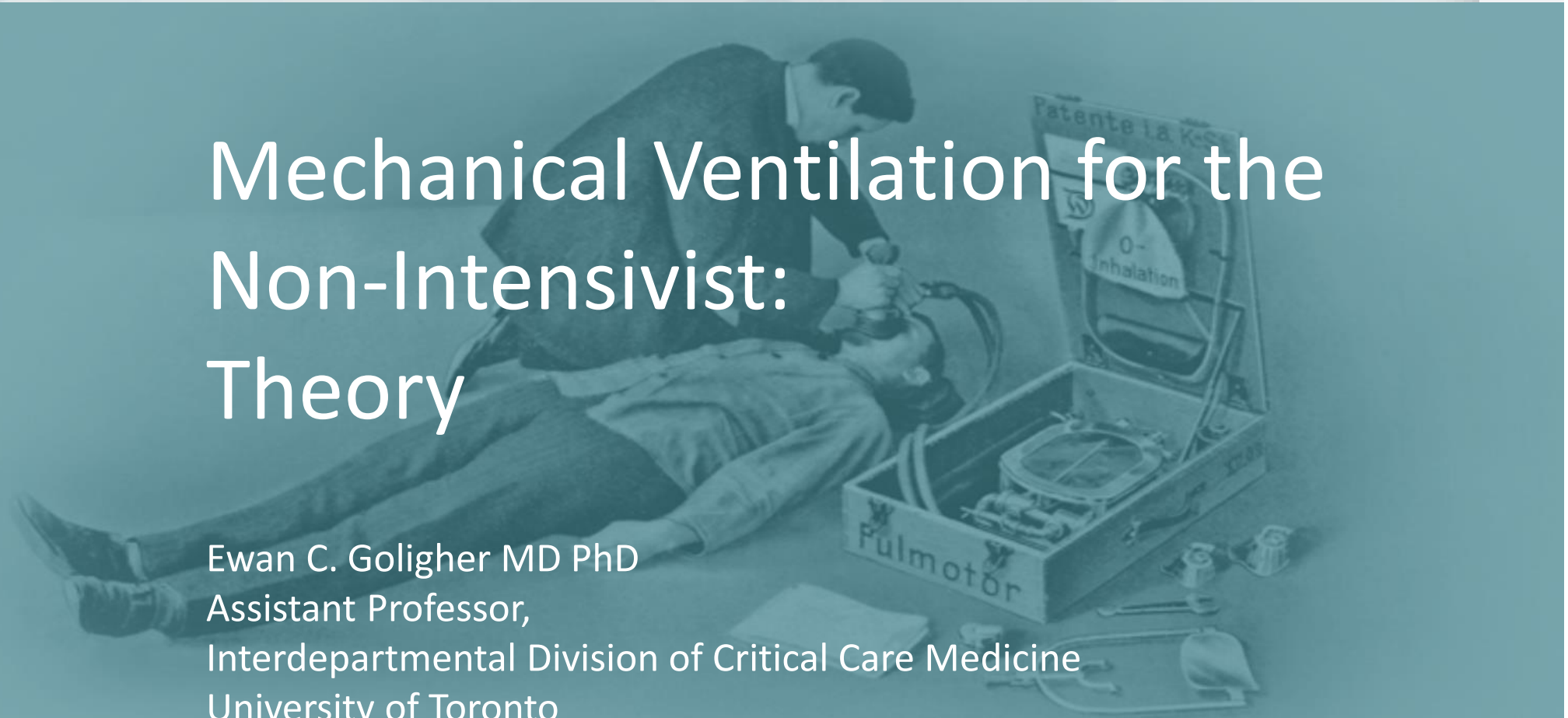
Mechanical Ventilation for the Non-Intensivist: Theory



