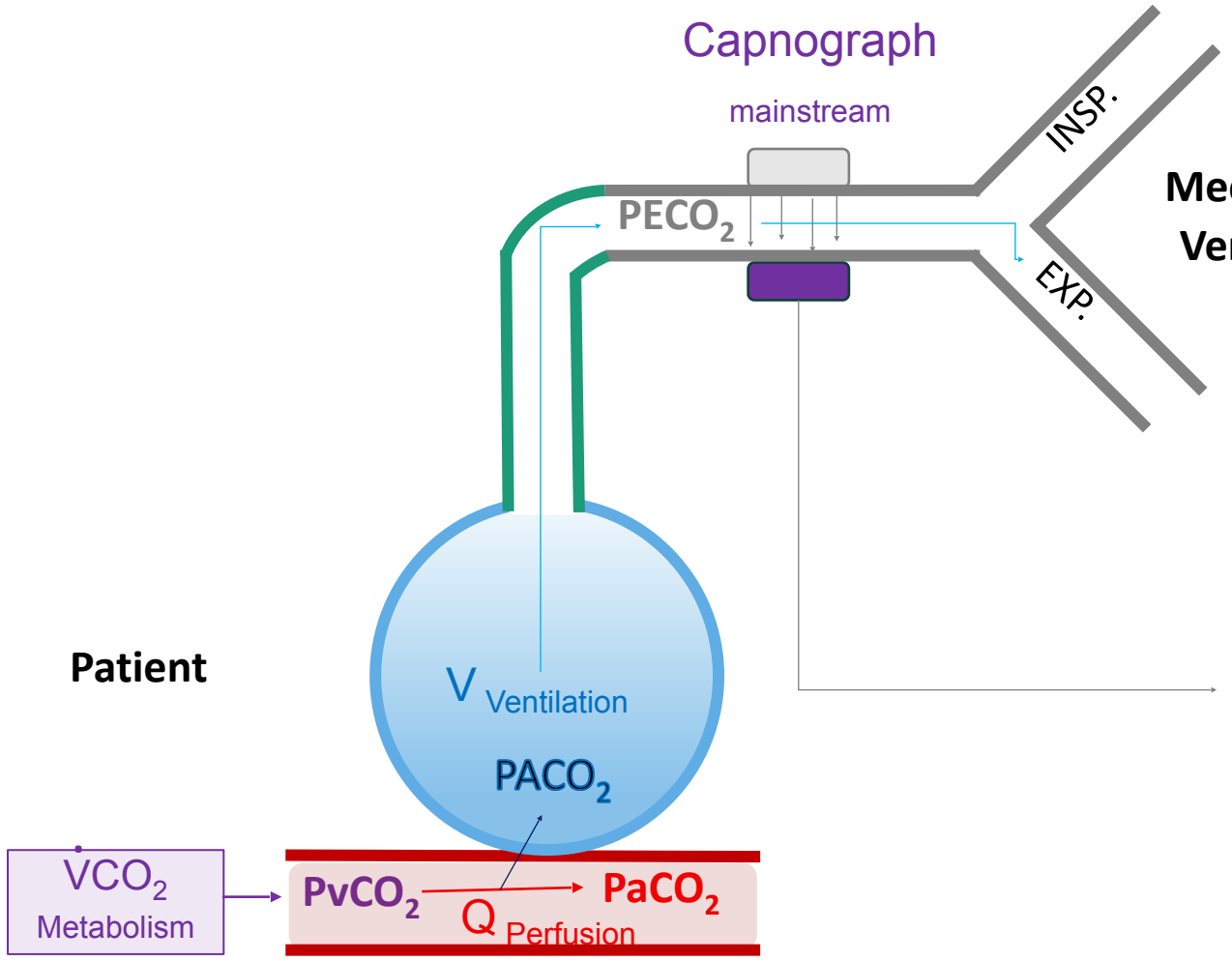
Indications for capnography in intubated patients receiving mechanical ventilation

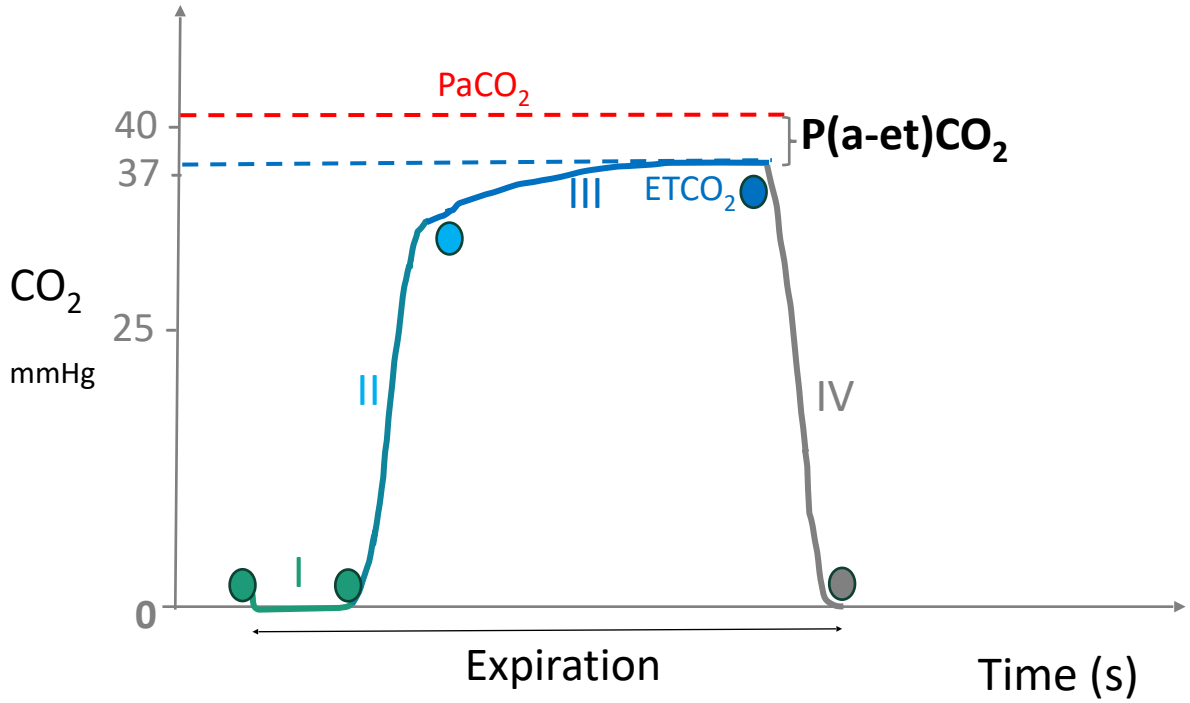
- Continuous monitoring of pulmonary ventilation
  - Early detection of hypoventilation and hyperventilation, essential in neurological patients and elevated intracranial pressure
  - Adjustment of tidal volume, respiratory rate, and minute ventilation
- Confirmation and continuous monitoring of endotracheal tube position
  - Detection of esophageal intubation, displacement, and accidental extubation
- Identification of mechanical and obstructive alterations
  - Capnogram morphology analysis: “shark fin,” auto-PEEP, asynchronies
- Assessment of CPR quality and identification of return of spontaneous circulation
- Estimation of physiological dead space, V/Q alterations, and PEEP titration
  - $P(a-et)CO_2$ gradient and $ETCO_2$ trend analysis
- Detection of ventilator malfunction and endotracheal tube issues
  - Circuit disconnection, tube obstruction, secretion accumulation

