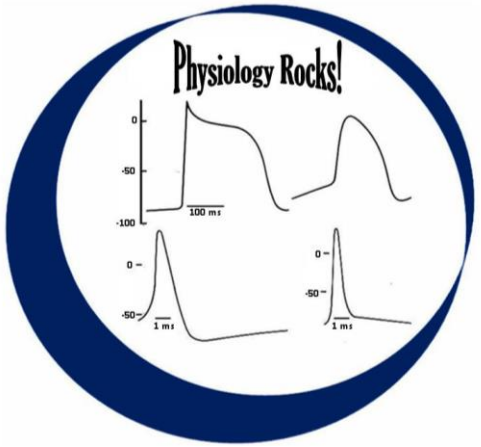
Lecture 9

Cardiac Cycle – PV Loops – Sounds & Murmurs



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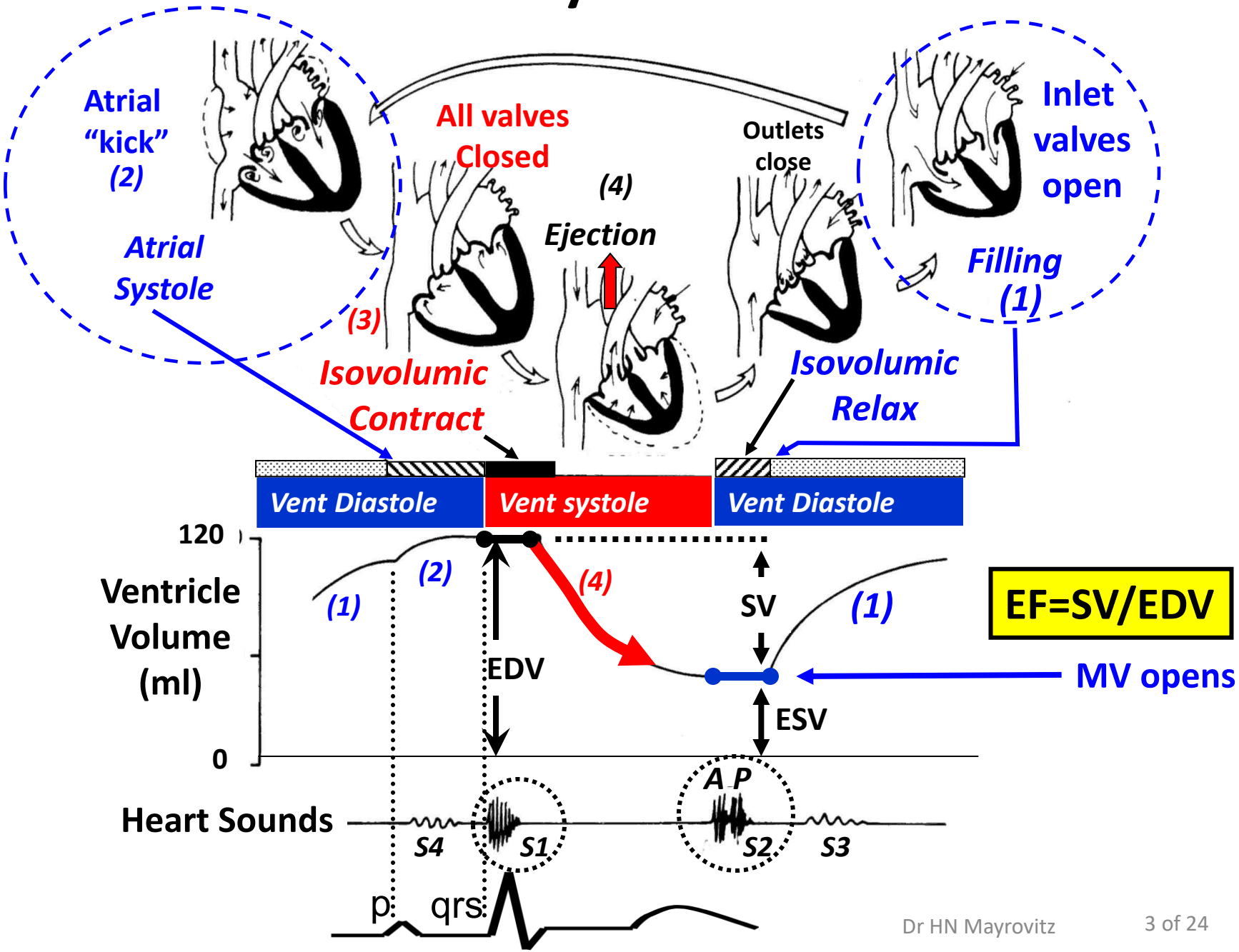
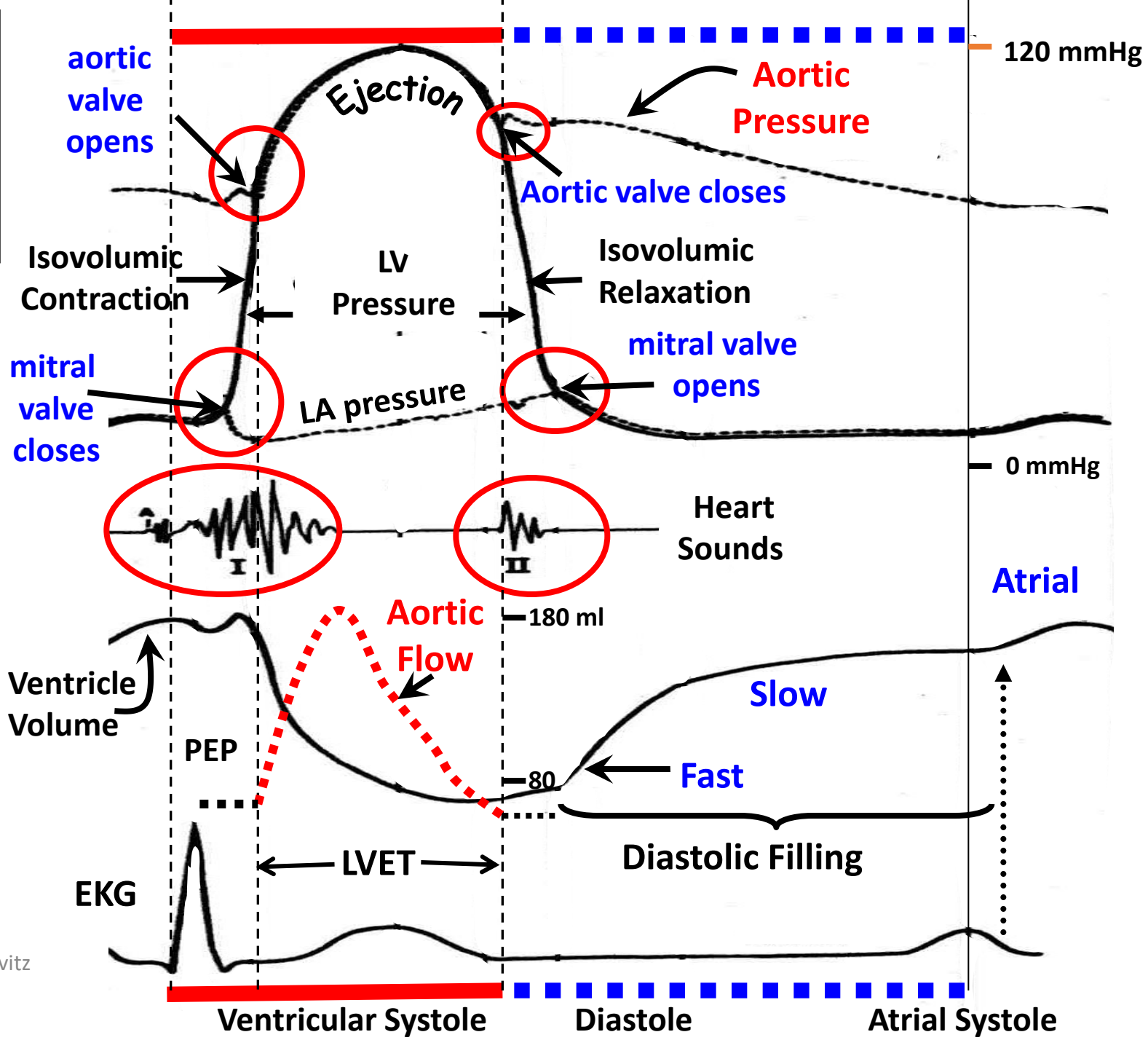
Topics

- Cardiac cycle overview - review
- Cardiac cycle – Carl Wiggers diagram
- Cardiac pressure-volume loops - Introduction
- Cardiac pressure-volume loops – afterload effects
- Cardiac pressure-volume loops – contractility effects
- Measuring EDV, ESV and EF via echocardiography data
- P-V loop interactive questions
- Heart sounds and murmurs
- Clinical correlation – E and A parameters
- Respiration-related dependencies
- Intramyocardial pressures as determinants
- Interactive questions: PV loop vs Wiggers diagram

