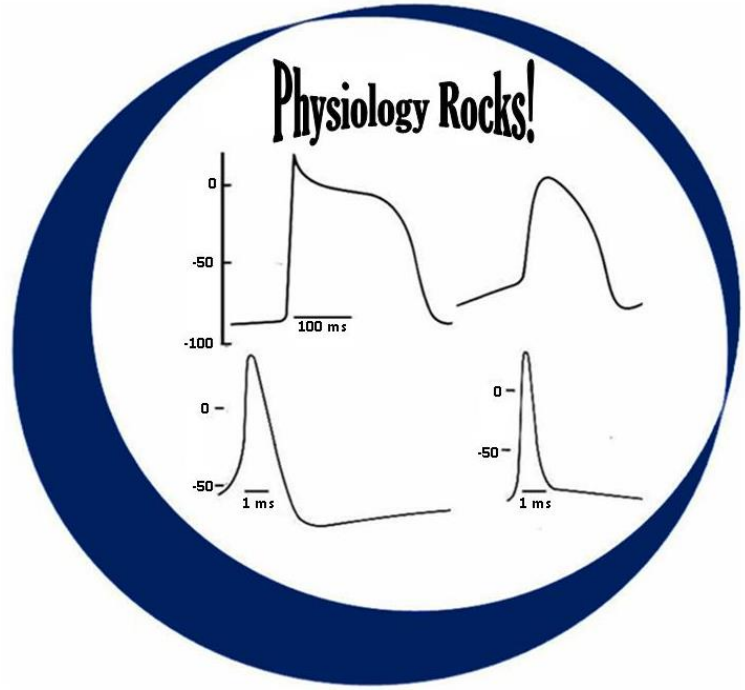
Lecture 26

Cardiac Cycle – Wiggers – Heart Sounds



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