

Acute Respiratory Failure

ACUTE CARE MEDICINE SERIES

Carl Shanholtz, M.D.

Tuesday August 31, 2004

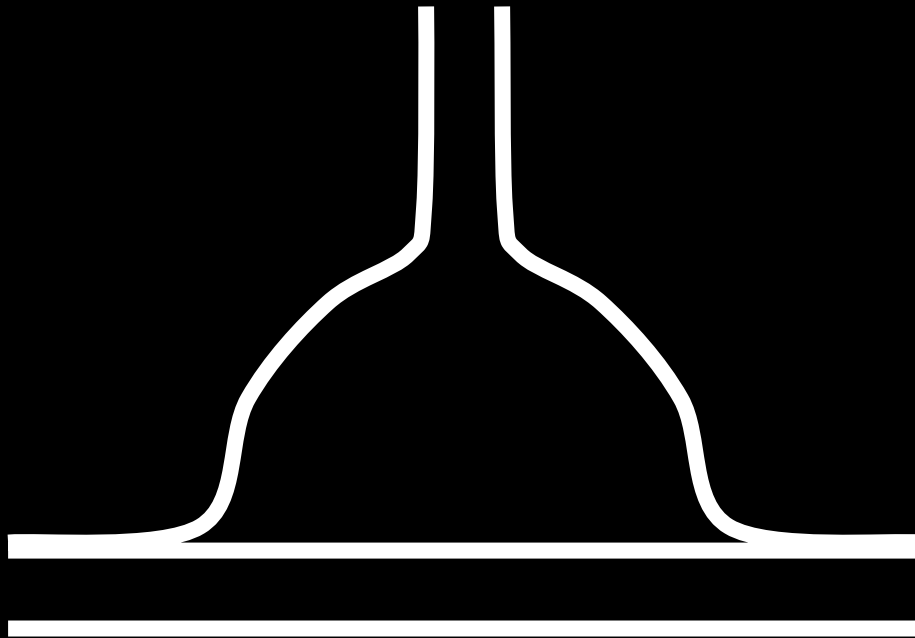


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*Division of Pulmonary and
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University of Maryland Medicine

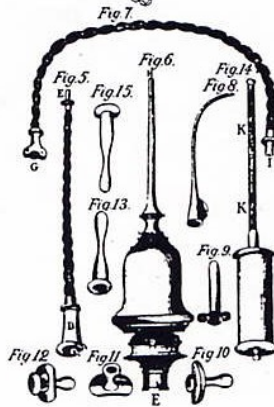
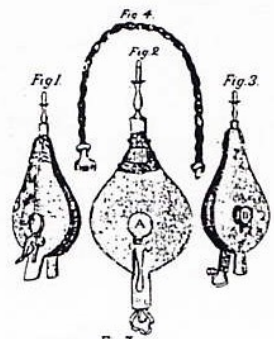
**MARLENE AND STEWART
GREENEBAUM CANCER CENTER**



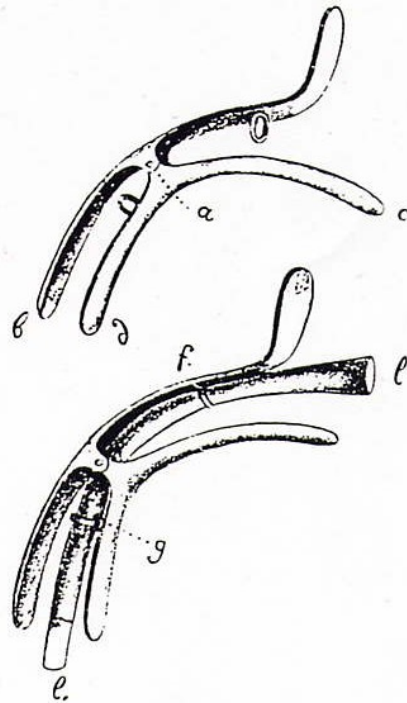




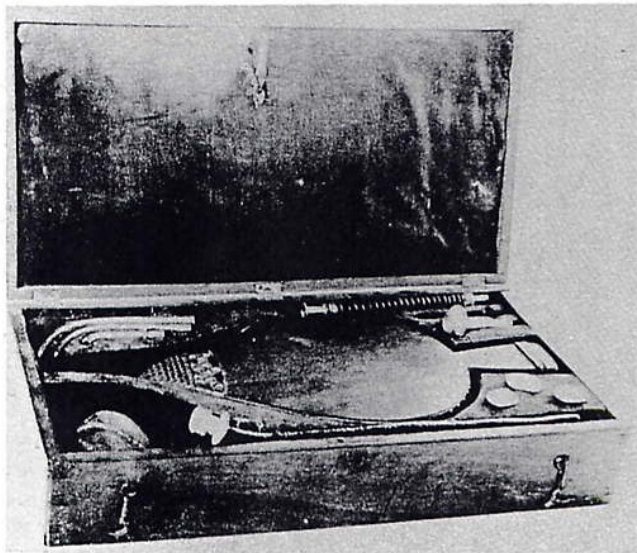
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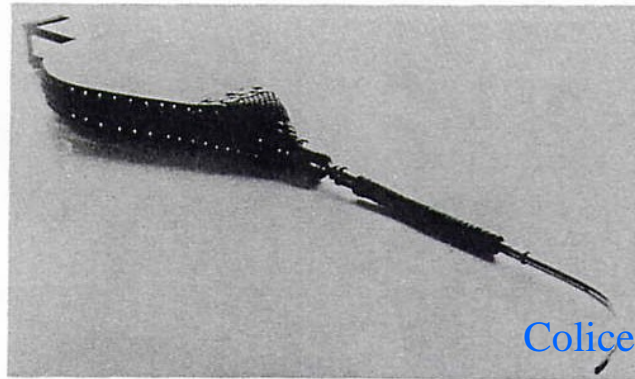
A



B



C



D



Types of Respiratory Failure

- Acute overwhelming lung disease
- Neuromuscular disorders
- Acute on chronic lung disease
- Acute respiratory distress syndrome
- Infant respiratory distress syndrome



Case 1

- It's 3 AM, you've settled into the on-call room 20 minutes ago, and you are called by the nurse on the floor that the "stable" patient you admitted 4 hours ago is in respiratory distress.
- Rather than leap out of bed you ask for the following, none of which are available:
 - blood gas
 - pulse oximeter reading
 - respiratory rate
- How did the nurse know from standing in the doorway that the patient was in respiratory distress?