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Educational Objectives

Concepts

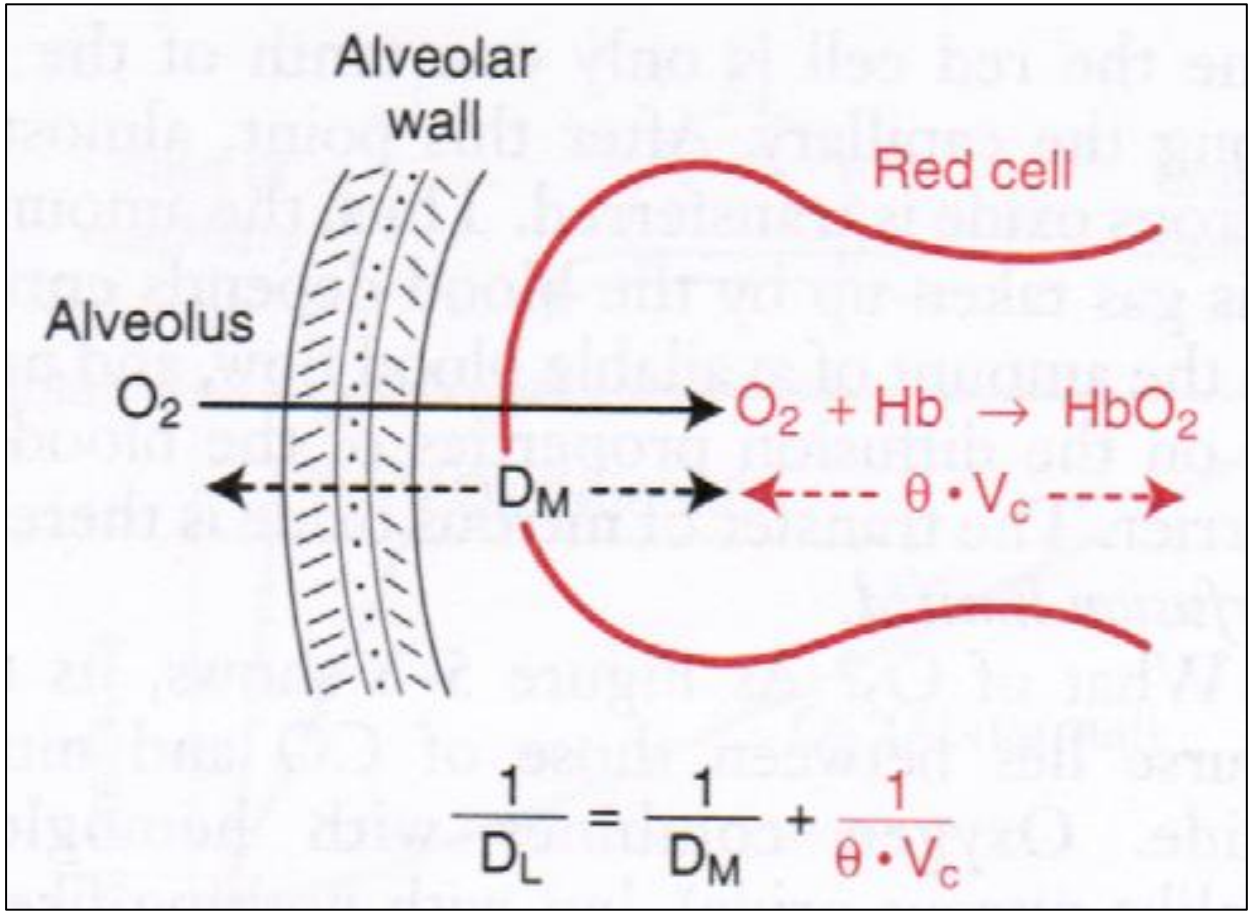
- Goals of mechanical ventilation
- How breathing works
- How mechanical ventilation works
- Side effects of mechanical ventilation

Goals of Mechanical Ventilation

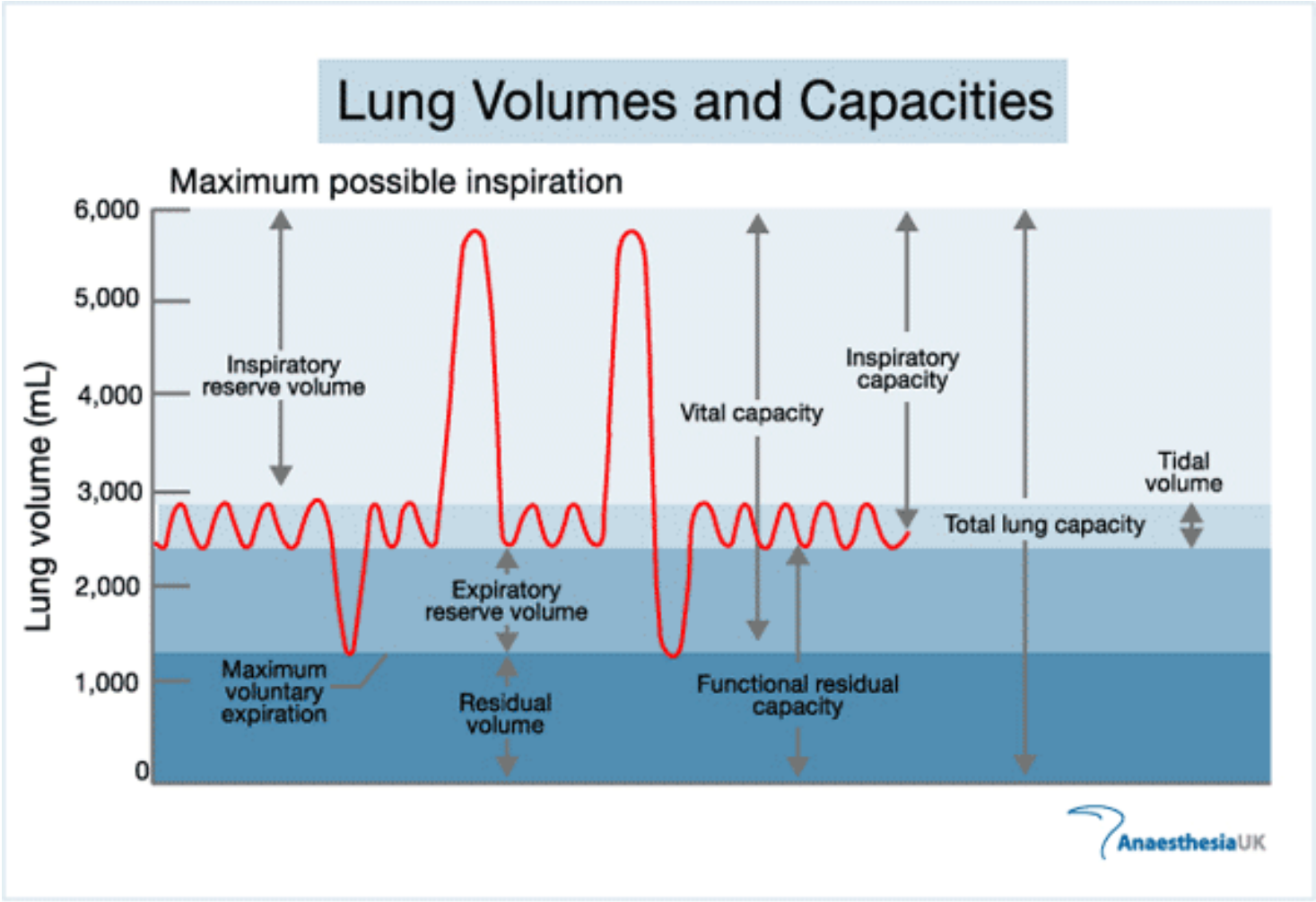
- Primum non nocere
- Oxygen delivery
- Acid-base homeostasis

