Supplemental Digital Appendix 1

Example of a Team-Based Learning (TBL) Session Adapted From a First-Year Cardiorespiratory Course at Lee Kong Chian School of Medicine, Singapore

This TBL session included 90 students and two teachers (one of whom acted as the facilitator, the other as the content expert). The session lasted four hours. The Individual Readiness Assurance Test (iRAT) took 20 minutes and the Team Readiness Assurance Test (tRAT) 40 minutes. Answering the students' burning questions lasted approximately an hour, while the application exercises took two hours.

Preparation (pre-class)

Sample learning outcomes (provided to students with video-recorded learning materials):

- Recall the relationship between ventricular wall tension, chamber radius, and chamber pressure (Law of Laplace)
- List the sequence of events from excitation that brings about contraction then relaxation of ventricular cells
- Explain the mechanisms underlying Starling's Law of the Heart
- Compare using a graph the length-tension relationships for cardiac and skeletal muscle
- Explain the concepts of preload and afterload
- Recall the mechanical events of the cardiac cycle
- Illustrate by means of a graph the electrocardiographic events and pressure events of the atria, ventricles, aorta, and pulmonary artery
- Recognize the origin of the heart sounds
- Define cardiac output and indicate its determinants
- Recall simple pressure-volume diagrams from the events during the cardiac cycle and annotate these graphs appropriately

Readiness assurance (in-class)

Sample iRAT/tRAT questions (27 questions total):

1. What change in the cardiac cycle follows immediately after the opening of the aortic valve?

a) The left ventricular pressure decreases
b) The aortic pressure decreases
c) The left ventricular volume decreases
d) The mitral valve closes

2. In a healthy young person, what systolic and diastolic pressures (in mmHg) would be expected in the systemic and pulmonary circulation respectively?

a) 150/90 & 25/5
b) 90/60 & 20/5
c) 120/80 & 25/5
d) 130/70 & 40/15

3. Referring to the pressure volume loop of the heart, which point represents the opening of the mitral valve?

a) A
b) B
c) C
d) D

Sample student-generated "burning questions":

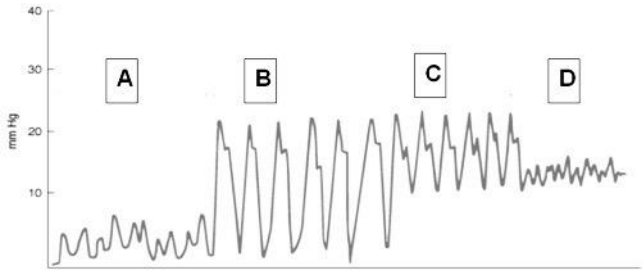
"We are under the impression that isovolumetric relaxation occurs as ventricular pressure decreases, after aortic valve closure and before the AV valve opens—Please clarify why the answer is not diastasis (reduced ventricular filling stage of diastole)."

"Why is there a reduction in end-systolic volume after the valves have closed?"

Application (in-class)

Sample application exercise question (10 questions total):

This pressure vs. time tracing is recorded in a 40-year-old man who had a catheter passed from his right internal jugular vein to the superior vena cava and into his heart. The recorded tracing shows four different waveforms (A to D) as the catheter is passed through the chambers of the heart.



1) Link the locations (A to D) on the left with the correct anatomical location of the catheter.