Capnography in intubated patients receiving mechanical ventilation

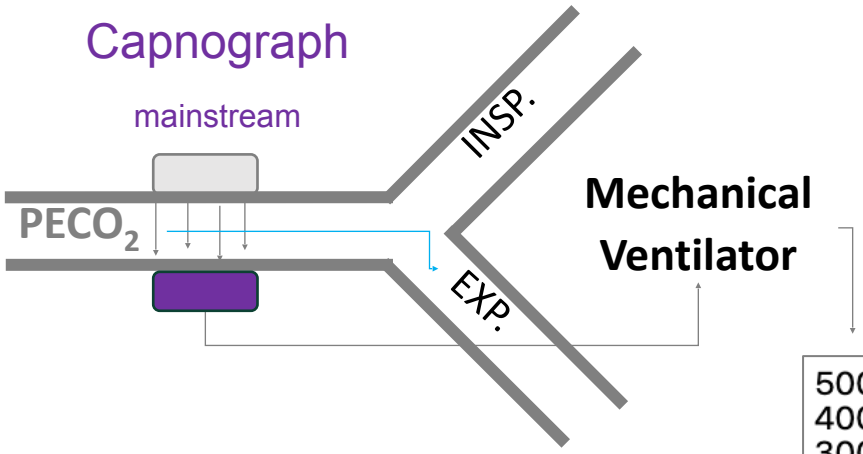


Normal capnogram – phases

- I Dead space
- II Alveolar emptying
- III Alveolar plateau
- IV Inspiration

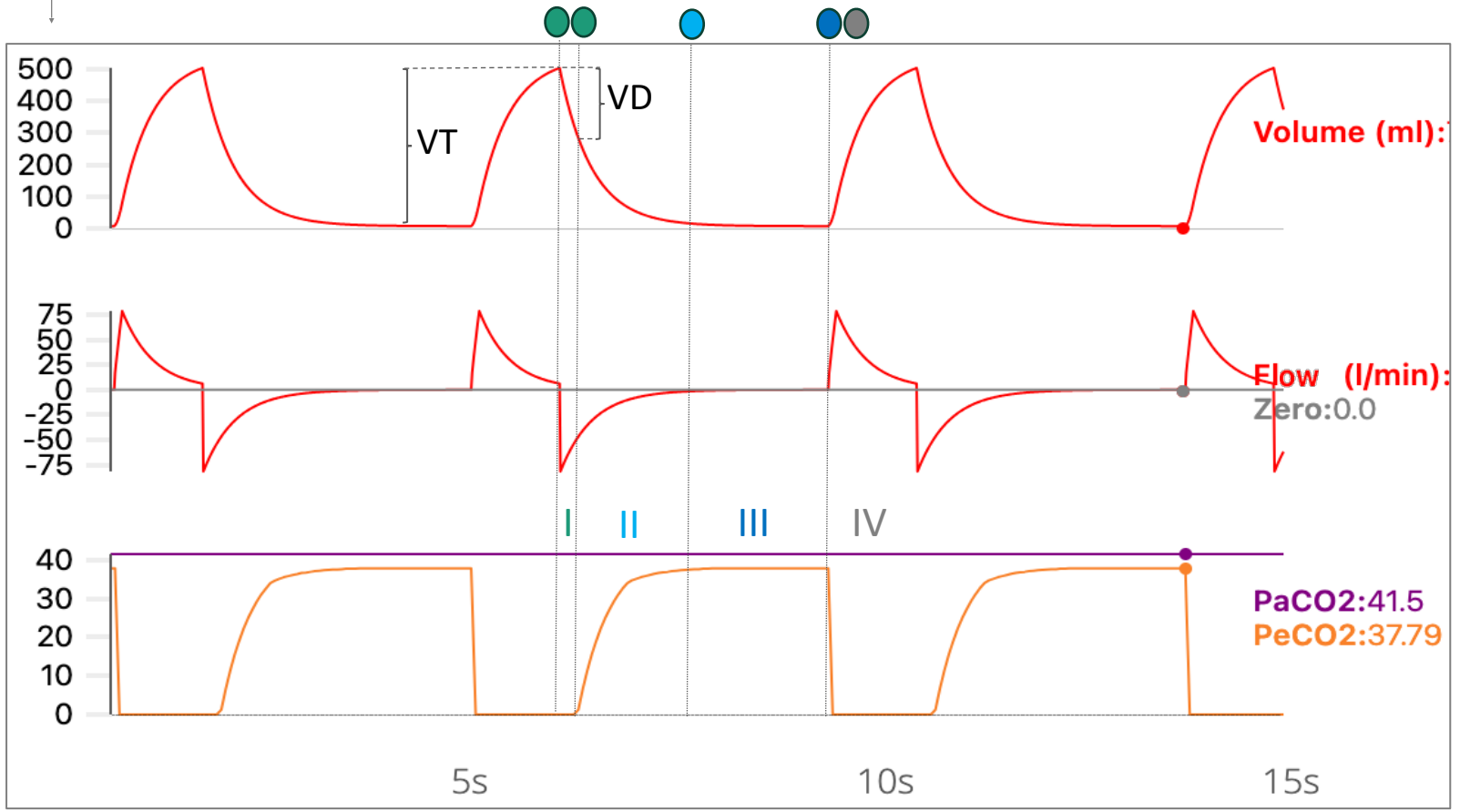


Capnography in intubated patients receiving mechanical ventilation



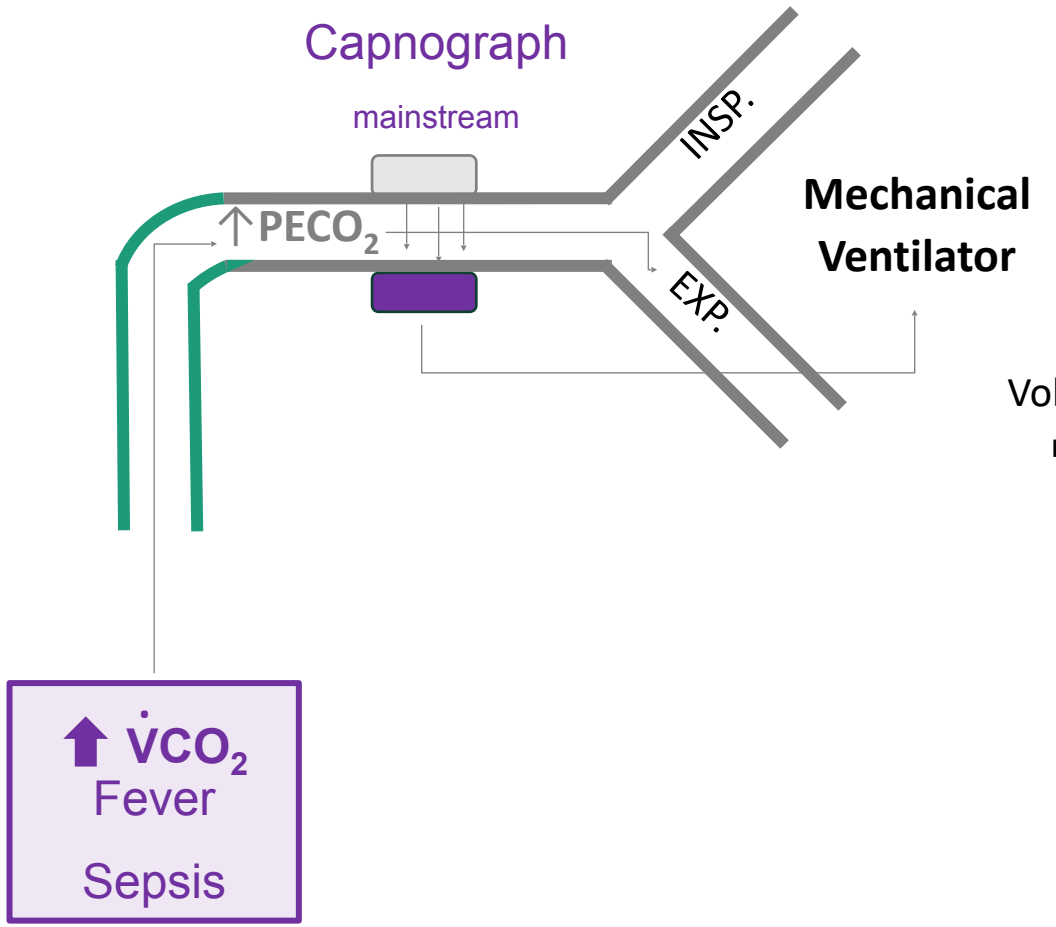
Normal capnogram integrated with mechanical ventilation waveforms

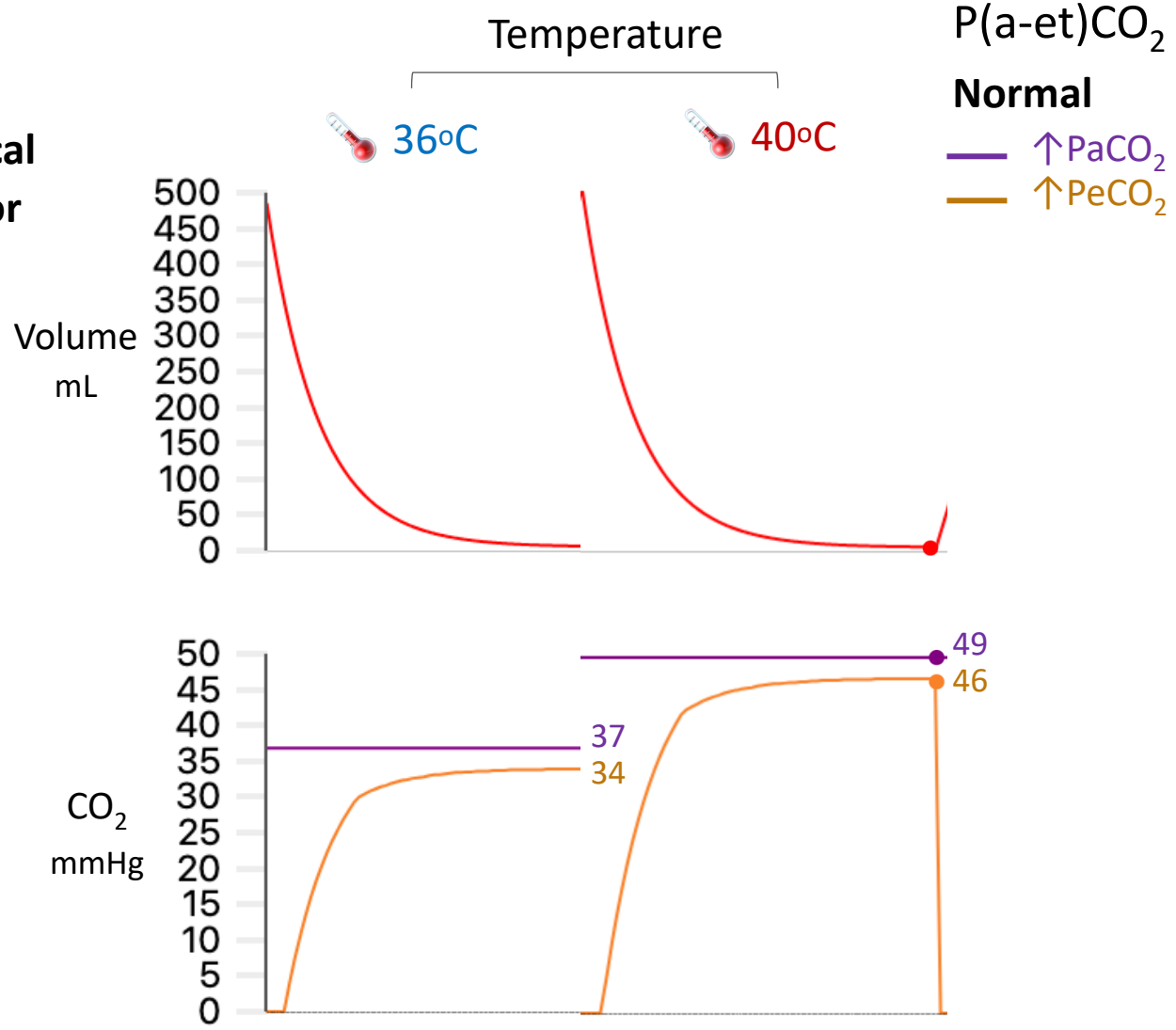
- I Dead space
- II Alveolar emptying
- III Alveolar plateau
- IV Inspiration