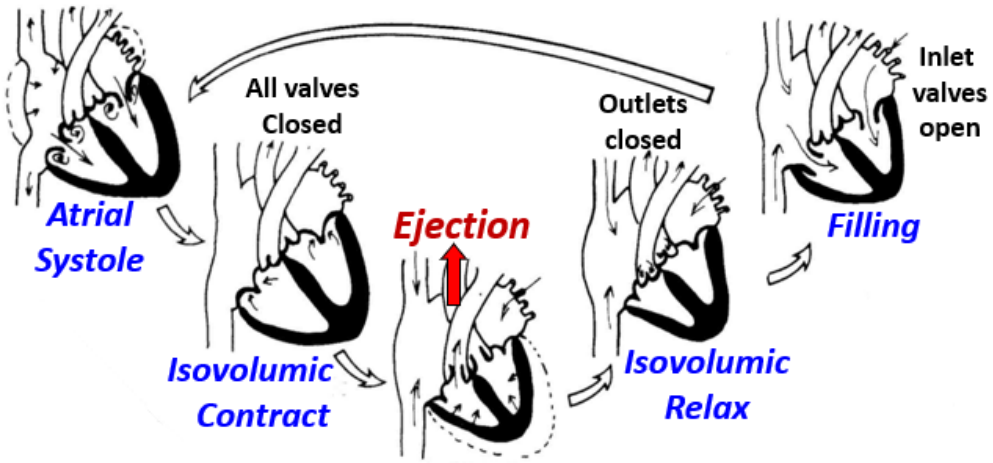
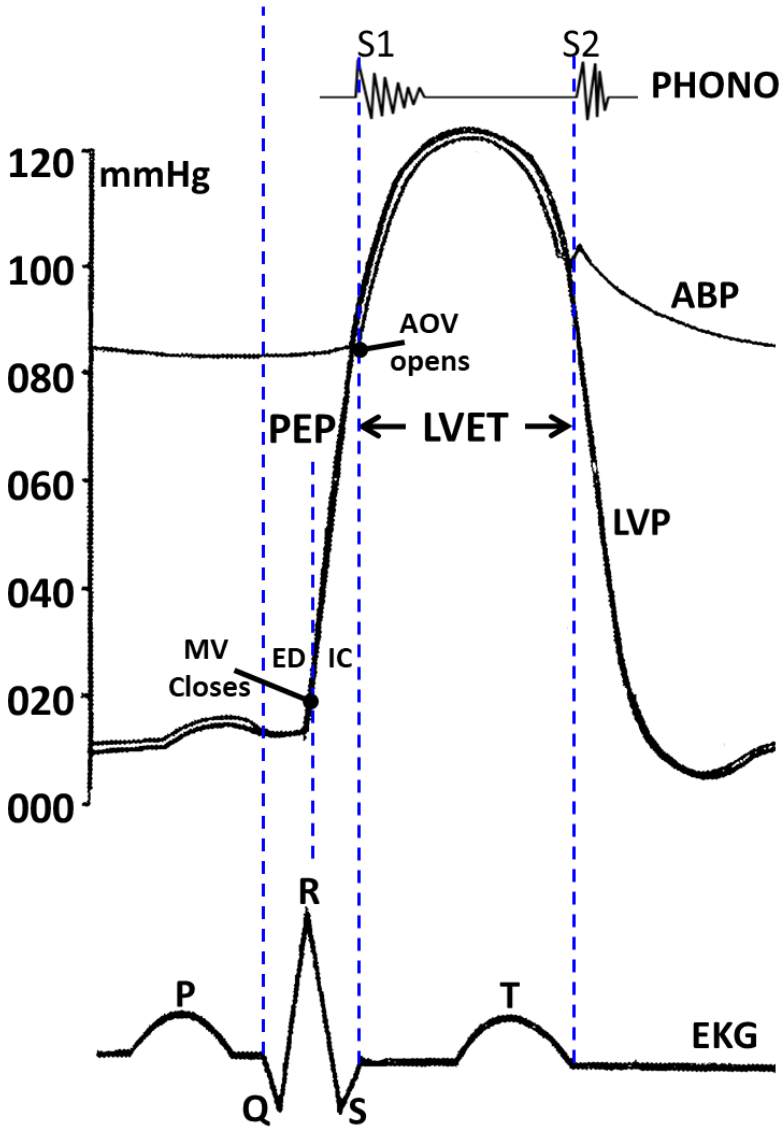
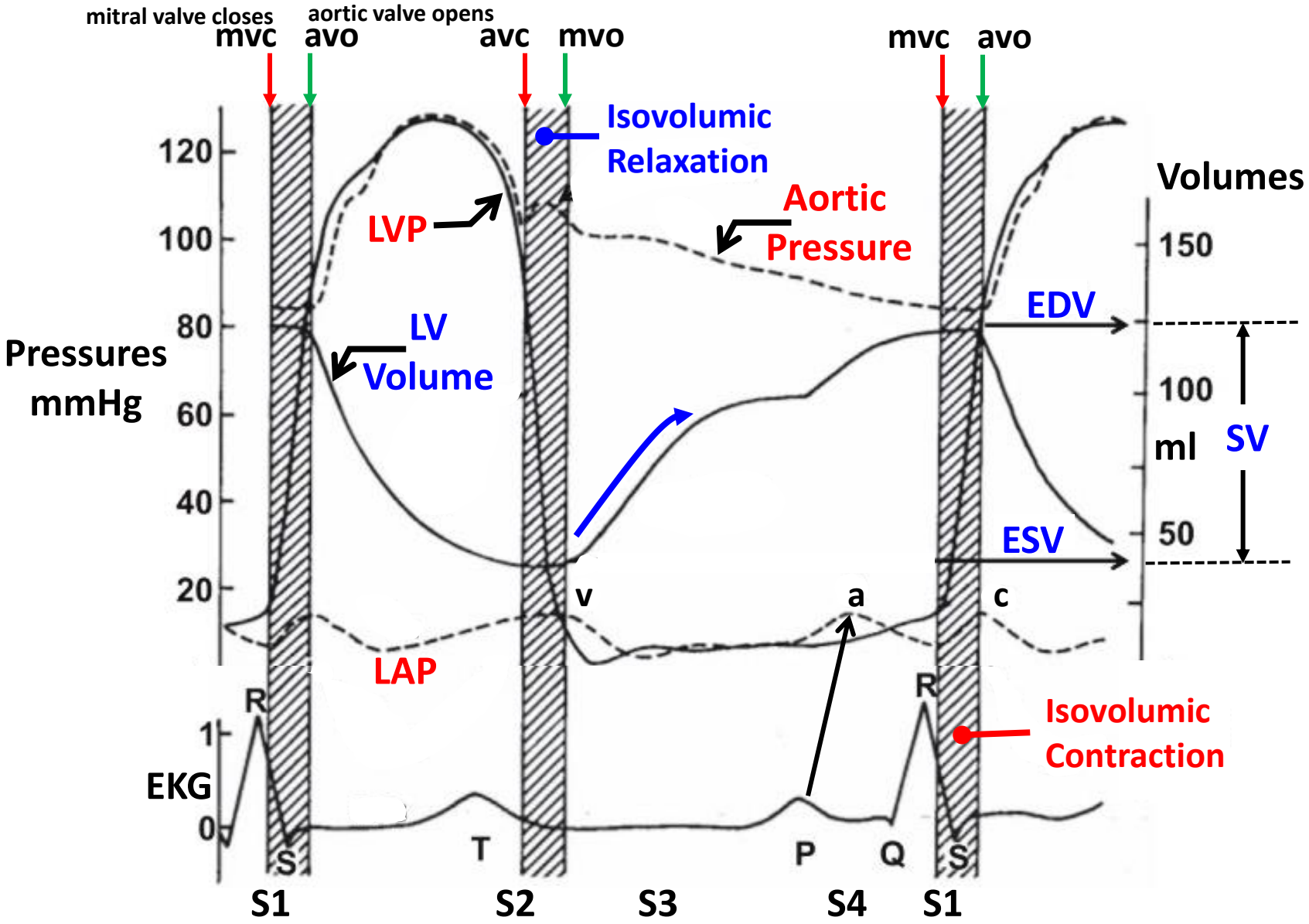
Cardiac Cycle Dynamics