Respiratory Distress

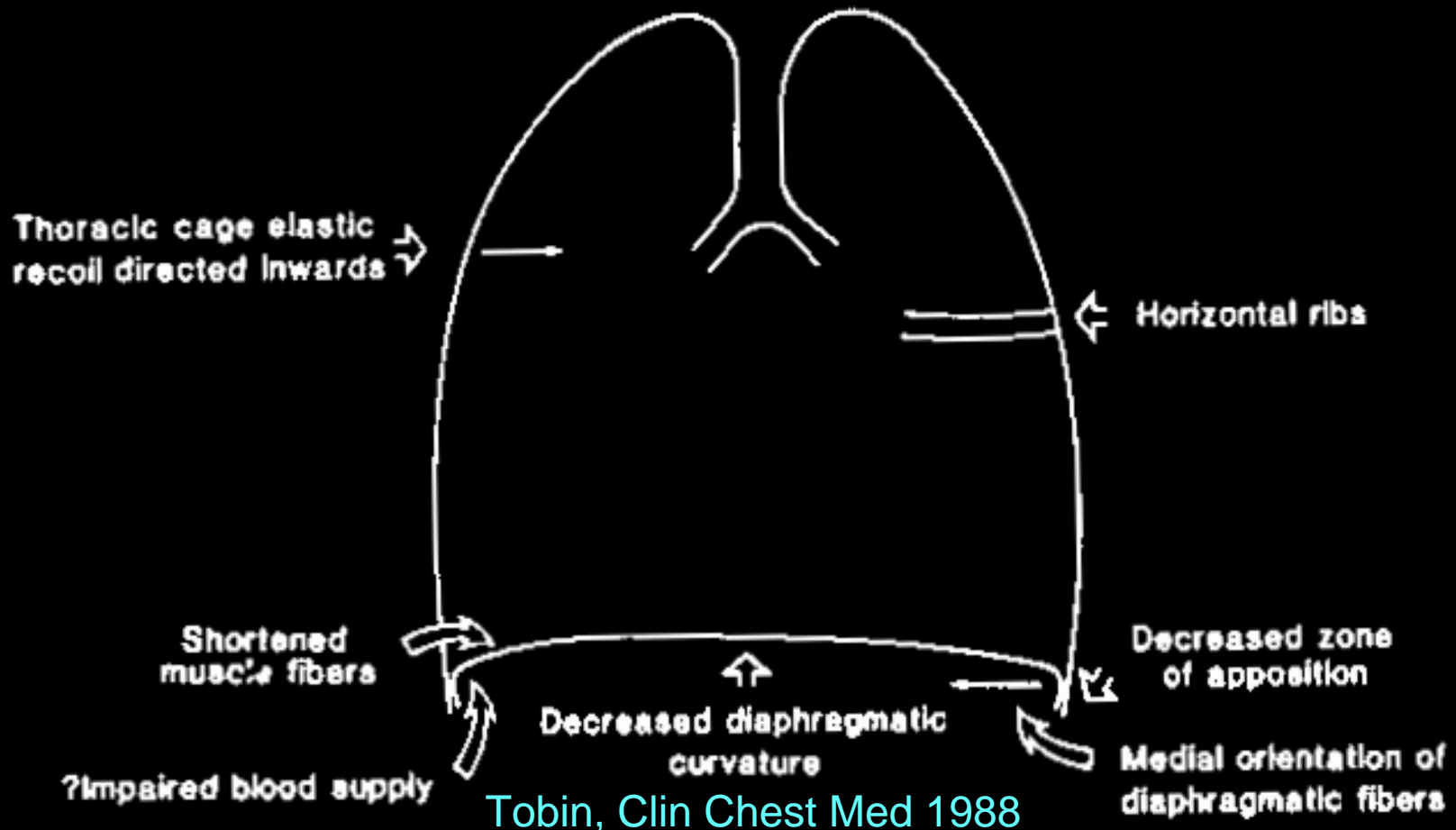
SIGNS AND SYMPTOMS

- Dyspnea
- Tachypnea/tachycardia
- Posture
- Accessory muscles
- Diaphoresis
- Apnea/bradycardia
- Paradoxical breathing
- Respiratory alternans
- Hoover's sign



Respiratory Muscle Function

EFFECTS OF HYPERINFLATION



ALAND
KANE

Respiratory Failure

GAS EXCHANGE

- Hypercapnia
- Hypoxemia
- Acidosis



Case 2

- You are with a friend skiing in the Rockies when, after getting off the chair lift at the summit (10,512 ft) he needs to catch his breath. You reach into your ski jacket, pull out a blood gas kit and analyzer, and find the following: pH 7.40, $p\text{CO}_2$ 40 mmHg, $p\text{O}_2$ 55 mmHg.
- Why was your friend hypoxemic?
- Hey, what's blood gas equipment doing in your ski jacket, anyway?