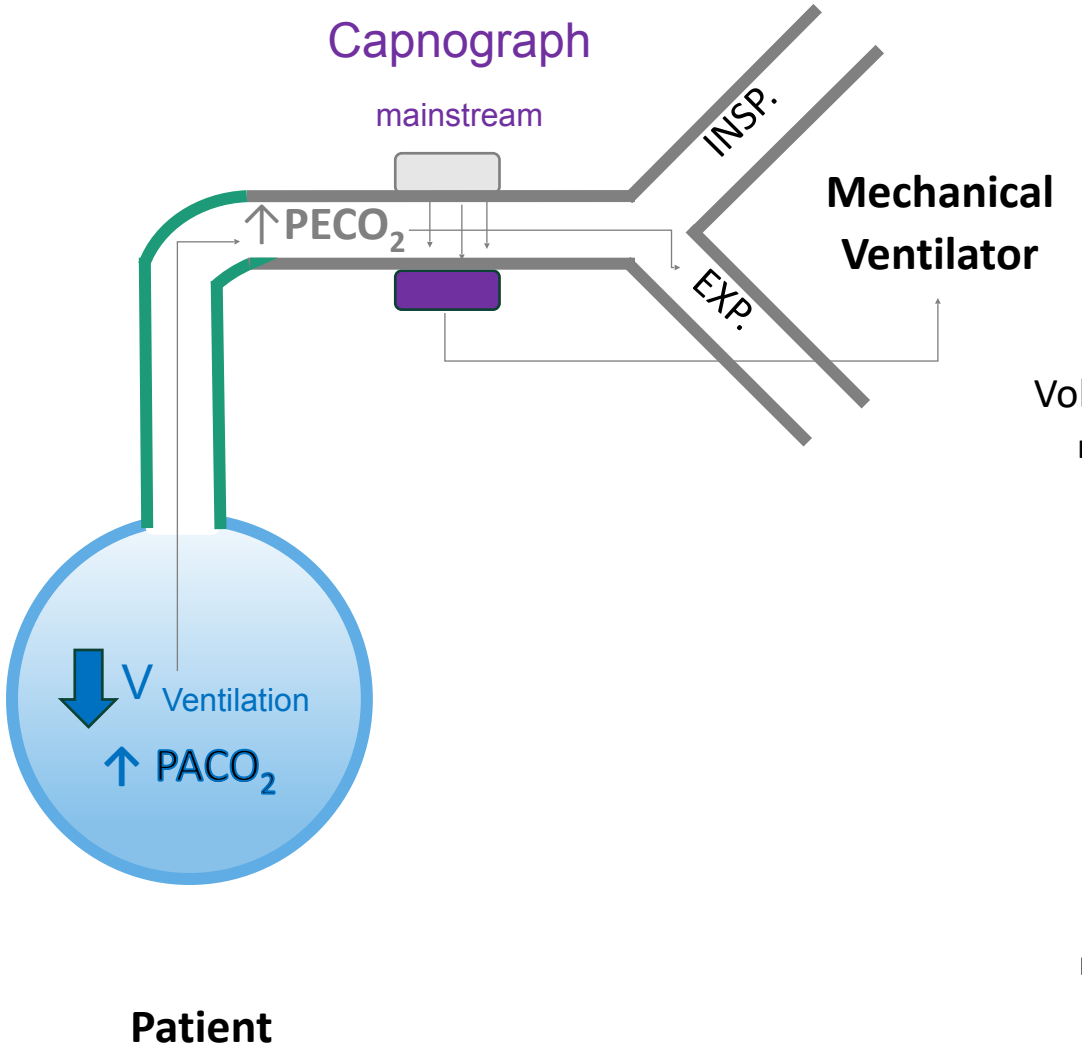
xlung

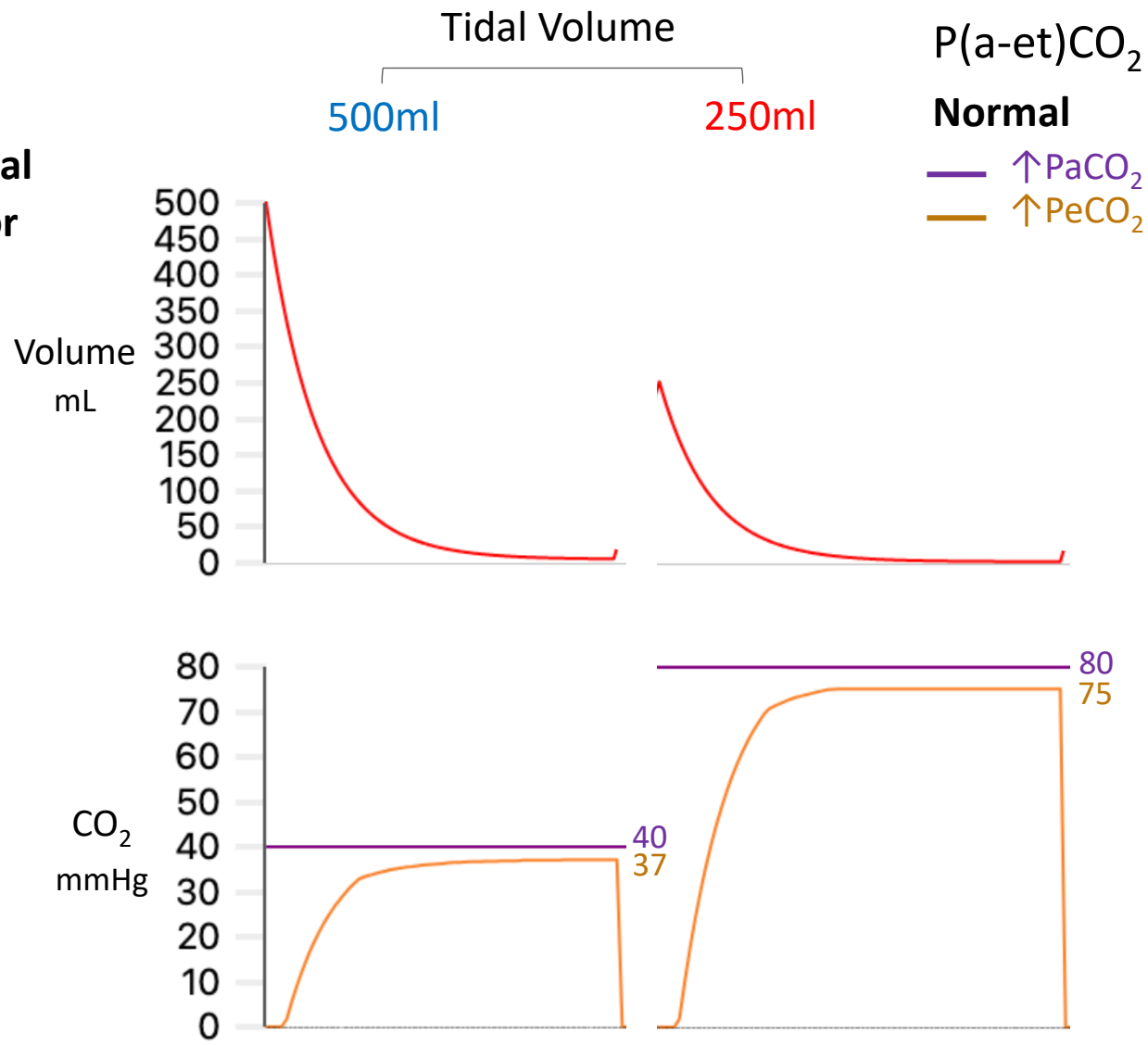
Capnography in intubated patients receiving mechanical ventilation
↑ metabolism and CO_2 production