Definitions
S1: 1st heart sound
S2: 2nd heart sound
ABP: Aortic Blood Pressure
LVP: Left Ventricle Pressure
PHONO: phonocardiogram
PEP: Pre-Ejection Period
ED: Electromechanical Delay
IC: Isovolumic contraction
LVET: Left Ventricle Ejection Time
STI: Systolic Time Interval = PEP + LVET

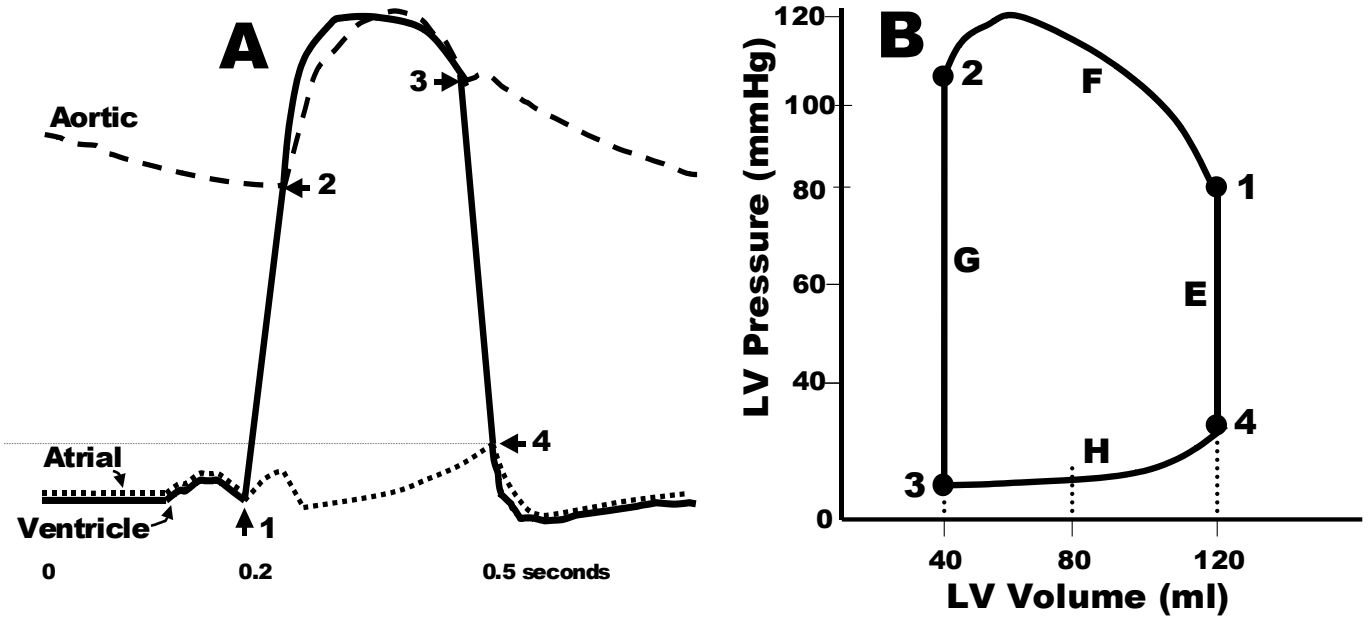




Cardiac Cycle Essentials: REVIEW

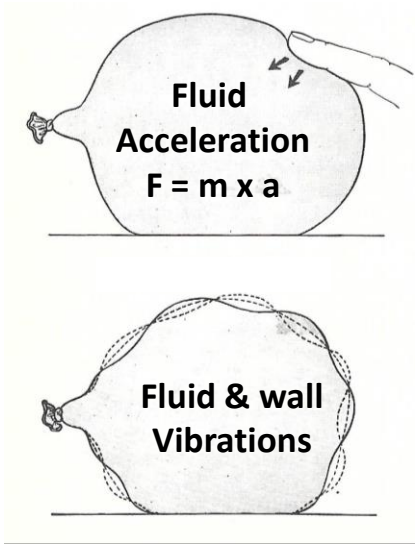


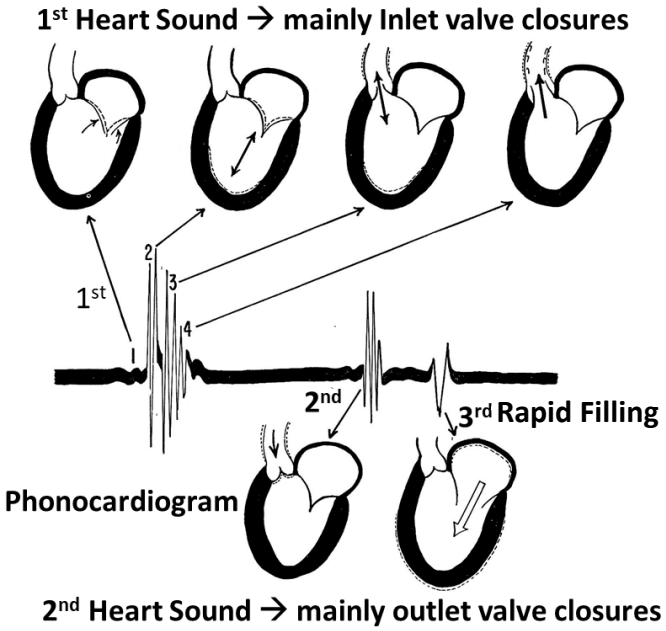
Relationships: Wiggers vs. PV Loops: Interactive



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 patient's HR is 70 what is her cardiac output?
8. The patient's systolic blood pressure is approximately what value?
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?

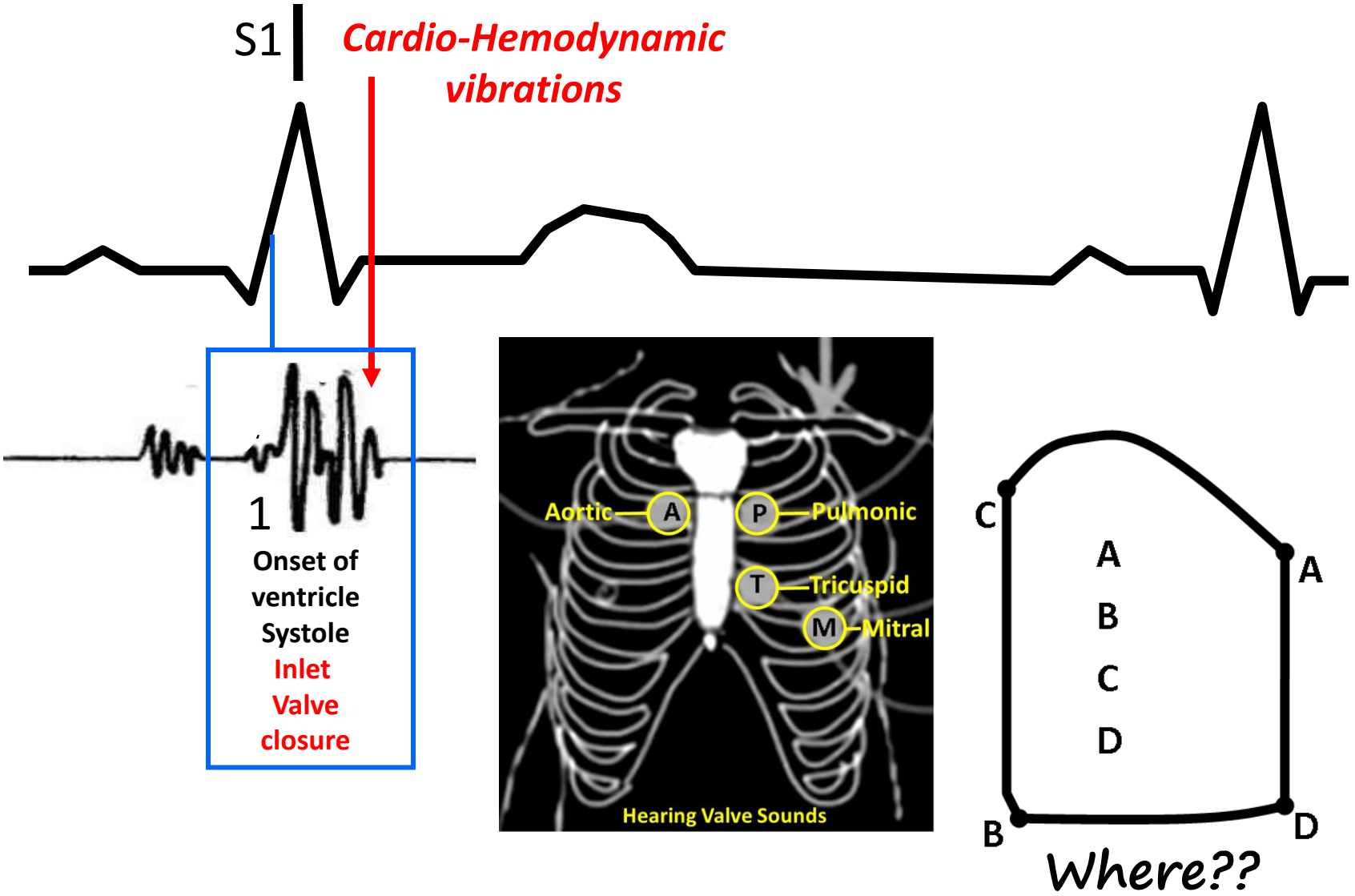
Cardio-Hemodynamic Vibrations (heart sounds)



