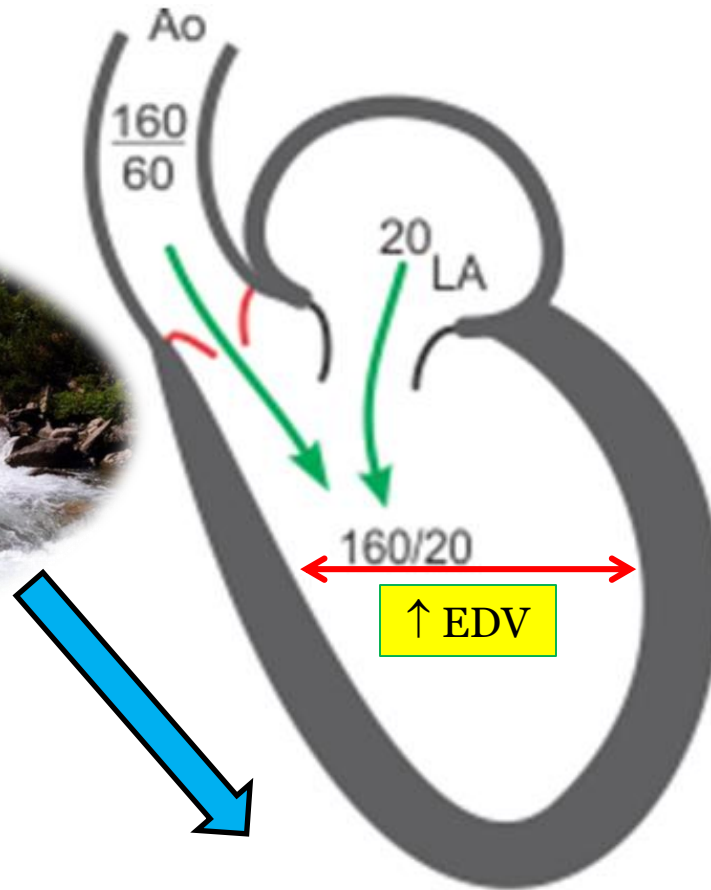


Aortic Regurgitation: *the Curriculum*

- Background
- *Physiologic Consequences* ($\rightarrow \uparrow EDV$)
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 - **Eccentric hypertrophy**
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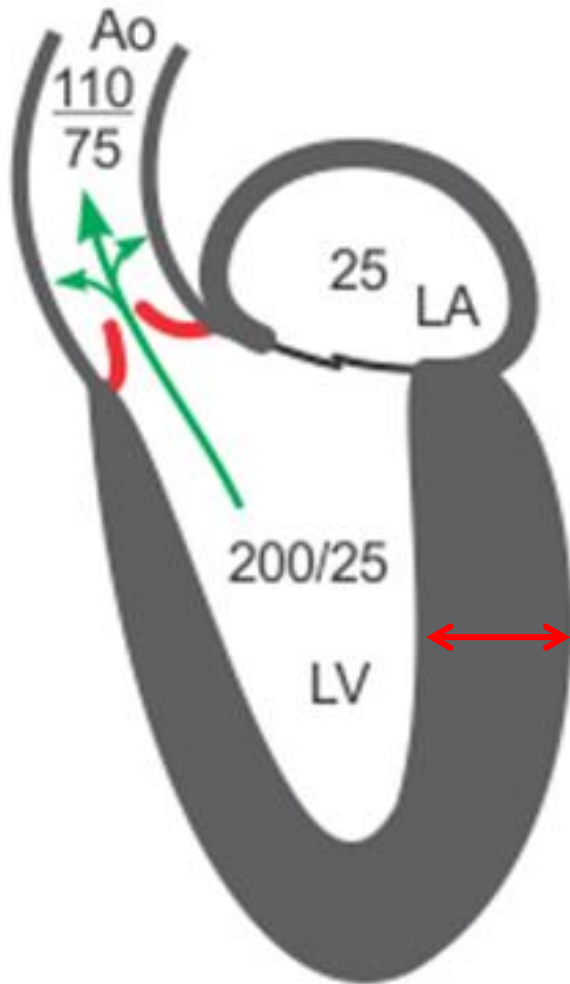


Physiologic Consequences



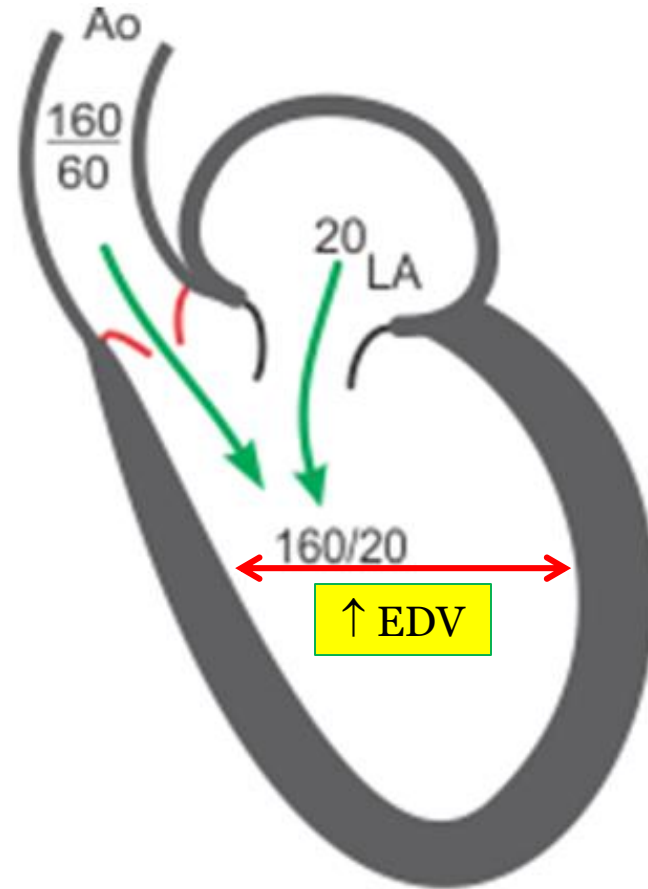
Aortic Regurgitation

Volume overload
Eccentric hypertrophy
Dilated (**chamber**) CM



Aortic Stenosis

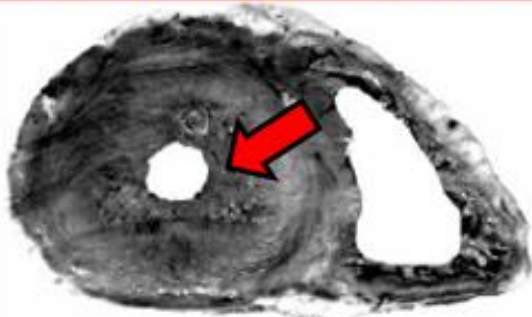
Pressure overload
 Concentric LVH
 Hypertrophic (wall) CM



Aortic Regurgitation

Volume overload
 Eccentric hypertrophy
 Dilated (chamber) CM

Increased wall thickness ↓ wall stress

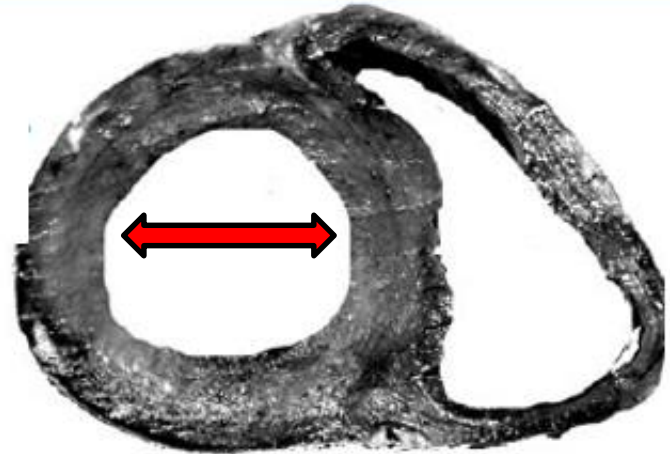


Physiologic Purpose:
↓ Wall Stress ($= P \times r / 2h$)

Pressure (\uparrow Afterload):
Aortic Stenosis

Concentric Hypertrophy

Longer myocytes (Starling forces) have improved contractile force (think EDV)



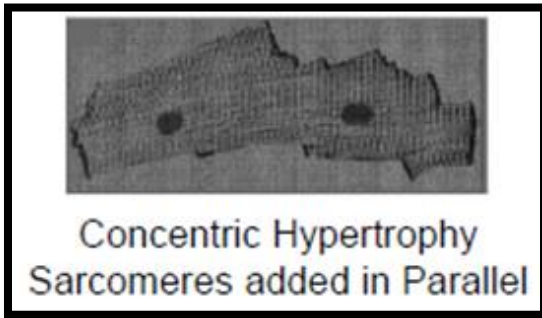
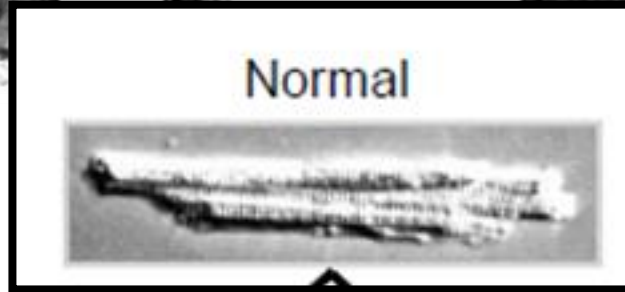
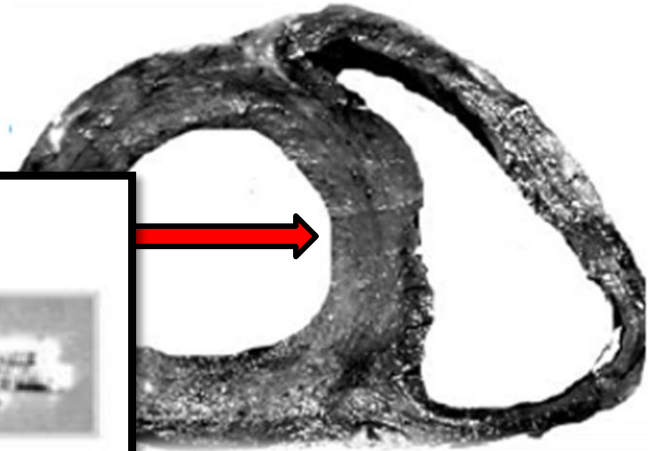
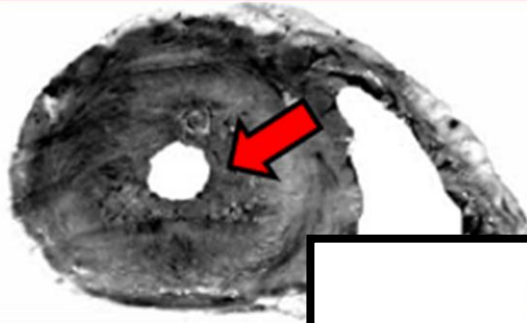
Physiologic Purpose:
Starling Force