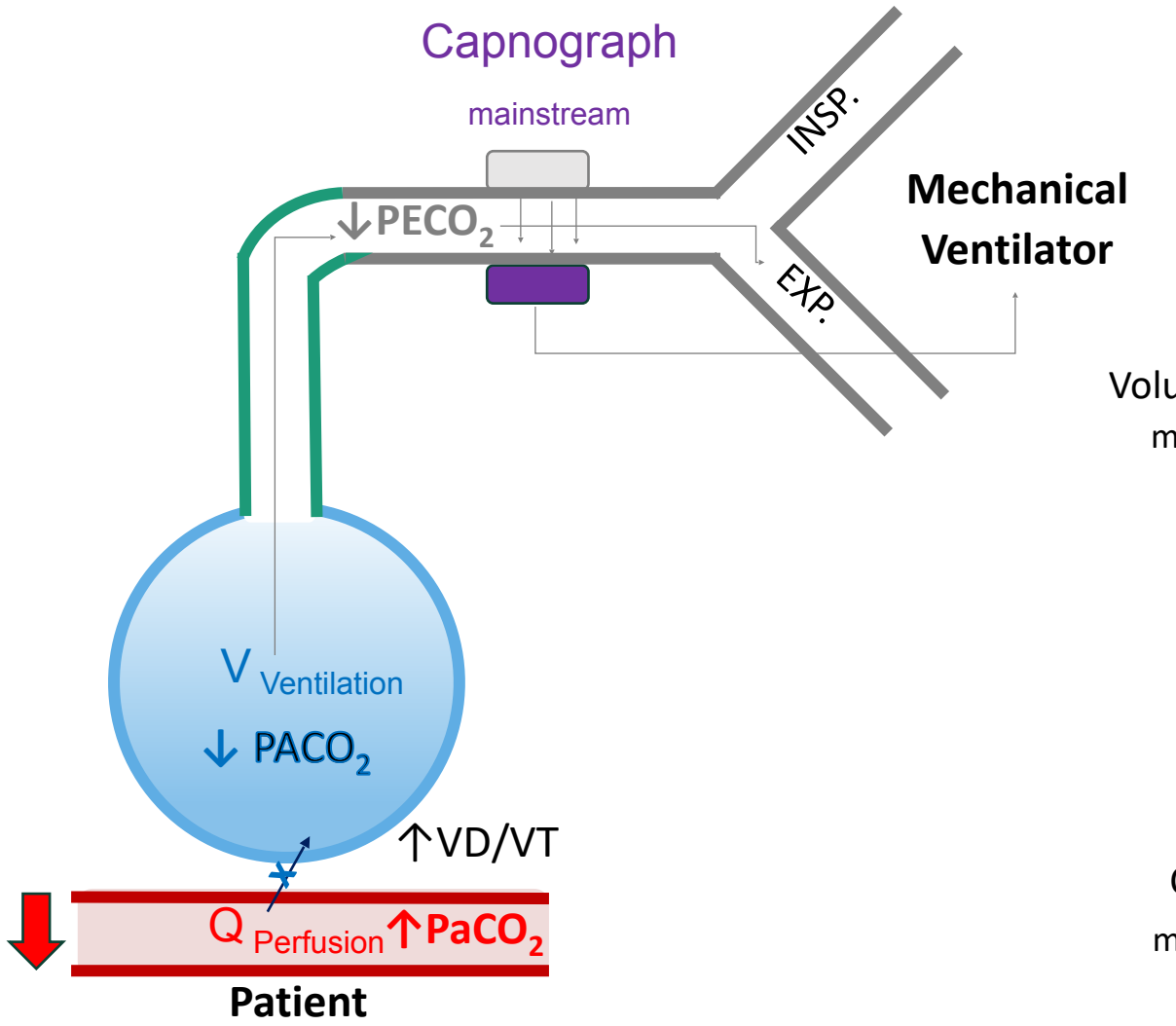


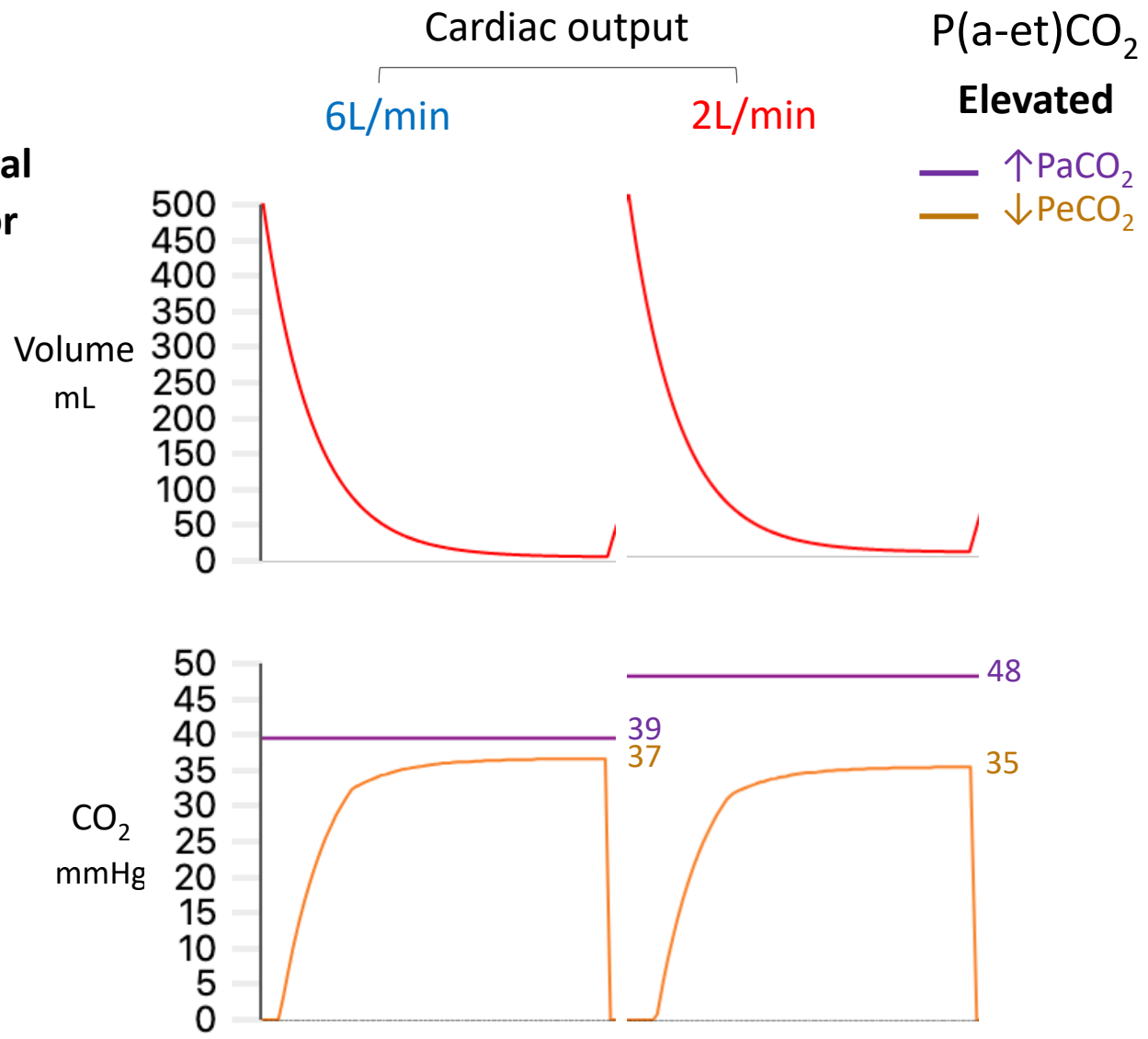
Capnography in intubated patients receiving mechanical ventilation
Alveolar hypoventilation due to reduced tidal volume