Cardiac Cycle Overview



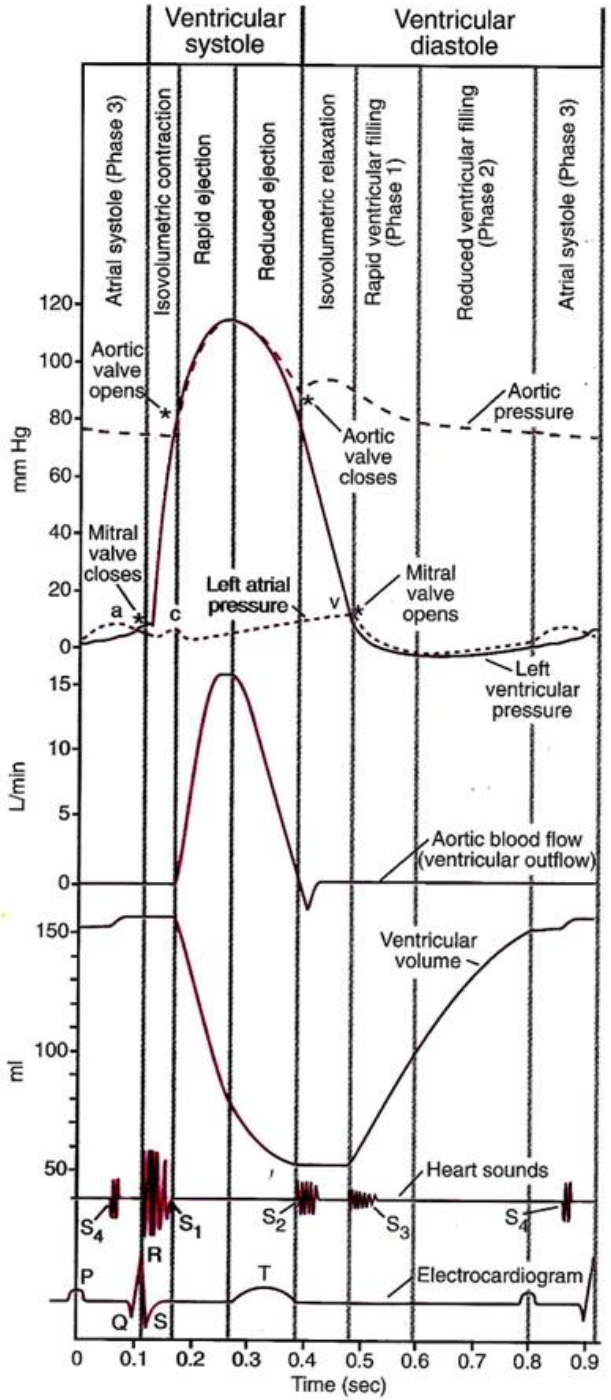
Cardiac Cycle: Carl Wiggers's Diagram



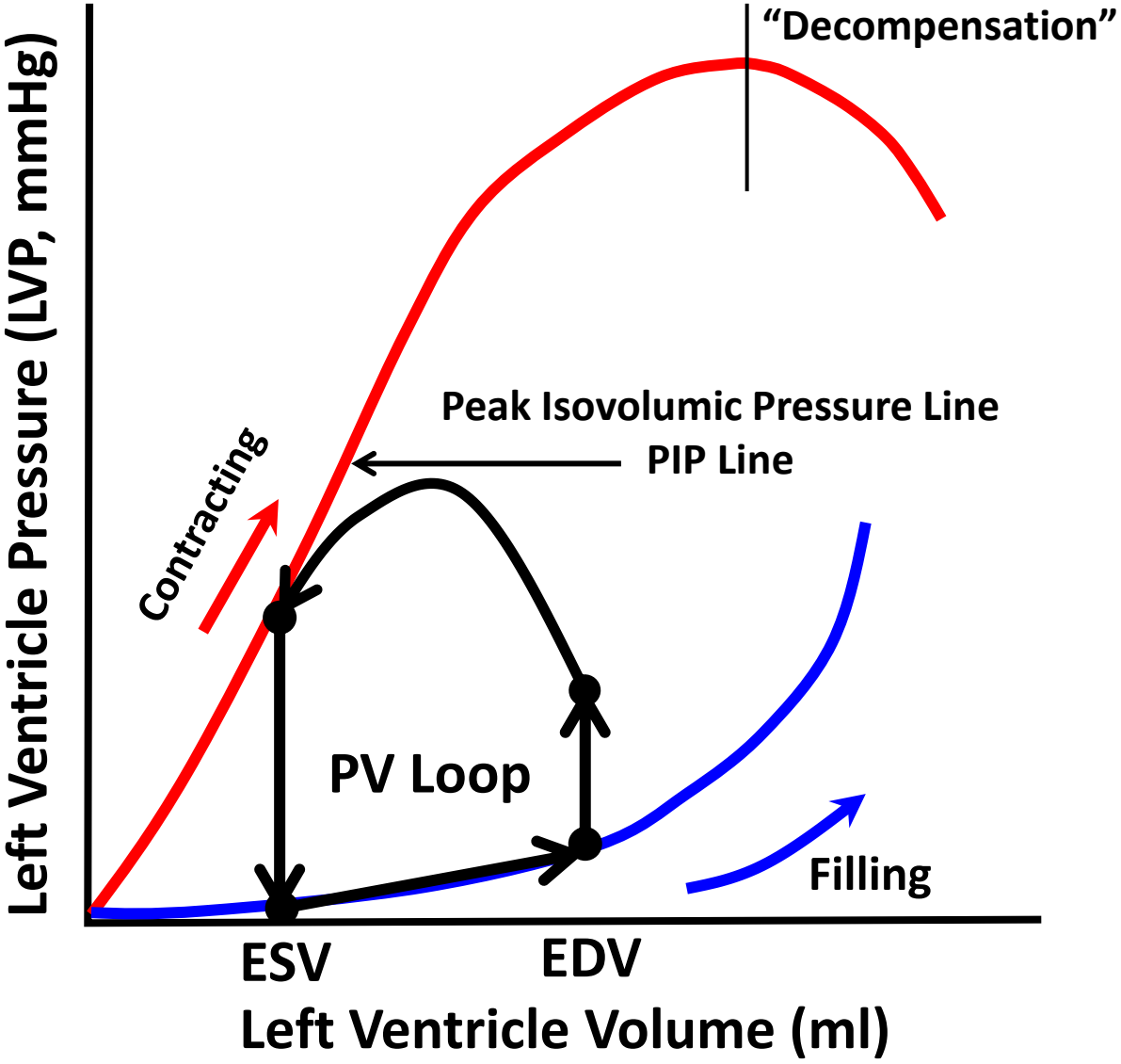
Alternate representation of the Wiggers diagram with segments very well shown with text.

Includes the timing of the 3rd and 4th heart sounds.

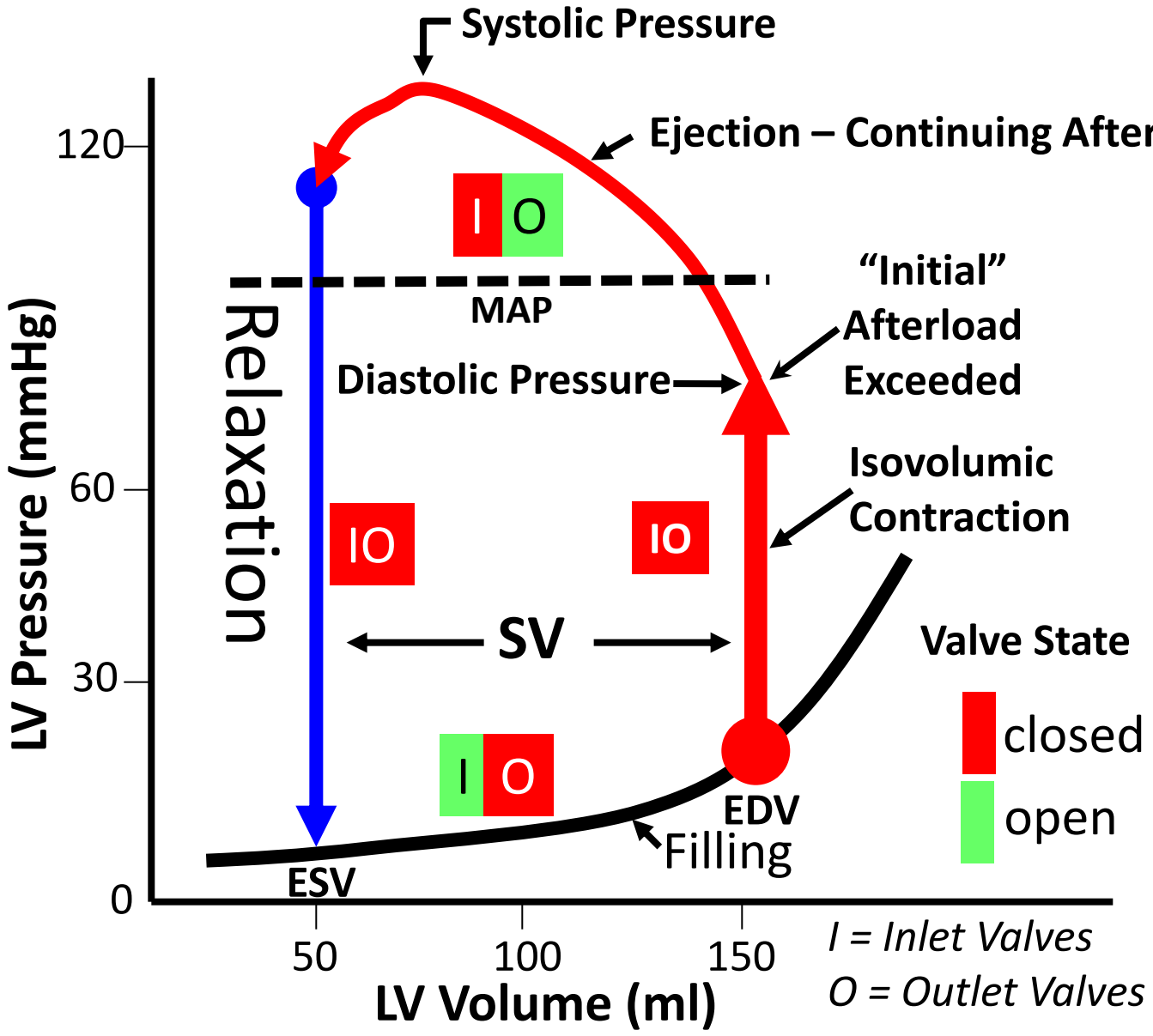
The location of the a, c, and v waves of the left atrial pressure are labeled