Causes of Hypoxemia

- Low PiO_2

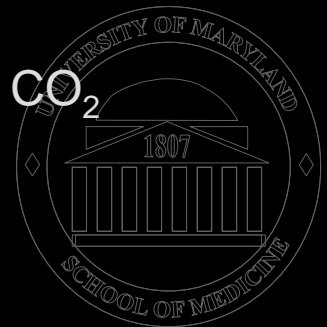
- Alveolar Gas Equation:

- $PAO_2 = PiO_2 - PACO_2 \left[FIO_2 + \frac{1-FIO_2}{R} \right]$

- Abridged Equation for $FIO_2 < 50\%$:

- $PAO_2 = PiO_2 - \frac{PACO_2}{R}$

- Where R is the respiratory quotient or the ratio of CO_2 production to oxygen consumption



Case 3

- You are performing the first central venous catheter placement in your life. Consequently, you decide to use conscious sedation by injecting midazolam (Versed) 10 mg IV into your patient, a 45 kg 80 yo woman.
- After the procedure, while you are writing the note and disposing of the 3 kits you've used, you are told that the patient's pulse oximeter is 85%.
- ABG shows: pH 7.24, pCO₂ 60 mmHg, pO₂ 55 mmHg.
- You are hypoxemic because the MICU fellow is strangling you. Why is the patient hypoxemic?



Causes of Hypoxemia

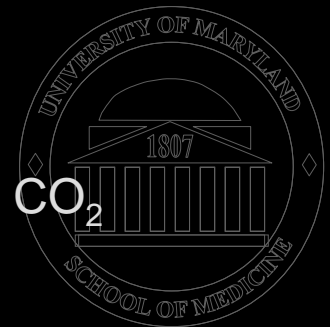
- Low P_{iO_2}
- Hypoventilation
 - Alveolar Gas Equation:

- $$PAO_2 = P_{iO_2} - PACO_2 \left[F_{iO_2} + \frac{1 - F_{iO_2}}{R} \right]$$

- Abridged Equation for $F_{iO_2} < 50\%$:

- $$PAO_2 = P_{iO_2} - \frac{PACO_2}{R}$$

- Where R is the respiratory quotient or the ratio of CO_2 production to oxygen consumption



Case 4

- Your patient on the Cancer Center had a pneumonectomy for lung cancer. He is normoxic at rest, but when he ambulates down the hall, he becomes hypoxemic. What is the physiologic mechanism for this?

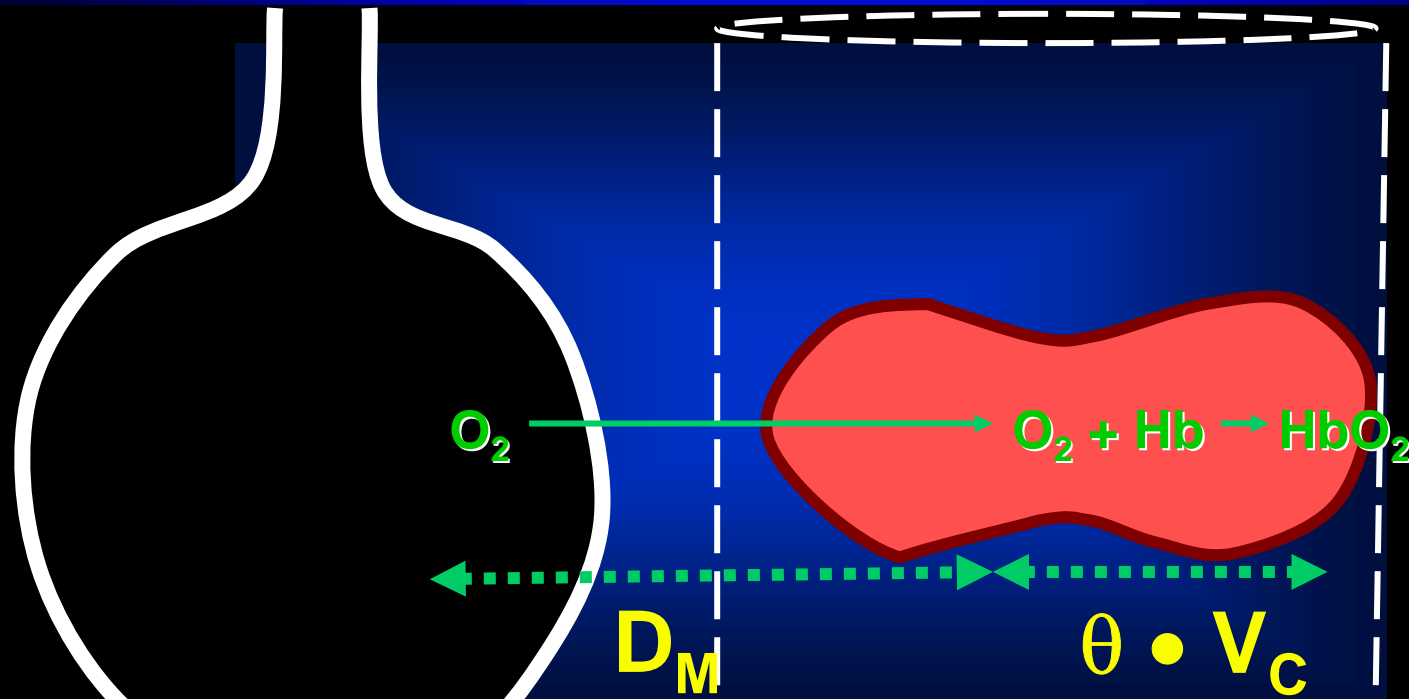


Causes of Hypoxemia

- Low P_{iO_2}
- Hypoventilation
- Diffusion Defect



Determinants of Diffusion



$$\frac{1}{D_L} = \frac{1}{D_M} + \frac{1}{\theta \cdot V_C}$$



Case 5

- You are seeing a patient in the Emergency Room with an acute asthma exacerbation. She has a PaO_2 60 on room air. After 100% O_2 by NRB mask is applied, her PaO_2 goes up to 450 mmHg.
- What is the mechanism of her hypoxemia?



