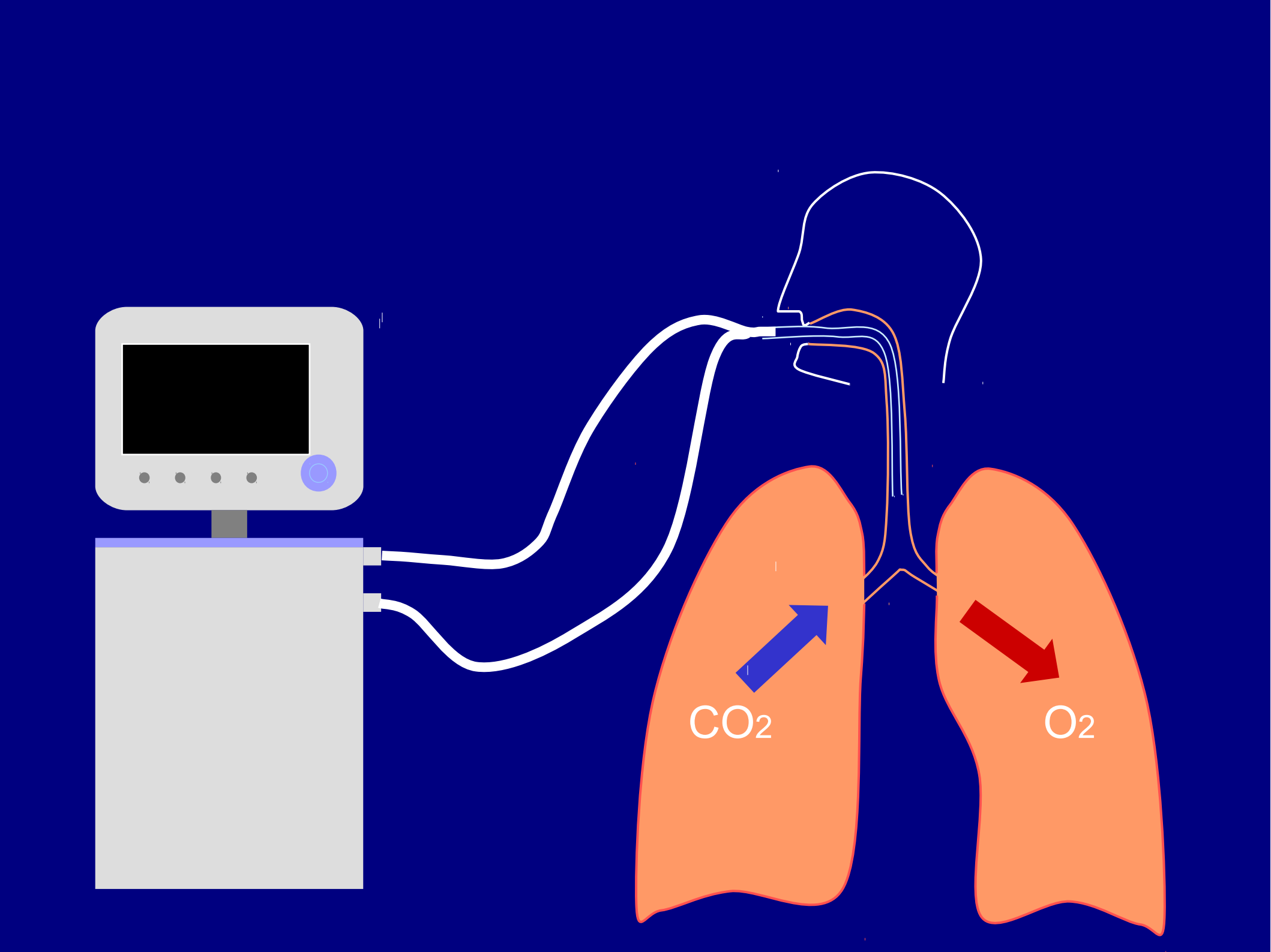
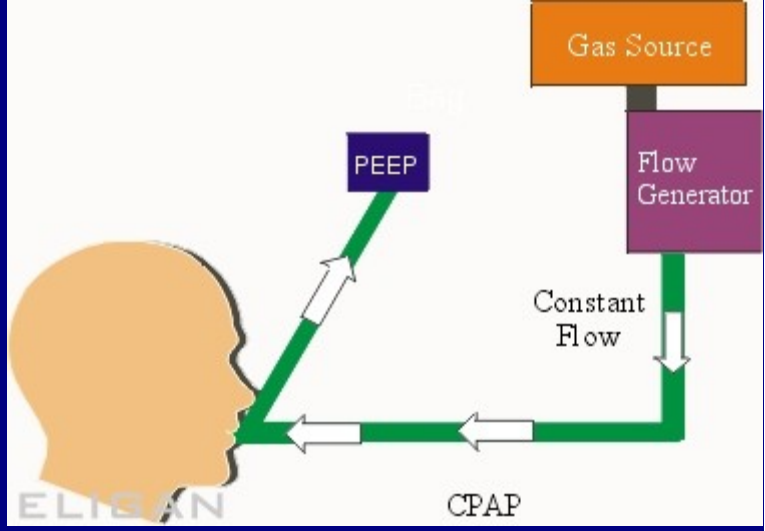
Basic of Arteficial Ventilation

L.Dadak


CO_2
O_2

Ventilator



- generates a controlled flow of gas into a patient's airways. Oxygen and air are received from cylinders or wall outlets, the gas is pressure reduced and blended according to the prescribed inspired oxygen tension (FiO2), accumulated in a receptacle within the machine, and delivered to the patient using one of many available modes of ventilation.

