

Lessons I've Learned about Mechanical Ventilation

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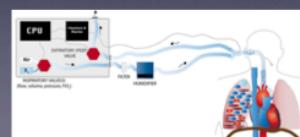
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Objectives

- Review Physiology of Lung
- Describe ventilator settings for prototypical scenarios
- Compare two common full support modes of ventilation
- Delineate emergencies using waveforms



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Disclosures



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reasons to intubate

Airway

mouth and neck infections, tumors, foreign bodies, bleeds
exam: stridor, voice change, mishandling of secretions, airway posturing
difficult intubation likely

intubate early in dynamic airways

bullets neck trauma
bites anaphylaxis / angioedema
burns thermal and caustic airway injuries

Breathing

failure of oxygenation or ventilation
often amenable to noninvasive ventilation and medical therapies

Circulation

augment tissue oxygen delivery by unloading muscles of respiration
sepsis

Disability

CNS catastrophes, CNS depression, status epi, neuromuscular weakness
exam: avoid gag-assess ability to swallow and handle secretions
vomiting in the obtunded patient is a particular concern

Expected course

anticipated decline, transfer to radiology or another institution

Feral

need for immediate aggressive sedation to protect patient/others
especially with concern for concomitant dangerous medical condition



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It's Complicated

- So many options (modes, settings, etc)
- So many confusing terms
- So many different clinical settings & patient diagnoses
- So many strong opinions

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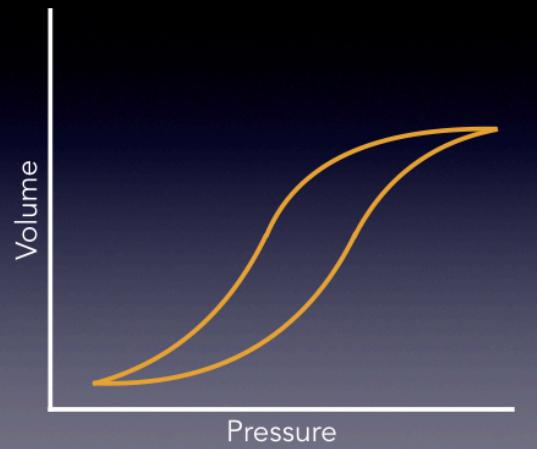
Goals of Mechanical Ventilation

- Providing adequate oxygenation and ventilation
- **Avoiding iatrogenic harm**
- Avoiding unnecessary prolongation of intubation

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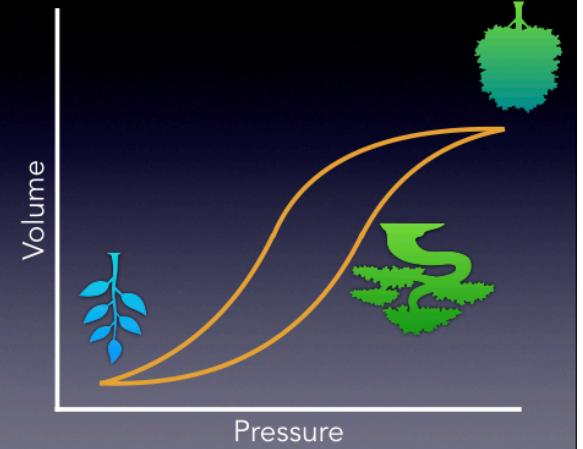
Mechanics



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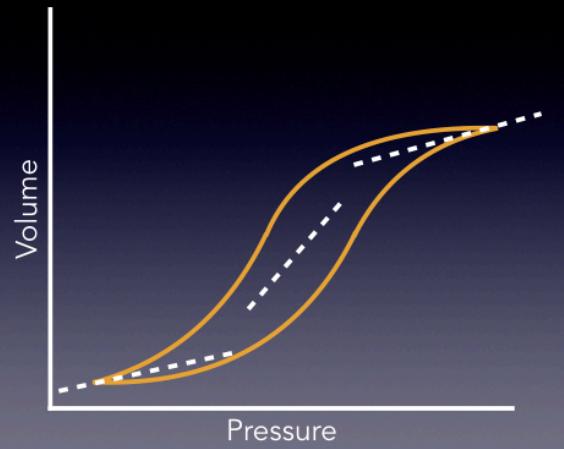
Mechanics