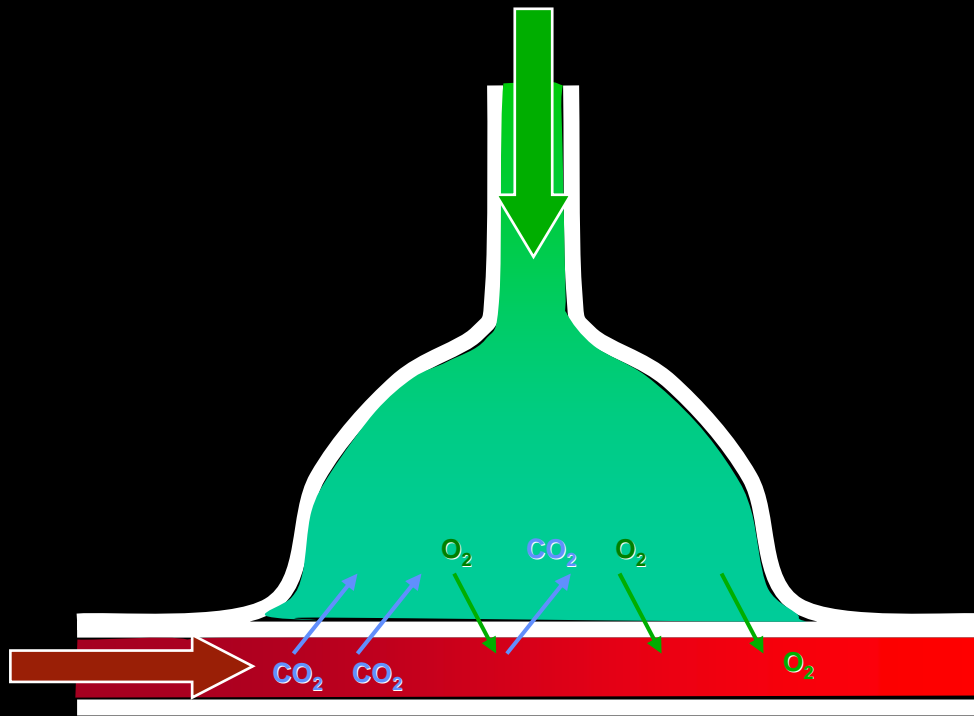
Causes of Hypoxemia

- Low PiO_2
- Hypoventilation
- Diffusion Defect
- Ventilation-Perfusion Mismatch