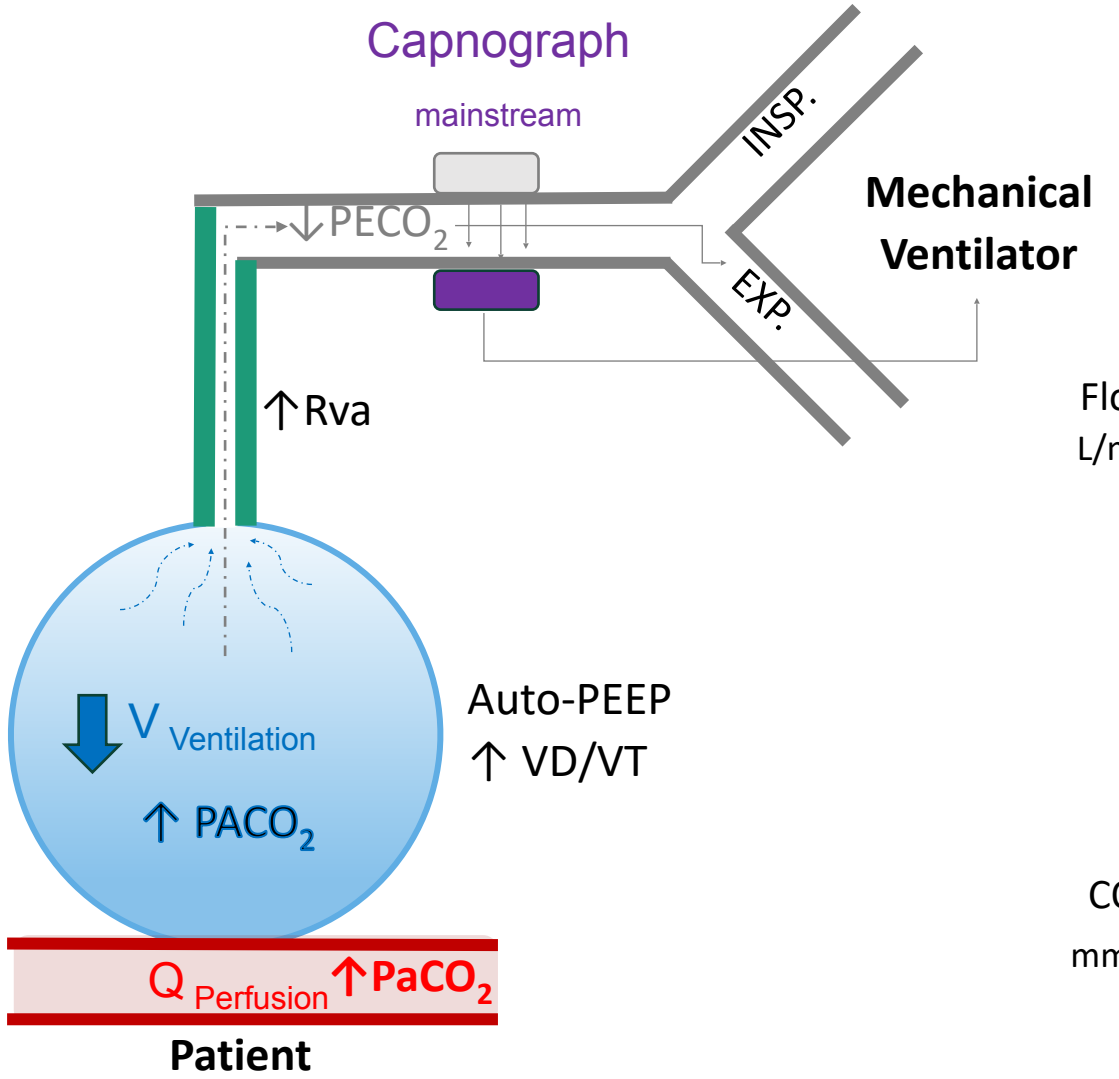


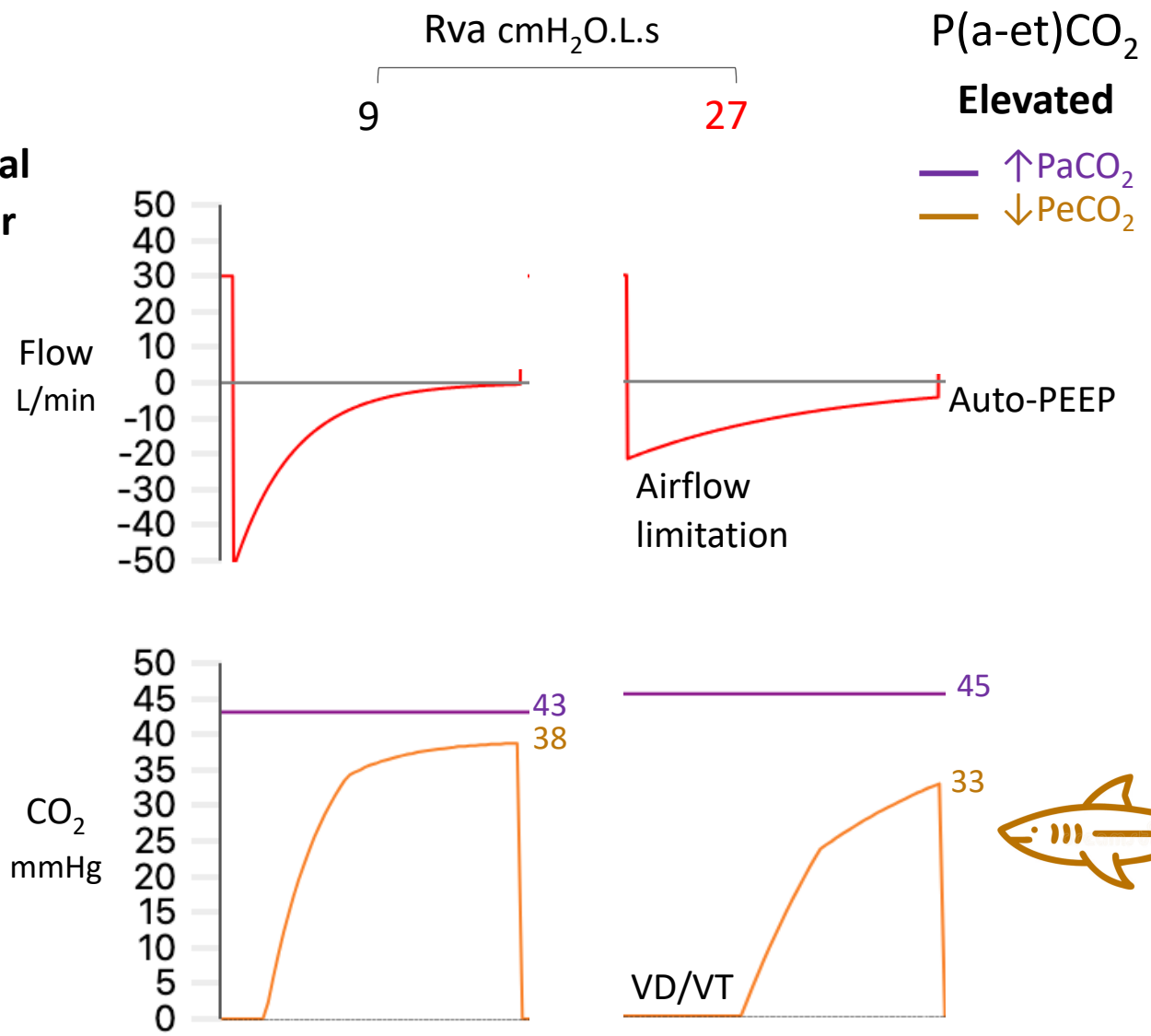
Capnography in intubated patients receiving mechanical ventilation
Pulmonary hypoperfusion due to hemodynamic shock (↓ Cardiac Output)



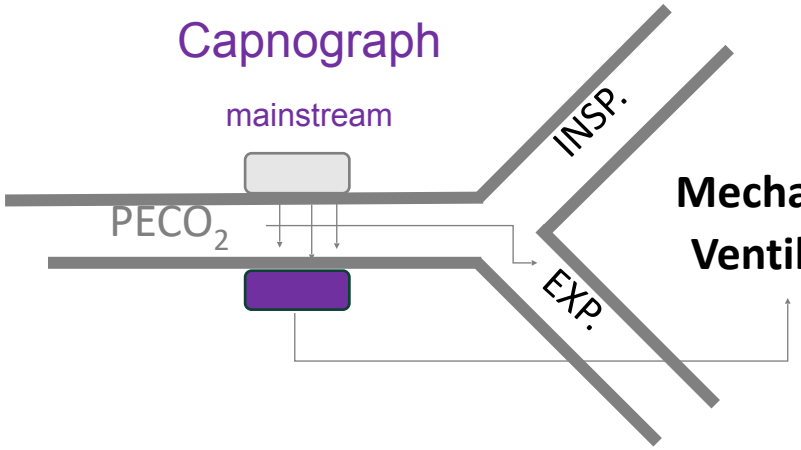


Capnography in intubated patients receiving mechanical ventilation
Airflow limitation with increased airway resistance and auto-PEEP





Capnography in intubated patients receiving mechanical ventilation
Recovering respiratory muscle effort after NMB