Positive pressure ventilation

- gas **flow**s along a pressure gradient between the upper airway and the alveoli.
  The magnitude, rate and duration of flow are determined by the operator.
-
- Flow is either volume targeted and pressure variable, or pressure limited and volume variable.

Mode of ventilation

- Control / assist
- Support

- Volume
- Pressure

- SIMV = Synchronized Intermittent Mandatory Ventilation

Mode of vent.

- VCV = eliminate CO2
  - anesthesia
  - post-arrest
- PCV = lung problem
- PSV = weaning from ventilator

Getting oxygen in

- Depends on
  - P_AO_2
    - F_IO_2
    - P_ACO_2
    - Alveolar pressure
    - Ventilation
  - Diffusing capacity
  - Perfusion
  - Ventilation-perfusion matching

Carbon dioxide out

- Respiratory rate
- Tidal volume
- Deadspace

Main determinants

Oxygen in

↑F_IO_2

↑mean alveolar pressure

PEEP

- Re-open alveoli and ↓ shunt

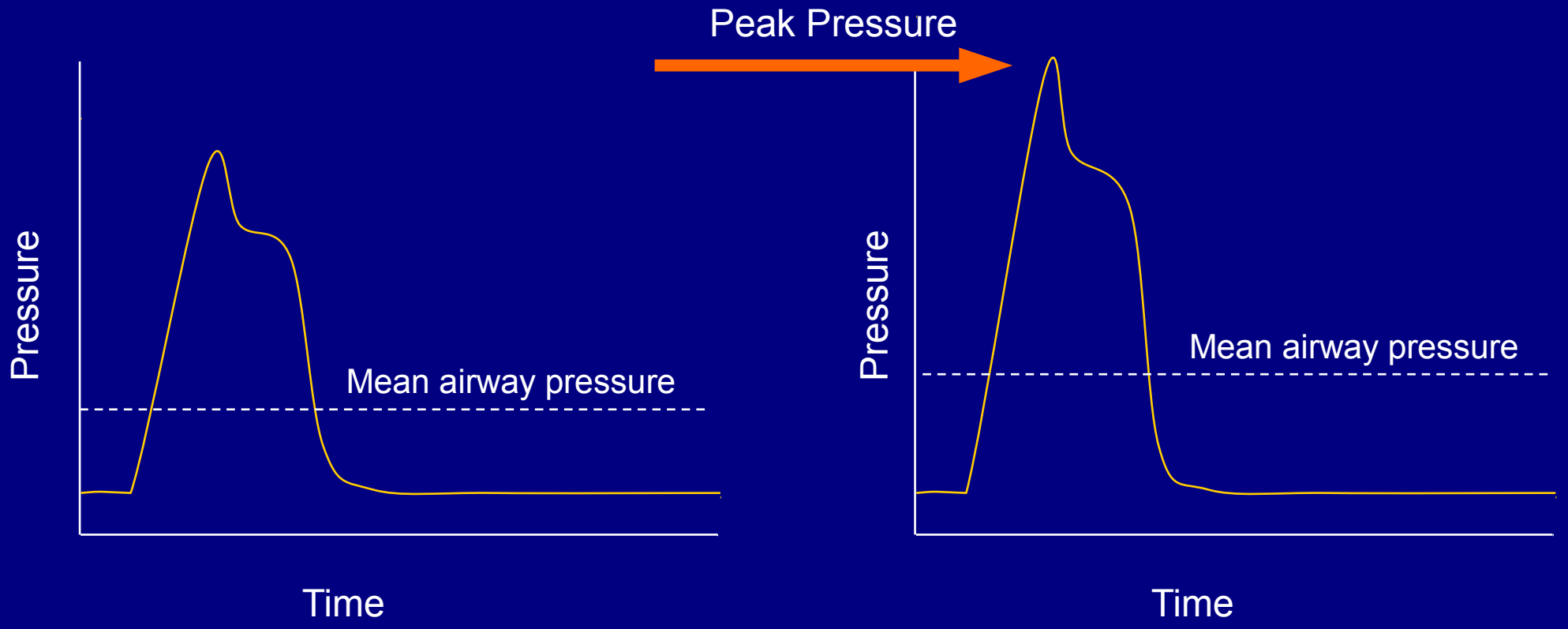
Carbon dioxide out

↑ventilation

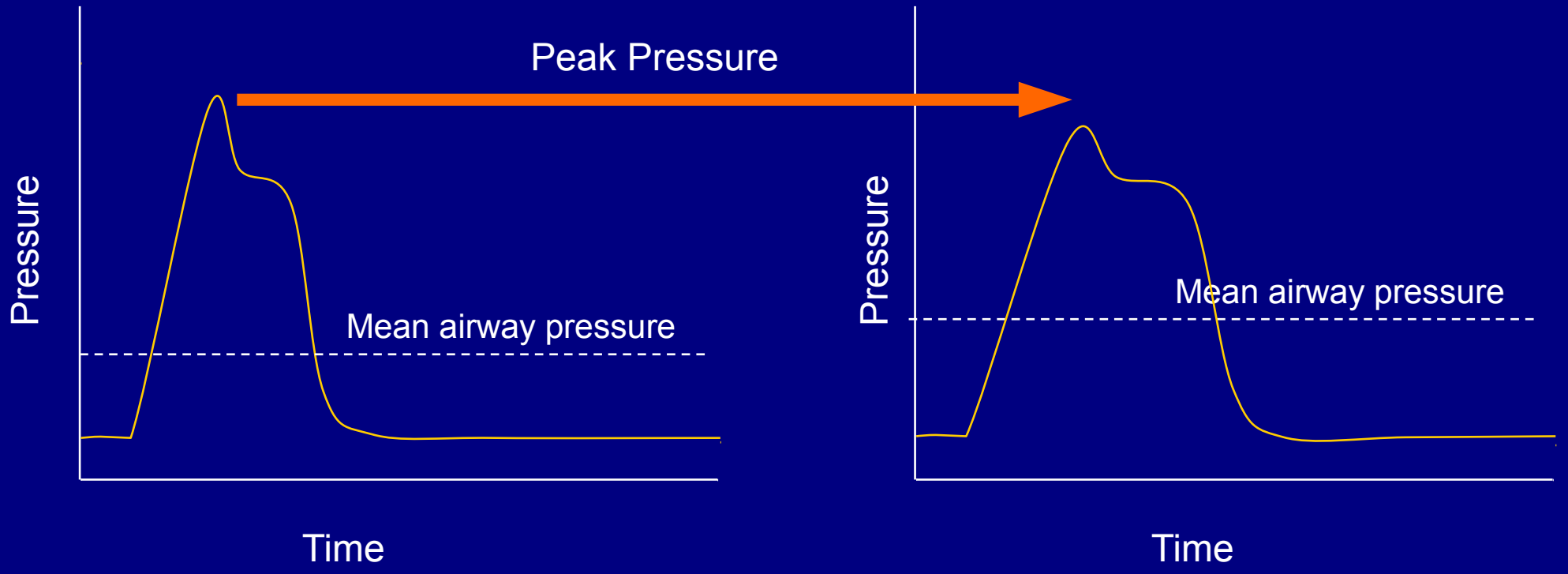
↑RR

↑tidal volume

Mean airway pressure



Mean airway pressure



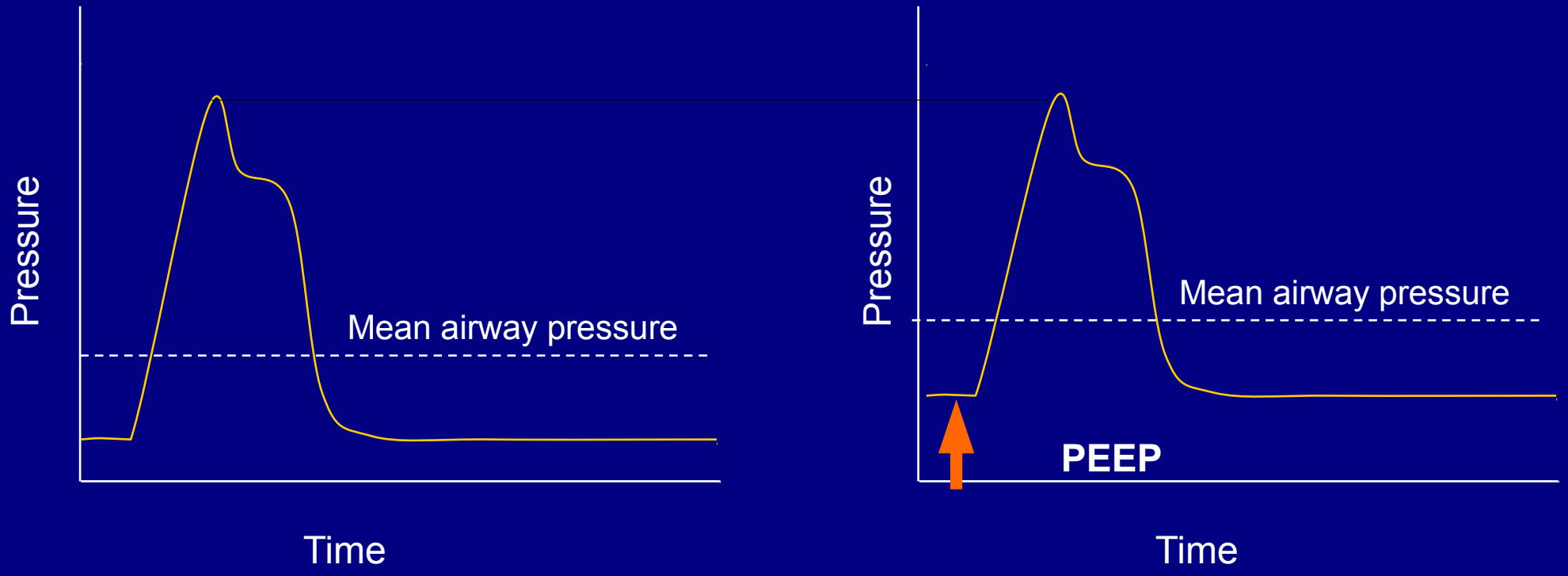
Inspiratory time

- Set as:
  - % of respiratory cycle
  - I:E ratio
- Expiratory time not set
  - Remaining time after inspiration before next breath

Inspiratory time

- Increased inspiratory time
  - Improved oxygenation
  - Unnatural pattern of breathing
    - Deeper sedation
  - Increased risk of gas trapping