Volume (\uparrow EDV):
Aortic Insufficiency

Eccentric Hypertrophy

Increased wall thickness \downarrow wall stress

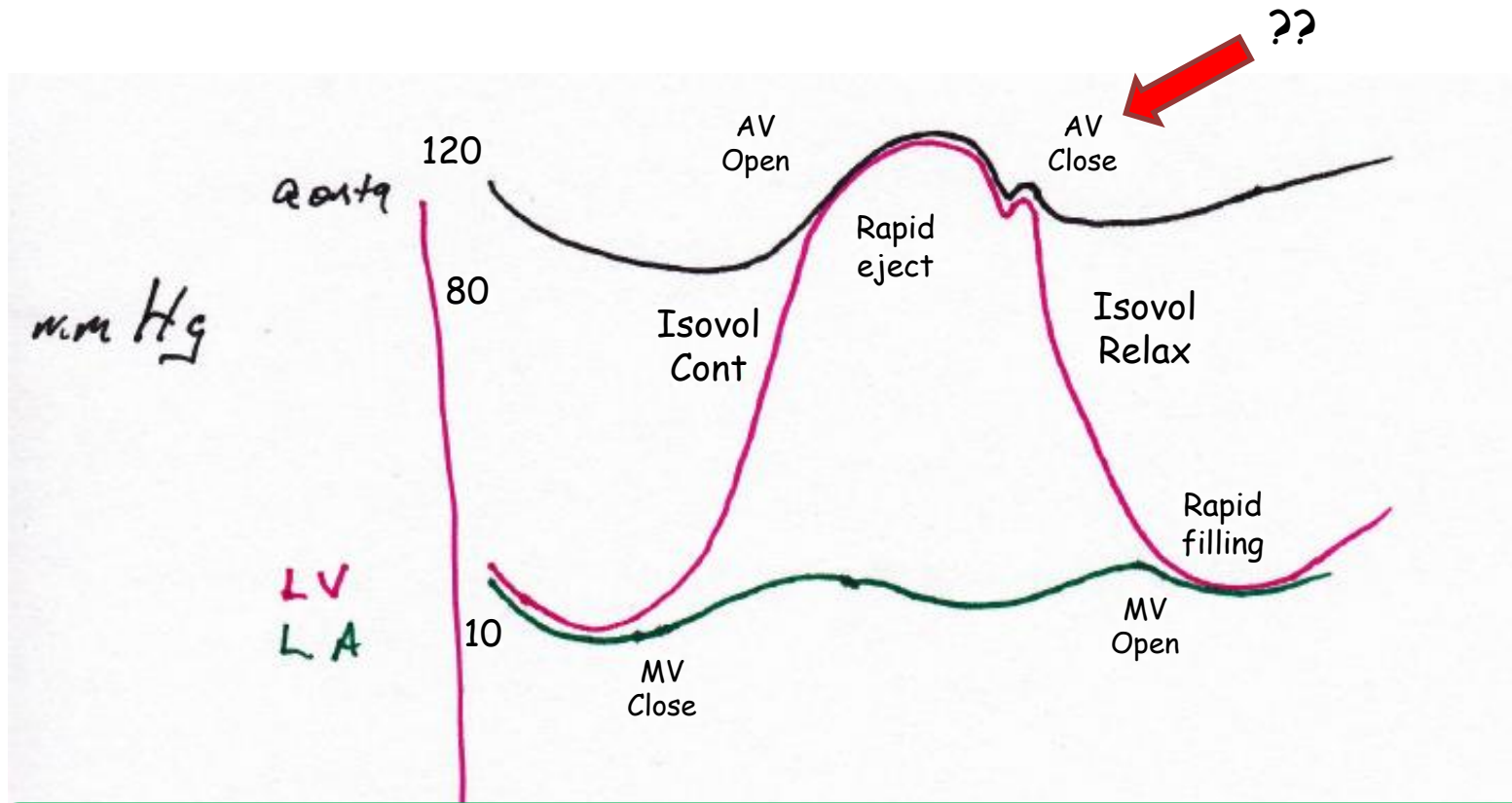
Longer myocytes (Starling forces) have improved contractile force (think EDV)



Pressure (\uparrow Afterload):
Aortic Stenosis

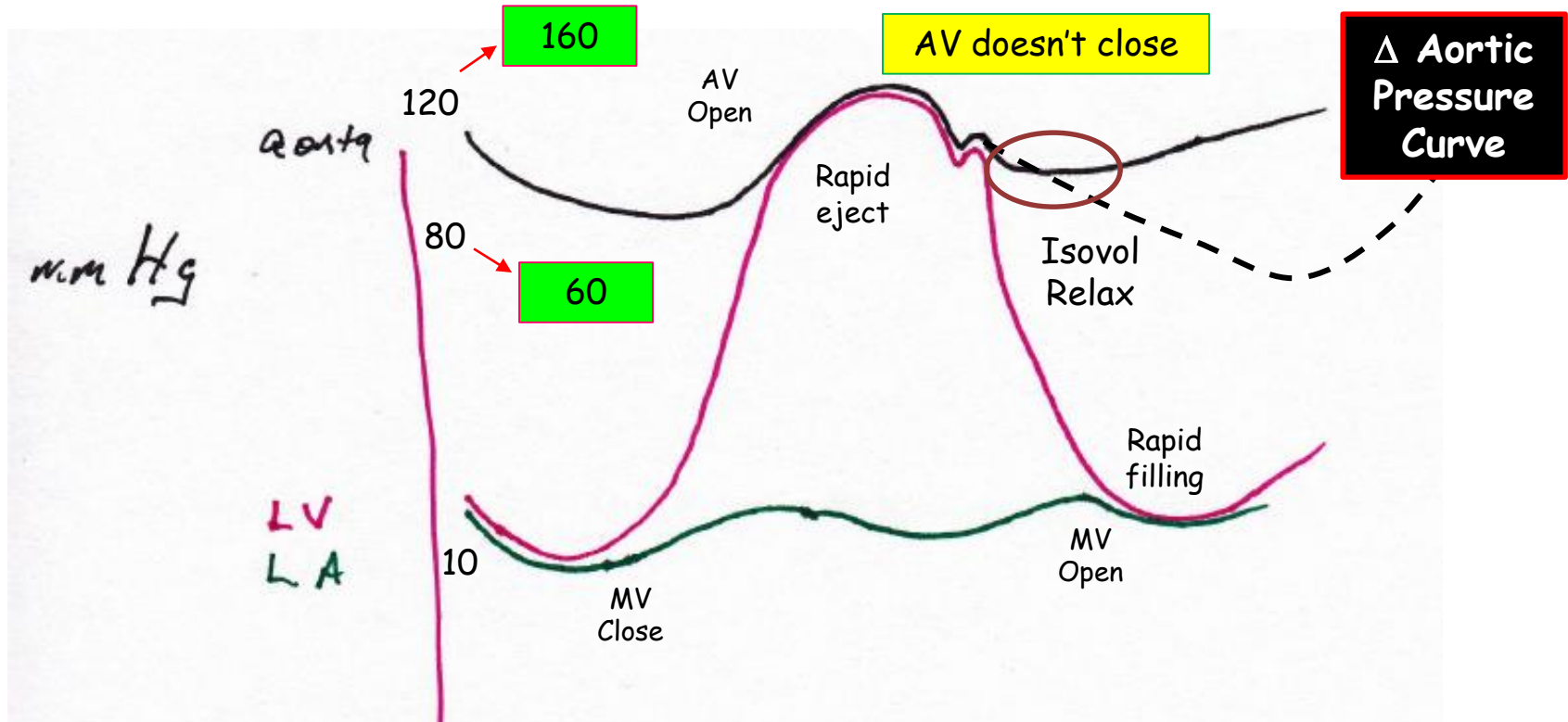
Volume (\uparrow EDV):
Aortic Insufficiency

Aortic Regurgitation: Hemodynamics I

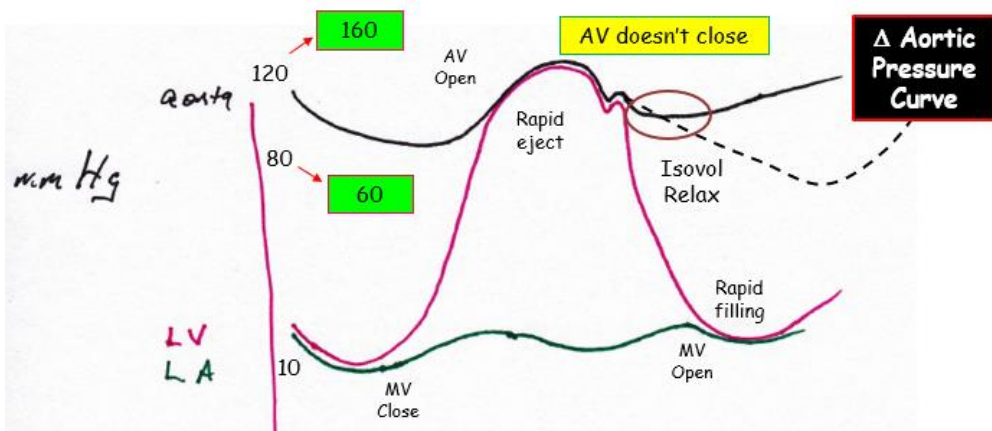


Which portion of the curve is effected by AI?