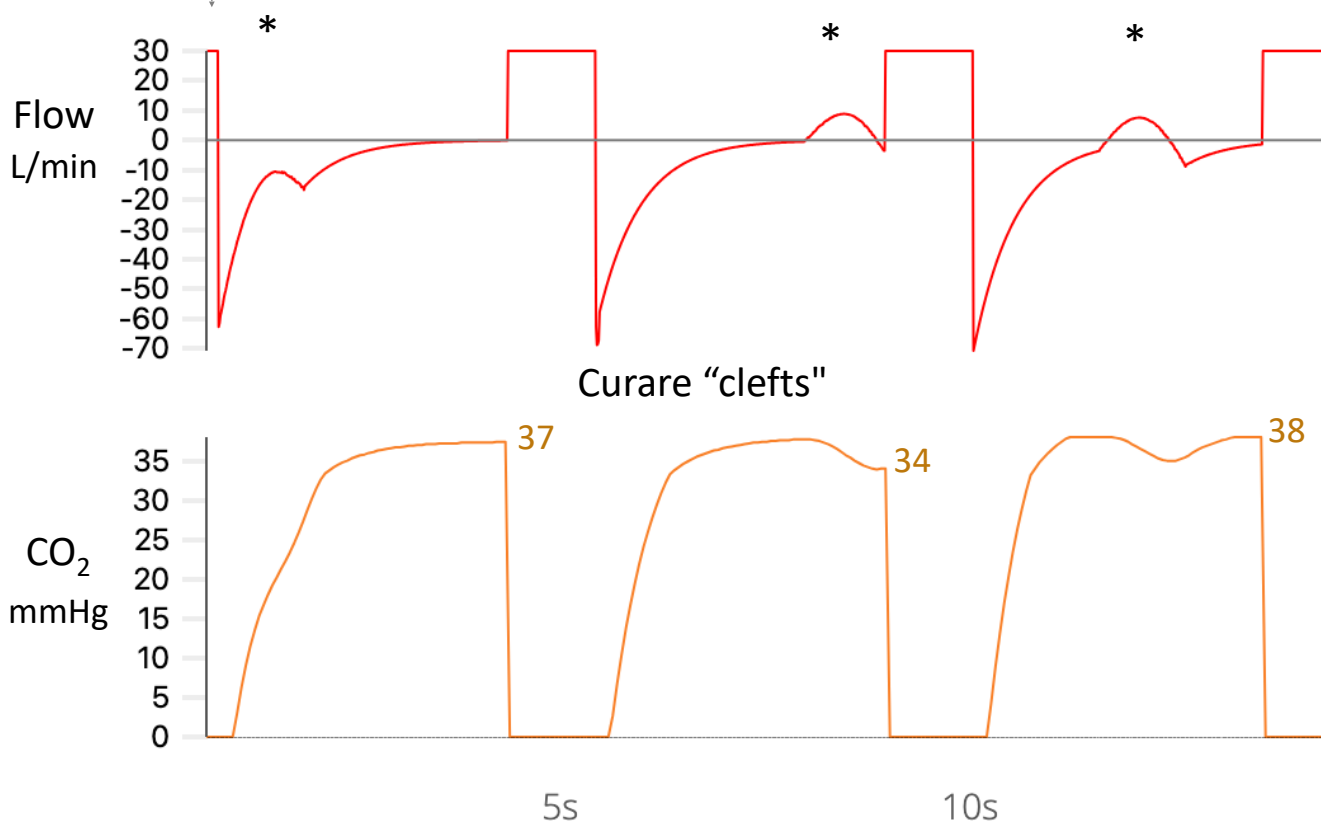
Mechanical Ventilator

$EtCO_2$

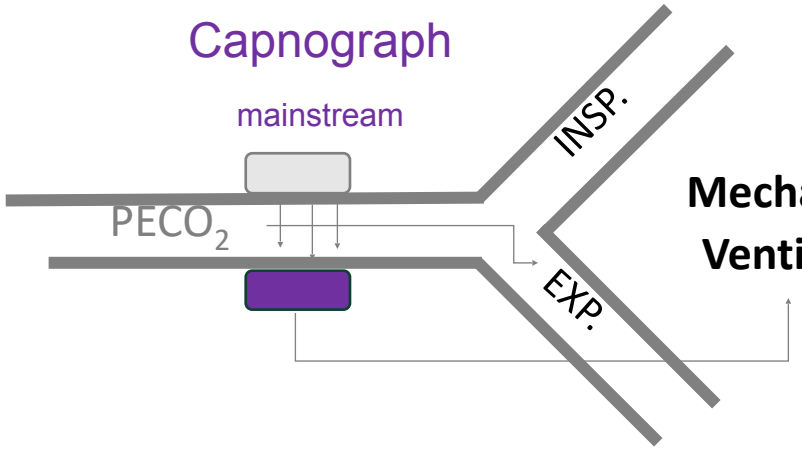
$P(a\text{-}et)CO_2$

Variables

*Ineffective efforts



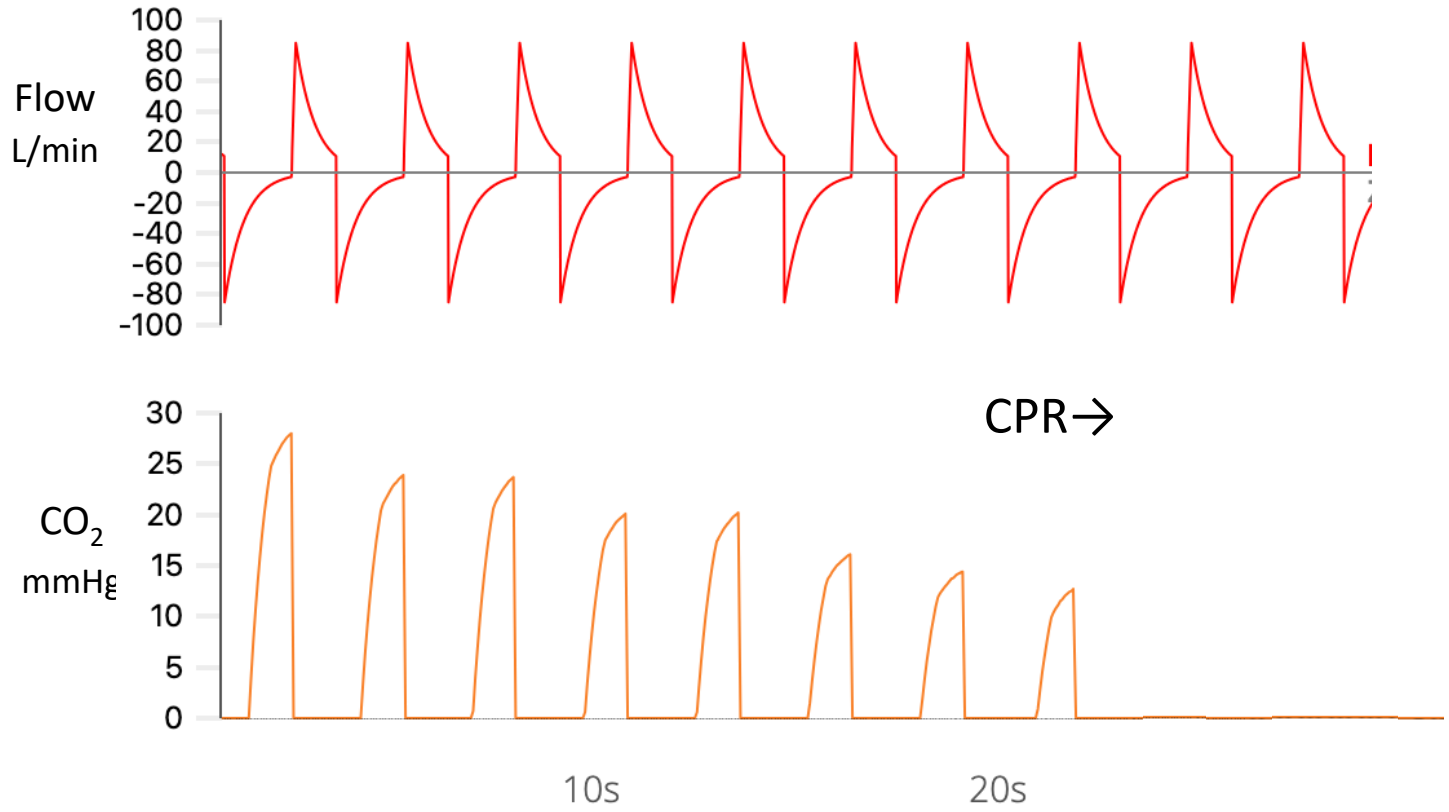
Capnography in intubated patients receiving mechanical ventilation
Progression to cardiac arrest