Mean airway pressure



PEEP

Improves oxygenation

- ↑mean alveolar pressure
- ↓shunting

Other settings

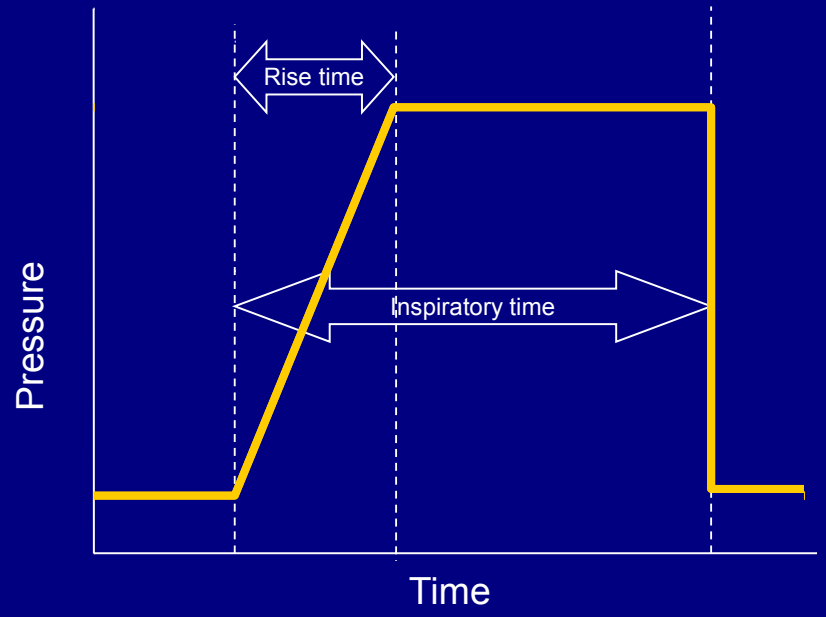
- Trigger sensitivity

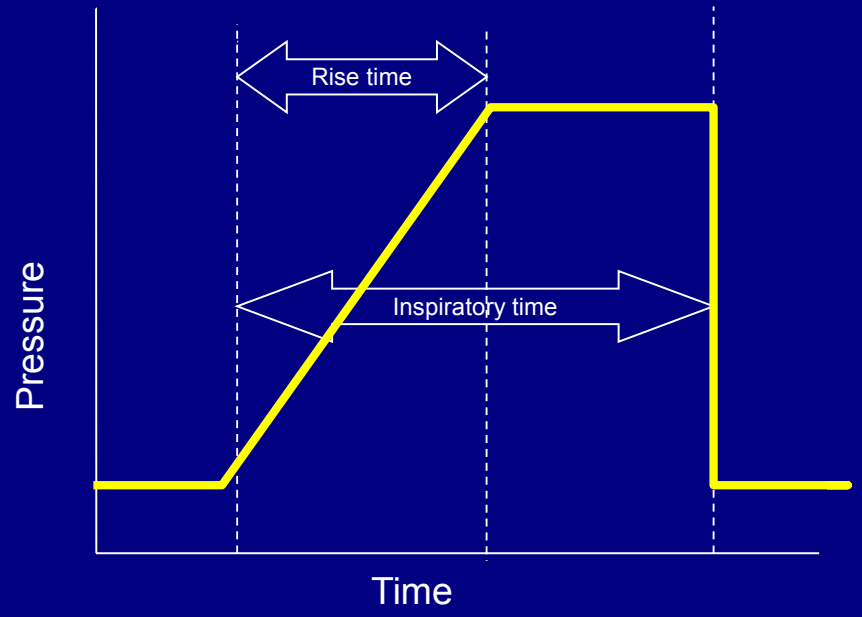
↑sensitivity preferable

Flow triggering general more sensitive than pressure triggering

↓flow or ↓pressure ⇒ ↑sensitivity

Other settings





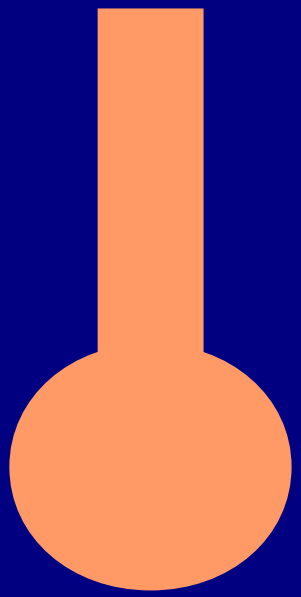
Respiratory complications

- Nosocomial pneumonia
- Barotrauma