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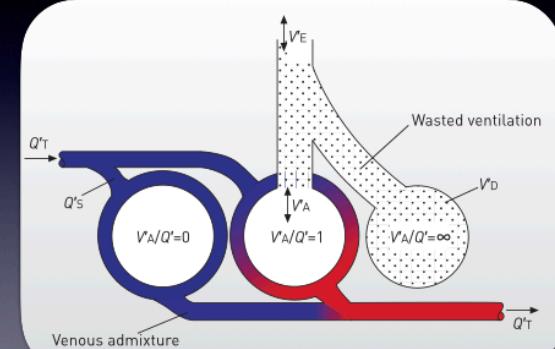
Mechanics



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Ventilation & Perfusion



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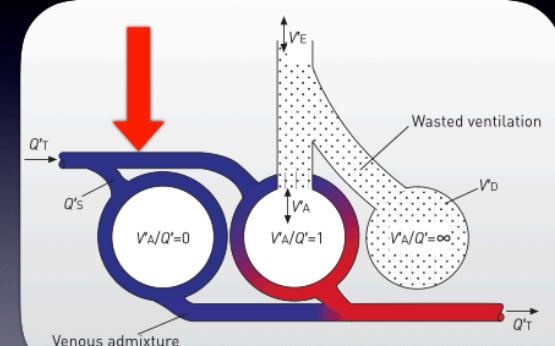
Oxygen



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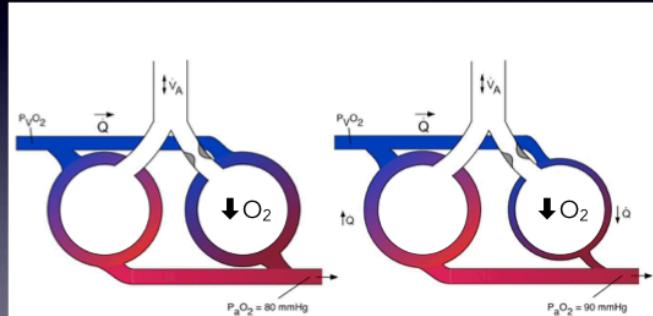
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Hypoxic Pulmonary Vasoconstriction