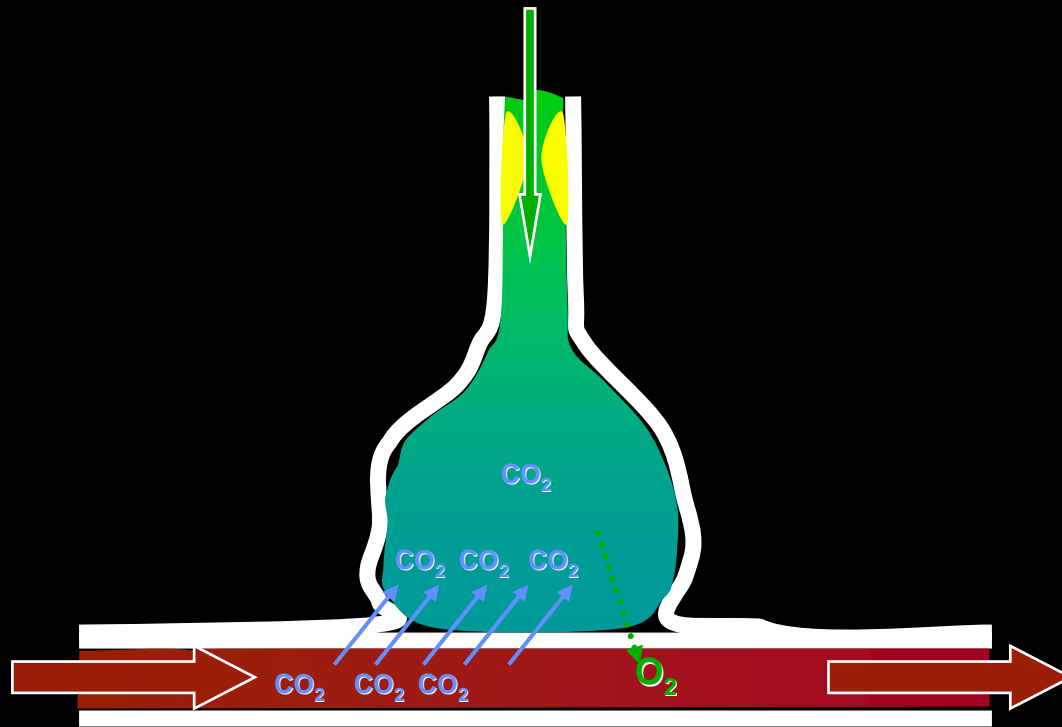
Ventilation-Perfusion

NORMAL RELATIONSHIP



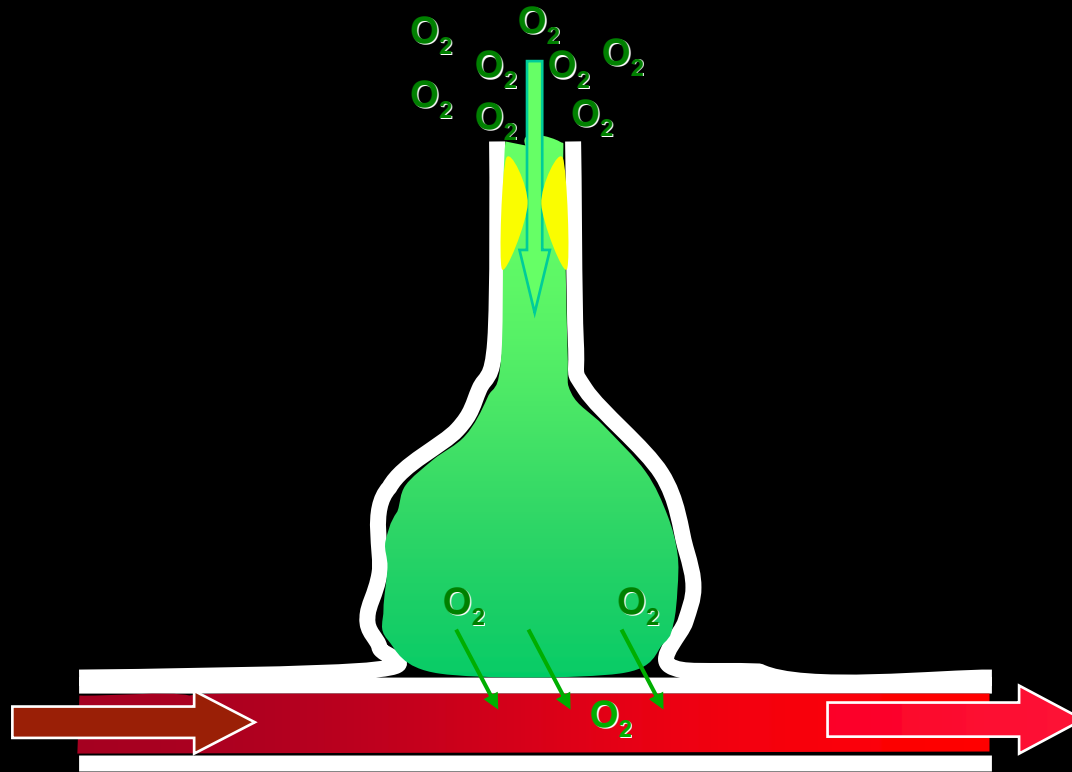
Ventilation-Perfusion Mismatch

DECREASED ALVEOLAR VENTILATION



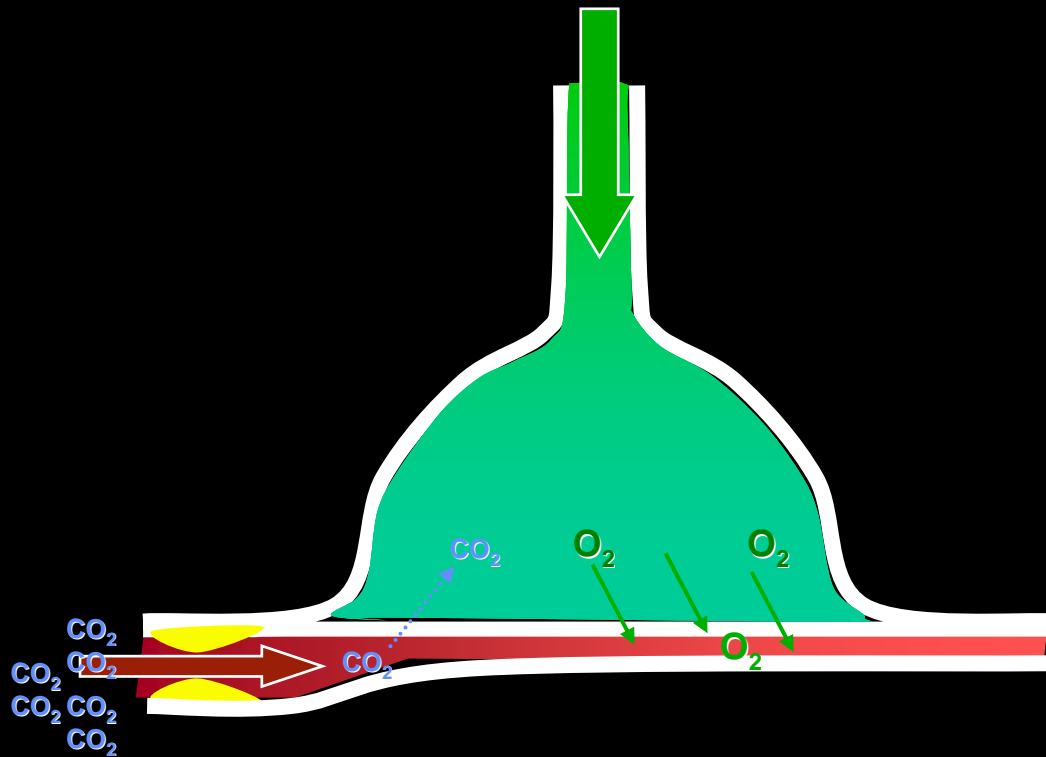
Ventilation-Perfusion Mismatch

EFFECT OF INCREASING OXYGEN TENSION



Ventilation-Perfusion Mismatch

DECREASED PERFUSION



Case 6

- A 34 yo is admitted with community-acquired pneumonia and ARDS. The patient is intubated shortly after arrival. On 100% FIO₂ the PaO₂ is only 58 mmHg.
- What is this patient's physiologic mechanism of hypoxemia?
- How would you improve oxygenation?