- Gas trapping

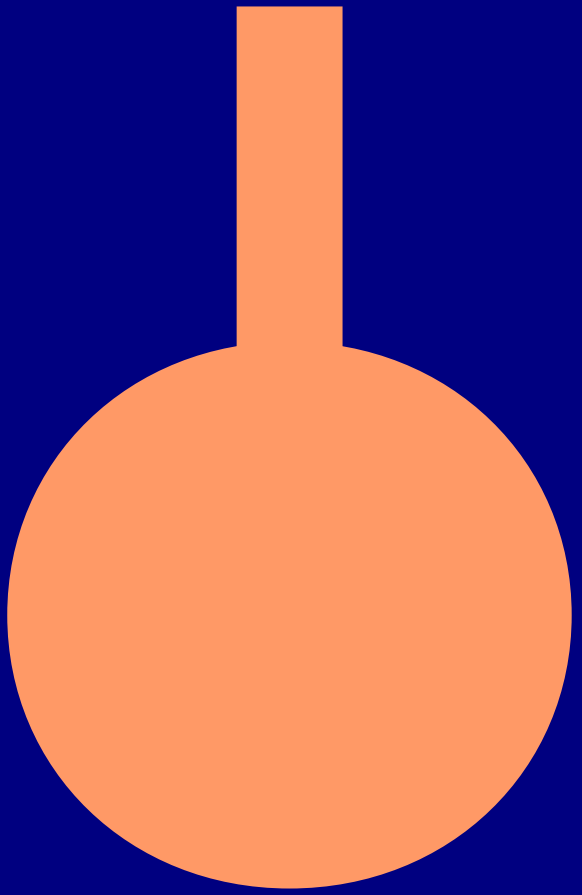
Barotrauma

- High pressures (barotrauma)
- High volumes (volutrauma)
- Shear injury

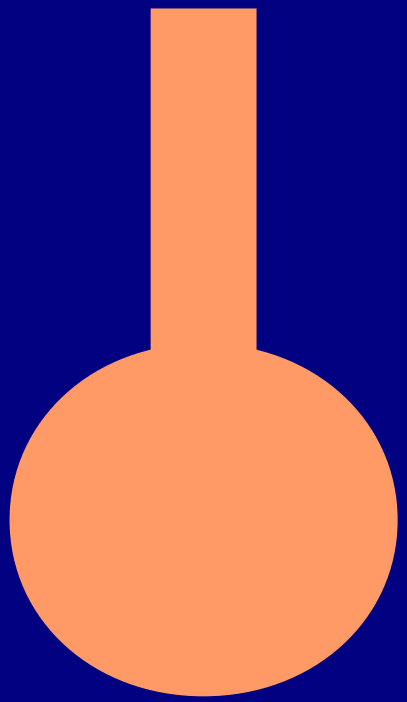
Gas trapping



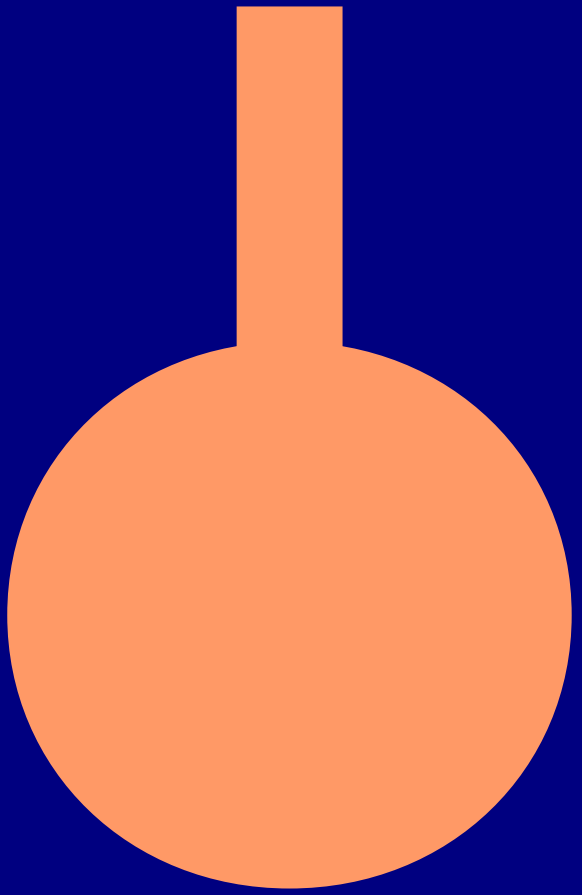
Gas trapping



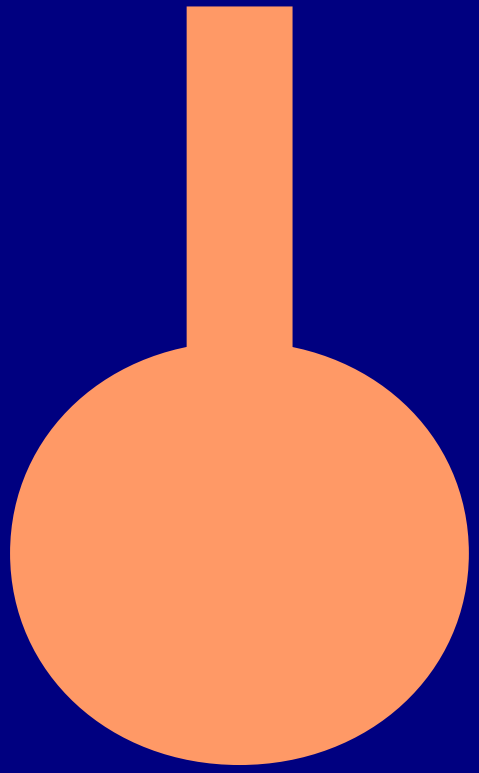
Gas trapping



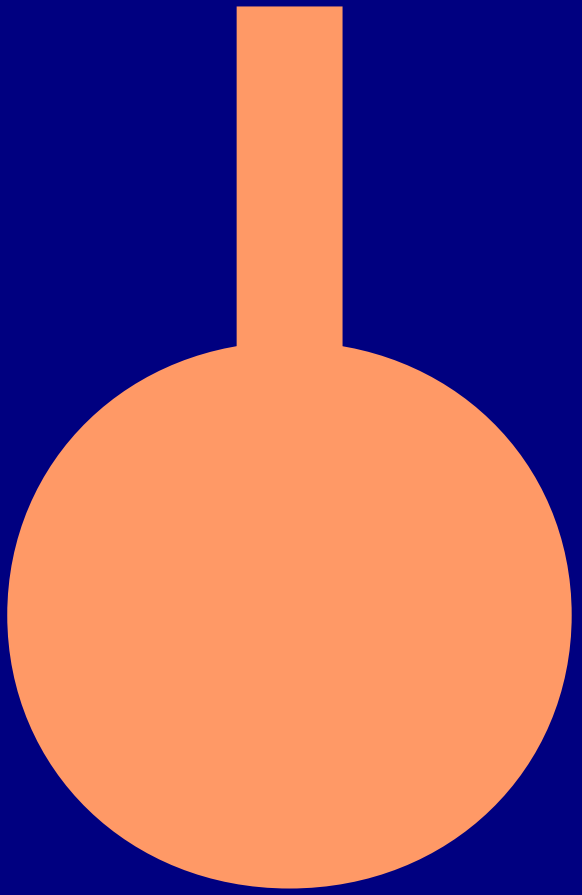
Gas trapping



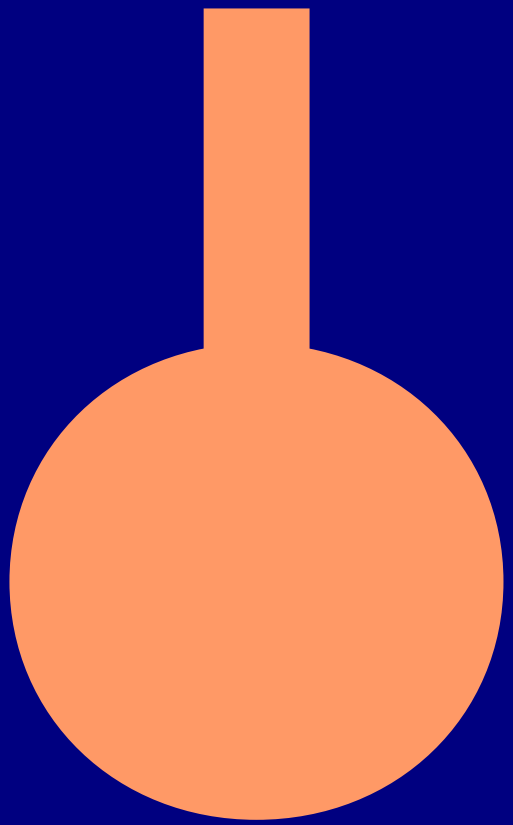
Gas trapping



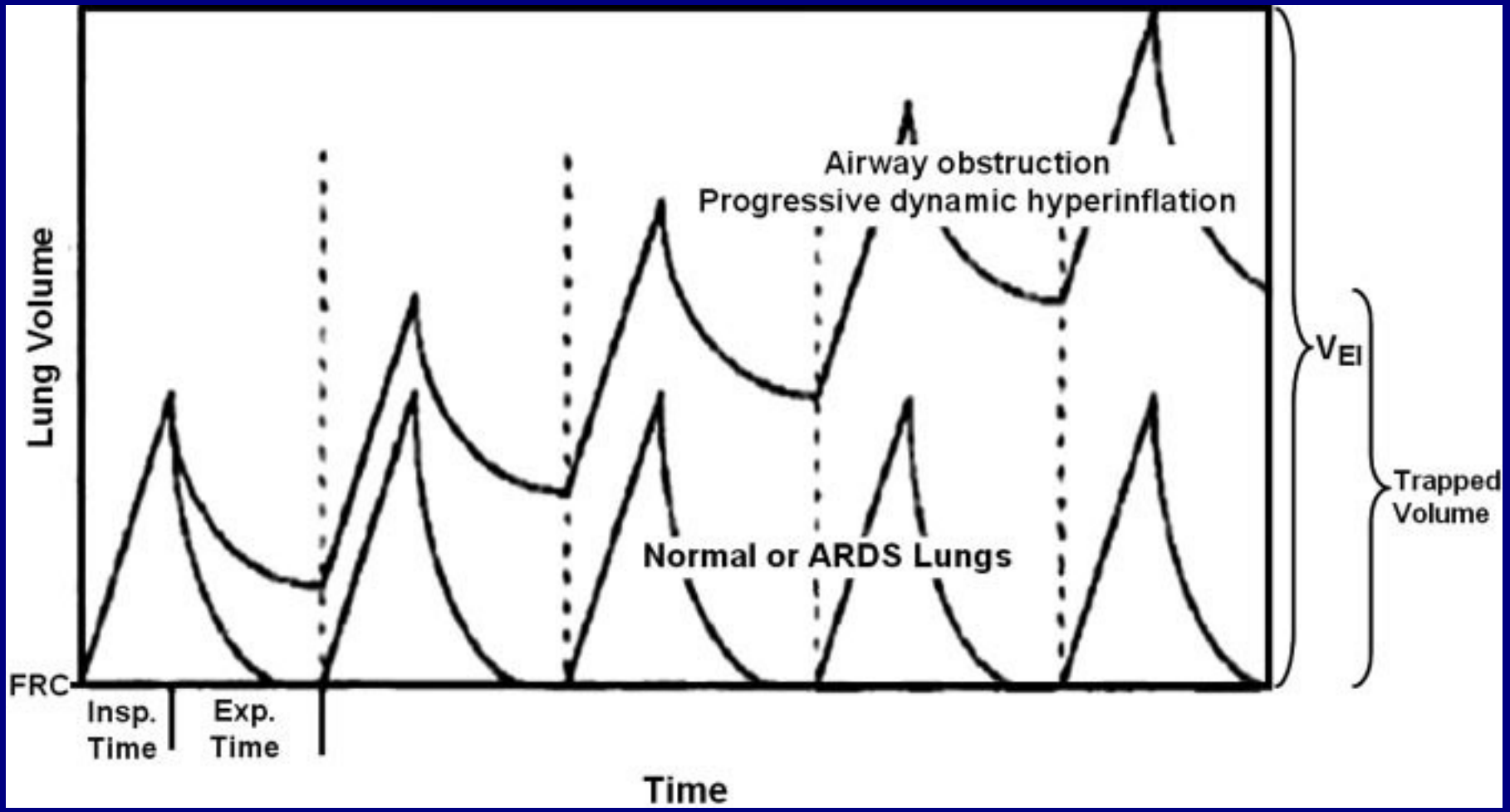