How Breathing Works

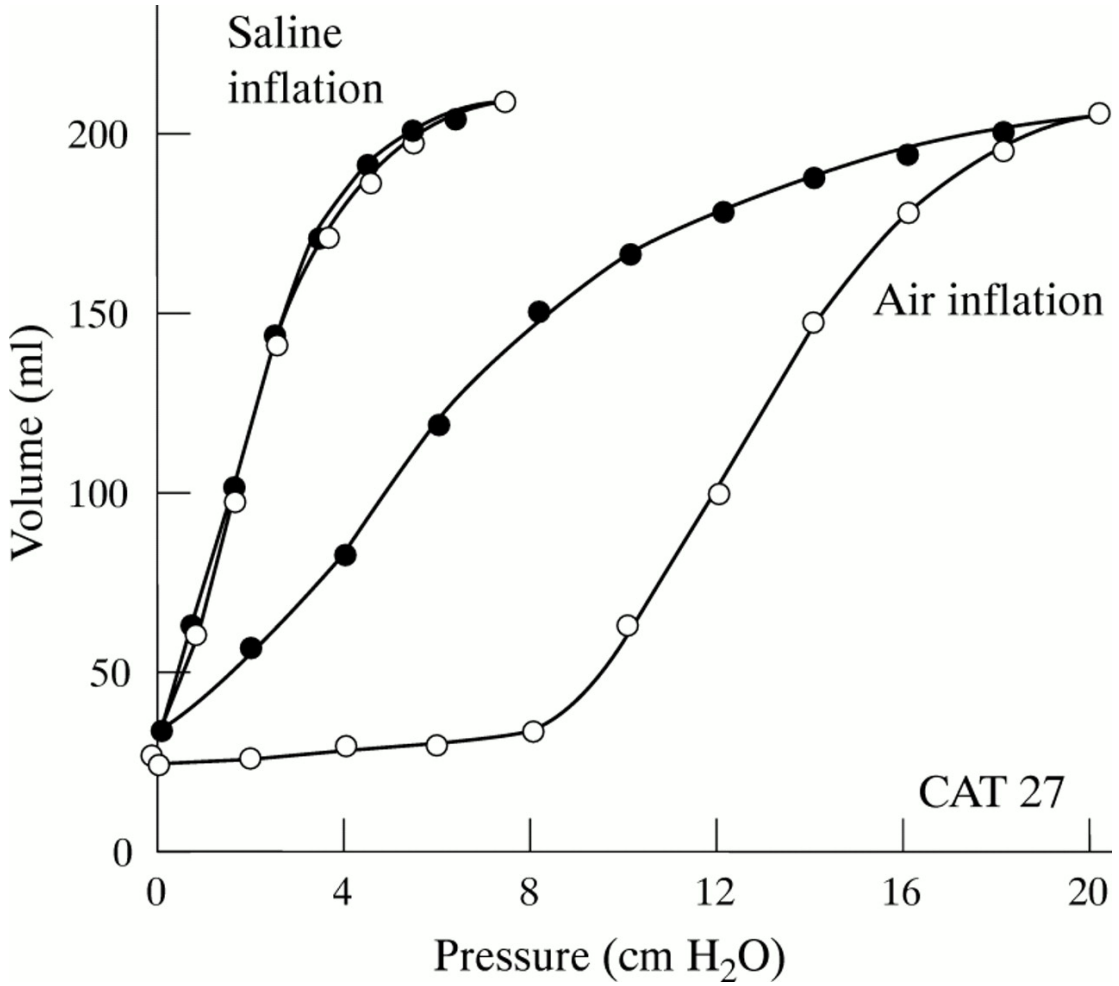
- Gas exchange
  - Oxygen
  - Carbon dioxide