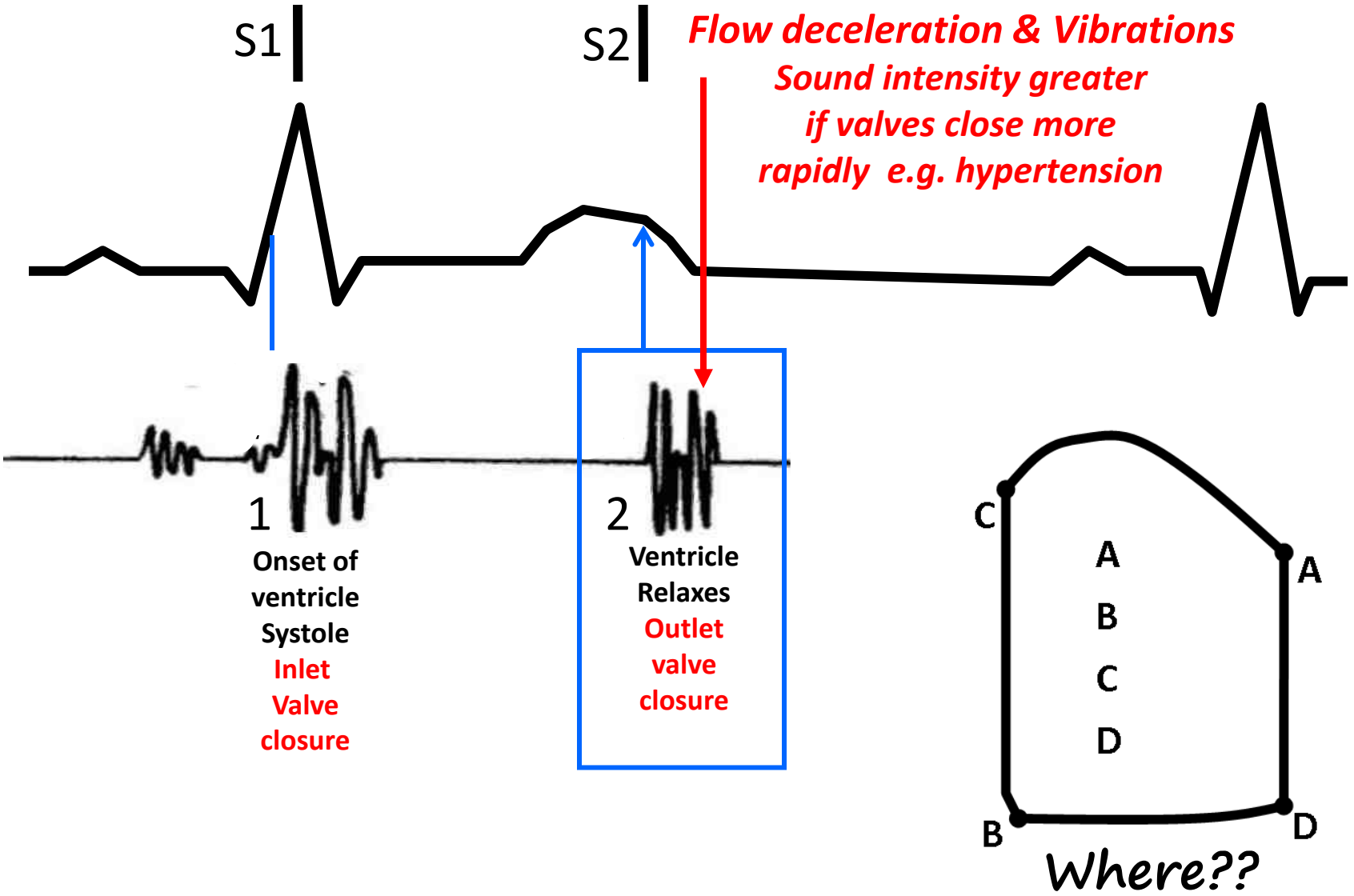


- Sounds due to blood and wall vibrations caused by accelerations and decelerations
- Forces causing the vibrations are as a consequence of F = mass x acceleration
- Blood and heart wall vibrations → low frequency vibrations dominate < ≈ 200 Hz with intensity audibility between about 30 – 100 Hz
- Intensity 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