Cardiac Pressure-Volume Loop: Introduction



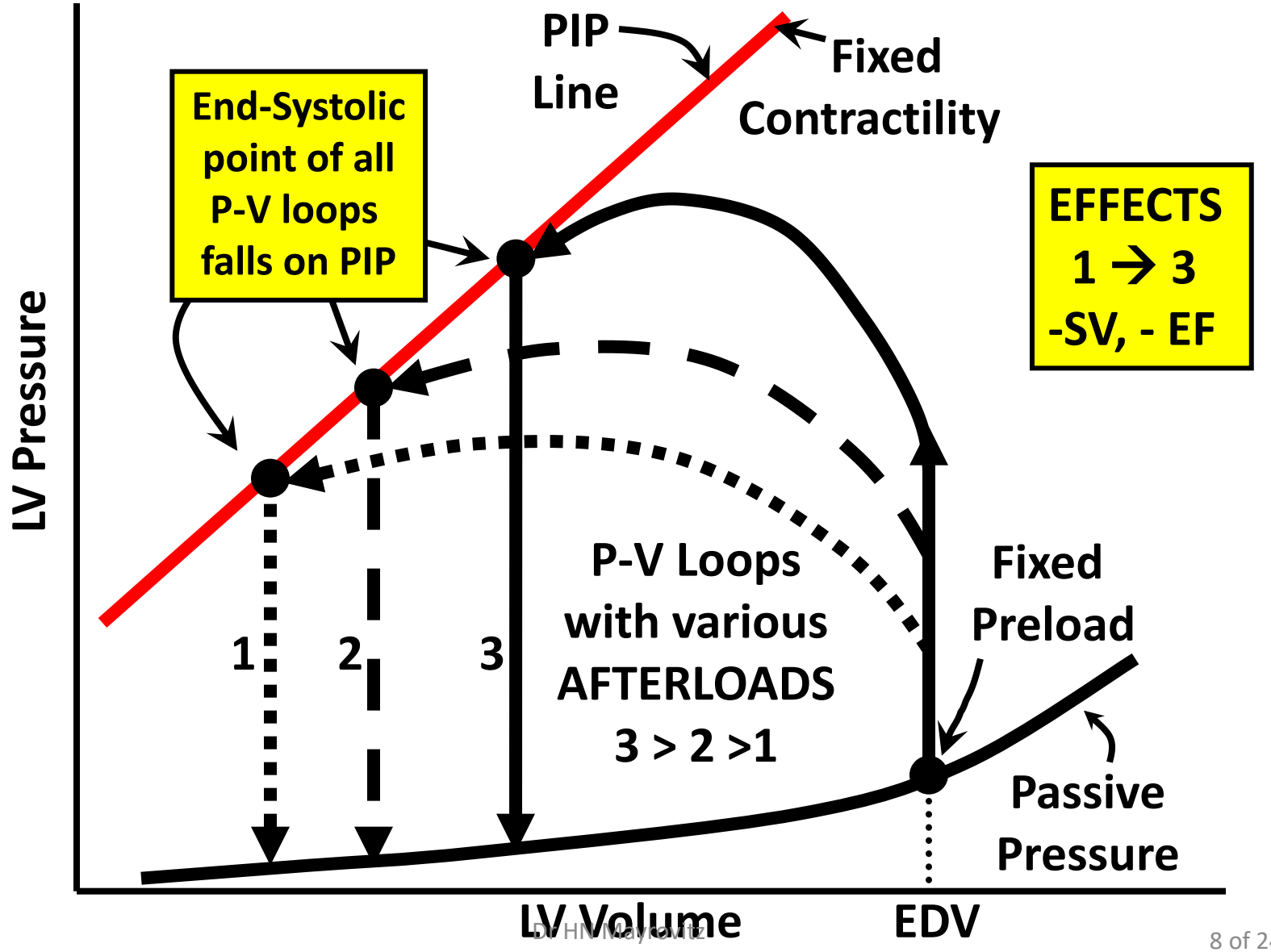
Cardiac Pressure-Volume Loop



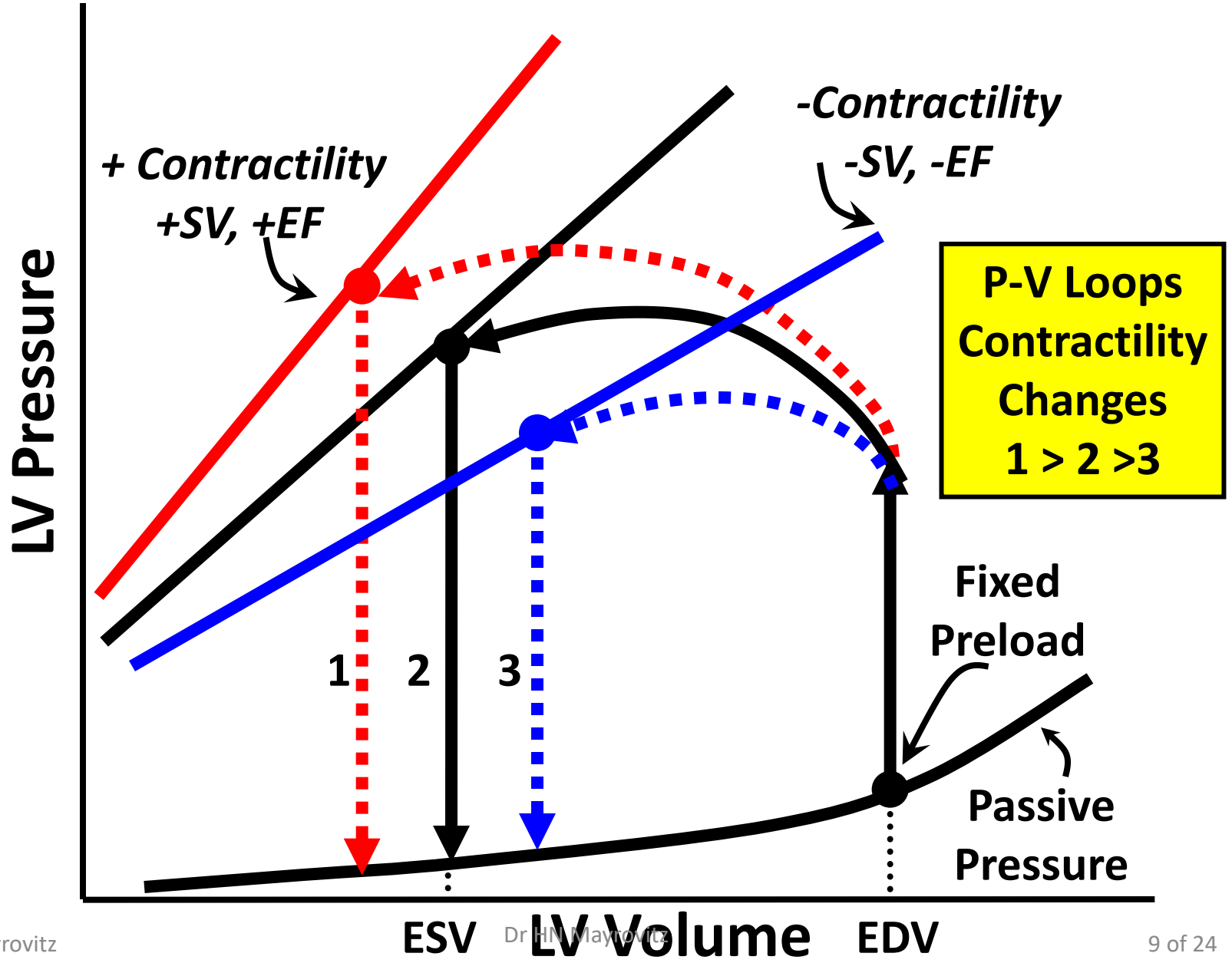
Aortic pressure is a clinical surrogate for true afterload