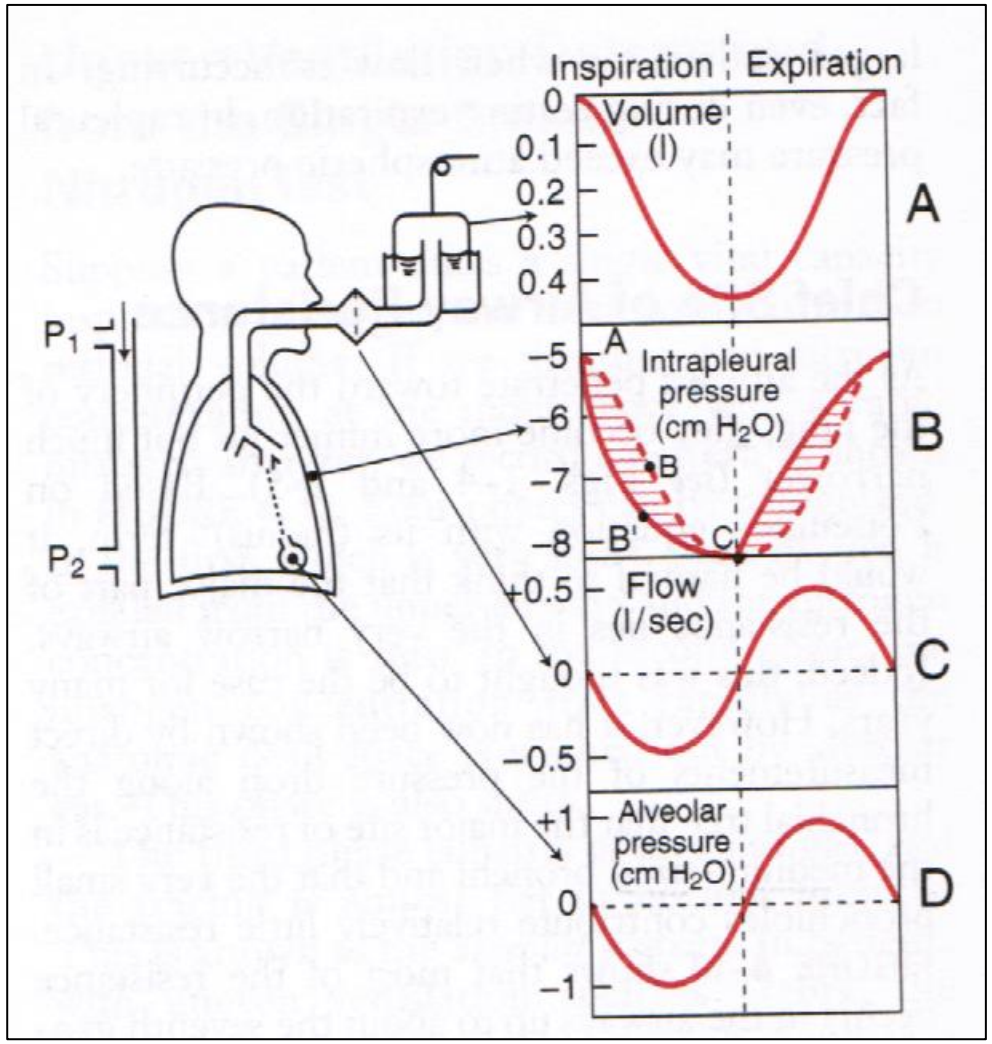
How Breathing Works



How Breathing Works

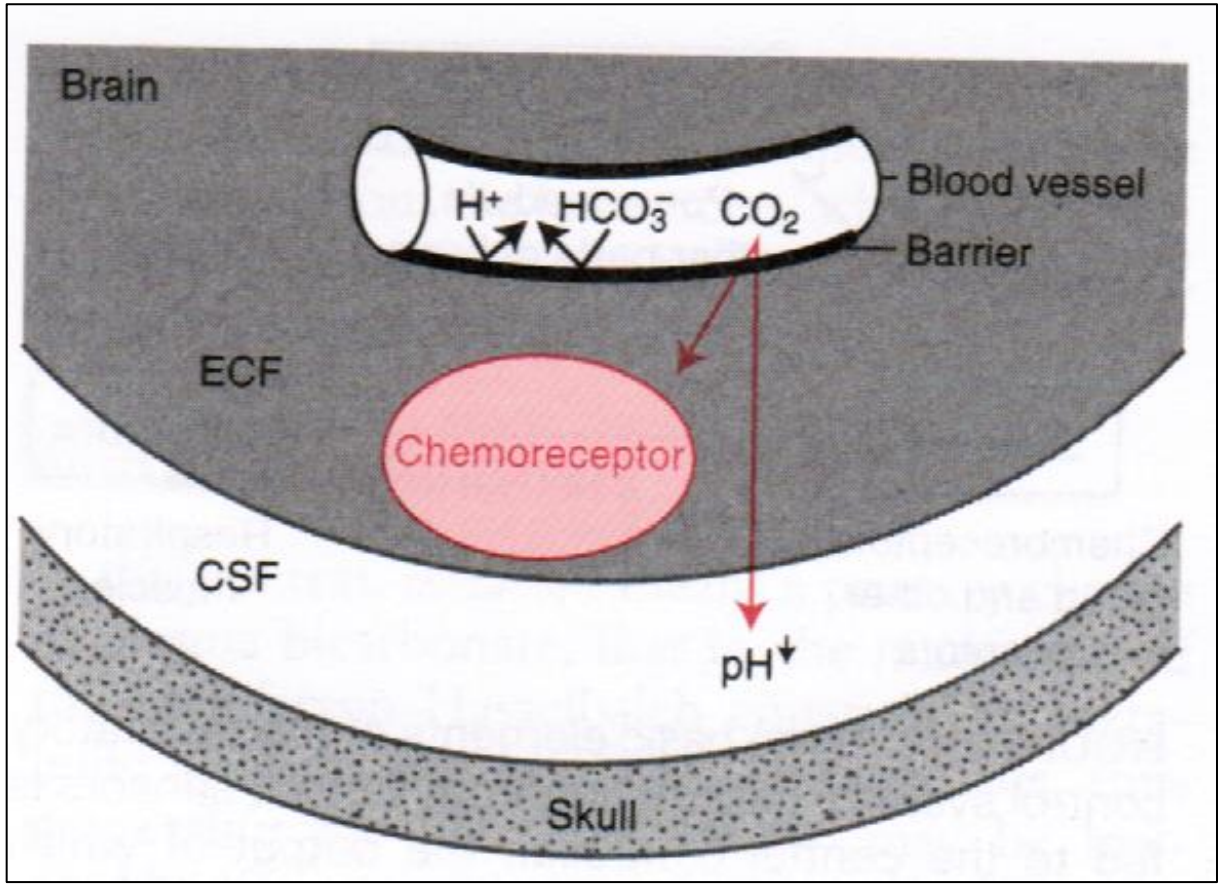


How Breathing Works



How Breathing Works

- Control of breathing
  - Trigger
  - Target
  - Limit/cycling criterion



How Mechanical Ventilation Works

- CO_2 clearance - minute ventilation
  - Trigger
  - Target
  - Limit/cycling criterion

- Oxygenation