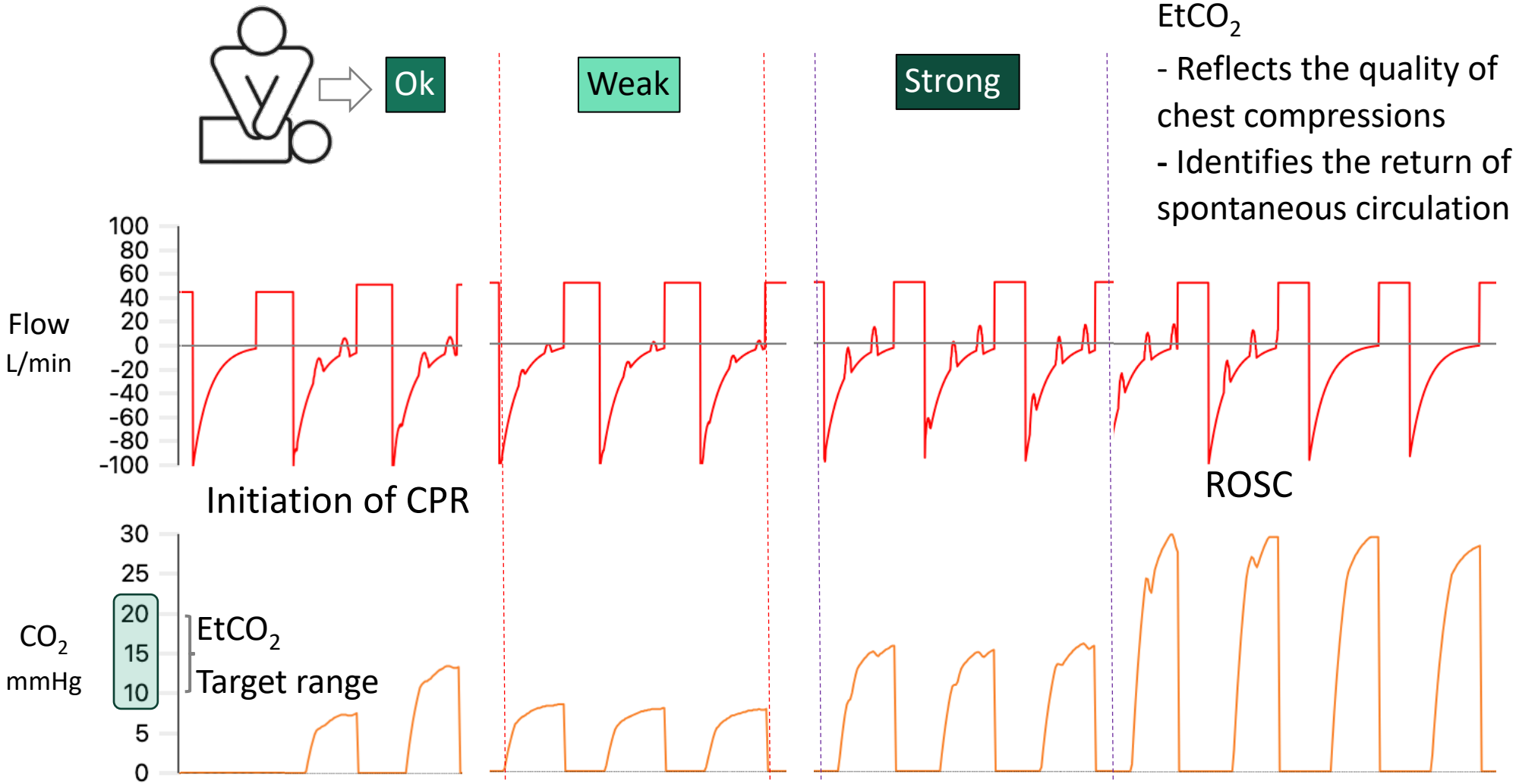
Mechanical Ventilator

$EtCO_2$

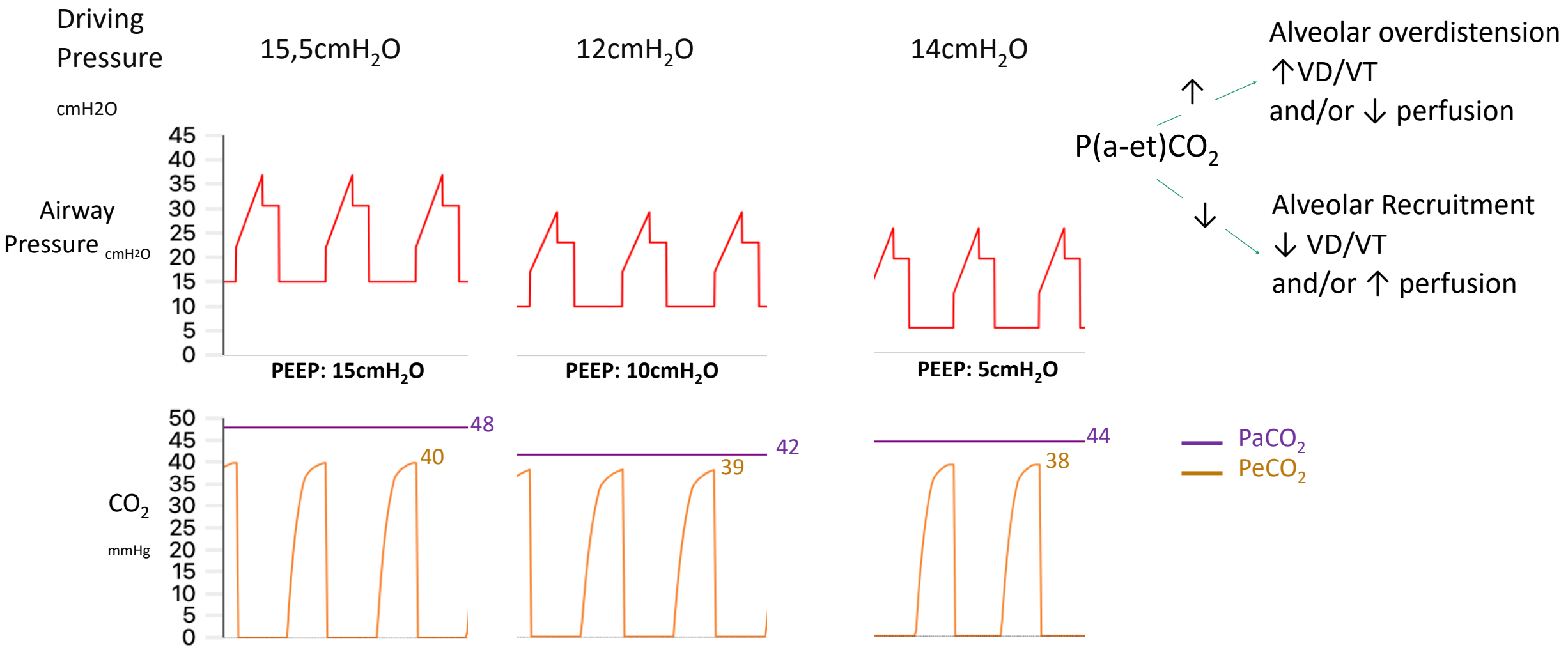
Rapid decline to zero



Capnography in intubated patients receiving mechanical ventilation
Cardiopulmonary resuscitation until ROSC after cardiac arrest

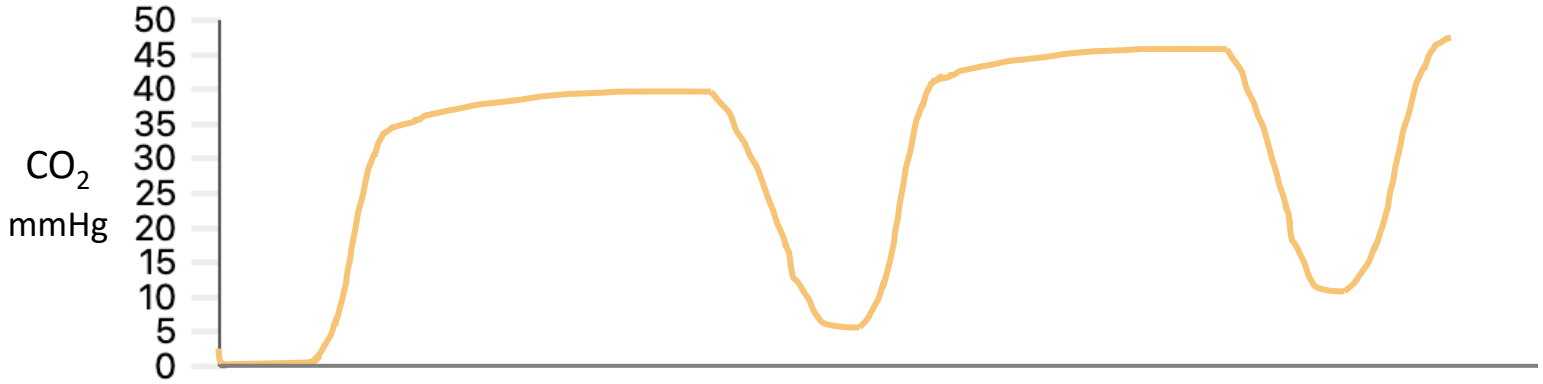


Capnography in intubated patients receiving mechanical ventilation
Effect of PEEP on respiratory mechanics and P(a–et)CO_2 in ARDS



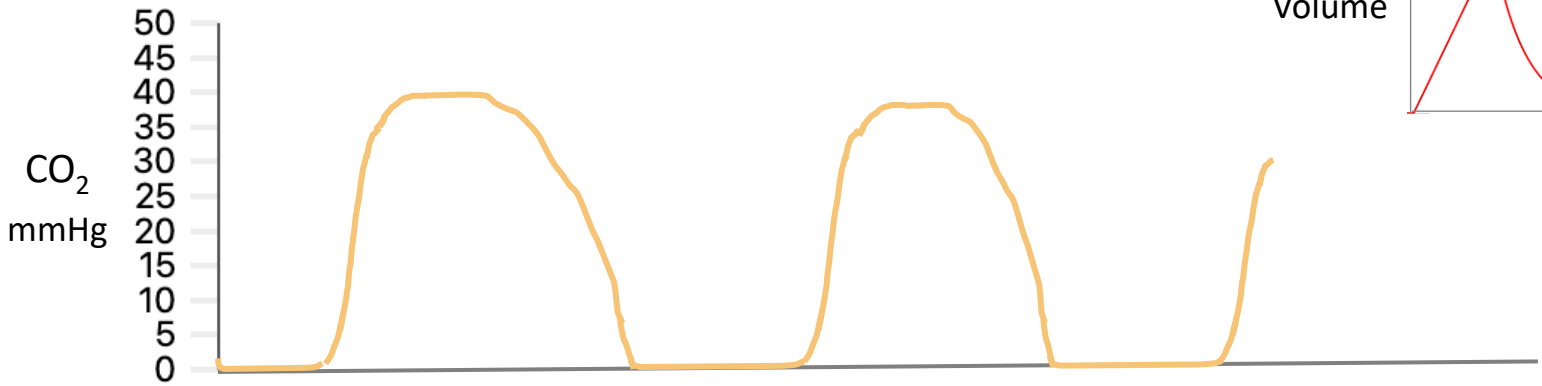
Capnography in intubated patients receiving mechanical ventilation Findings Associated with Ventilatory Support Problems