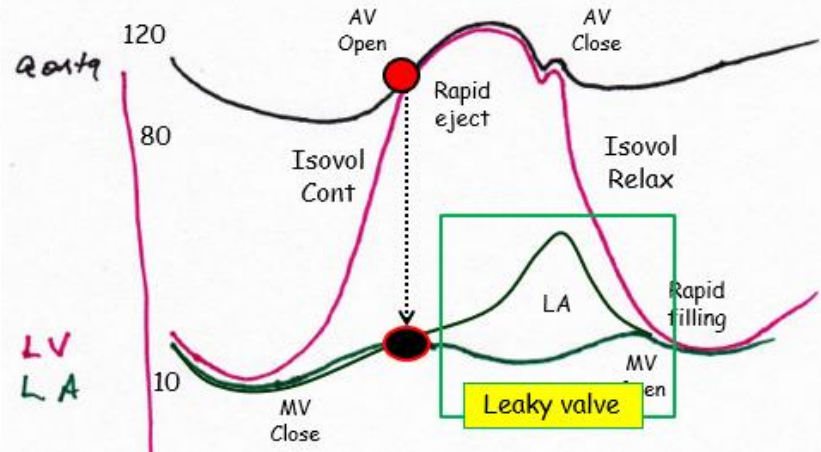
Aortic Regurgitation: Hemodynamics I



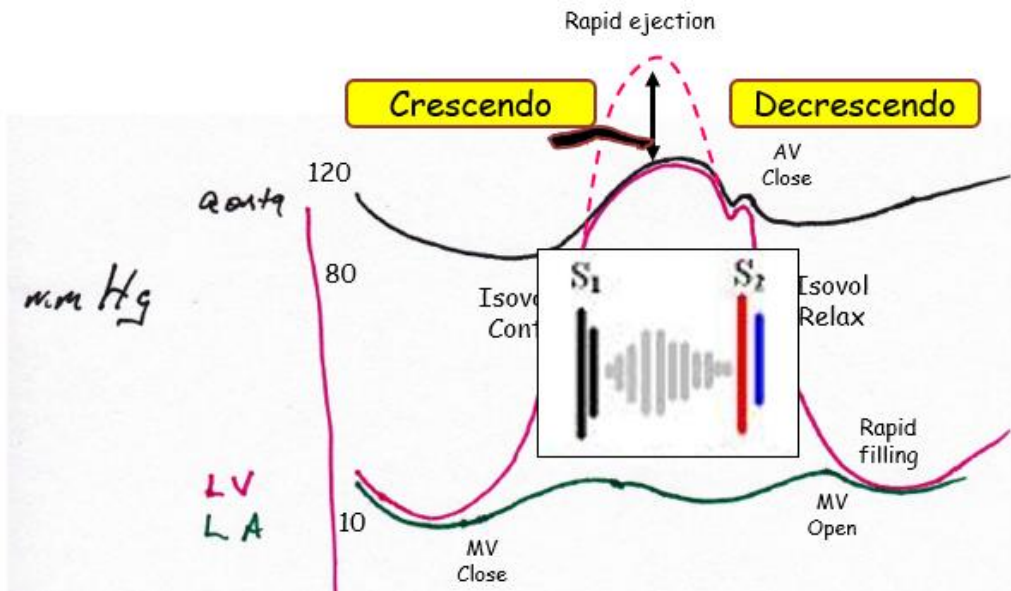
The aortic pressure curve reveals **higher** systolic pressure and **lower** diastolic pressure (reflecting the widened pulse pressure).