  - F_IO_2
  - PEEP

How Mechanical Ventilation Works

- Getting a respiratory rate (f)

Controller	Trigger
Ventilator	Time (1/F set by RT)
Patient	Flow or pressure

How Mechanical Ventilation Works

- Getting a tidal volume (Vt)

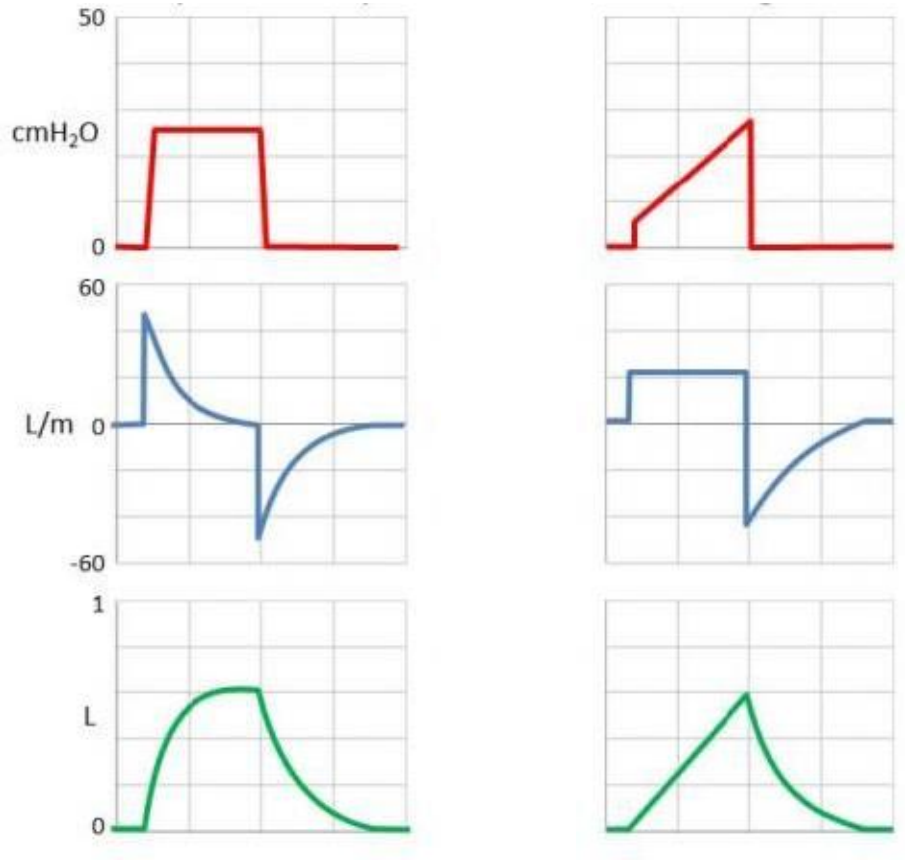
Mode	Target	Limit
Volume control	Flow	Volume
Pressure control	Pressure	Time
Pressure support	Pressure	Flow