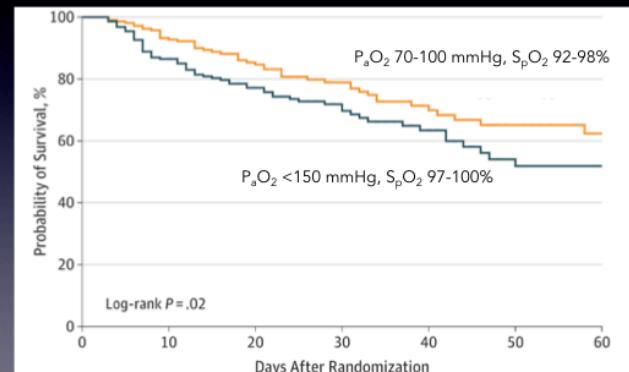


Luks, Glenny, et al. *Respir Physiol* 2019

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Oxygen-ICU RCT

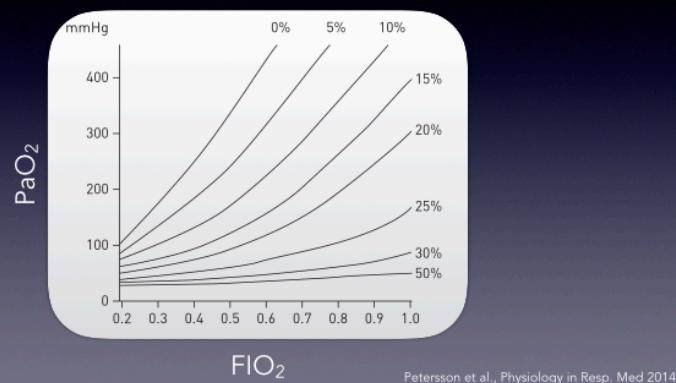


Girardis et al., *JAMA* 2016

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Shunt & FIO_2

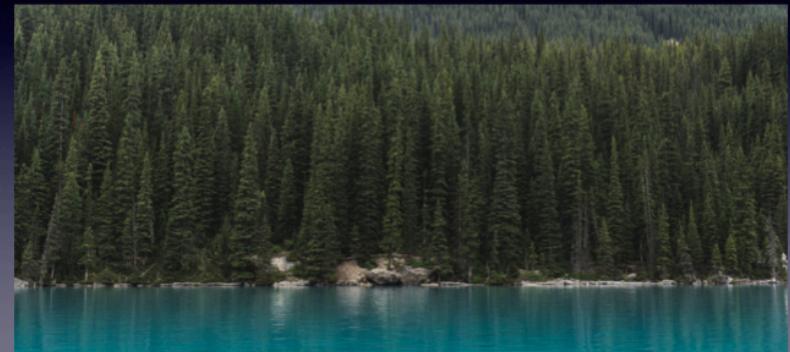


Petersson et al., *Physiology in Resp. Med* 2014

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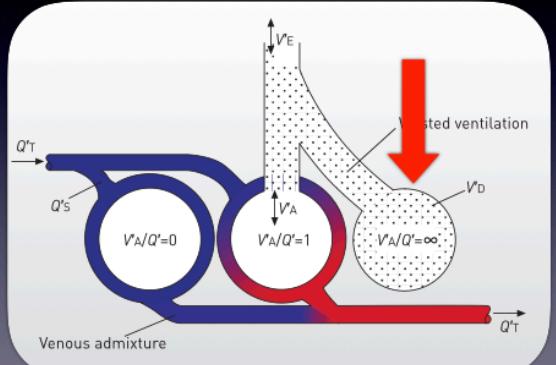
Carbon Dioxide



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PaCO₂

- Carried very efficiently from tissues to lung
- Eliminated quickly once delivered to alveoli

$$P_A CO_2 \propto \frac{\dot{V}CO_2}{\dot{V}_A}$$

$$\dot{V}_A = \dot{V}_E - \dot{V}_D$$

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PaCO₂

- Carried very efficiently from tissues to lung
- Eliminated quickly once delivered to alveoli

$$PaCO_2 \sim \frac{CO_2 \text{ Production}}{f * Vt (1-Vd/Vt)}$$

$$\dot{V}_E - \dot{V}_D$$

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Avoiding Harm



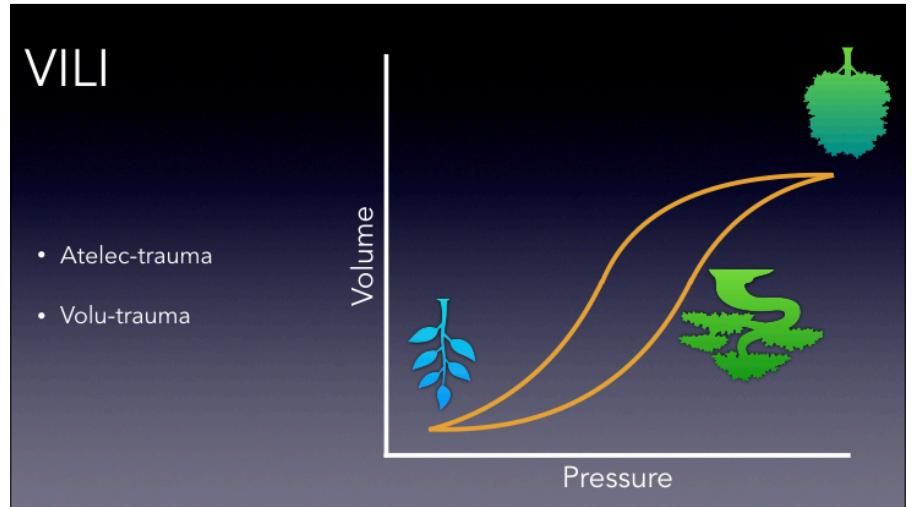
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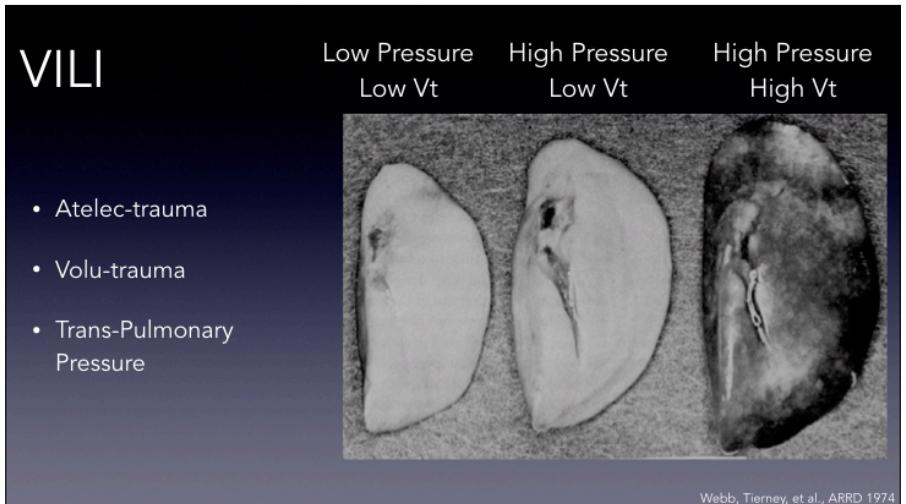
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