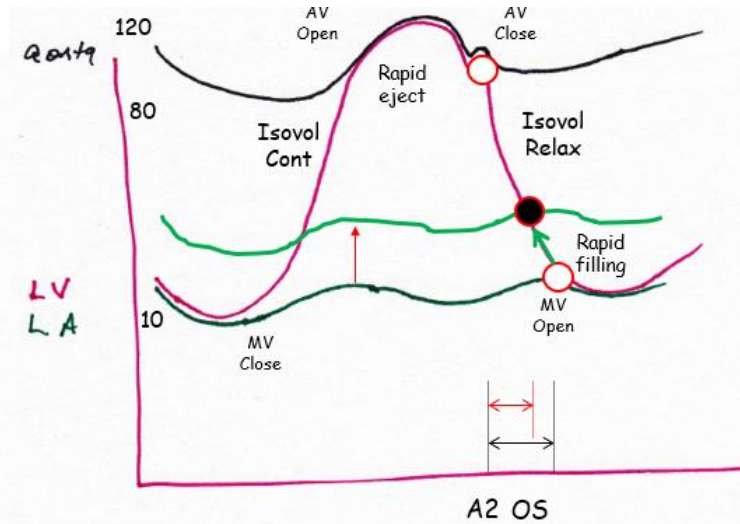
Aortic Regurgitation, Aorta



Mitral Regurgitation, LA, Sys

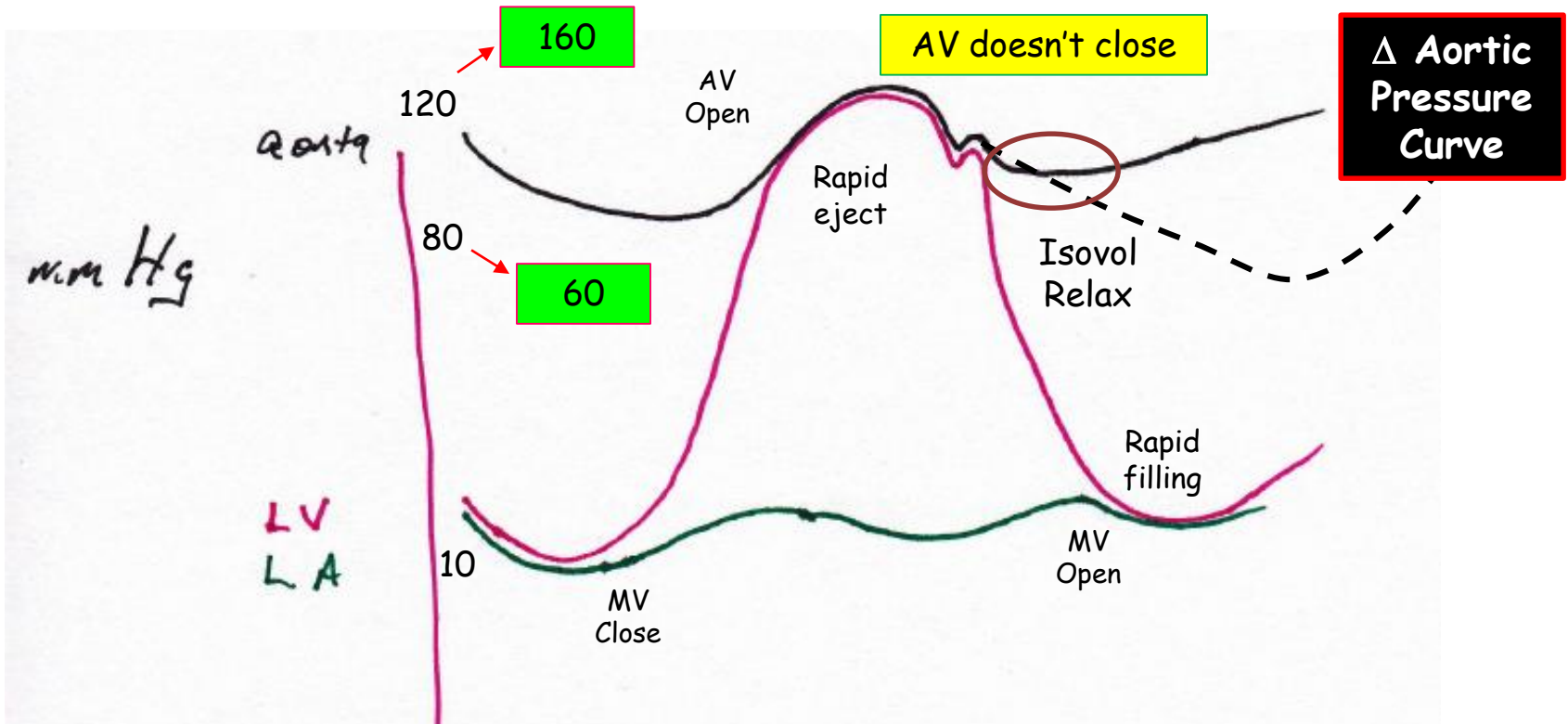


Aortic Stenosis, Delay



Mitral Stenosis, LA, A2:O2

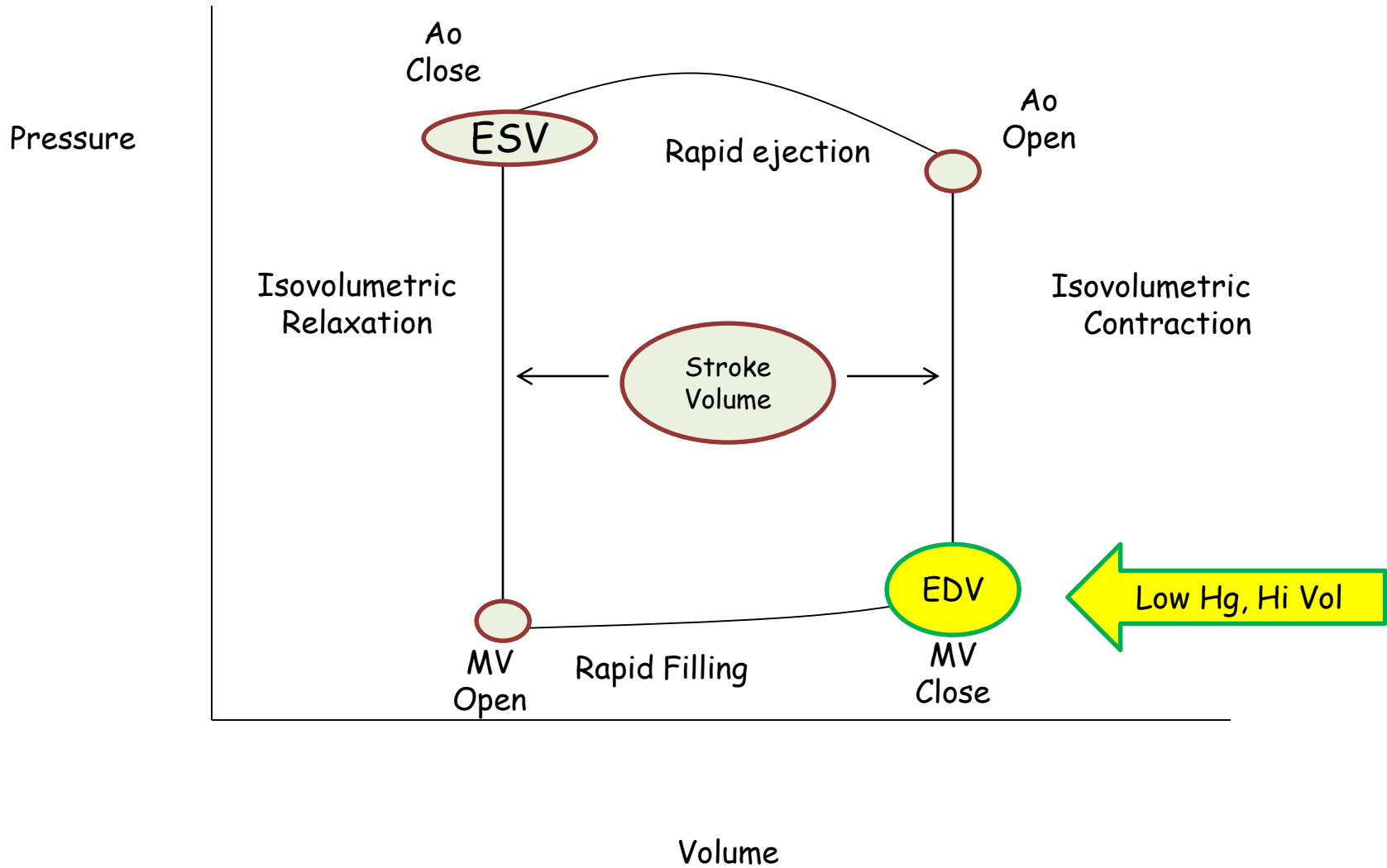
Aortic Regurgitation: Hemodynamics I



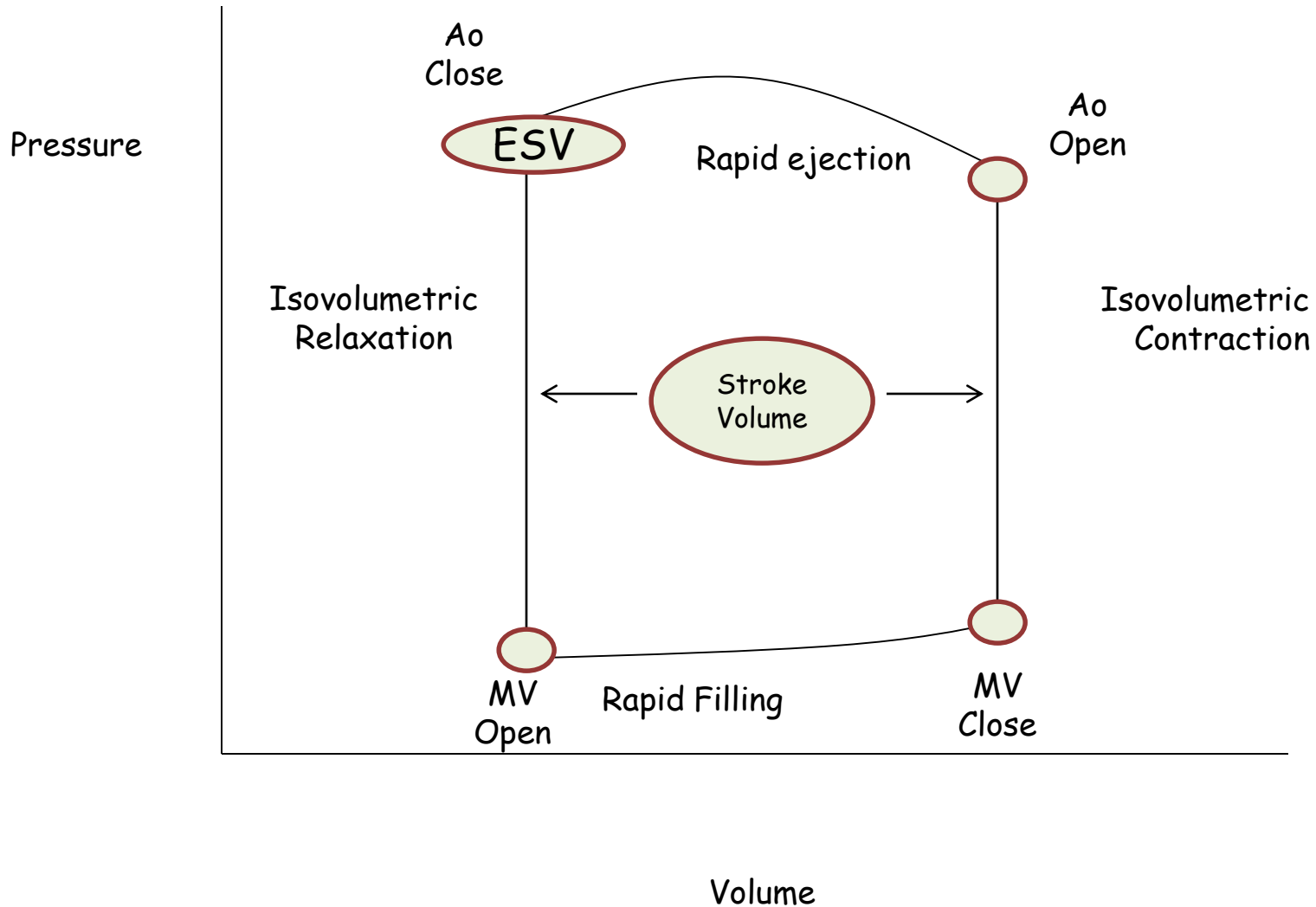
The aortic pressure curve reveals higher systolic pressure and lower diastolic pressure (reflecting the widened pulse pressure).

AI is more commonly and physiologically represented by the LV pressure-volume loop.

Hemodynamics II: LV Pressure-Volume Curve

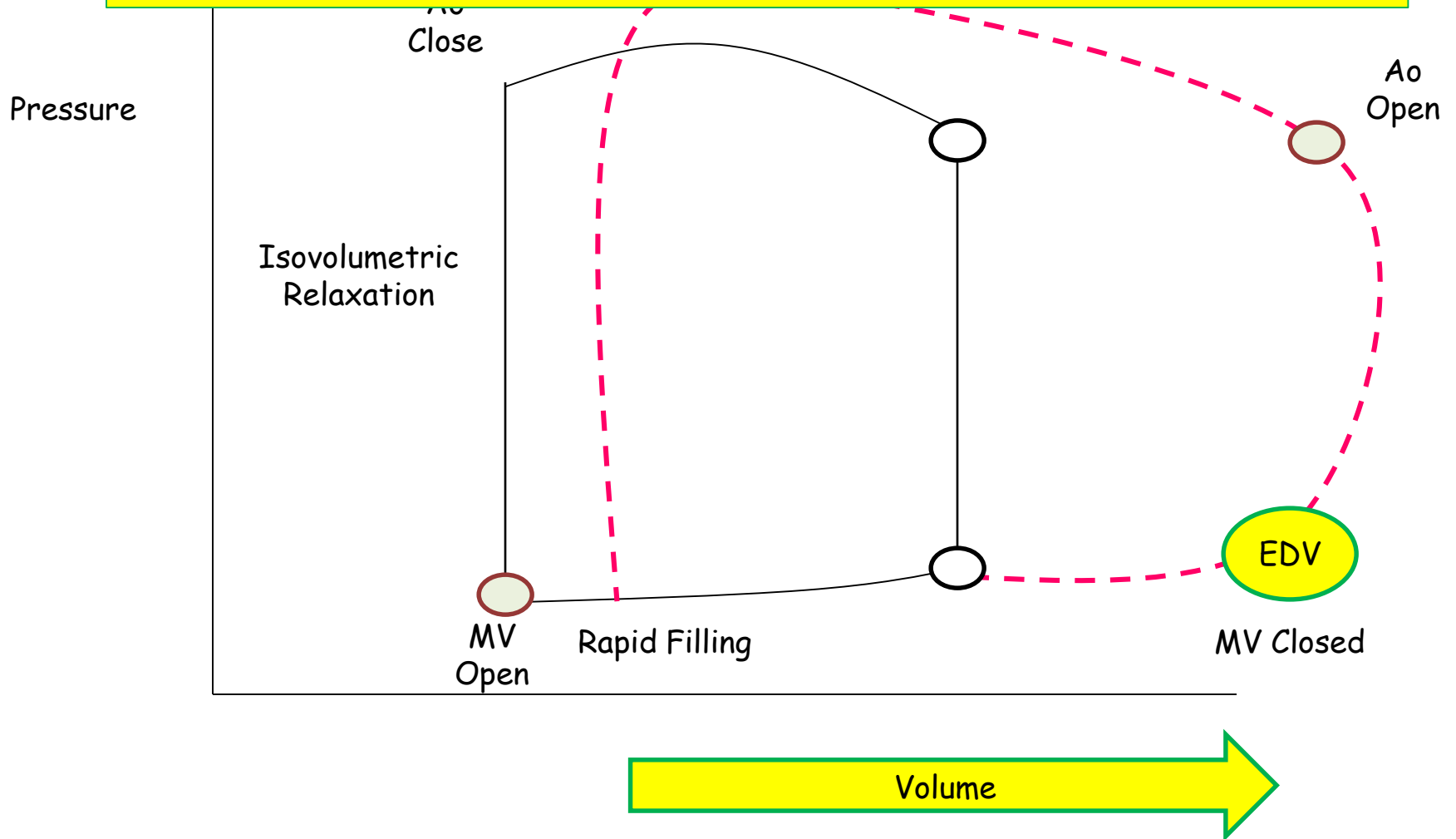


We should be able to construct the AI curve
(*consider the regurgitant volume*)?