How Mechanical Ventilation Works

Pressure

Flow

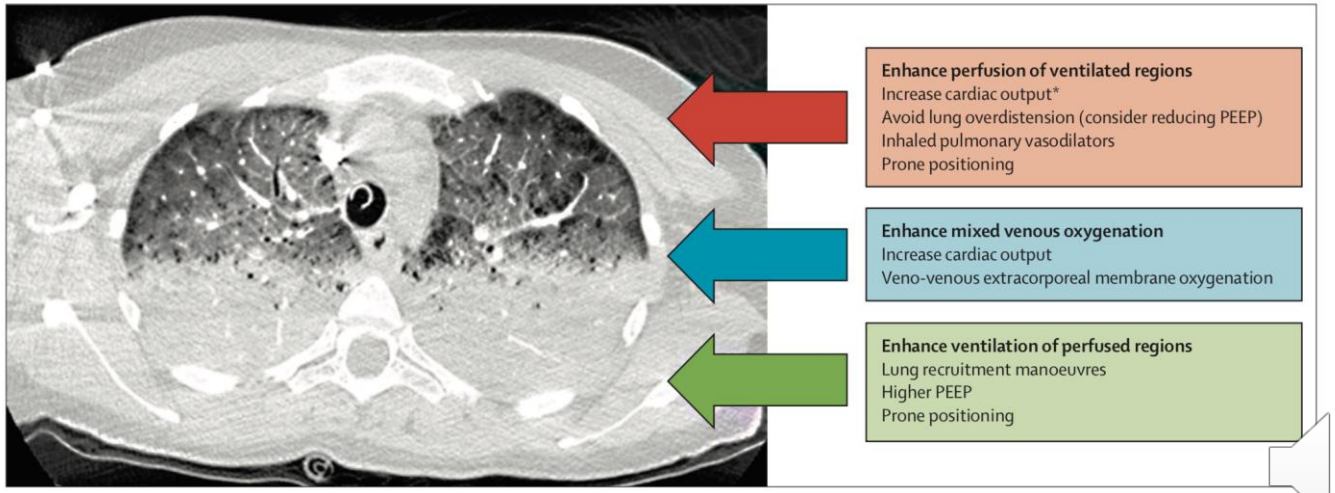
Volume



How Mechanical Ventilation Works

- How does mechanical ventilation improve oxygenation?
  - Improves V/Q matching
  - Reduces shunt
  - Allows delivery of assured high F_IO_2

F_IO_2	Increases alveolar P_AO_2
Positive end-expiratory pressure (PEEP)	Keeps alveoli open (recruitment)



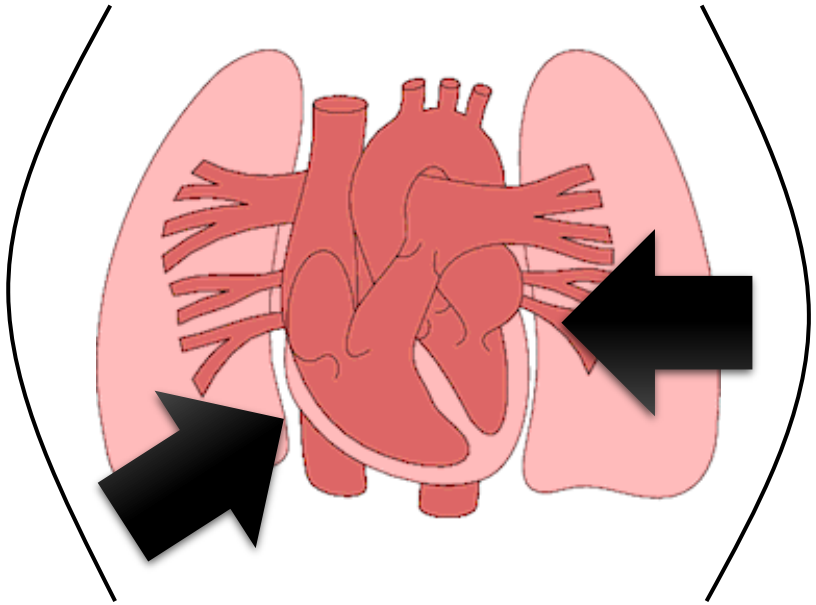
Goligher, Ferguson, Brochard *Lancet* 2016

Side Effects of Mechanical Ventilation

- Hemodynamic effects of positive pressure
- Ventilator-induced lung injury
- Ventilator-induced respiratory muscle weakness