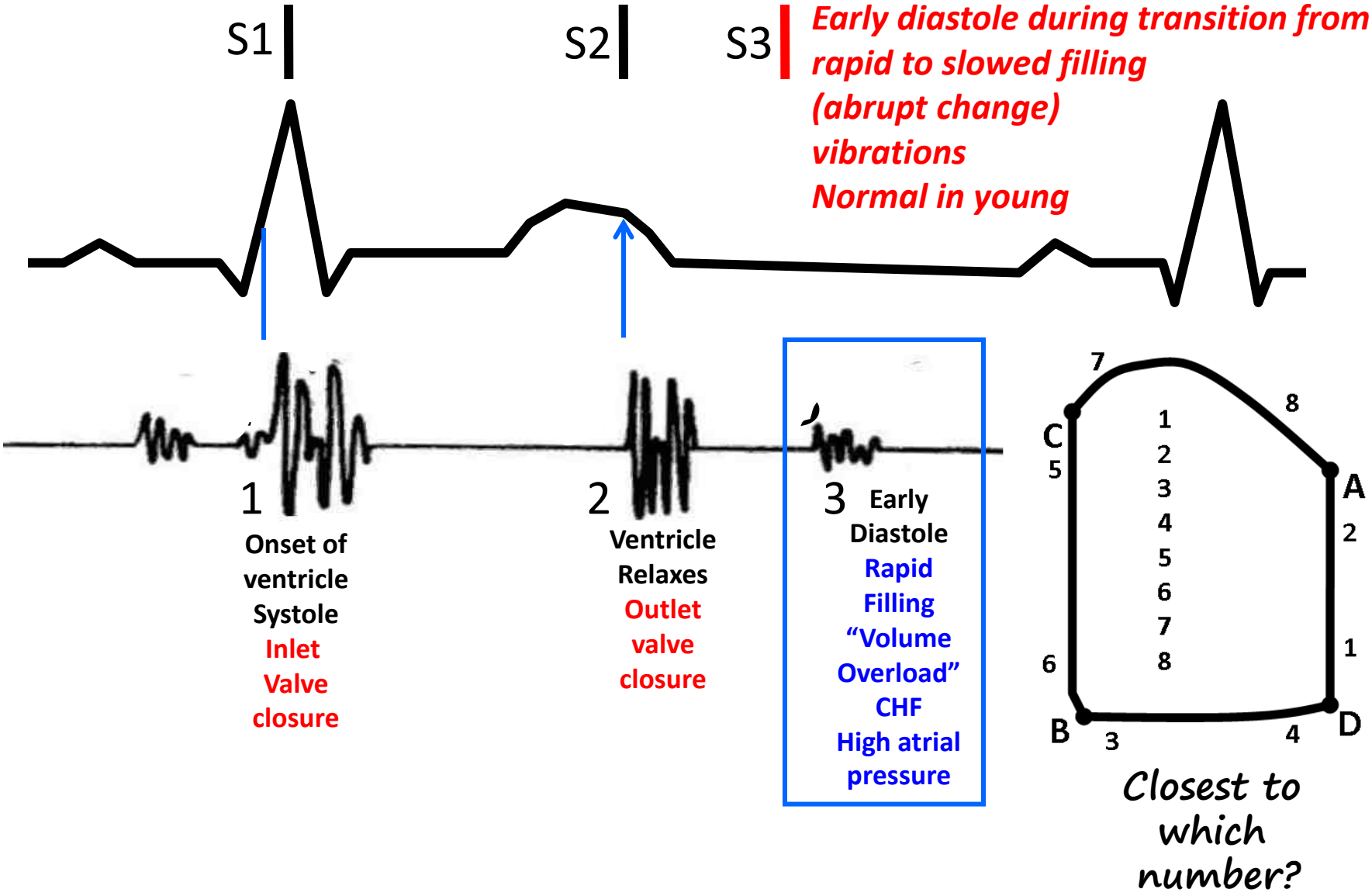
Heart Sound #1



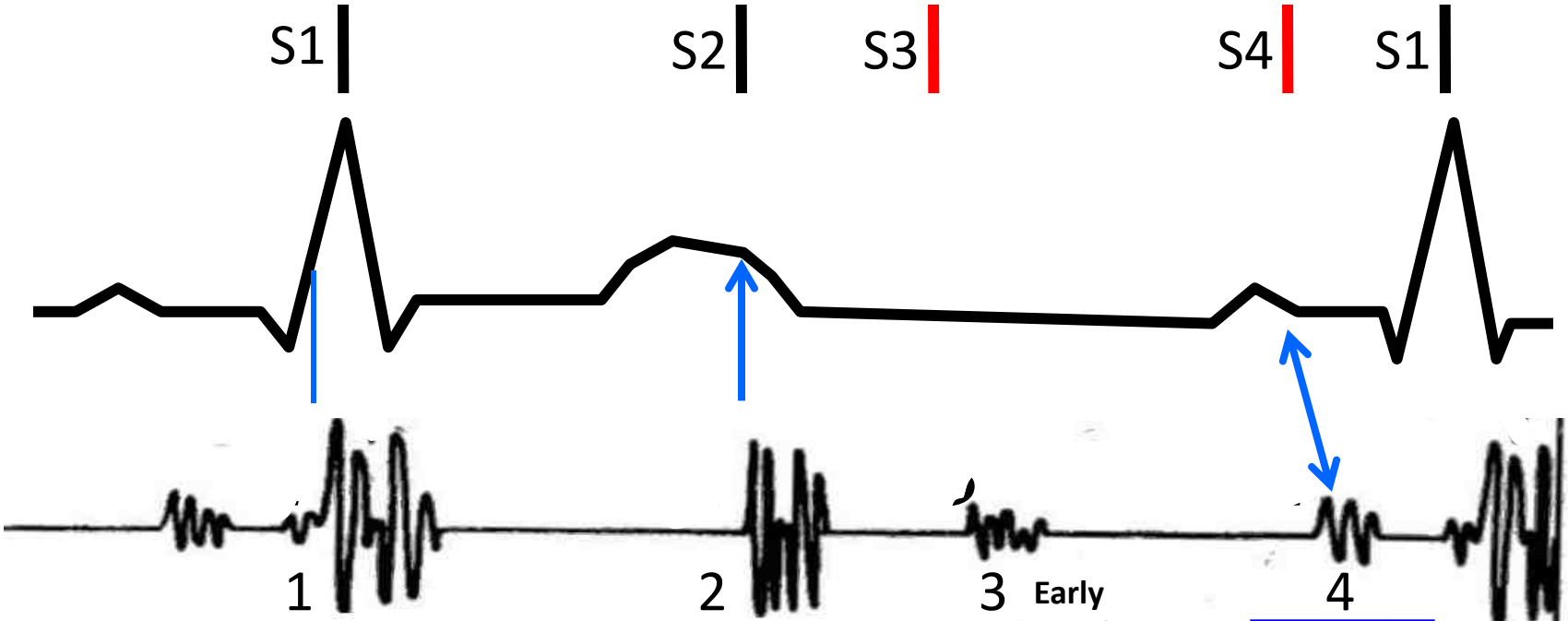
Heart Sound #2



Heart Sound #3



Heart Sound #4

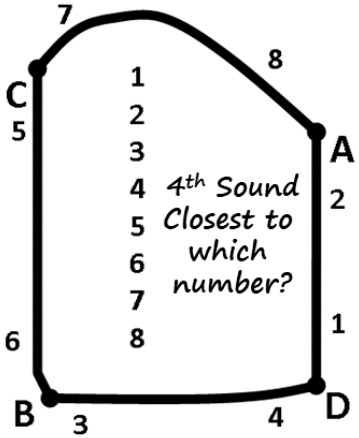


1 Onset of Ventricle Systole
Inlet Valve closure

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"