Gas trapping



Gas trapping



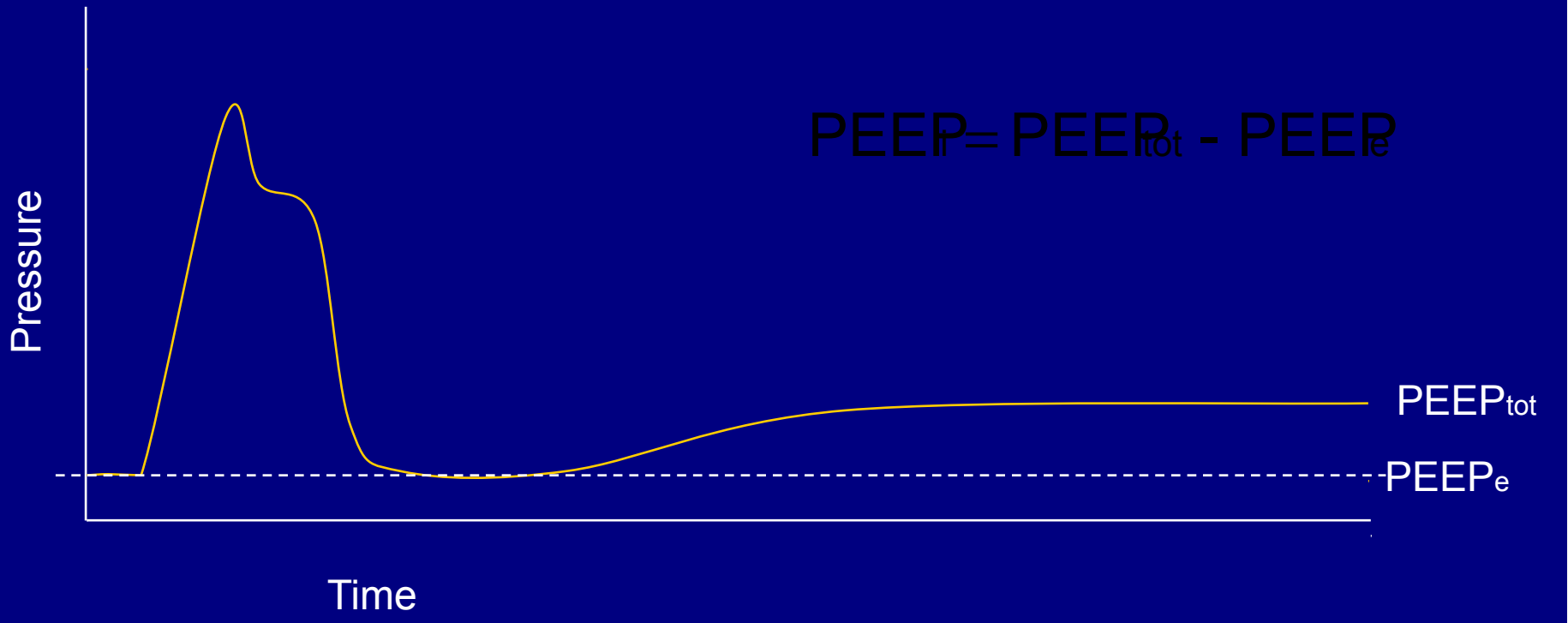
Gas traping


Airway obstruction
Progressive dynamic hyperinflation
Normal or ARDS Lungs
Lung Volume
FRC
Insp. Time
Exp. Time
Time
V_{EI}
Trapped Volume

Gas trapping

- Predisposing factors:
  - asthma or COPD
  - long inspiratory time ($\Rightarrow$expiratory time short)
  - high respiratory rate ($\Rightarrow$absolute expiratory time short)
- Effects