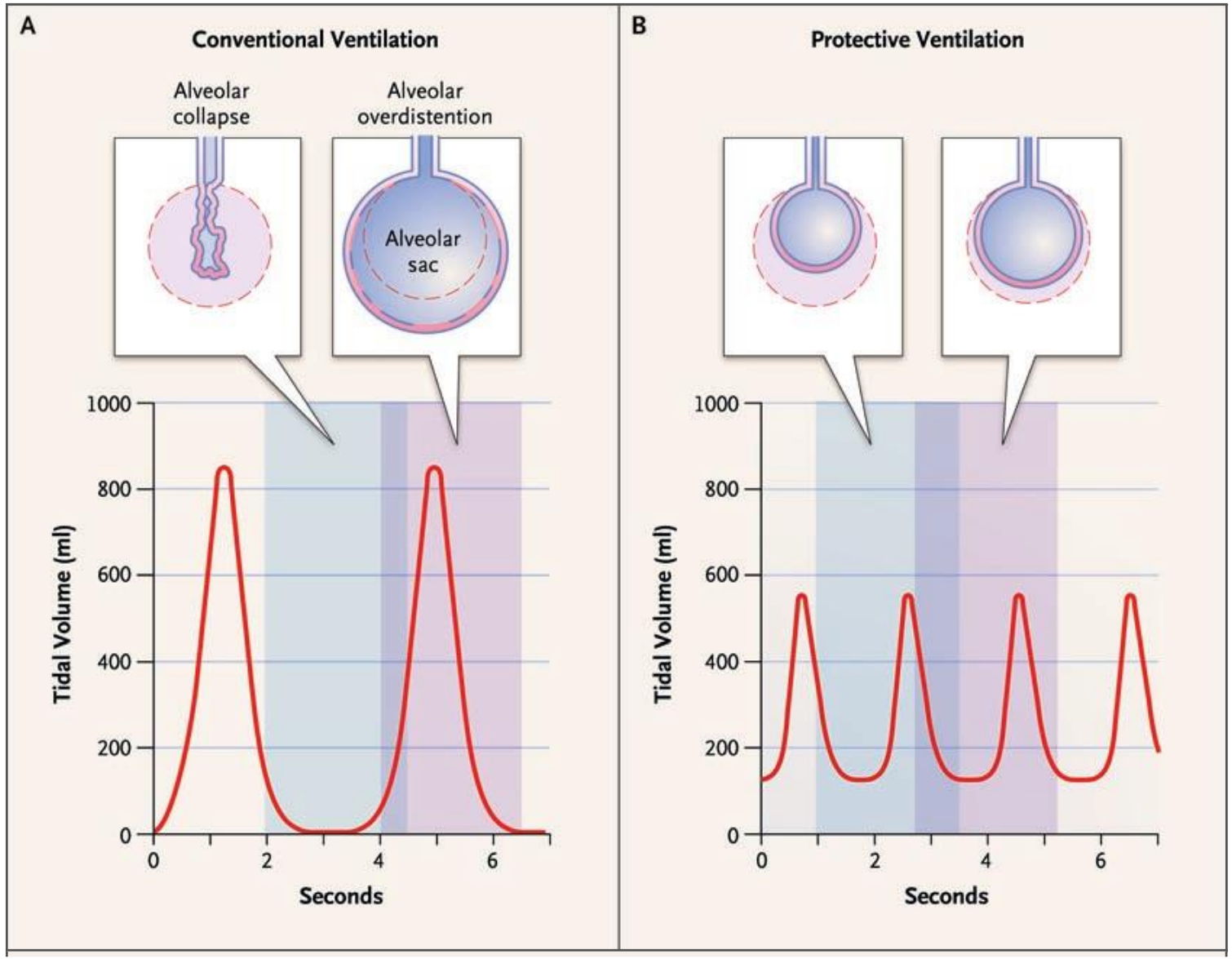
Hemodynamic Effects

- Heart-lung interactions
- Specific examples
  - LV dysfunction
  - RV dysfunction
- Intubation considerations



Ventilator-Induced Lung Injury

dos Santos CC, Slutsky AS. 2006.
Annu. Rev. Physiol. 68:585–618


A
Conventional Ventilation
Alveolar collapse
Alveolar overdistention
Alveolar sac
Tidal Volume (ml)
1000
800
600
400
200
0
0
2
4
6
Seconds
B
Protective Ventilation
Tidal Volume (ml)
1000
800
600
400
200
0
0
2
4
6
Seconds