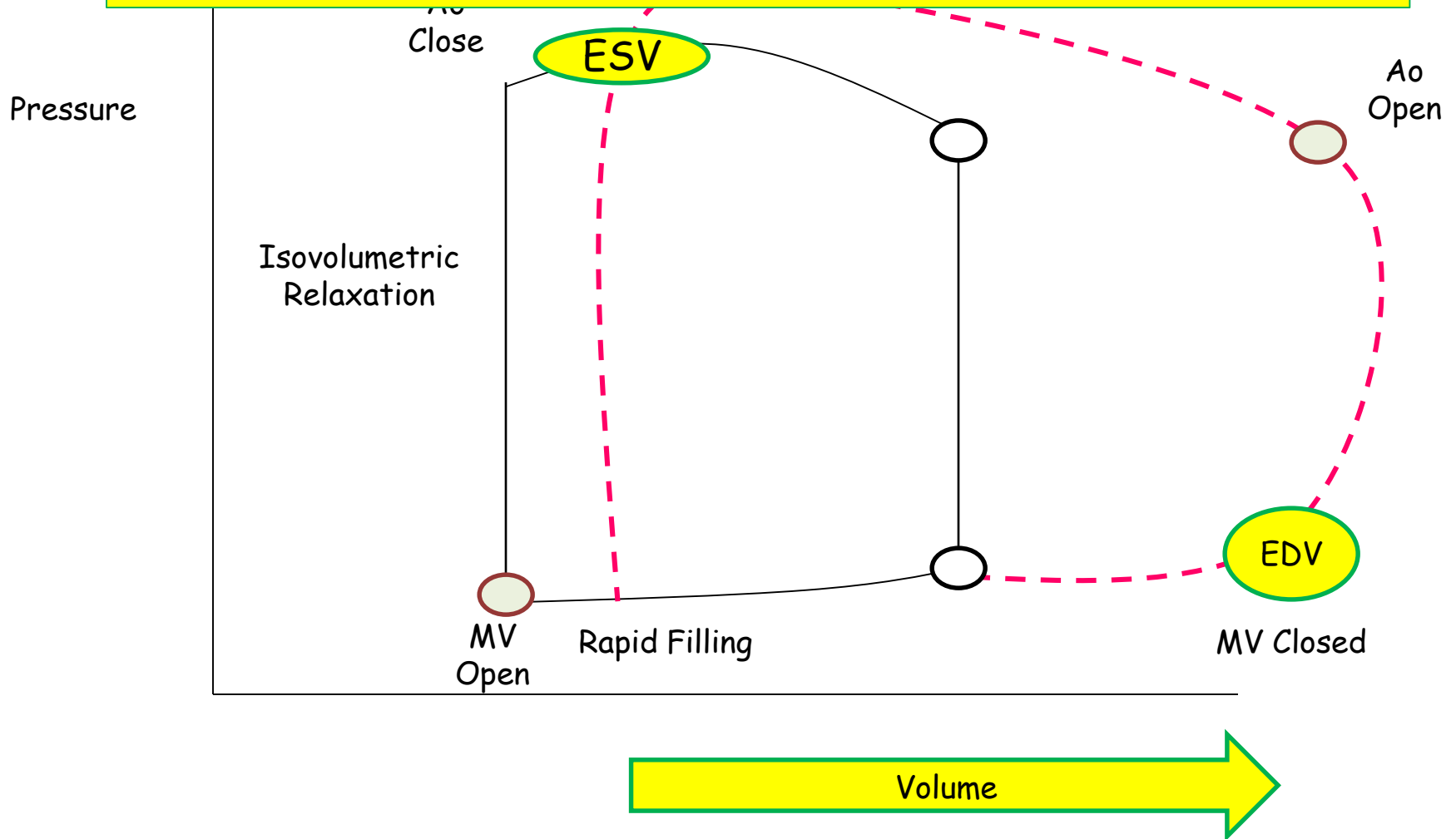
We should be able to construct the AI curve -
(parameters related to the regurgitant volume)

- \uparrow EDV



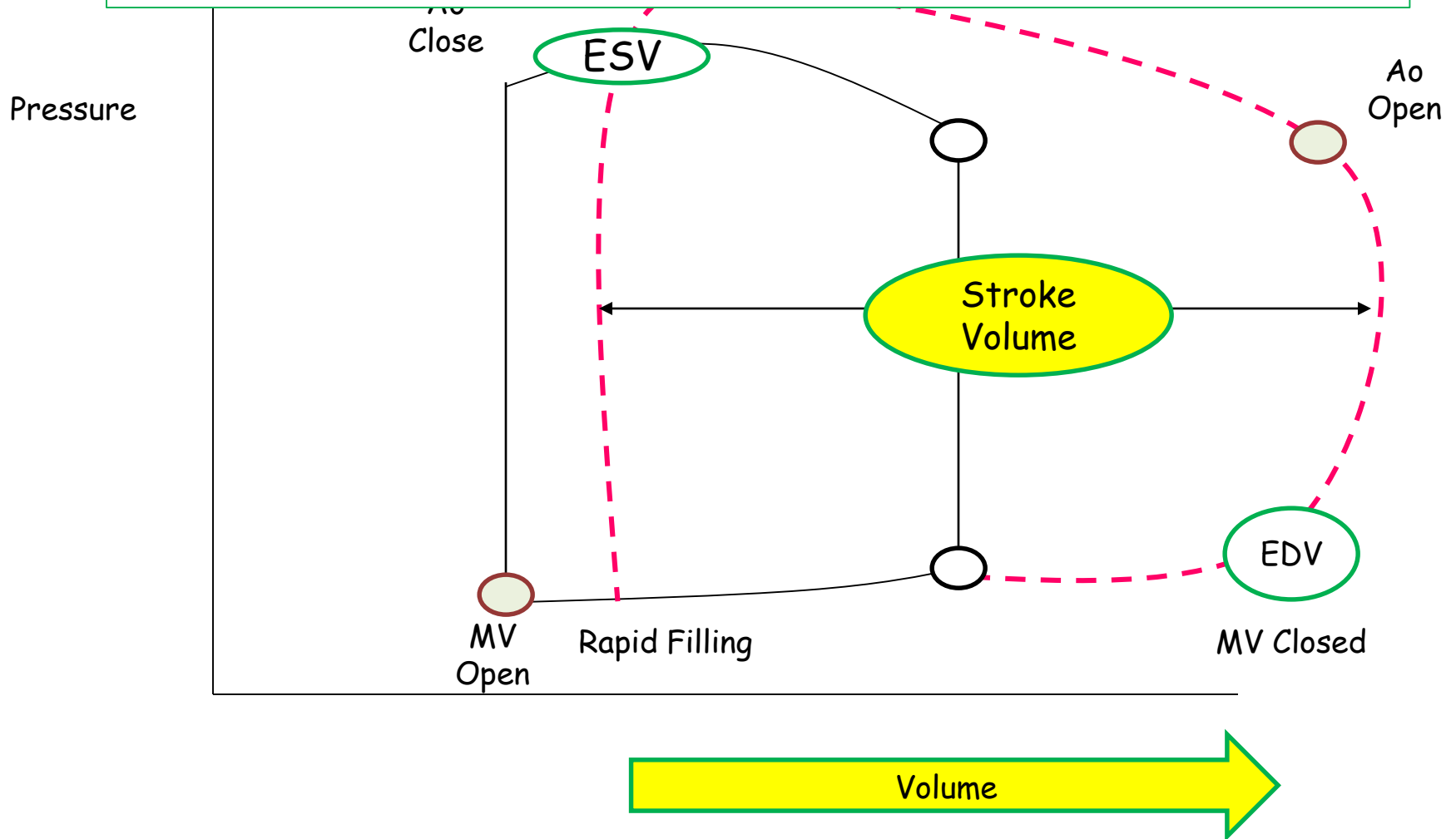
We should be able to construct the AI curve -
(parameters related to the regurgitant volume)

