Capnography During Cardiopulmonary Resuscitation (CPR)

Objectives

- American Heart Association (AHA) recommends the use of capnography not only for confirmation of tracheal tube placement but also to monitor the effectiveness of chest compressions during CPR.

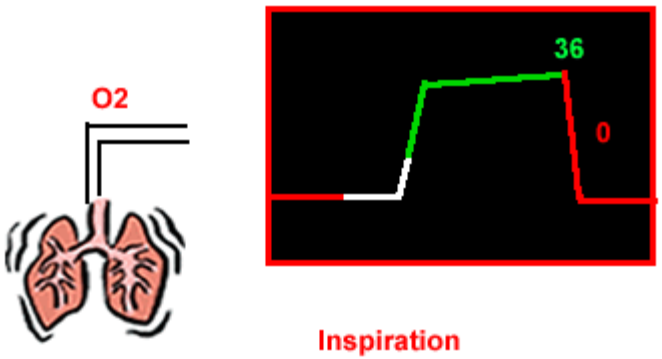
- After reviewing this brief clinical concept, the code leader will be able to interpret capnography to direct CPR more effectively

Definitions

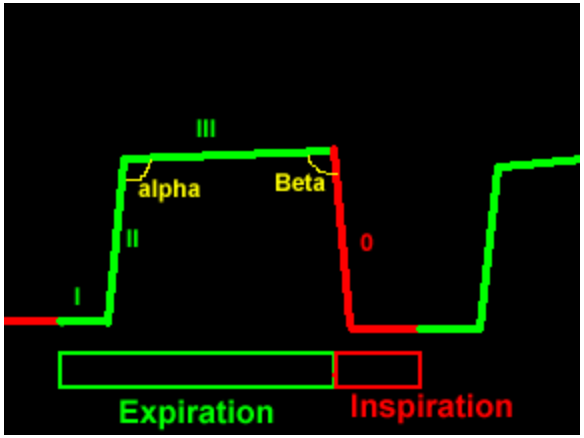
- $PETCO_2$: The maximum partial pressure of CO_2 at the end a breath. It is about 36- 40 mm Hg in healthy adults.
- $PACO_2$: Partial pressure of CO_2 in the alveoli.
- Capnogram: A plot of PCO2 versus time (time capnogram), or expired volume (volume capnogram). Time capnogram is common in clinical practice

Basic Physiology

- When you inhale CO_2 free air, and exhale and measure CO_2 at the mouth, you get the following tracing



Basic Physiology



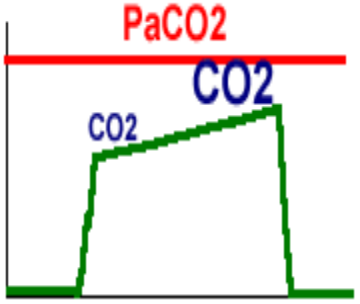
The expiratory segment divided into three phases phase I, II, and III

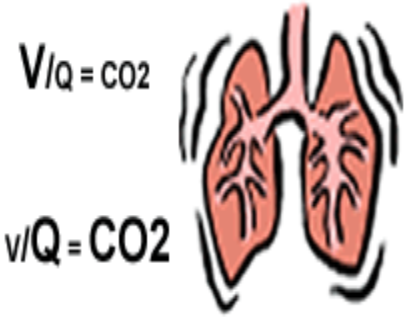
Phase I: Dead space gases

Phase II: Dead space gases mix with alveolar gases resulting in the rise of $PETCO_2$

Phase III: Represent CO_2 evolving from alveoli

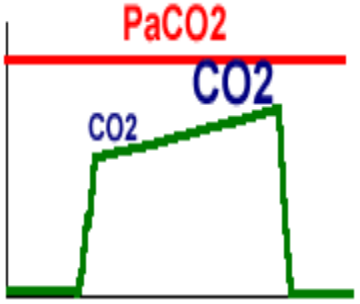
Basic Physiology

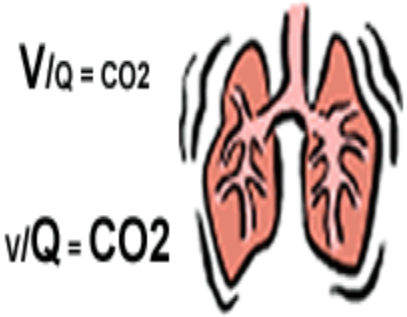




The height and slope of the alveolar plateau (phase III) is dependent on CO_2 content of the alveoli. The CO_2 content is in turn dependent on V/Q ratio of the alveoli. High V/Q alveoli contain relatively low PCO_2, while low V/Q alveoli contain relatively high PCO_2