MAP is an estimate of average afterload

Afterload Effects and Peak Isovolumic Pressure



Contractility Effects on P-V Loops



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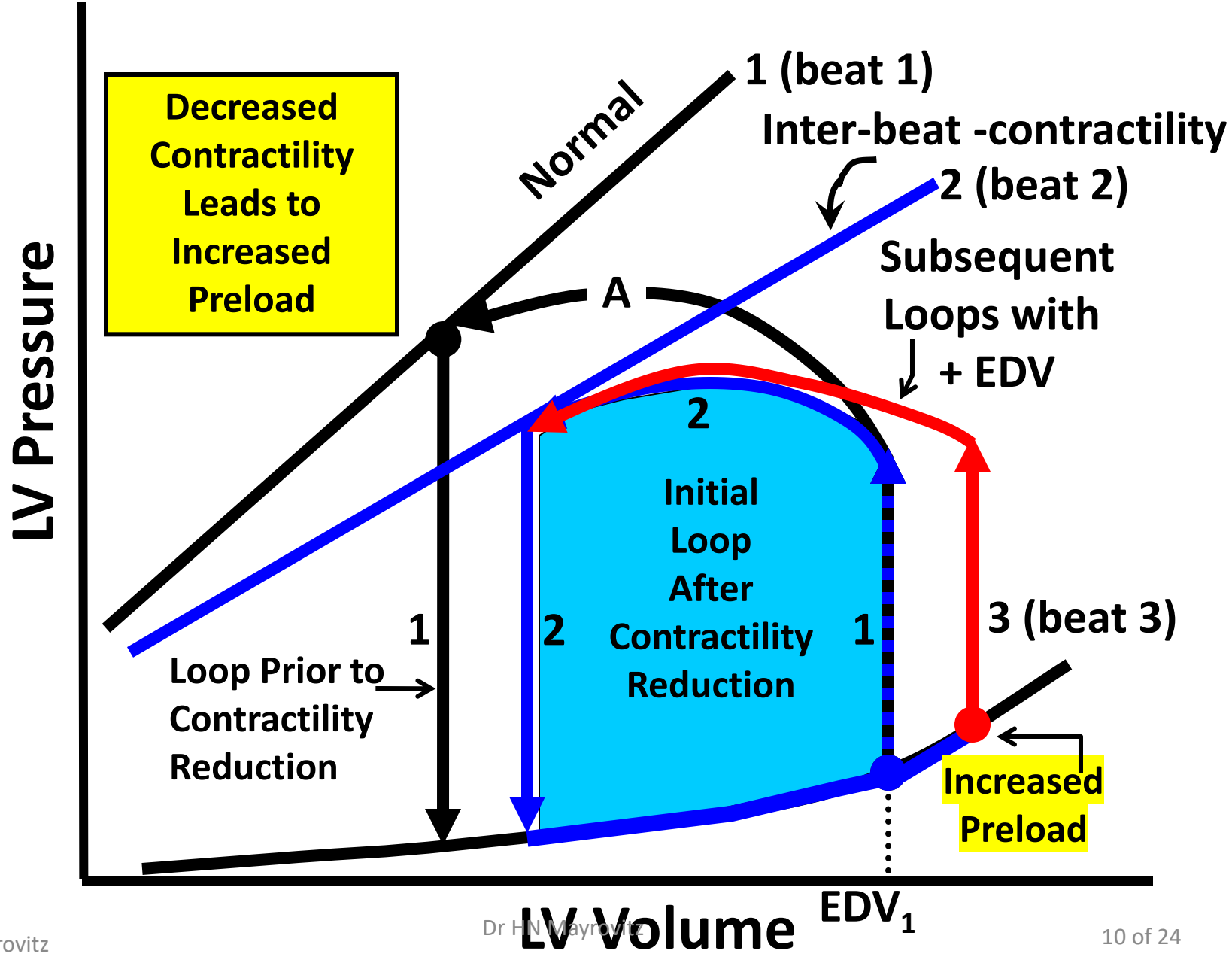
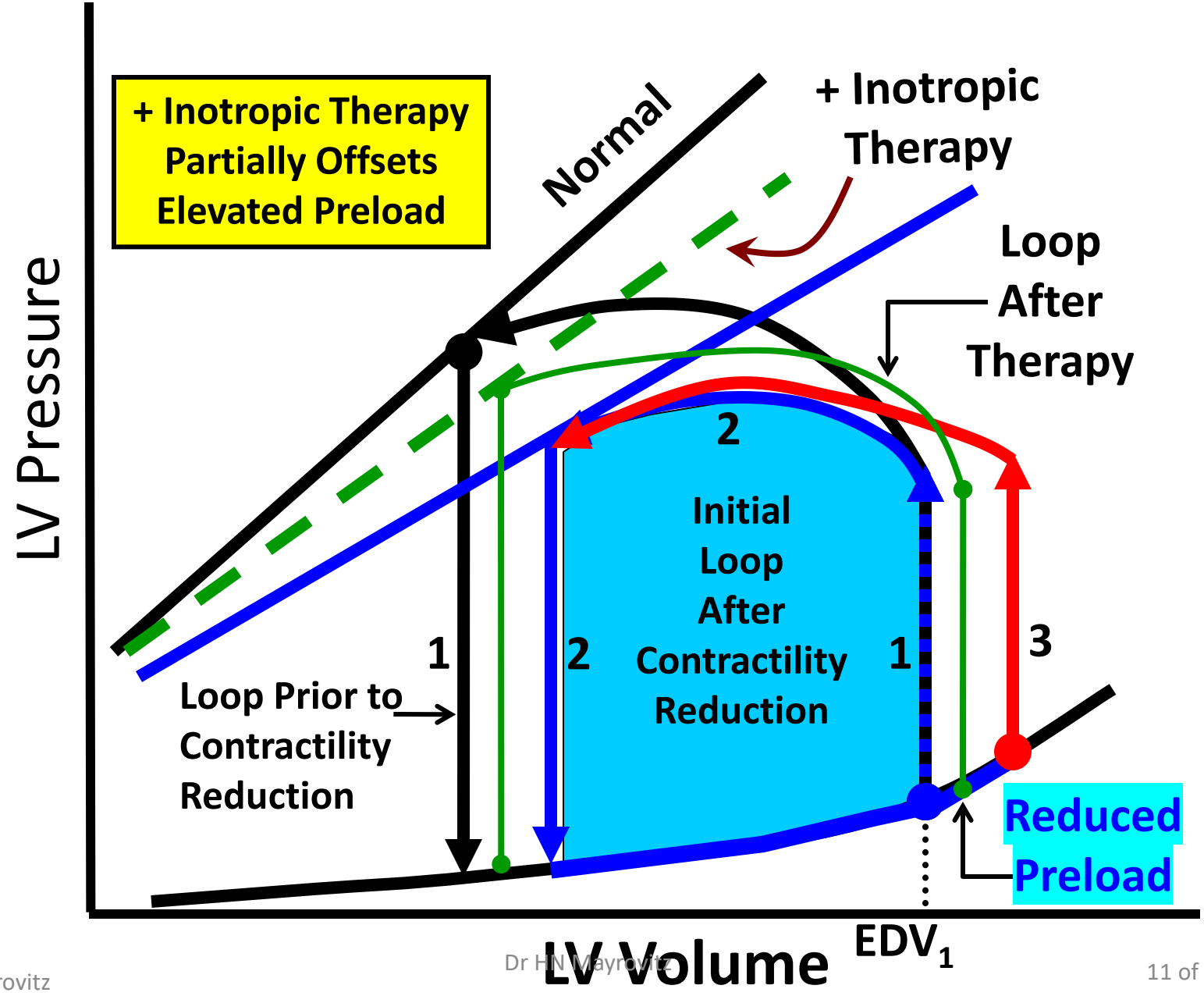
Decreased Contractility → Increased Preload



Positive Inotropic Therapy



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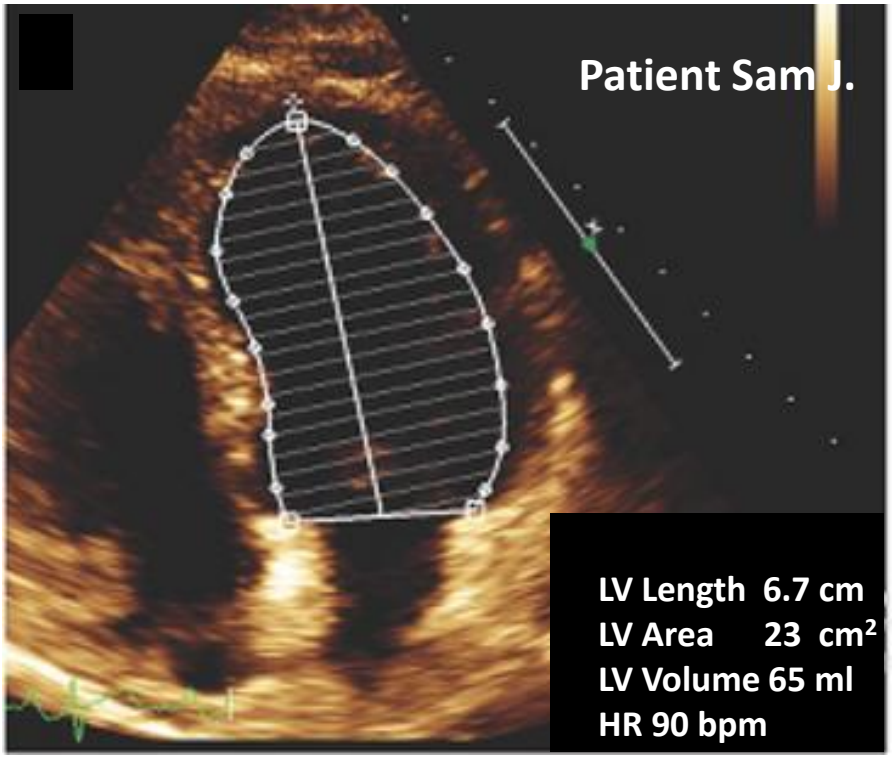
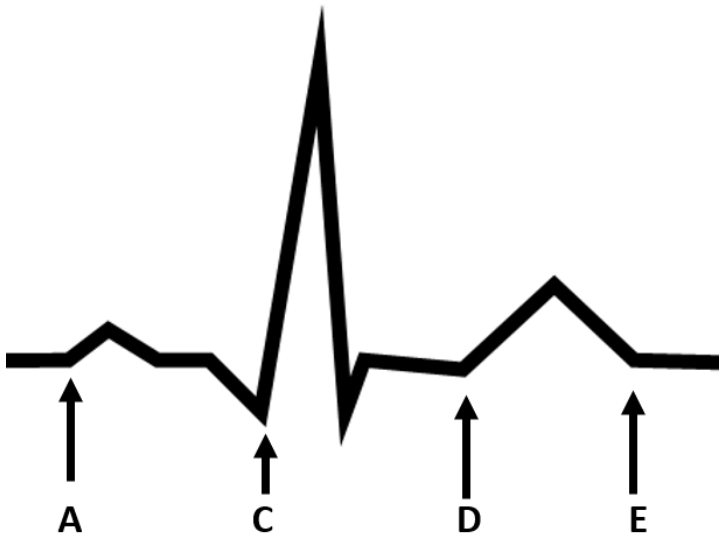
Measuring EDV via Echocardiography