- \uparrow EDV
- \uparrow ESV



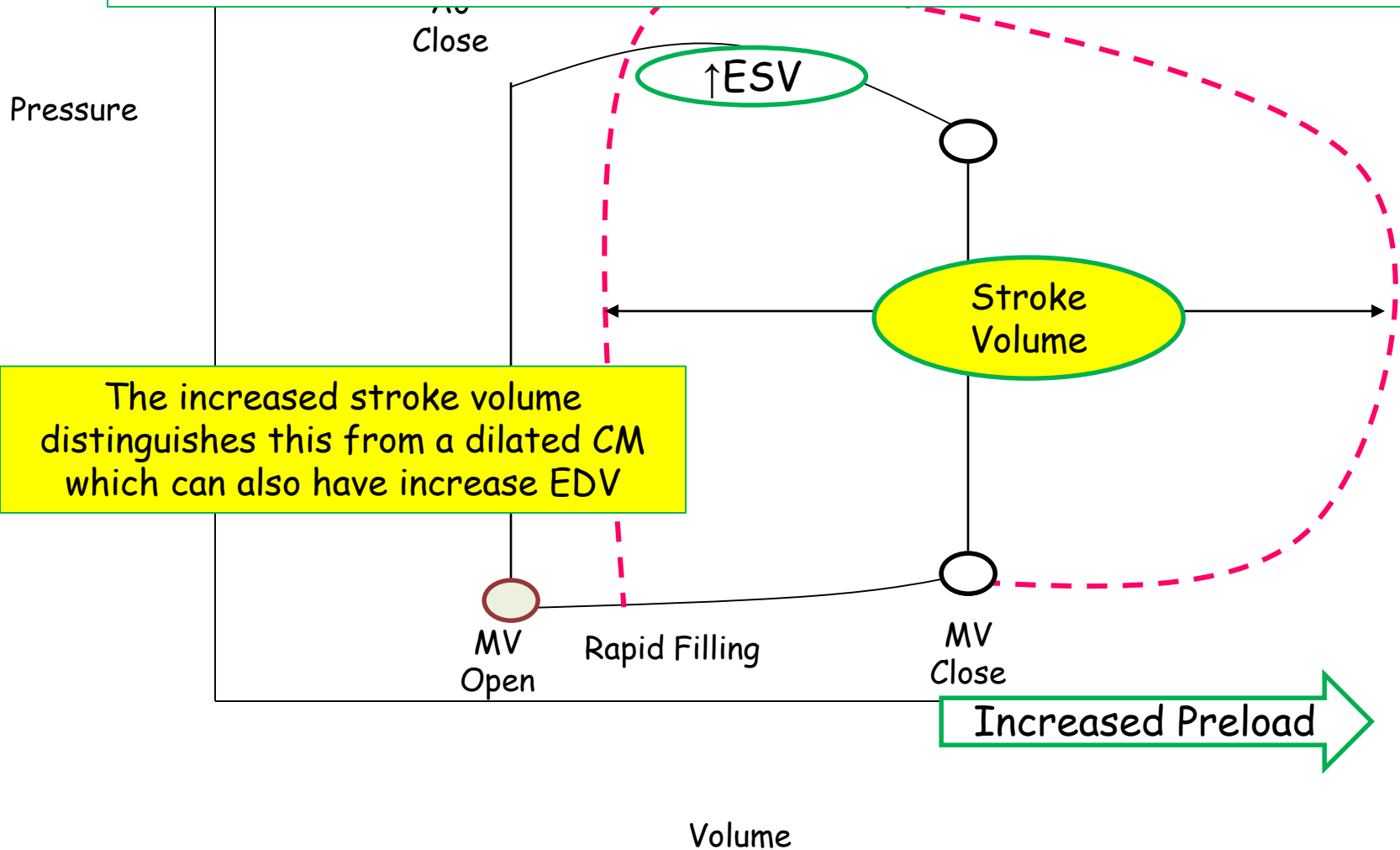
We should be able to construct the AI curve -
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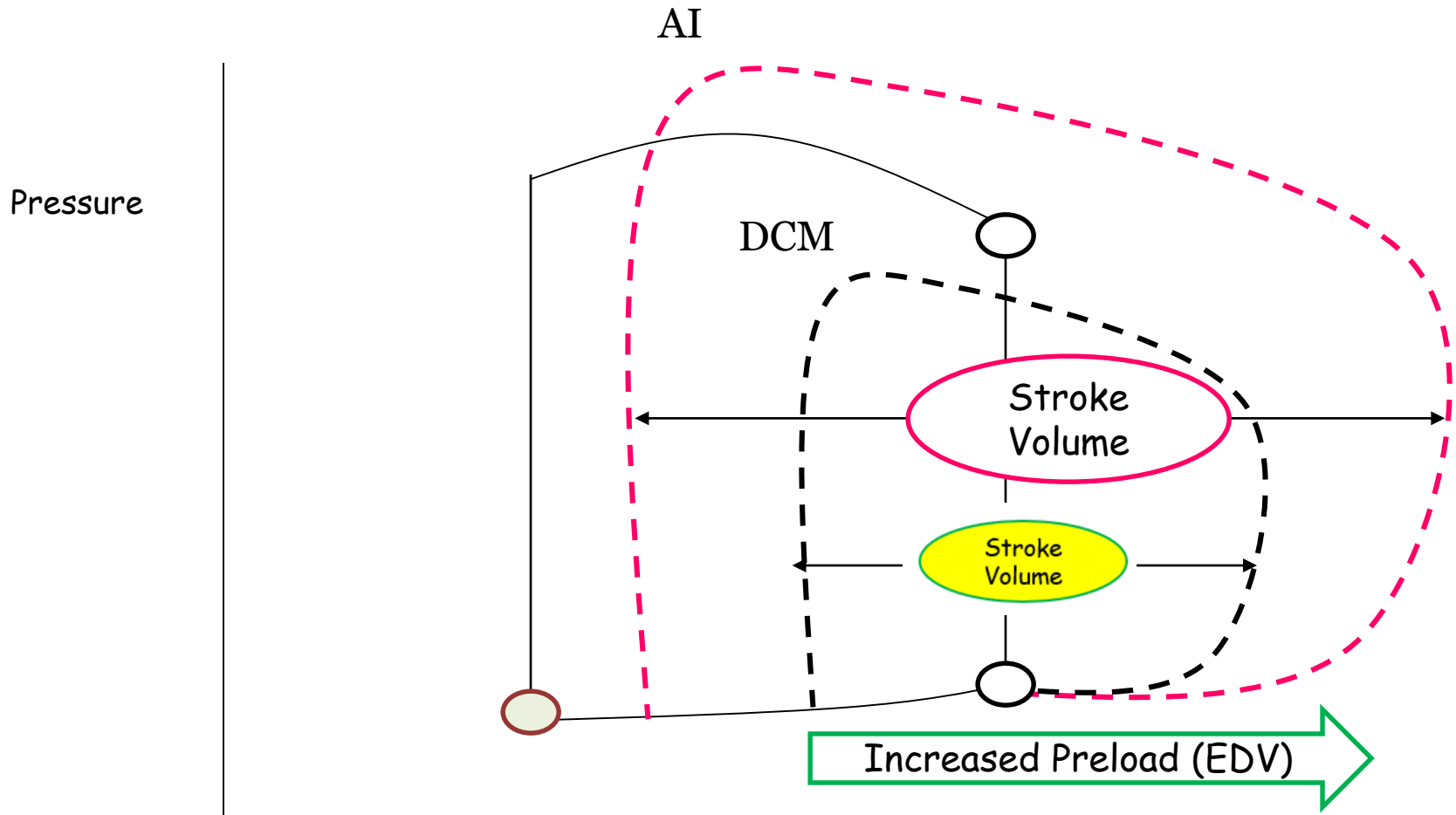
- \uparrow EDV
- \uparrow *Stroke Volume*
- \uparrow ESV



We should be able to construct the AI curve -
(parameters related to the regurgitant volume)

- \uparrow EDV
- \uparrow *Stroke Volume*
- \uparrow ESV



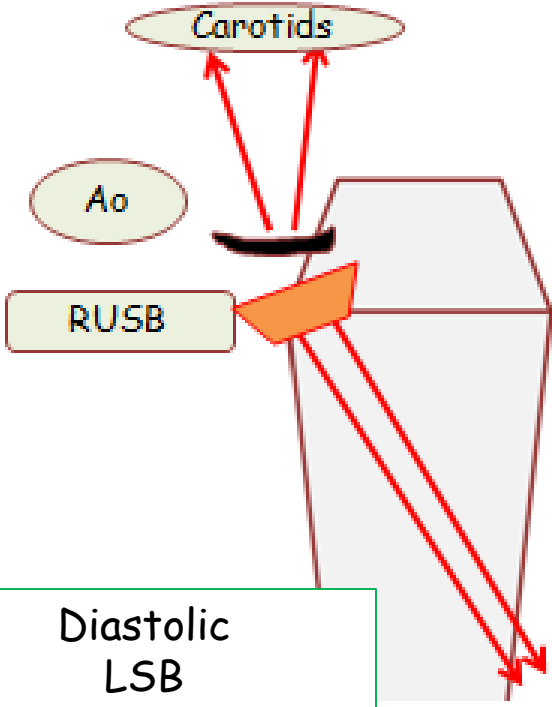


Dilated Cardiomyopathy:
Increased EDV
Decreased SV

Aortic Regurgitation: *the Curriculum*

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- **Physical Exam: *the Murmur***
 - *Chronic AI: Decrescendo at mid-LSB*
 - *Squatting maneuver* $\rightarrow \uparrow$ intensity
- **Demographics**
 - Endocarditis
 - Rheumatic fever, acute
 - Aortitis/Dissection

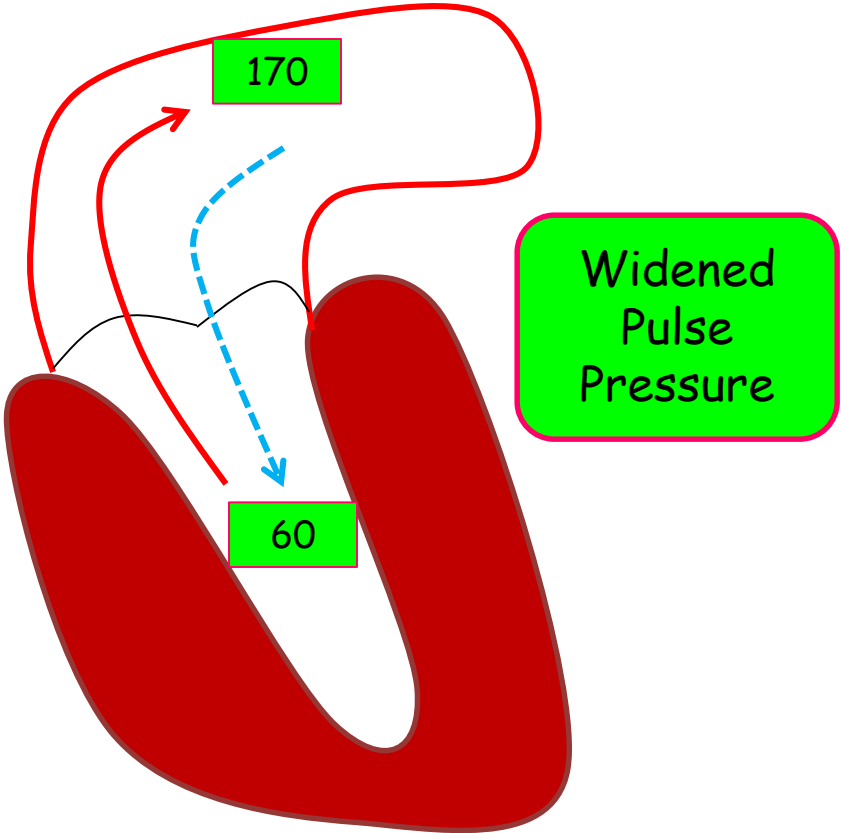
Aortic Valve Disorders



Diastolic
LSB
Wide pulse pressure

Diff Dx (LSB):
HCM }
VSD } **Systolic**

Regurgitation



170

60

Widened
Pulse
Pressure

Second relevant diastolic murmur (other: mitral stenosis)