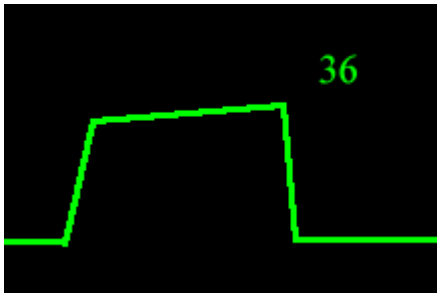
Basic Physiology

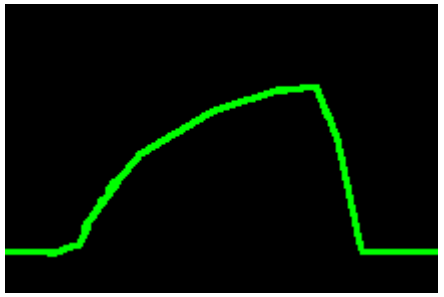




Hence, it can be concluded that the height and the slope of the alveolar plateau is dependent on Ventilation, cardiac output and more importantly on V/Q relationship.

Basic Physiology

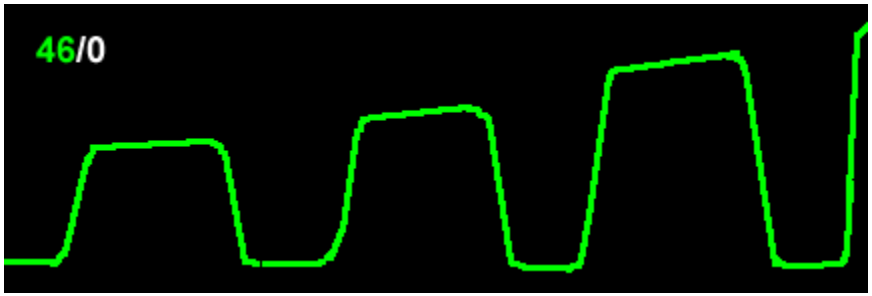




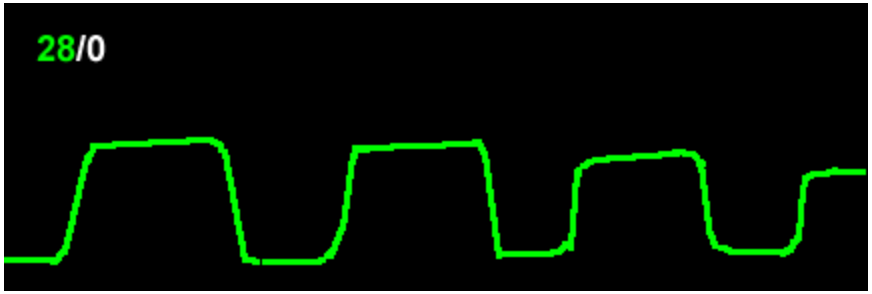
As for example in COPD, the V/Q perfusion abnormalities result in sloping phase II and phase III

Basic Physiology

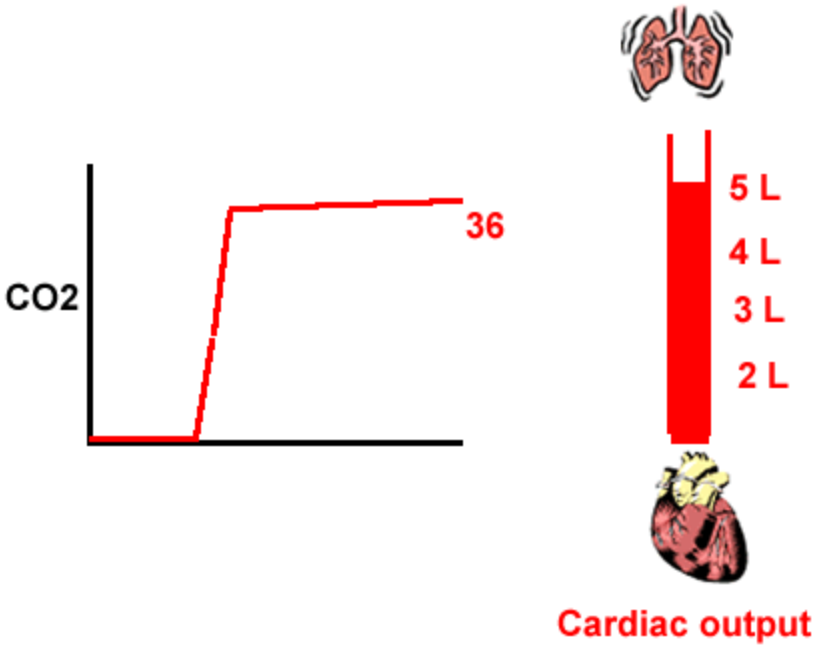
Hypoventilation



Hyperventilation



Basic Physiology



In the acute settings, for a given ventilation, $PETCO_2$ is function of cardiac output (pulmonary perfusion).
This is the basic principle of directing the uses of capnography during CPR