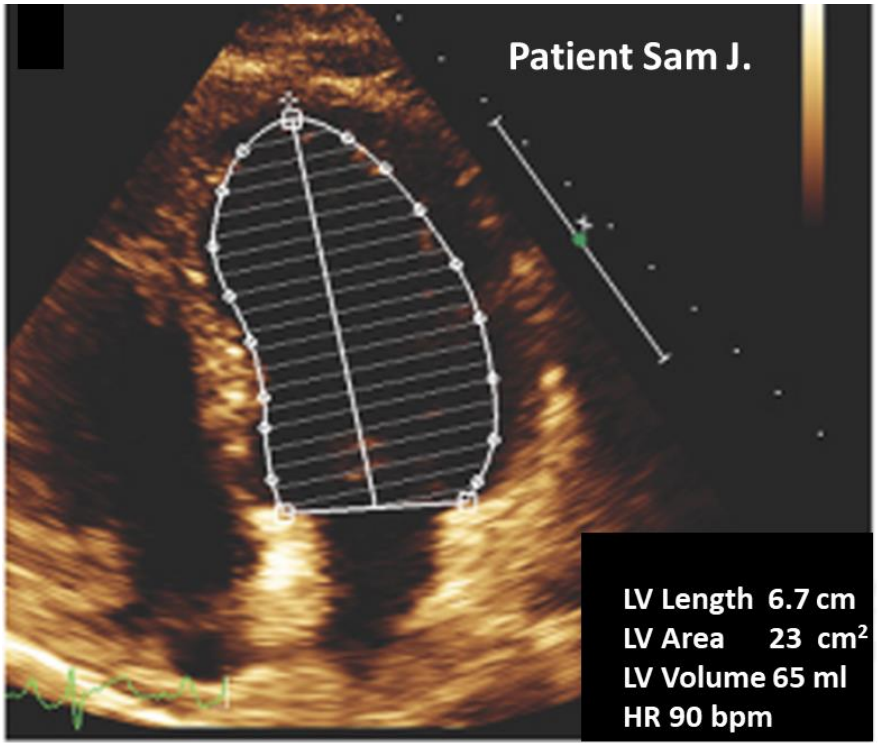


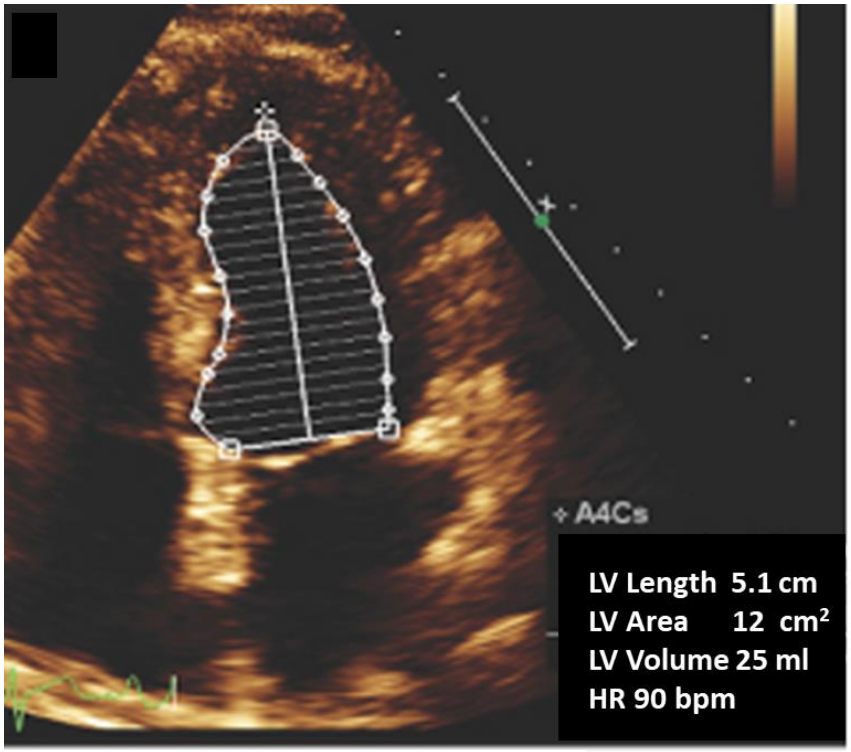


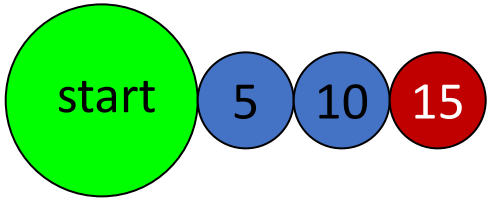
Of the times (A, C, D & E), which is best to measure EDV? 20 s