  - progressive hyperinflation of alveoli
  - progressive rise in end-expiratory pressure (intrinsic PEEP)

Intrinsic PEEP ($PEEP_i$)



Gas trapping

- Adverse effects
  - Barotrauma
  - Cardiovascular compromise

Cardiovascular effects

- Preload
  - positive intrathoracic pressure reduces venous return
  - exacerbated by
    - high inspiratory pressure
    - prolonged inspiratory time
    - PEEP

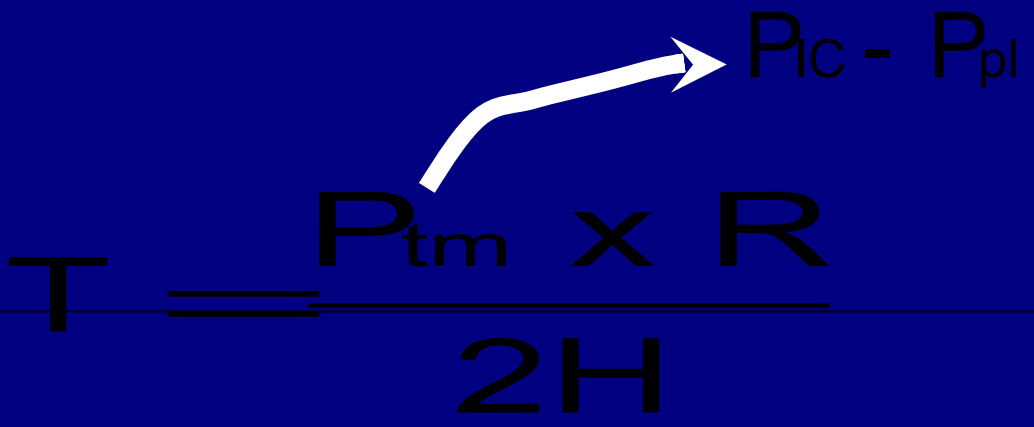
Cardiovascular effects

- decreased afterload due to decreased LV transmural pressure

$$T = \frac{P_{tm} \times R}{2H}$$

Cardiovascular effects

- decreased afterload due to decreased LV transmural pressure



Cardiovascular effects

- Overall effect depends on whether ventricular contractility is normal or abnormal

↓contractility

- (↓/) ↑cardiac output

normal contractility

- ↓cardiac output

Hypotension

- Consider
  - Drug induced
  - Gas trapping
  - Tension pneumothorax