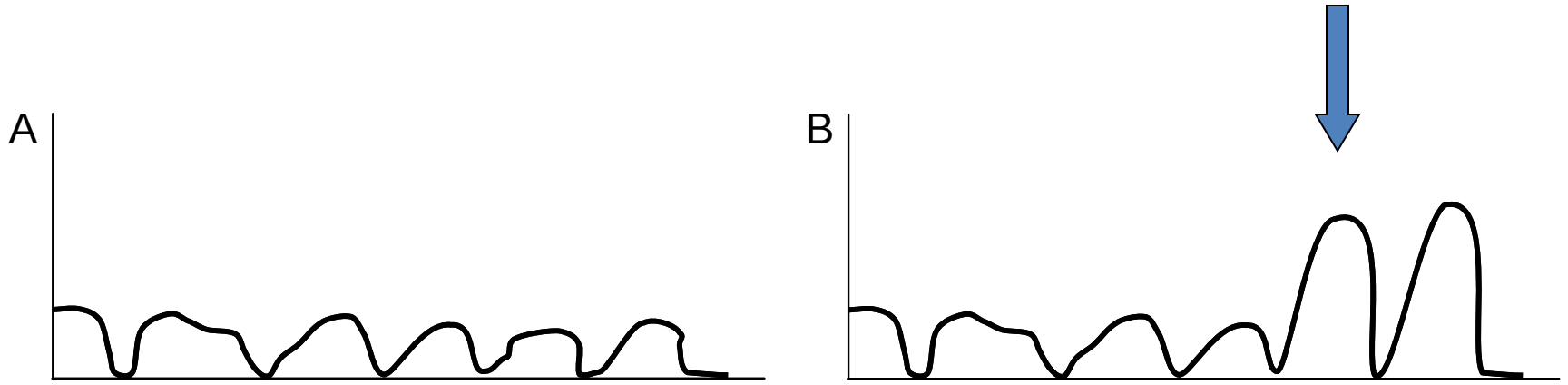
Utility of Capnography in CPR

- Most reliable method of confirming and monitoring correct placement of endotracheal tube.
- *If there is no CO_2 waveform during CPR, rule out esophageal intubation*

CO_2 waveform during CPR

Optimize chest compression for effective CPR so that $PETCO_2$ values are between 10 and 20 mm Hg. If $PETCO_2$ values less than 10 mm Hg or less measured after initiation of ACLS is associated with poor outcome

CO_2 waveform during CPR



An abrupt increase in $PETCO_2$ may indicate return of spontaneous circulation (ROSC). Increase in pulmonary circulation brings more CO_2 into lungs for elimination

Code Leader - Duties

- Delegate someone to check Check if CO_2 monitor is working
- After intubation, look for CO_2 waveforms during chest compressions. A flat tracing should alert for a misplaced ET tube.
- Monitor effectiveness of CPR by ensuring $PETCO_2$ values between 10 to 20 mm Hg.
- An abrupt increase in $PECO_2$ values indicate ROSC

Make sure that the CO_2 monitor and ECG are visible to the Code Team Leader

References

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- Anaesthesia 2011;66:544-9
- JAMA 1989;262;1347-51
- Resuscitation 2012;83:789-90
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- N Engl J Med 1997;337:301-6
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- Crit Care 2011;15:R29
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Questions 1

- American Heart Association recommends capnography during CPR for:
  (a) Confirming tracheal tube placement
  (b) Monitoring Ventilation
  (c) Monitoring effectiveness of chest compressions
  (d) A and C

Answer

(d)

Questions 2

- During CPR the code leader sees that there is no CO_2 waveform. What is most likely?

(a) Ineffective CPR

(b) Hypovenitlation

(c) Esophageal intubation

(d)Low cardiac output

Answer

(c)

Questions 3

- Which of the following is not true?
  (a) During acute hemodynamic instability, $PETCO_2$ is a direct function of cardiac output.
  (b) Effective CPR will result in $PETCO_2$ values between 5-10mmHg
  (c) An abrupt increase in $PETCO_2$ indicates ROSC
  (d) Capnogarphy is the most reliable method of confirming endotracheal tube placement during CPR

Answer

(b)

Questions 4

- The height of the slope of the alveolar plateau on the capnogram is dependent on:
  (a) Ventilation
  (b) Cardiac output
  (c) V/Q ratio
  (d) All of the above

Answer

(d)

Questions 5

- An abrupt increase in $PETCO_2$ may indicate:
  (a) Effective CPR
  (b) Return of spontaneous circulation
  (c) Hypoventilation
  (d) Hyperventilation

Answer

(b)