Solution

Measuring ESV via Echocardiography

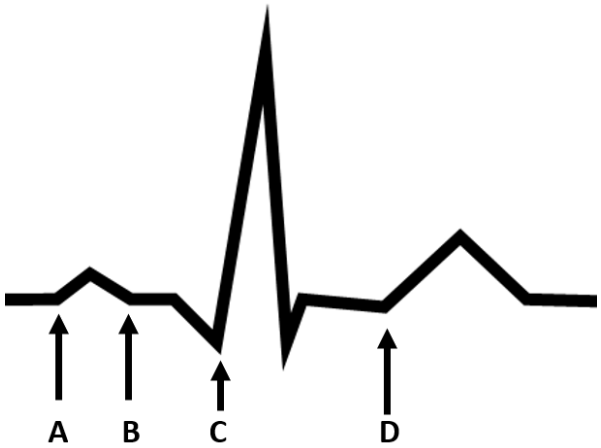




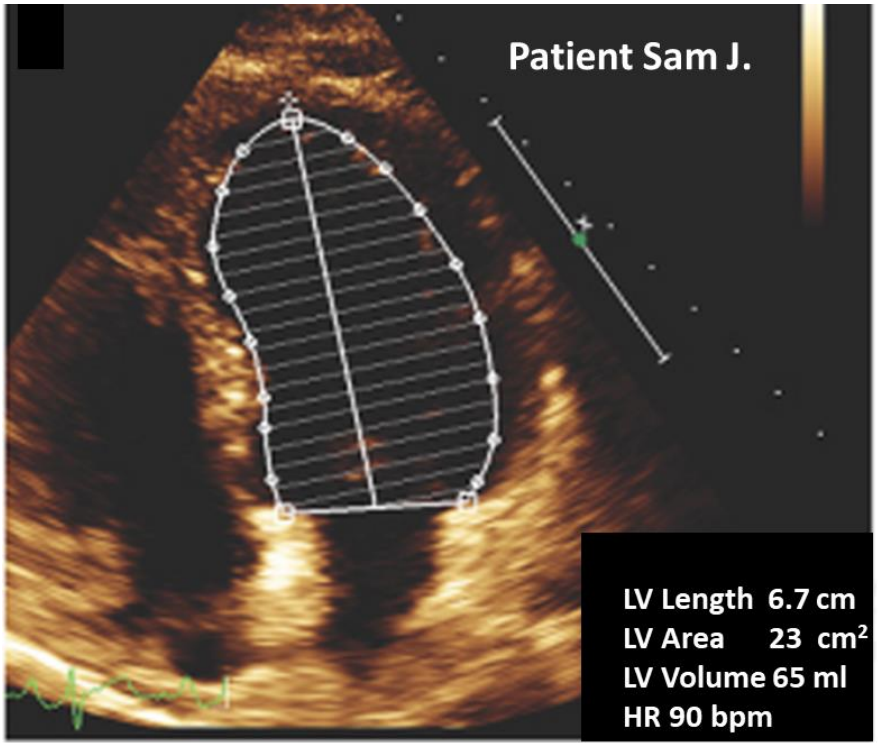


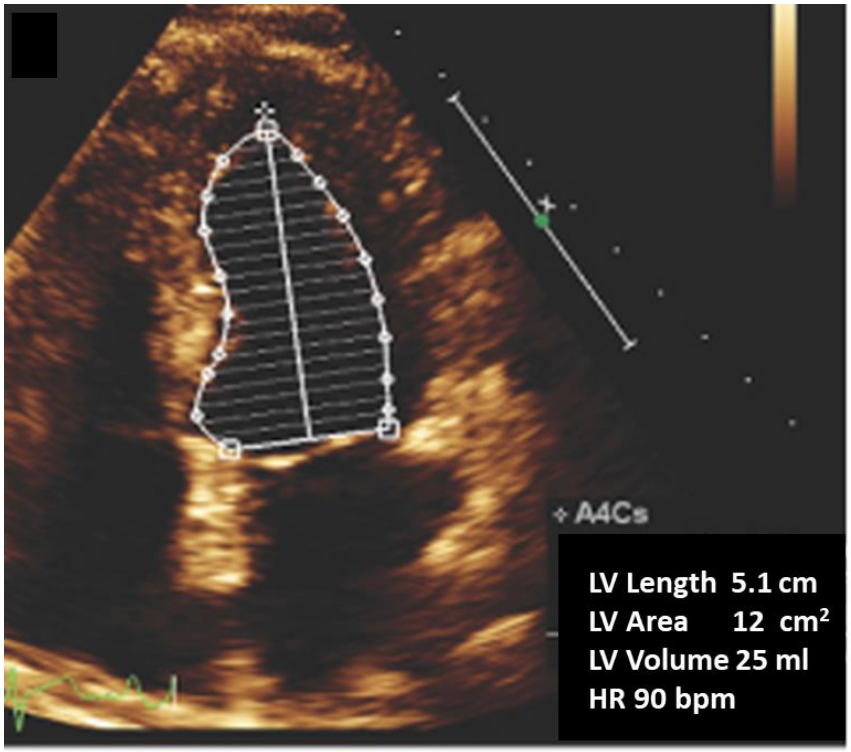
Solution

Of the times (A, B, C, D), which is best to measure ESV? 15 s



Measuring EF via Echocardiography

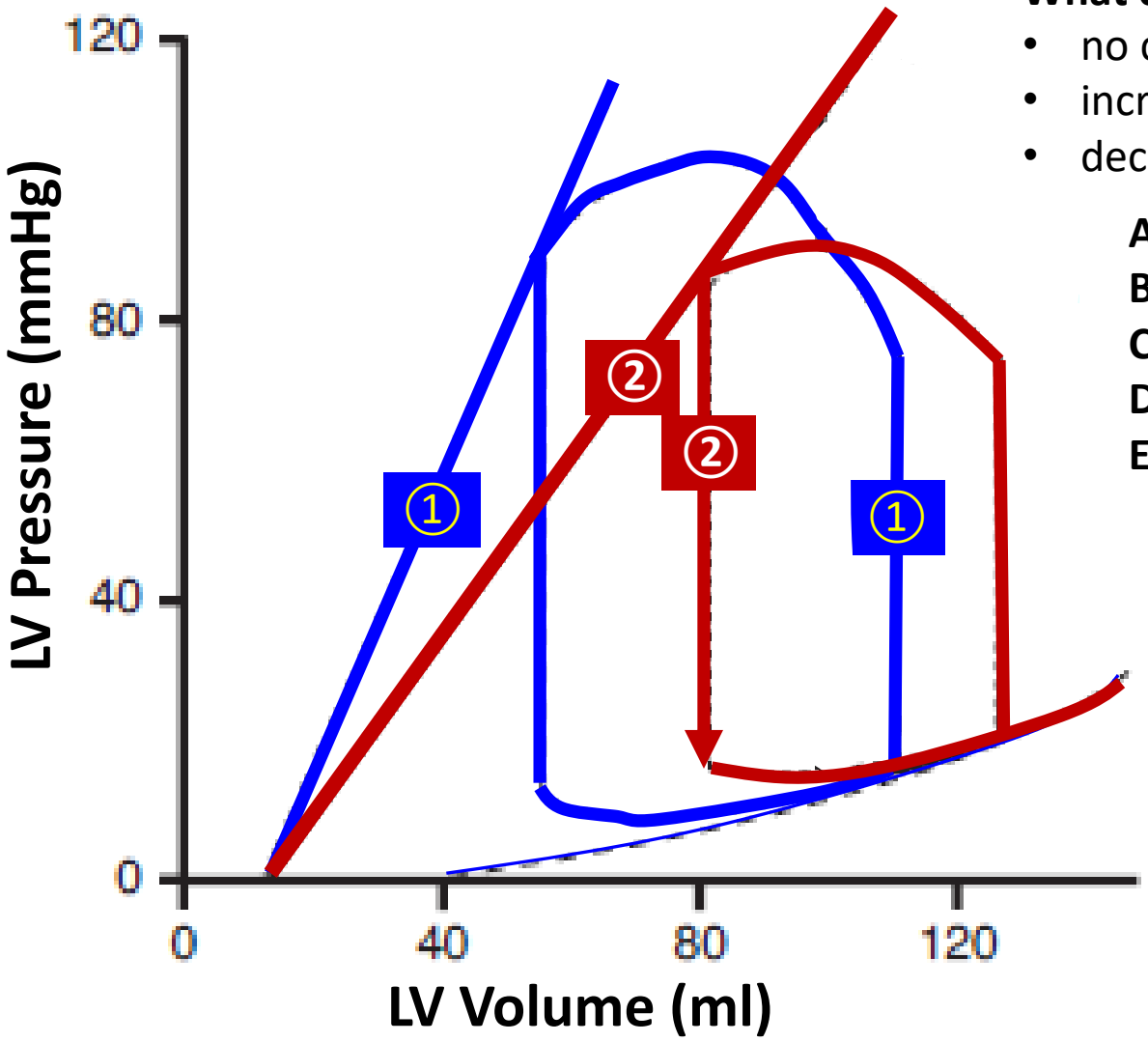




A) 0.50
B) 0.54
C) 0.58
D) 0.62
E) 0.65

Sam's EF is closest to which of the given values? 30s

Interactive Question

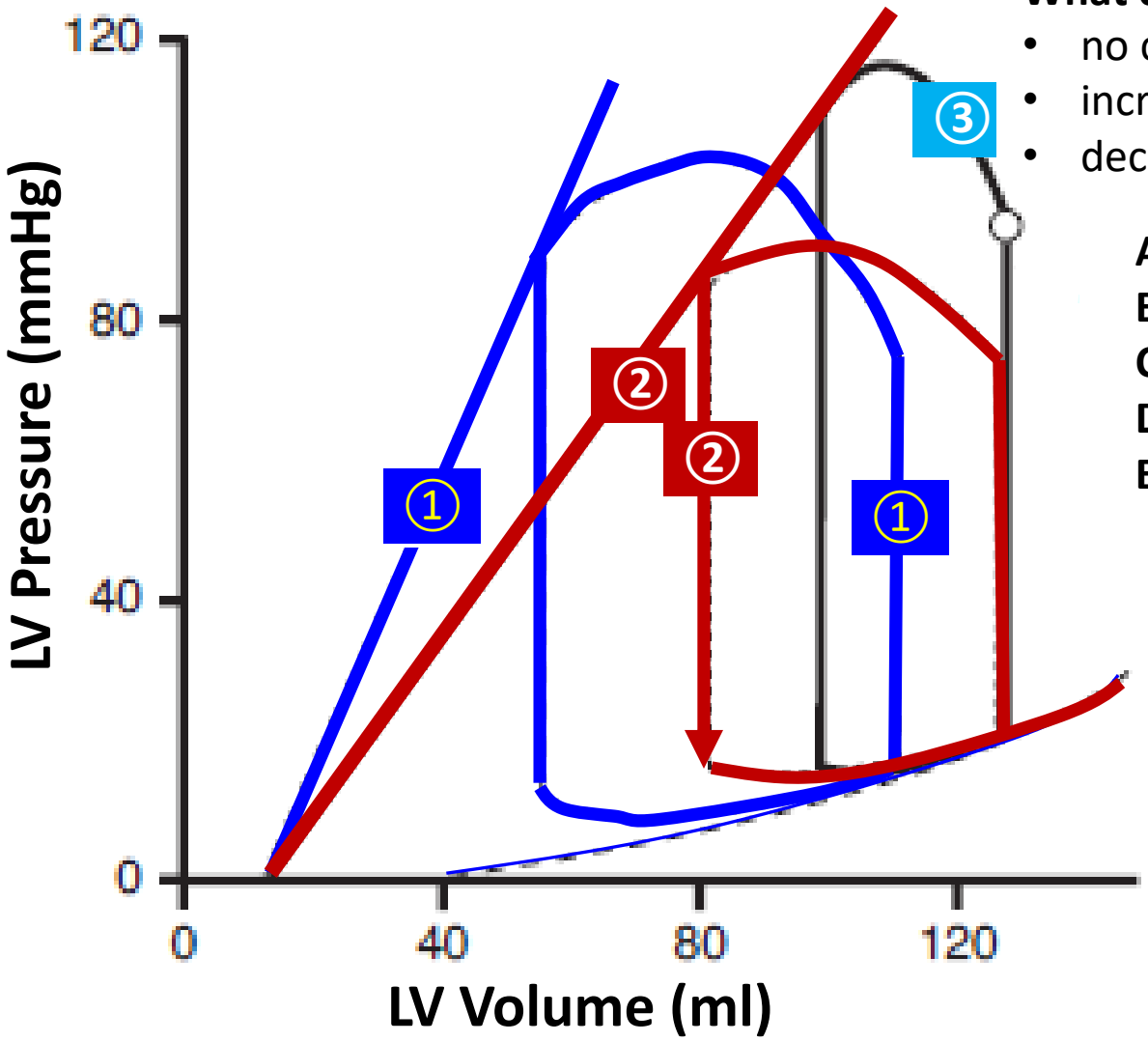


What changes from loop 1 → 2?

- no change
- increase
- decrease

A) Contractility
B) Stroke Volume
C) Preload
D) Afterload
E) Ejection Fraction

Interactive Question



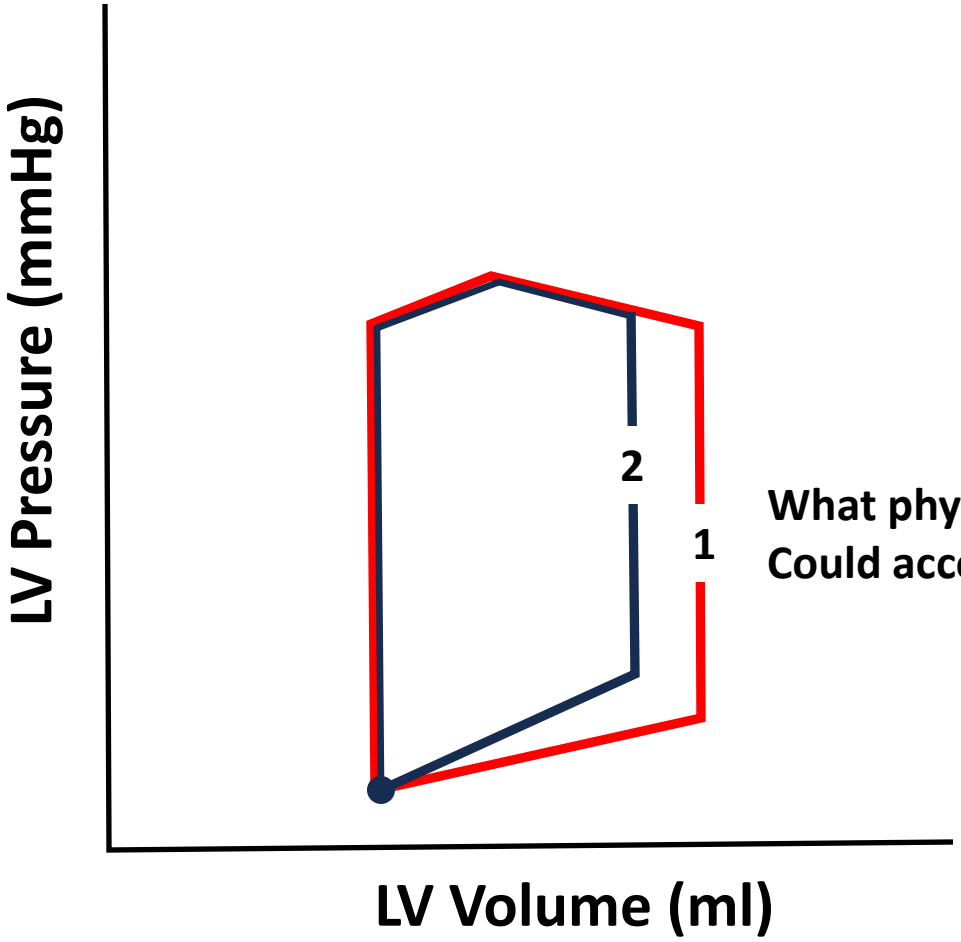
What changes from loop 2 → 3?