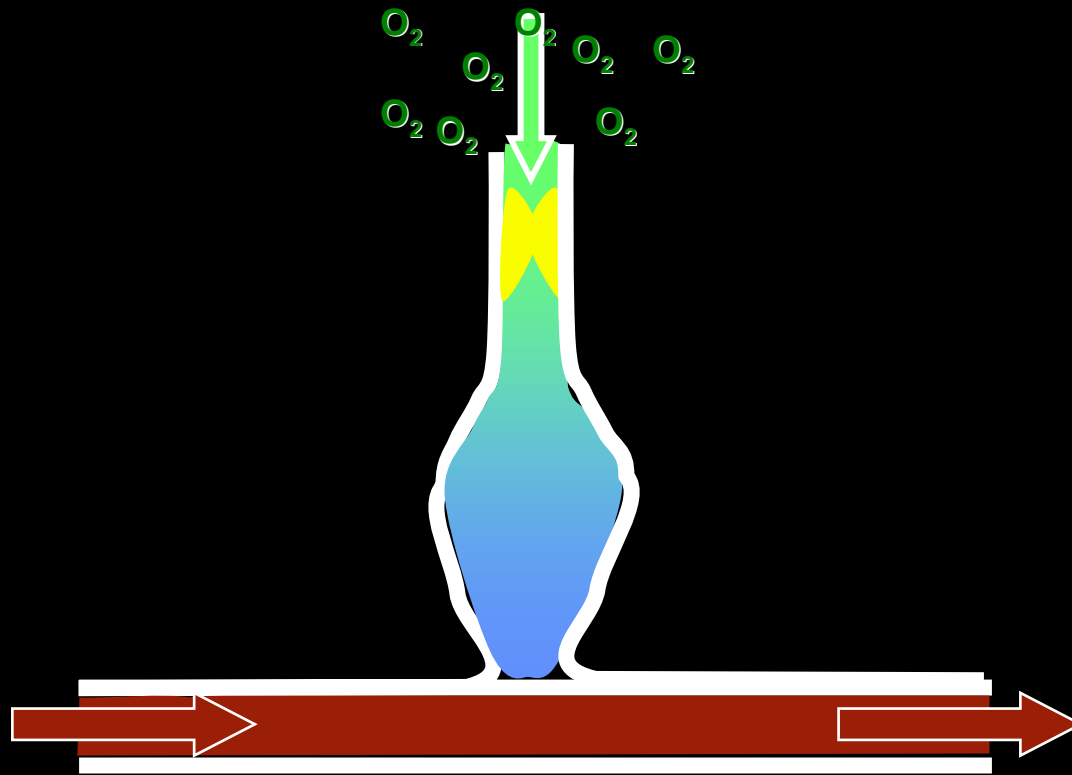


Causes of Hypoxemia

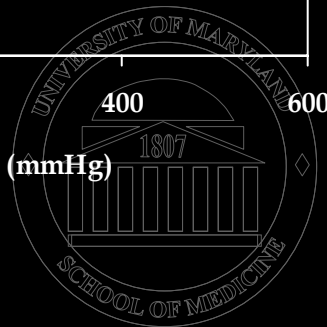
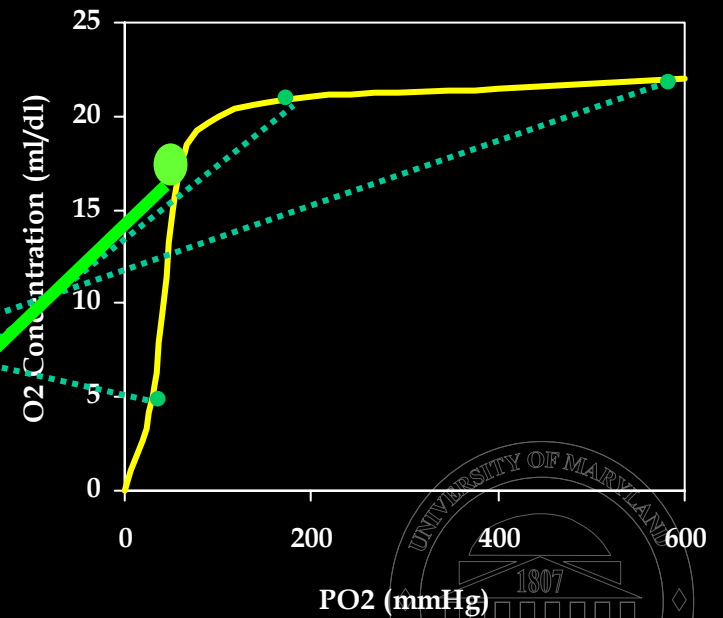
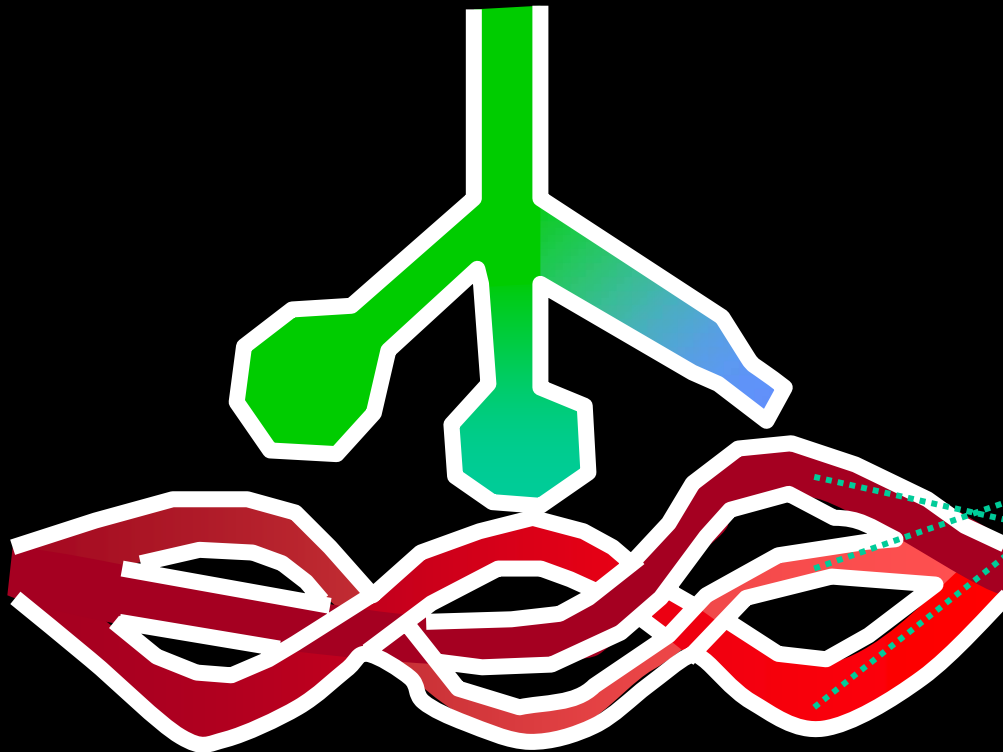
- Low PiO_2
- Hypoventilation
- Diffusion Defect
- Ventilation-Perfusion Mismatch
- Shunt