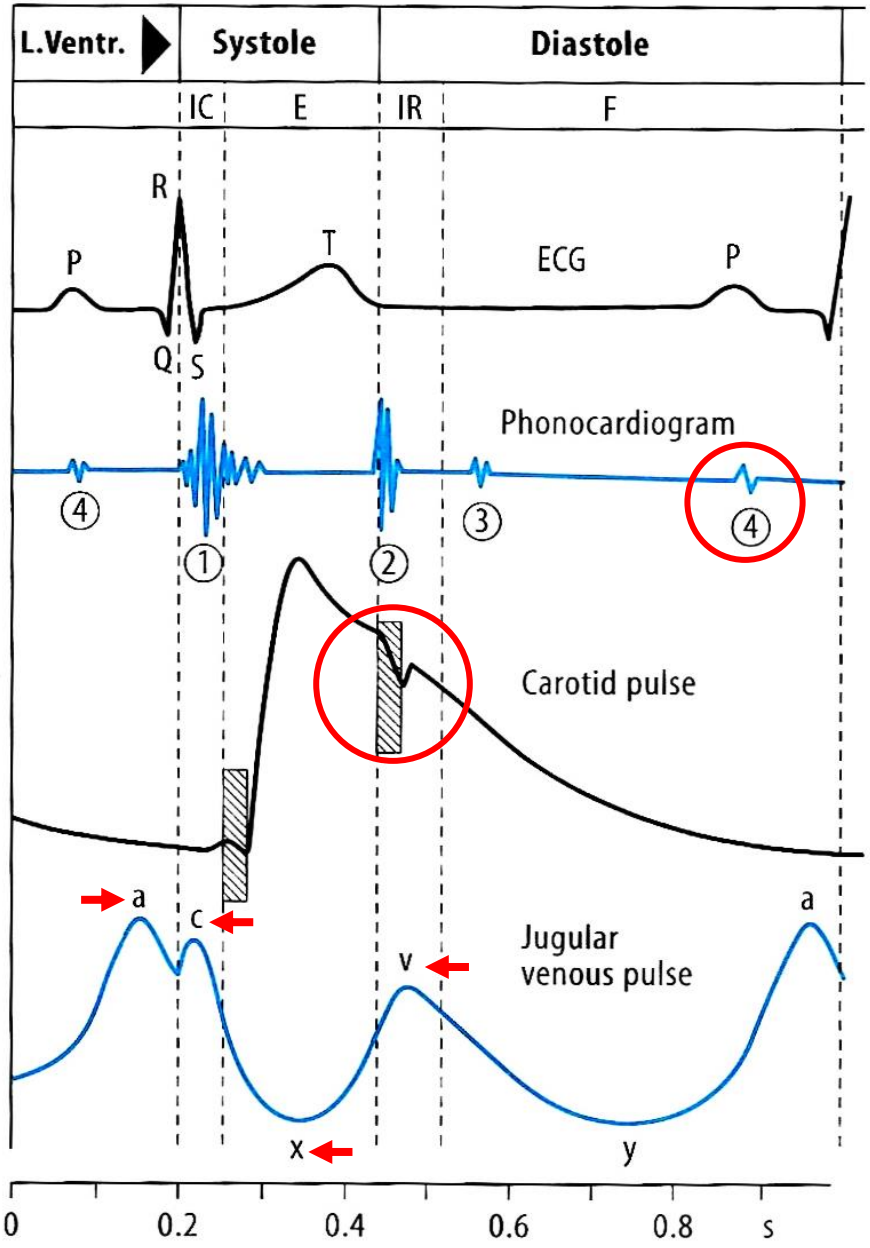
Murmurs

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

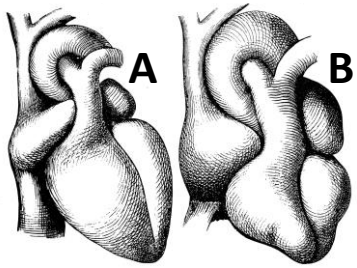
  (stenosis - valve or vascular)
- High cardiac output (functional)

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

Carotid Artery and Jugular Pulses



- Note the 4th heart sound of atrial contraction
- Hatched part of the carotid pulse indicates time delay between start of ventricular ejection and pulse arrival (sharp upstroke or the notch)
- The jugular or central venous pulse has three main waves; a-wave, c-wave and v-wave
- a-wave is caused by right atrial systole as the contraction pressure transmits to the central veins
- c-wave is caused by tricuspid valve bulging toward right atrium (isovolumic ventricle contraction)
- x-decent occurs as atrium relaxes and expanded via ventricle contraction as illustrated below



A=Ventricular Diastole
B=Ventricular Systole

- v-wave reflects increased atrial pressure as right atrium fills (tricuspid valve closed)

IC = isovolumic contraction, E = ejection
IR = isovolumic relaxation, F = ventricle filling

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Interactive Question

Which statement about the 3rd Heart sound is correct?

a) **It is always abnormal**

b) **It is more likely when LAP is elevated**

c) **It is more likely in patients over 18**

d) **It is more likely when a person is hypertensive**

e) **It is more likely when a person *is* hypovolumic**

Interactive Question

Which of the following would increase left ventricular myocardial contractility?

A. An increase in preload
B. A increase in afterload
C. Increased calcium current ($I_{Ca\text{-}L}$) during the AP plateau
D. A drug-induced reduction in the calcium pool
E. Administration of a positive chronotropic drug