- no change
- increase
- decrease

A) Contractility
B) Stroke Volume
C) Preload
D) Afterload
E) Ejection Fraction

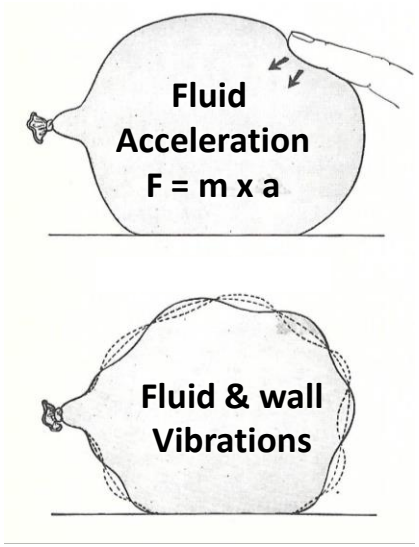
Interactive Question

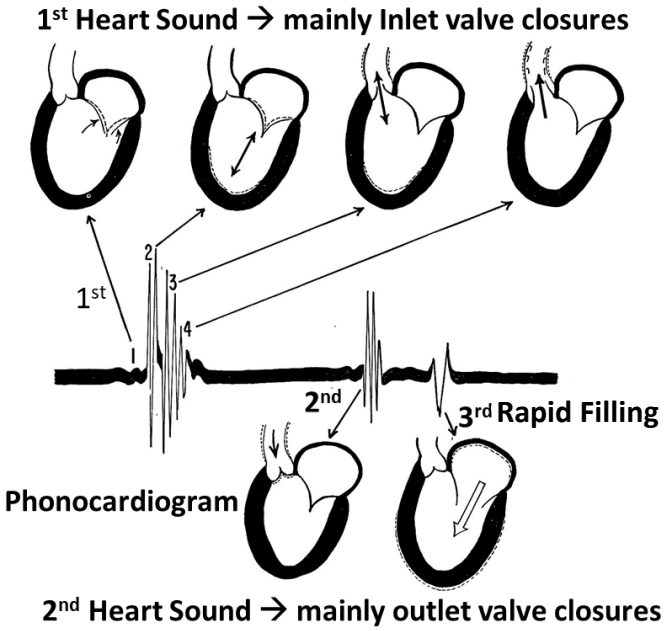
What are the main three changes in loop 2 compared to loop 1?



What physical ventricular change Could account for these findings?

Cardio-Hemodynamic Vibrations (heart sounds)



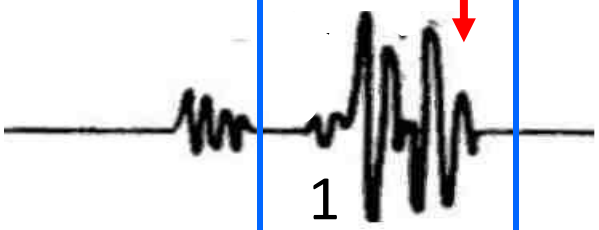


- Sounds due to blood and wall vibrations caused by accelerations and decelerations
- Forces causing the vibrations are as a consequence of F = mass x acceleration
- Blood and heart wall vibrations → low frequency vibrations dominate < ≈ 200 Hz with intensity audibility between about 30 – 100 Hz
- Intensity depends on magnitude of acceleration or deceleration of event causing vibration
- High arterial BP tends to produce greater sound since rate of valve closure greater
- Sound intensity at surface is greatest over areas not intervened by aerated lung or fat
- Heart sounds are widely distributed whereas valve murmurs tend to be much more localized
- The adjacent image illustrates the approximate regions for maximin sensitivity for each valve