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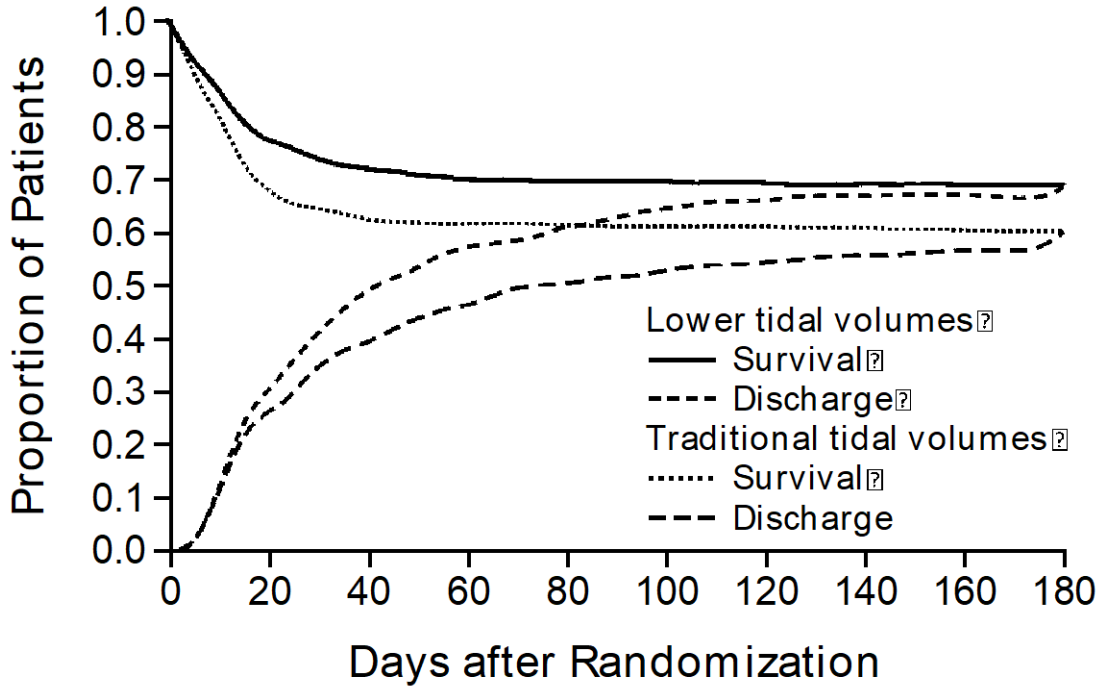
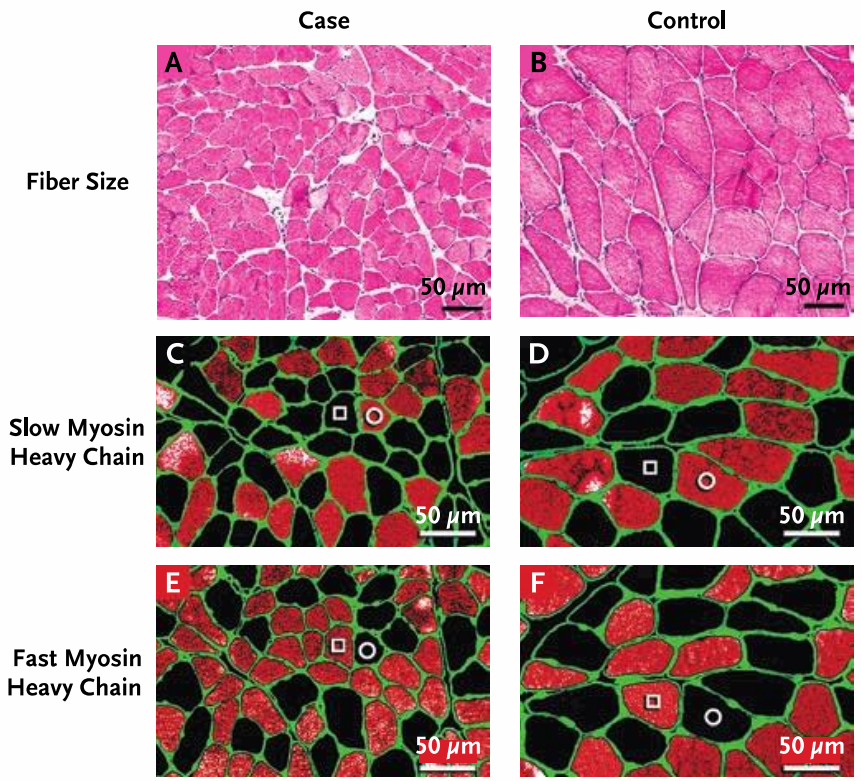
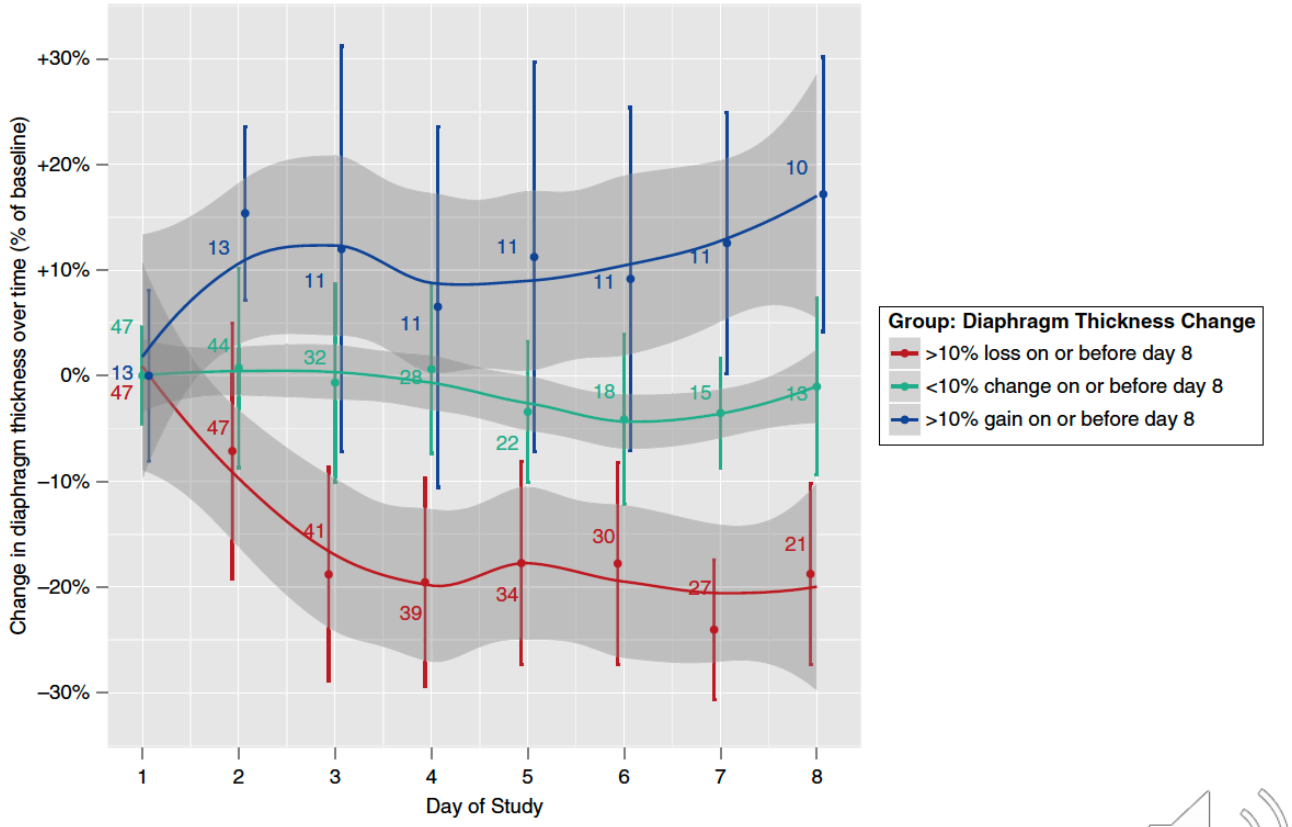
VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME



Ventilator-Induced Diaphragm Dysfunction





Mechanical Ventilation…

Is not a benign intervention!

Key Points

- Basic respiratory physiology
- How mechanical ventilation works
- Mechanical ventilation is not a benign intervention!