Interactive Question

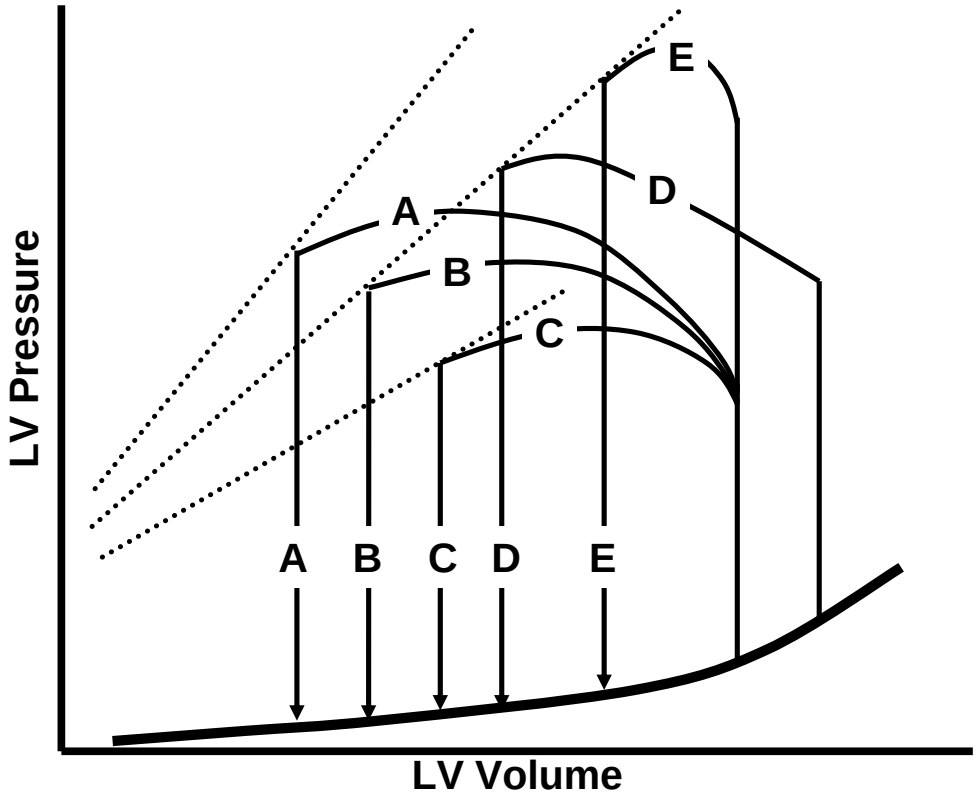
As a consequence of the Frank-Starling mechanism, a decrease in preload will result in:

A. a decrease in stroke volume
B. an increase in stroke work
C. an increase in contractility
D. a decrease in contractility
E. an increase in peak isovolumic pressure

Interactive Question

Which patient has the greatest myocardial contractility?

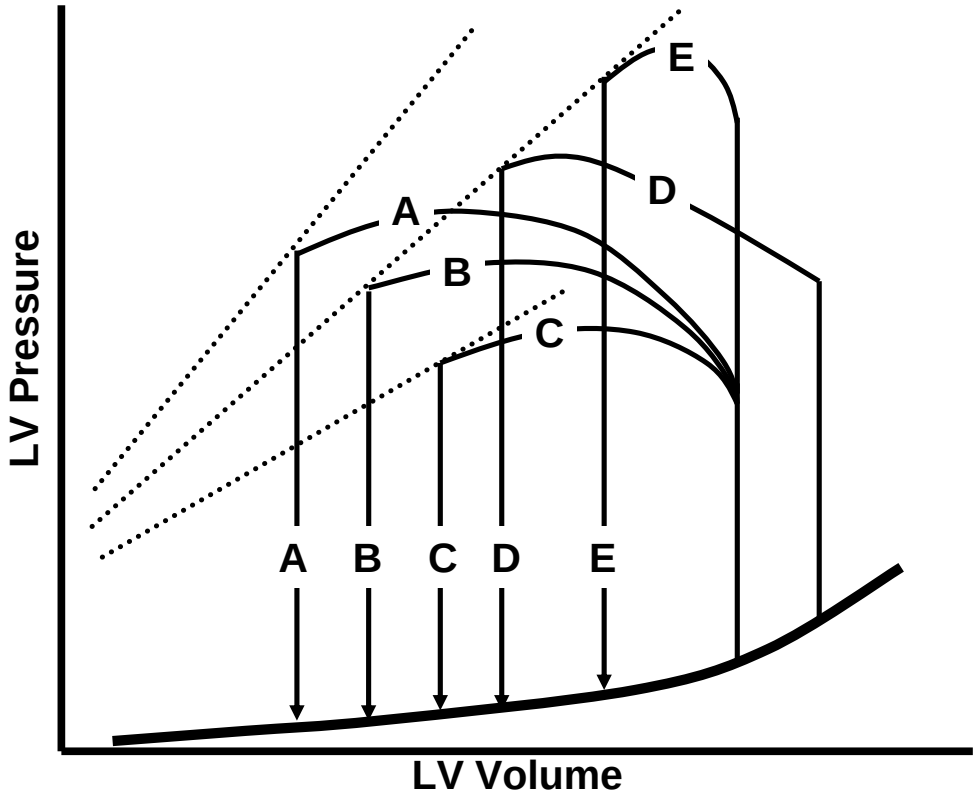
A. A
B. B
C. C
D. D
E. E



Interactive Question

Which patient has the greatest stroke volume?

A. A
B. B
C. C
D. D
E. E



Interactive Question

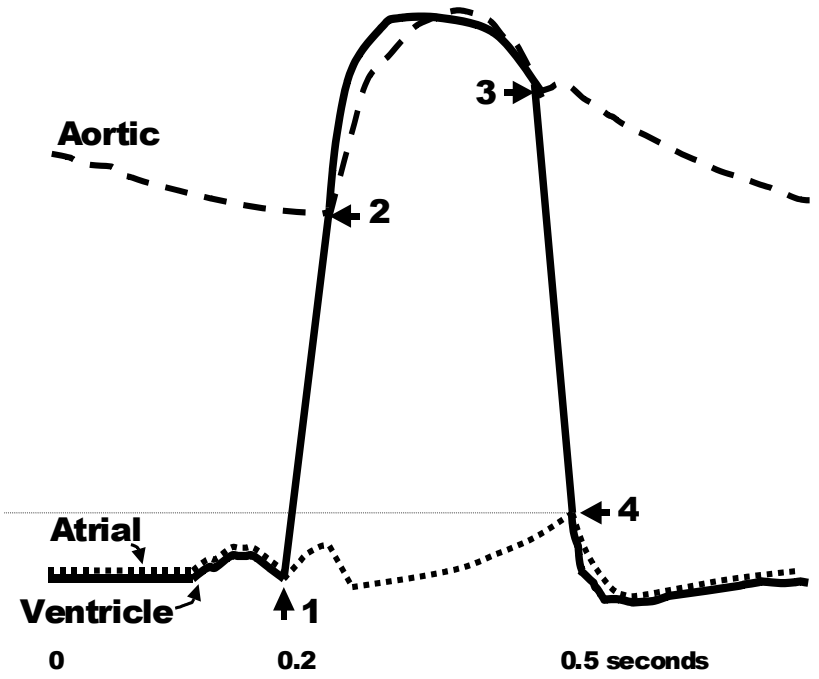
A person who is standing as compared to being supine will normally have:

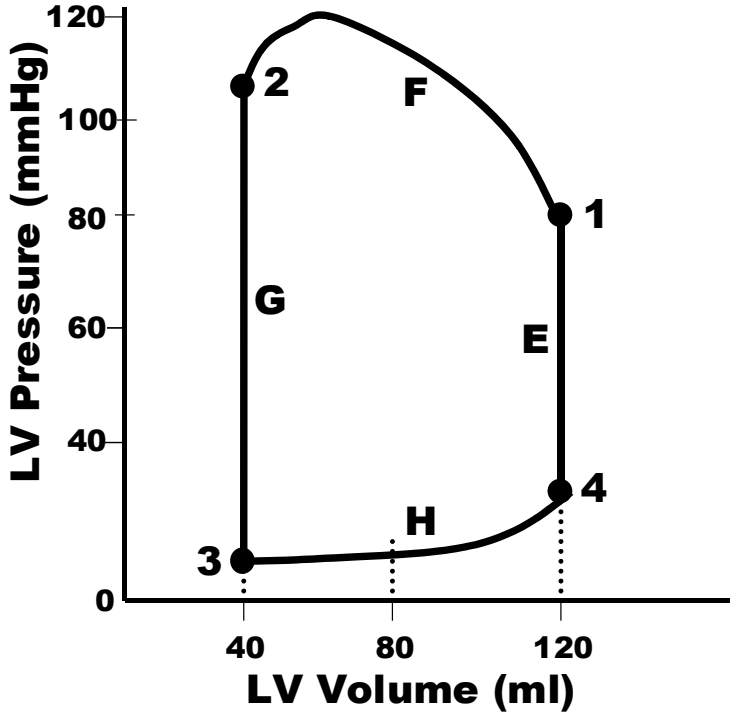
A. A greater central venous pressure
B. A lower heart rate
C. A reduced stroke volume
D. A greater left ventricular filling pressure
E. A greater left atrial volume

Interactive Question

For the figure below, which segment of the pressure-volume loop corresponds to the time interval between points 3-4?

A. E
B. F
C. G
D. H

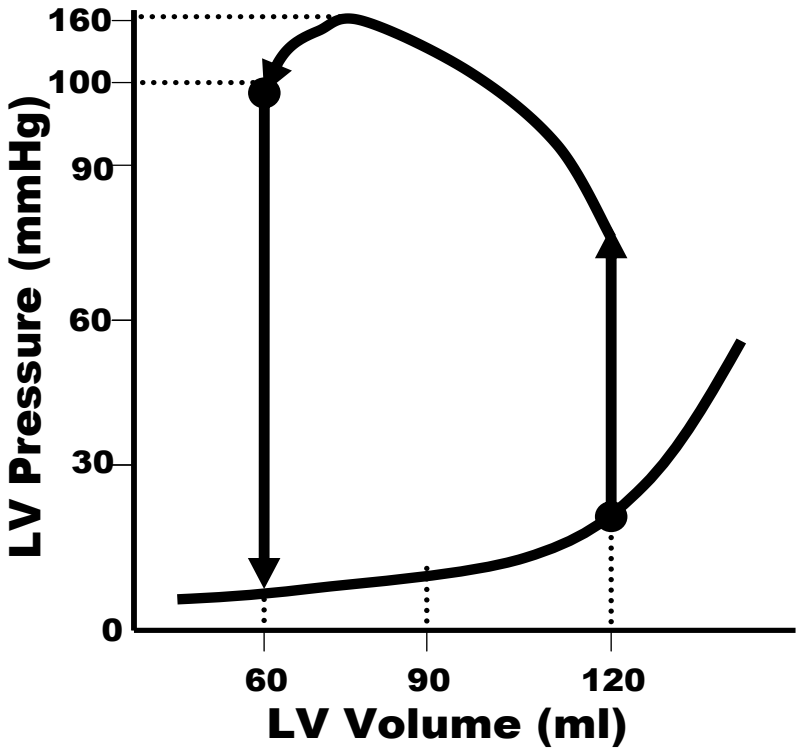




Interactive Question

Assuming no valve abnormalities, which statement is true?

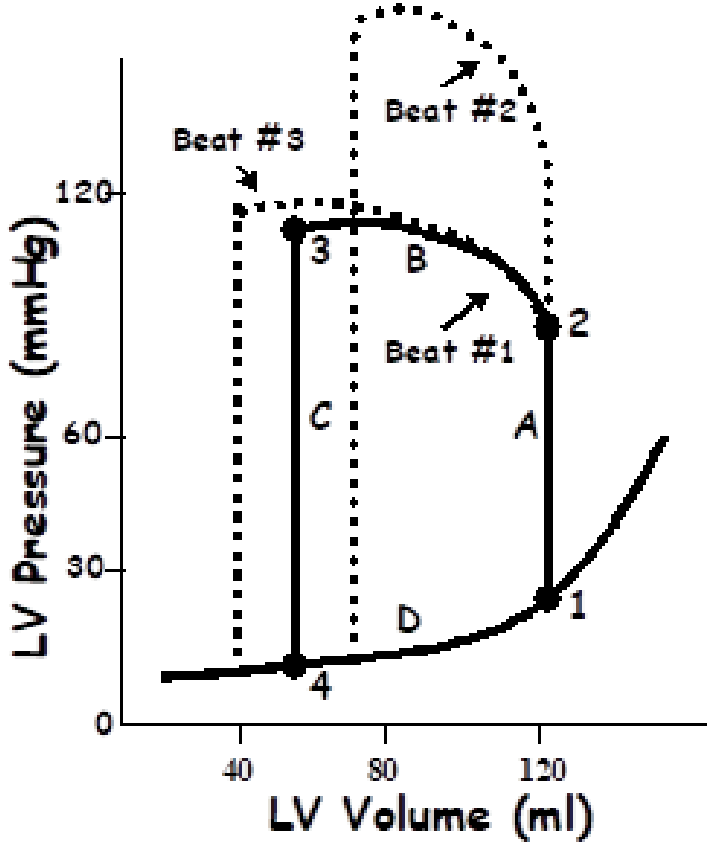
A. **Her aortic systolic pressure is about 100 mmHg**
B. **Her end diastolic pressure is about 120 mmHg**
C. **Her stroke volume is about 120 ml**
D. **Her aortic diastolic pressure is less than 90 mmHg**
E. **Her end systolic volume is less than 30 ml**



Interactive Question

Which change, between beat #1 and beat #2, best accounts for beat #2's loop?

a) Decreased preload
b) Increased afterload
c) Increased contractility
d) Increased heart rate
e) Decreased end systolic volume



End Lecture 26