Heart Sound #1

S1

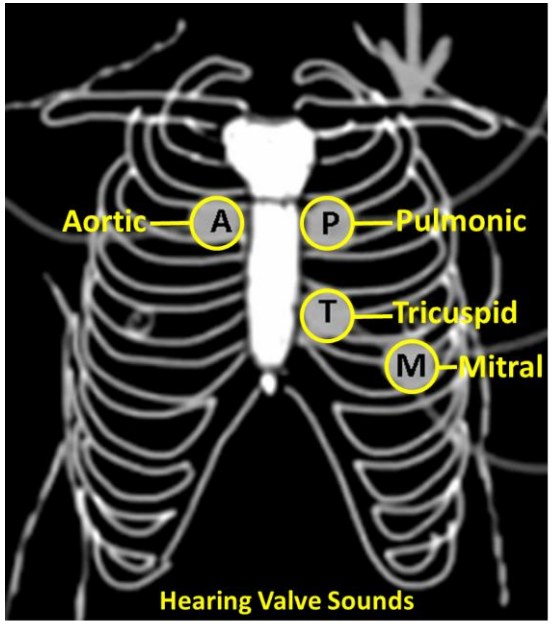
Cardio-Hemodynamic vibrations

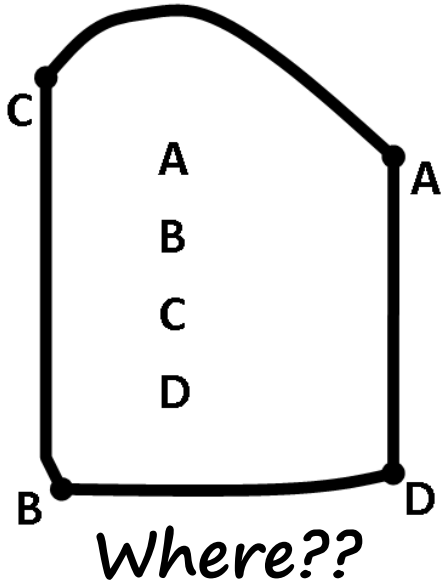


1

Onset of ventricle Systole

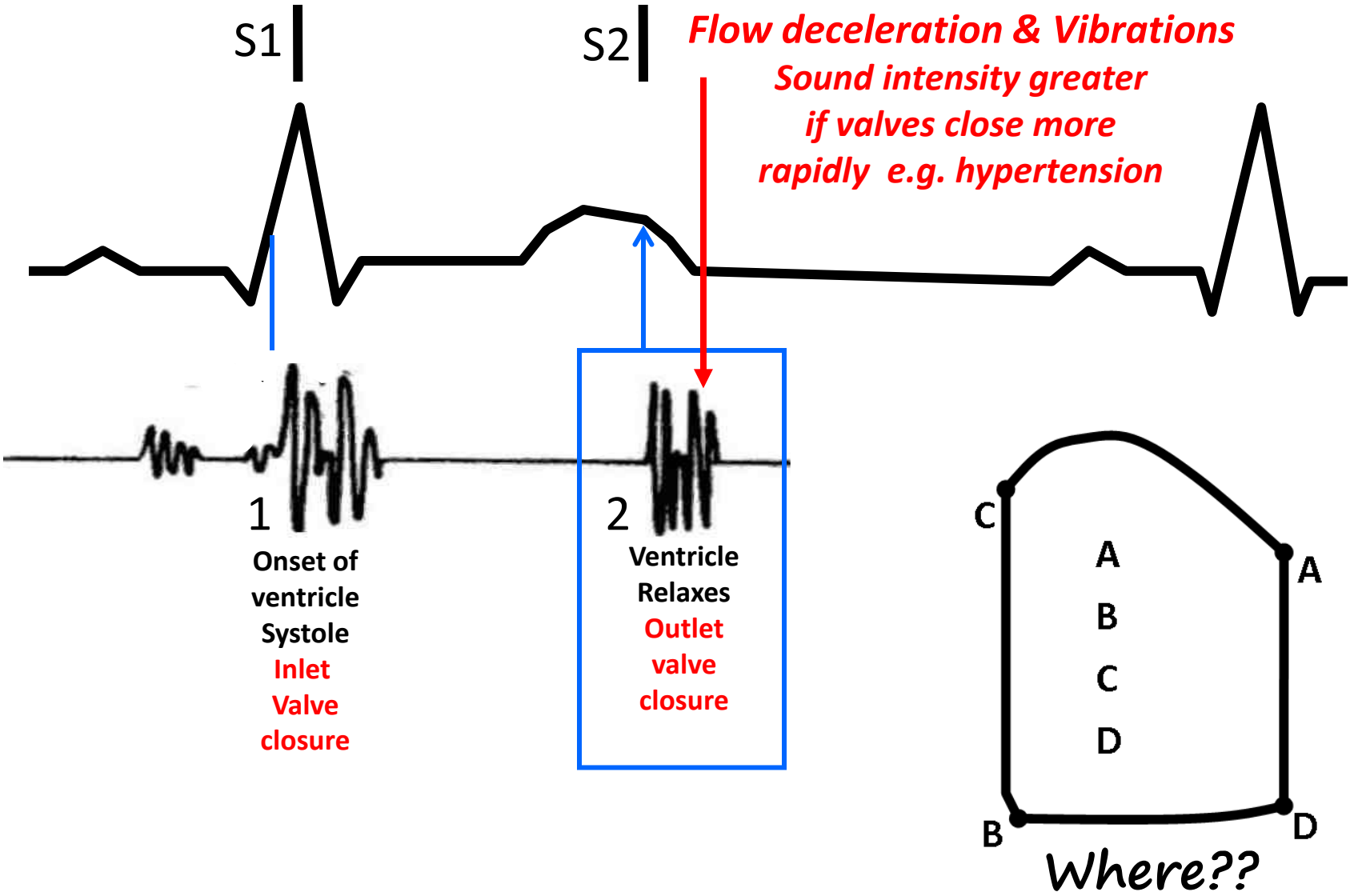
Inlet Valve closure



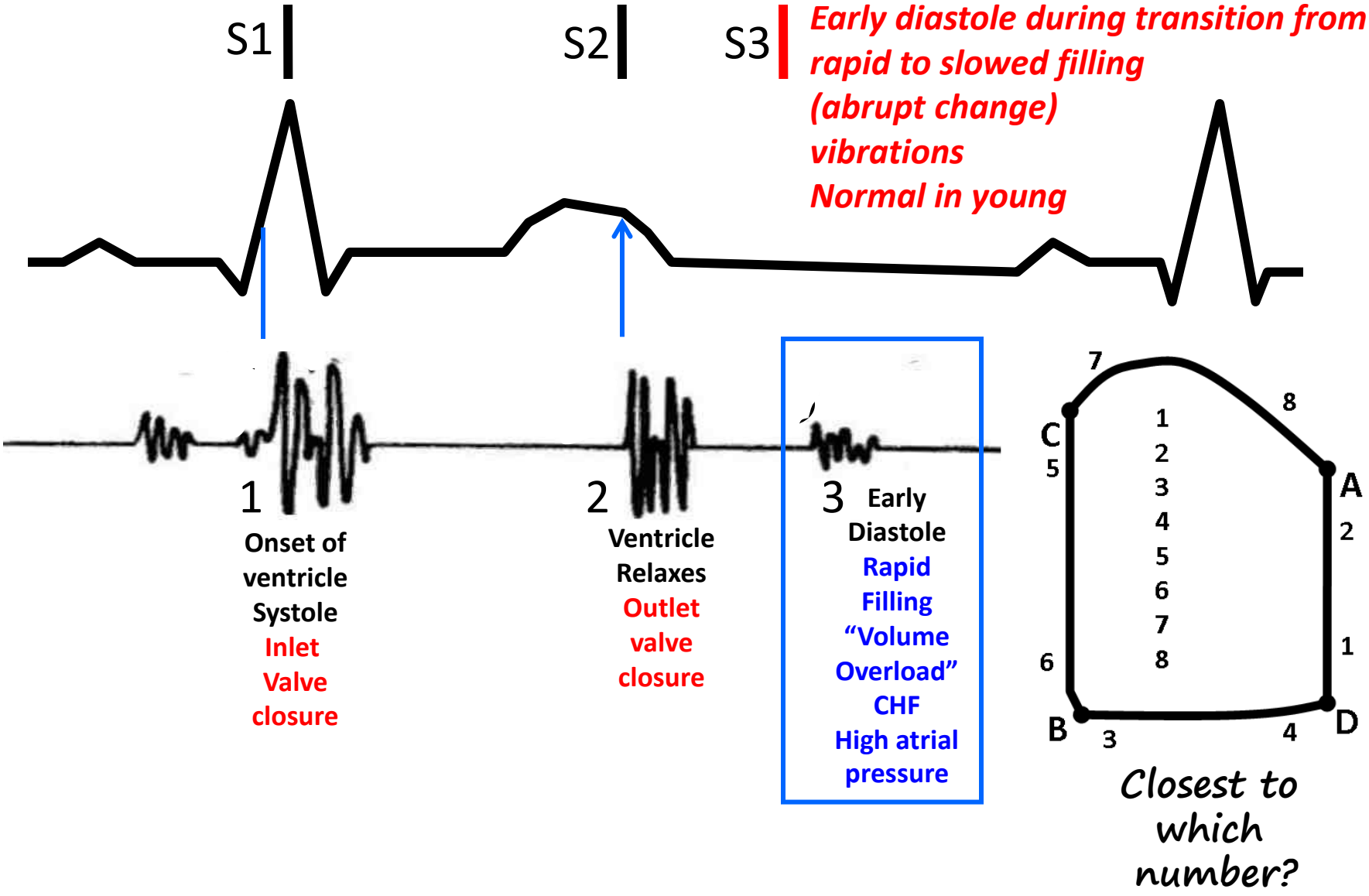


Where??

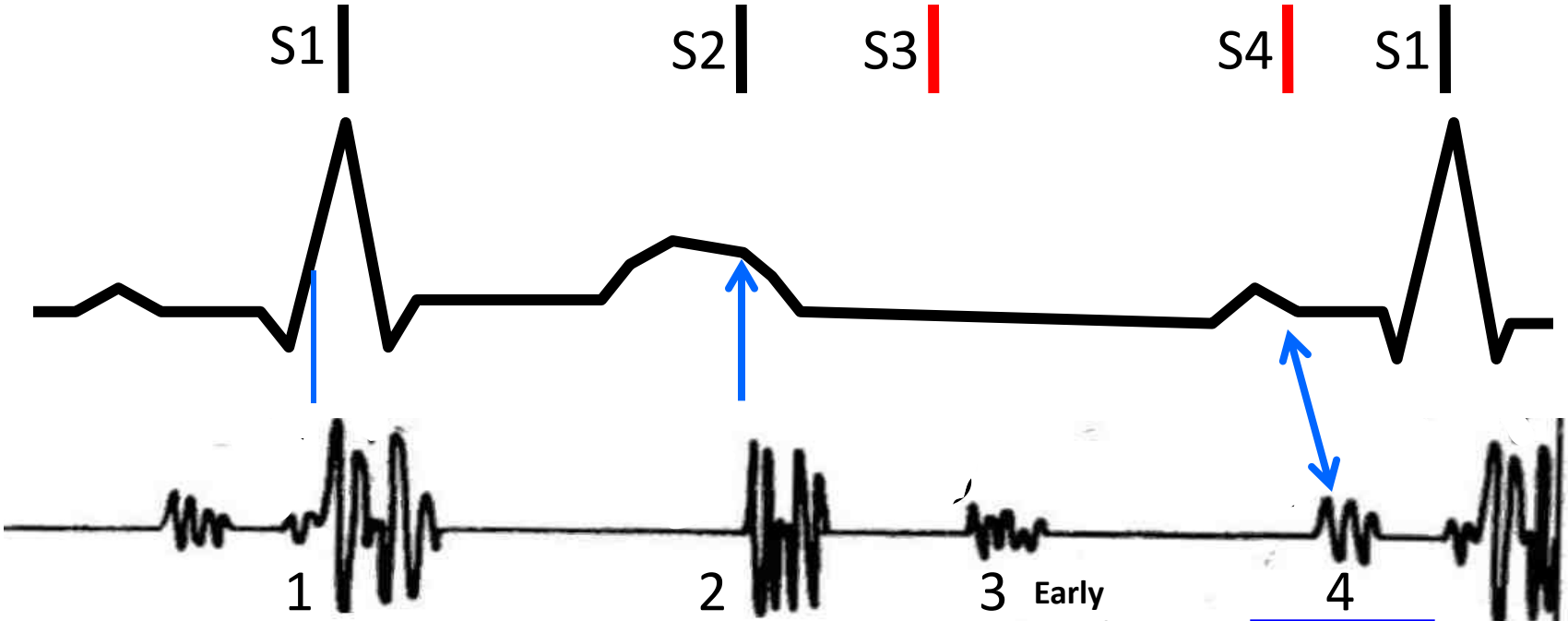
Heart Sound #2



Heart Sound #3



Heart Sound #4

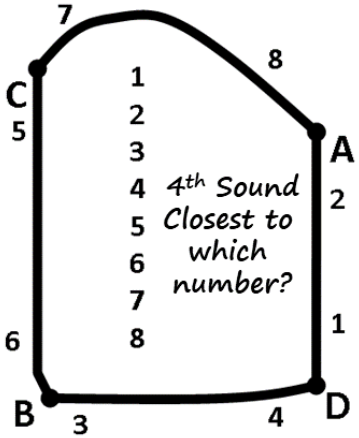


1 Onset of Ventricle Systole
Inlet Valve closure

2 Ventricle Relaxes
Outlet valve closure

3 Early Diastole
Rapid Filling
"Volume Overload"
CHF
High atrial pressure

4 Atrial Systole
"Stiff Ventricle"
LVH/RVH
"Atrial Gallop"



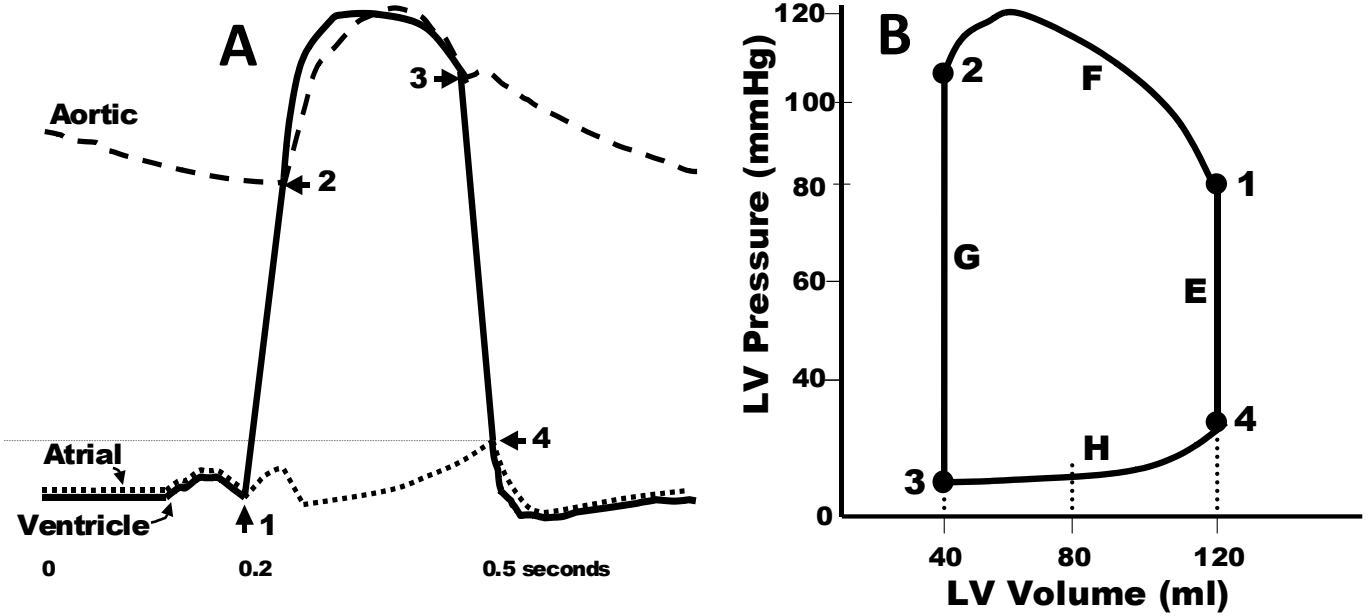
Murmurs

- Sound produced by turbulent flow
- Occur if local critical N_R exceeded
- In/distal to organic/structural obstruction

  (stenosis - valve or vascular)
- High cardiac output (functional)

  e.g severe anemia, hyperthyroid, fever etc.
- High regional flow

Interactive Questions: Wiggers vs. PV Loops



1. In A: what event is associated with point 2?
2. What does this point correspond to in the PV Loop?
3. In B: what occurs during segment E?
4. Between which two points in A does E correspond?
5. The QRS of the EKG starts closest to which point in B?
6. Which point in A corresponds to this point?
7. If the pts aortic SBP = 118 mmHg what can you conclude about the AOV?
8. If the pts HR was 60 bpm what is her CO?
9. The patient's end systolic volume is approximately what value?
10. If there was a 3rd heart sound, during which segment in B would it occur?

End CV Physiology Lecture 9

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