Physiologic Shunt

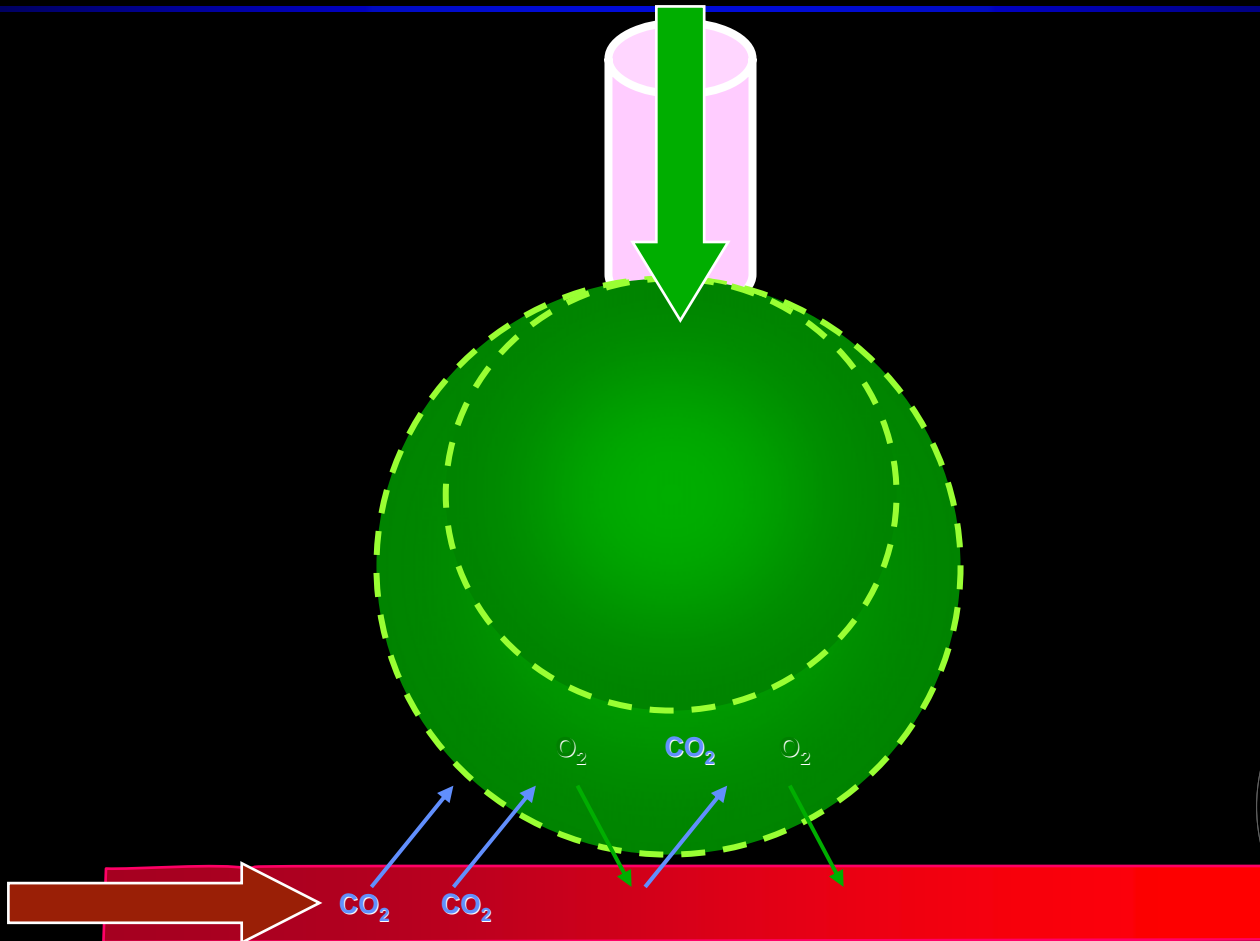


The Heterogeneous Lung



Shunt

EFFECT OF PEEP



Treatment

- Supplemental oxygen
- Bronchodilators
- Methylxanthines
- Secretion clearance
- Posture
- Investigate the cause