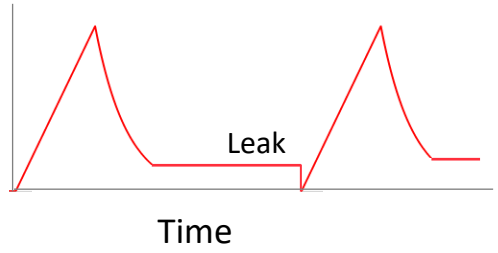
A) Rebreathing Due to Expiratory Valve Malfunction



$PiCO_2 > 0$

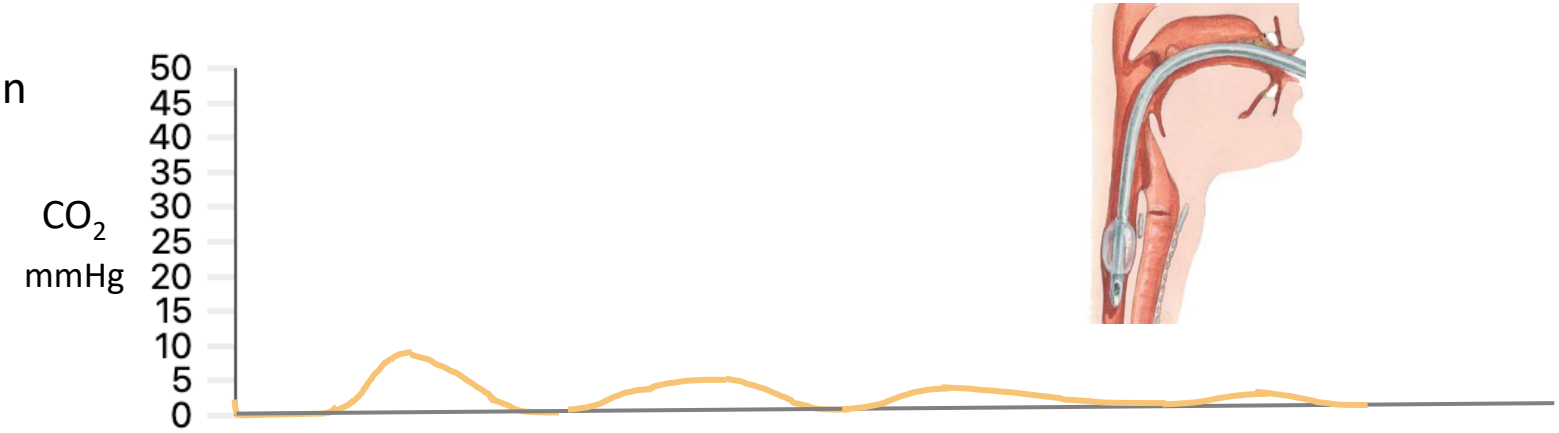
B) Air Leak



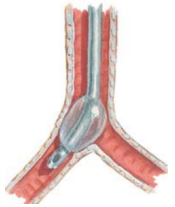


Capnography in intubated patients receiving mechanical ventilation
Findings Associated with Endotracheal Tube Problems

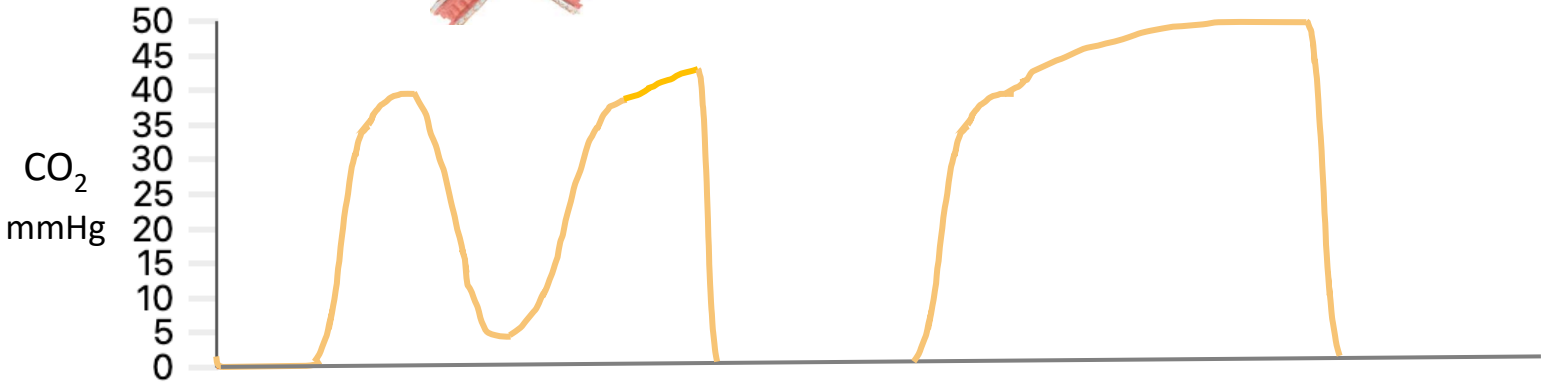
A) Esophageal Intubation



B) Endobronchial Intubation



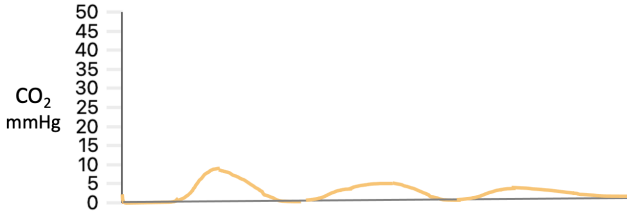
Endotracheal Tube Repositioned
in the Trachea



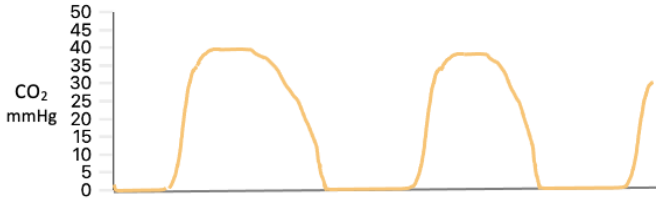
Capnographic Findings in Intubated Patients Receiving Mechanical Ventilation

↓$EtCO_2$

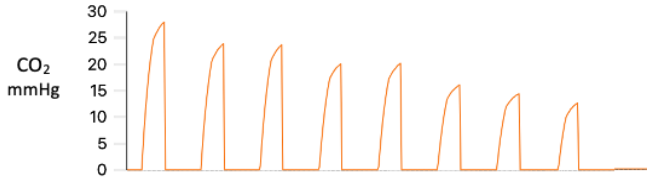
Esophageal intubation or circuit disconnection



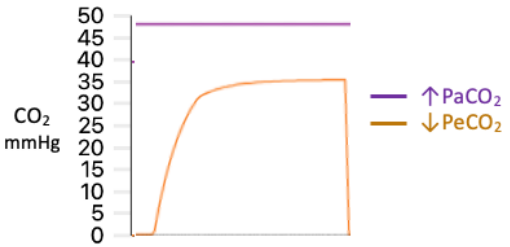
Air leak



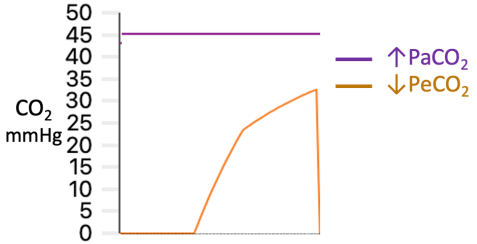
Cardiorespiratory arrest



Shock or pulmonary embolism

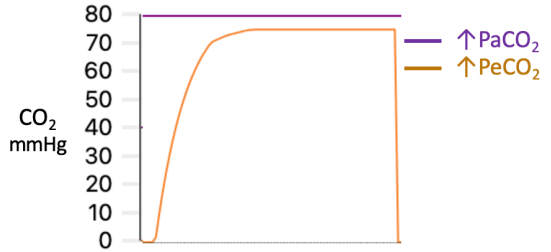


Airflow obstruction

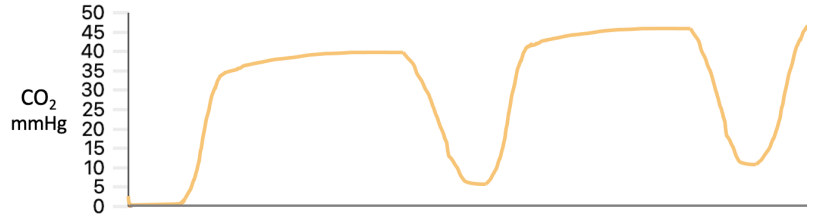


↑$EtCO_2$

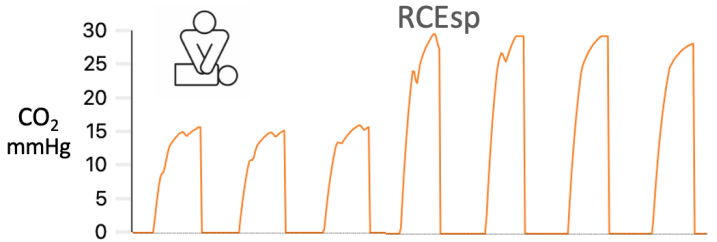
↑Metabolic rate and/or hypoventilation



CO_2 rebreathing



Return of spontaneous circulation (ROSC) during CRA



Alveolar overdistension
↑ Excessively high PEEP