AI

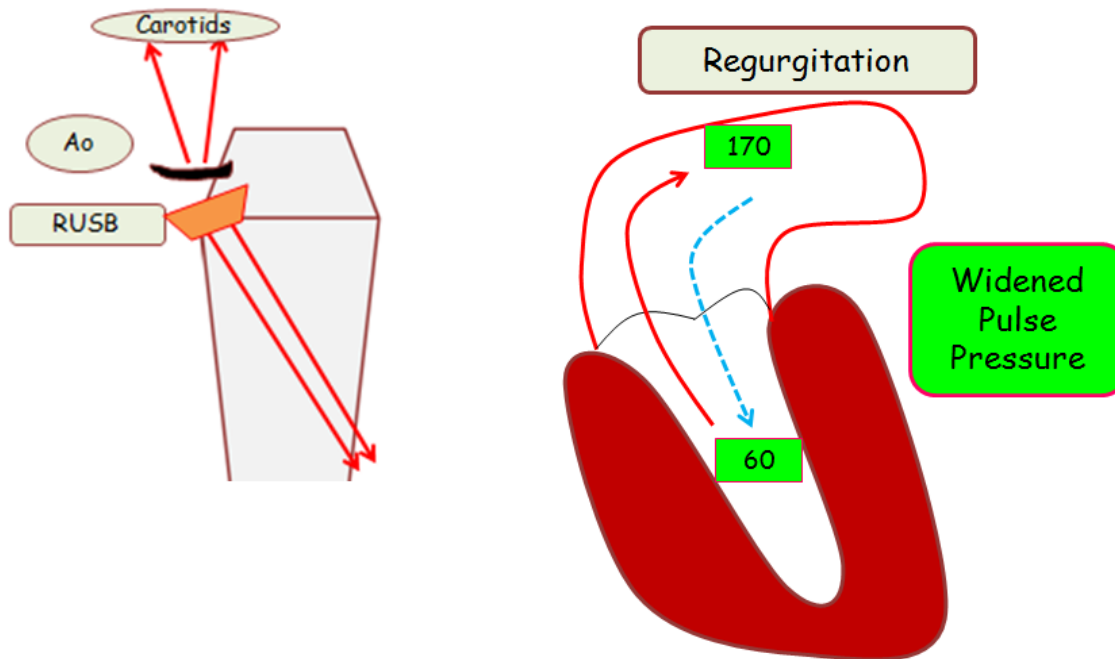
No opening snap.
Wide pulse pressure.
Different location.

Different hemodynamics.

Different constellation of derivatives.

Only overlap: *Rheum Fever BUT AI is an **early** manifestation...*

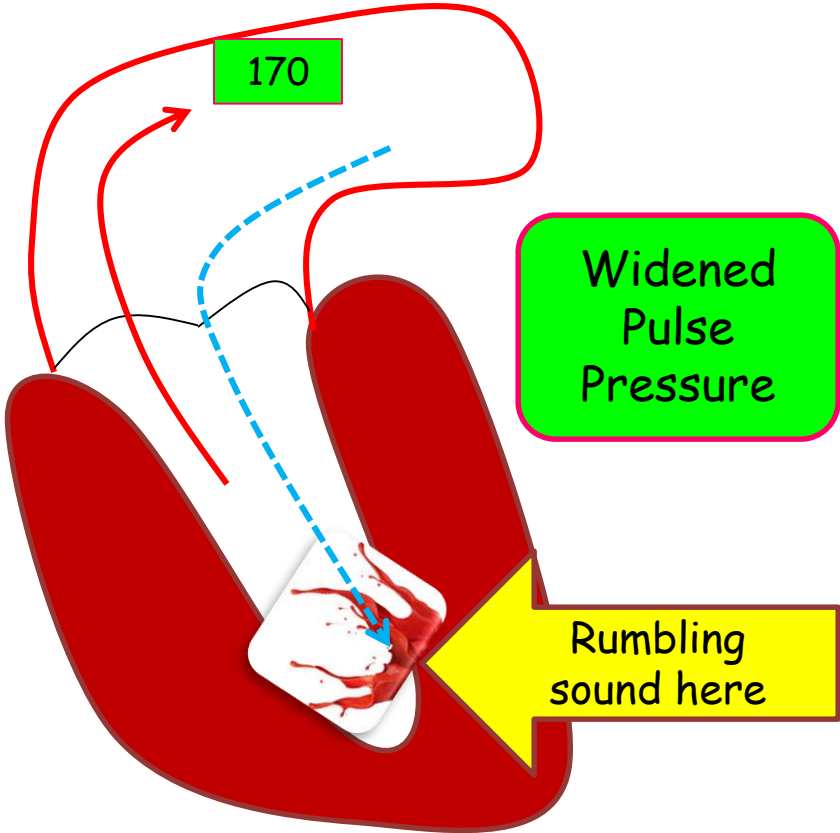
PLUS: *one other treat...*



Aortic Valve Disorders

Regurgitation

Austin Flint murmur



Apical, rumbling diastolic murmur

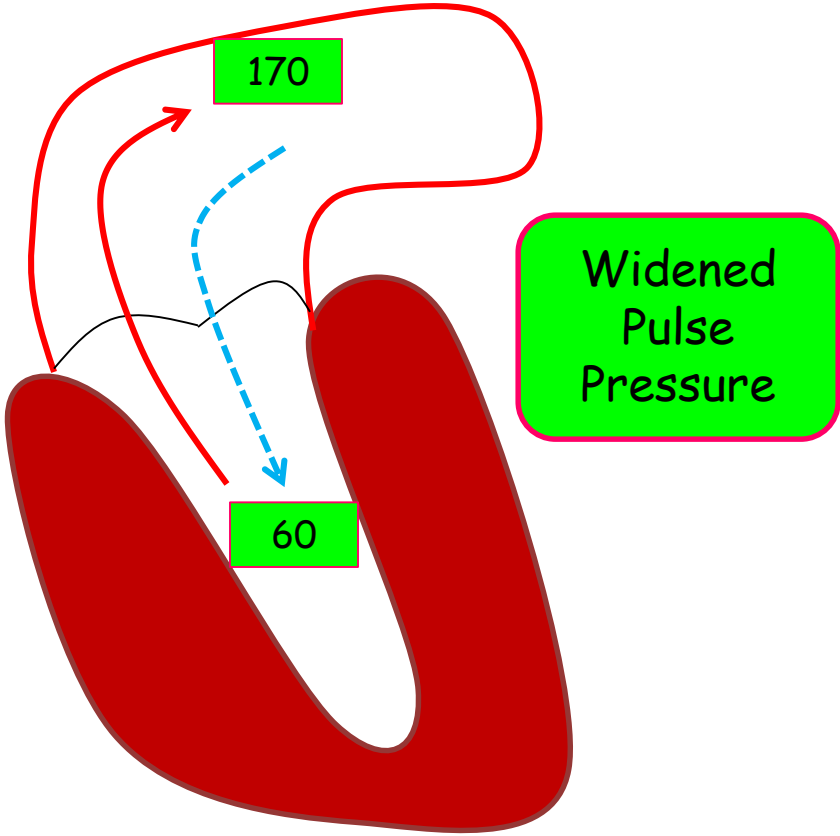
Aortic Valve Disorders

Heard after S2 → decrescendo



AI: No opening snap

Regurgitation



How will you recognize the AI patients?
Demographic Settings:

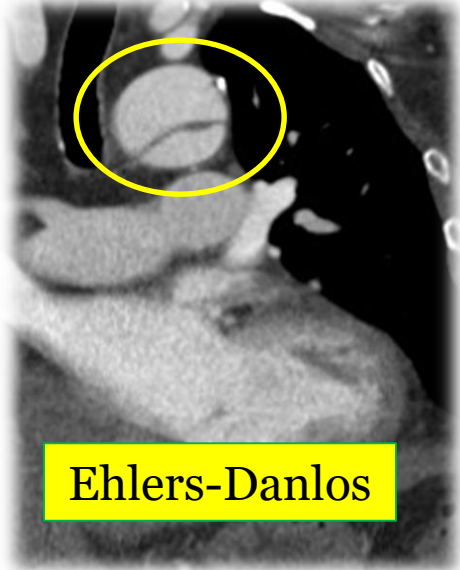
Endocarditis

Acute RF

Dissection with
Intimal Flap

Dilated Aortic
Root

Aortitis (Syphilis, Ank Spond, TA)
Dissection (HTN, EDS, Marfan's)



Ehlers-Danlos

How will you recognize the AI patients?
Demographic Settings:



Widened Pulse Pressure

Head bob - deMusset's

Water hammer (fem pulse, felt)

Pistol shot (fem pulse, heard)

Quincke's (finger capillary pulsation)

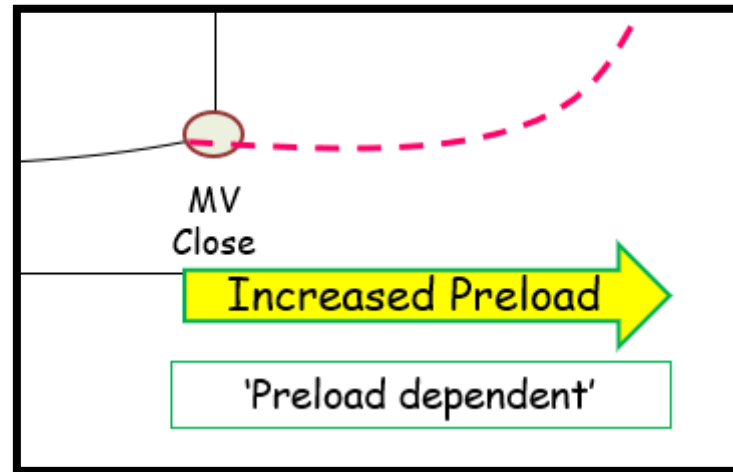
Bonus AI Thoughts (3):

Fast A fib?

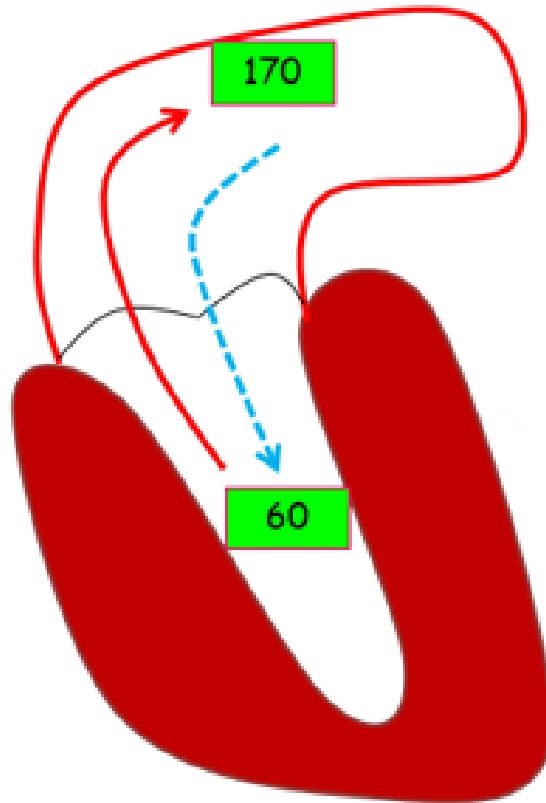


These patients are
preload dependent.

Would not tolerate fast a fib;
inadequate ventricular filling.



Bonus AI Thoughts (3):



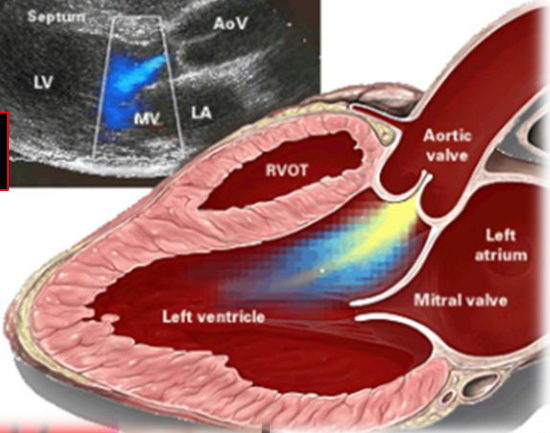
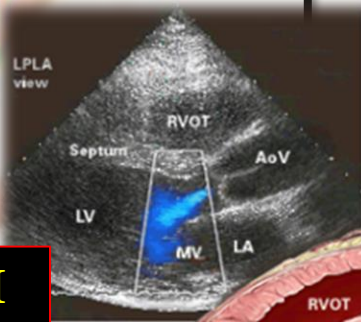
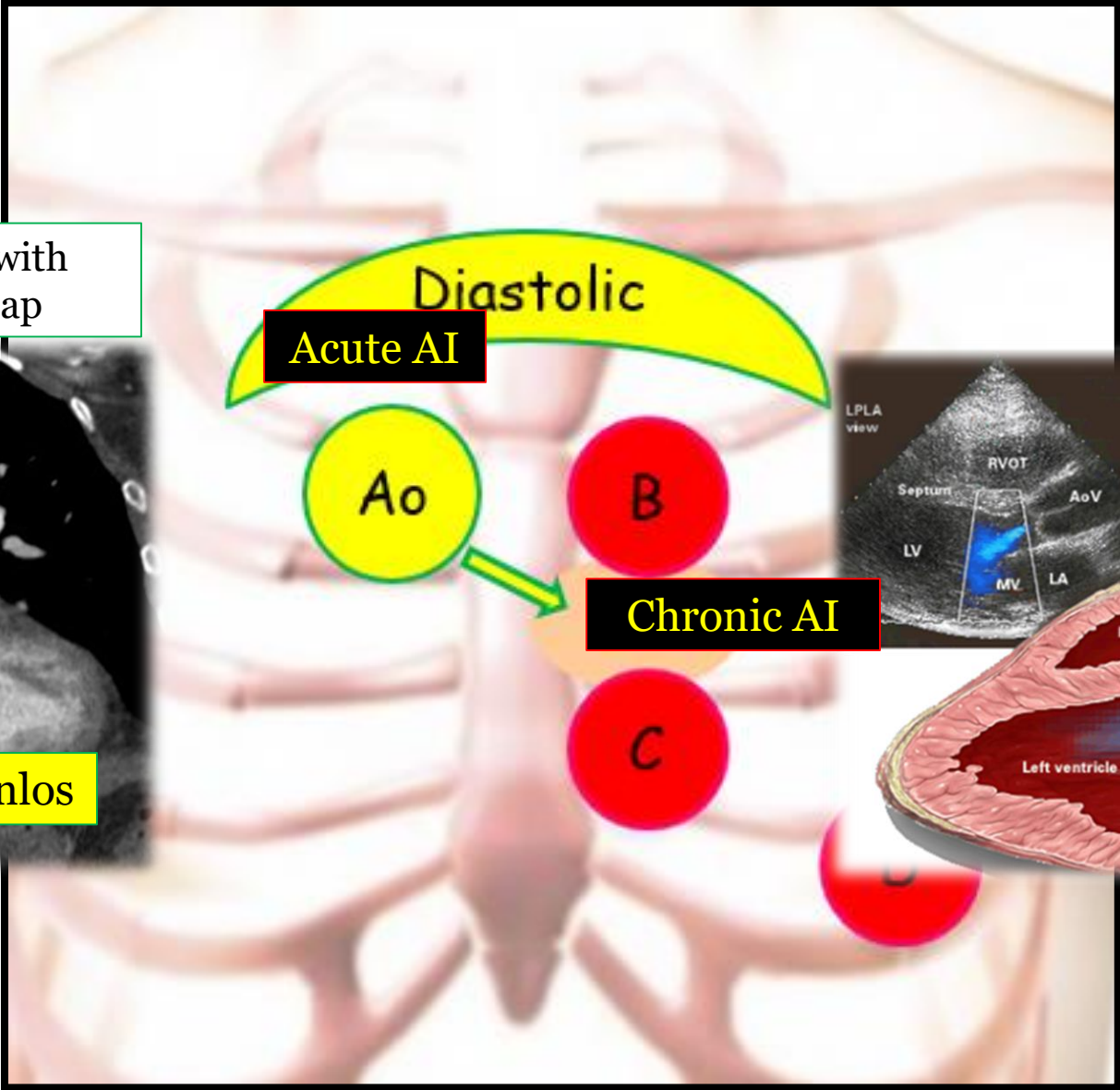
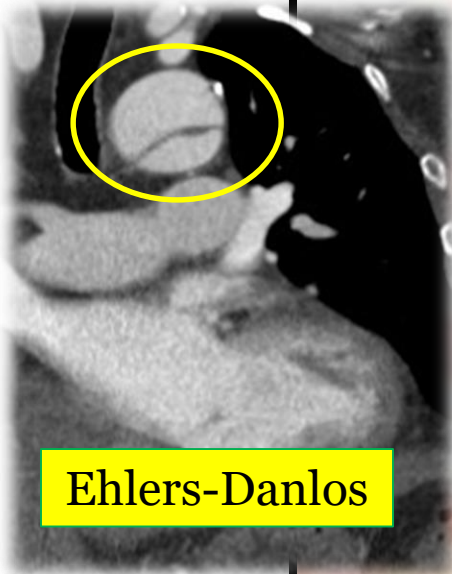
Rx AI?

Inotropy?
Chronotropy?
Preload?
Afterload?

Just like MR,
improve the
forward fraction

Bonus AI Thoughts (3):

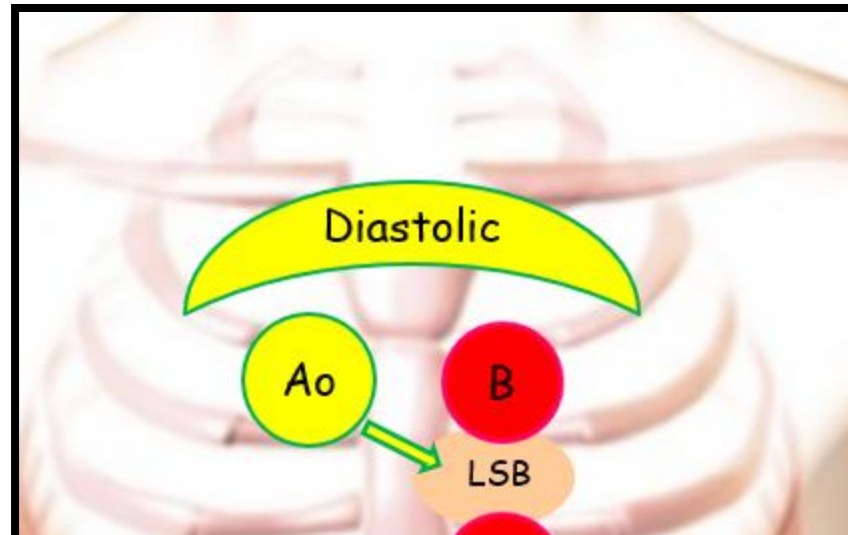
Dissection with Intimal Flap



Aortic Regurgitation: *the Curriculum*

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- Demographics
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 - Rheumatic fever, acute
 - Aortitis/Dissection

Aortic Insufficiency for the USMLE Step One Exam



Aortic Valve:

Take it off your bucket list!

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