Goals of Mechanical Ventilation

- Improved gas exchange
- Reduced work of breathing
- Airway protection

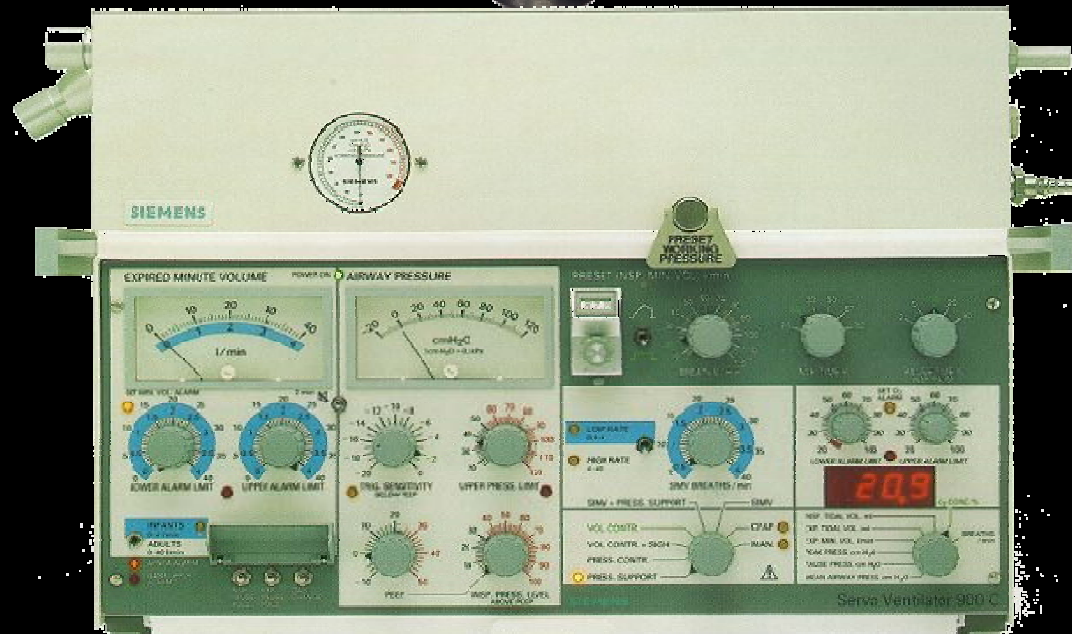


Indications for Mechanical Ventilation

- RR > 35/min
- Reduced maximum inspiratory pressure or vital capacity
- Minute ventilation <3L/min or >20 L/min
- PaO₂ < 55 mmHg despite supplemental O₂
- PaCO₂ acutely > 55 mmHg
- AaDO₂ on 100% FiO₂ > 450 mmHg
- “Looks bad” (e.g. cyanotic asthmatic with 3 prior intubations pointing to his airway)



The Managed Care Ventilator



MECHANICAL VENTILATION

Carl Shanholtz, M.D.
Medical Grand Rounds, July 17, 2002



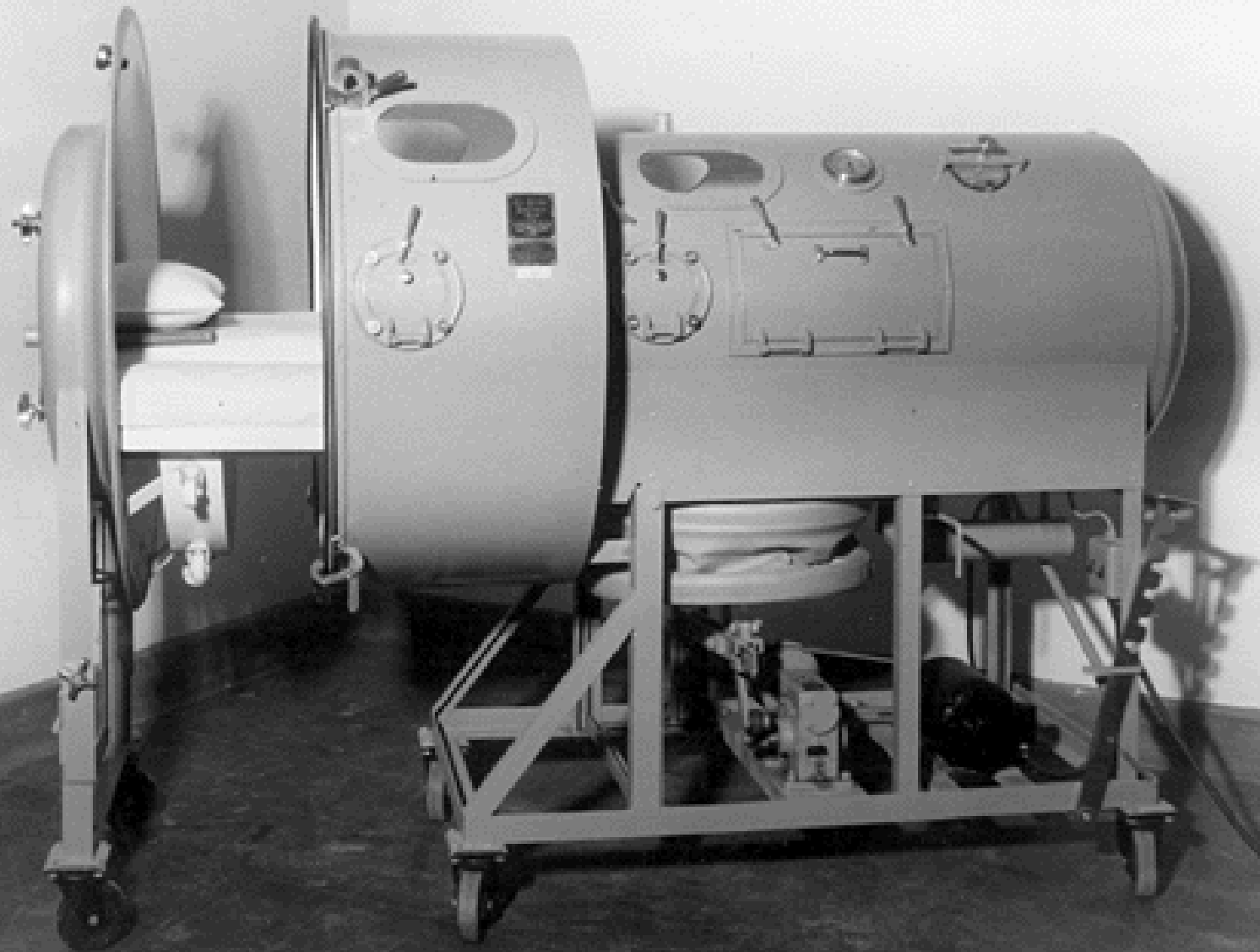
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MARLENE AND STEWART
GREENEBAUM CANCER CENTER



Iron Lung
CARRIE TINGLEY HOSPITAL
for Crippled Children
Hot Springs, N.M.



Work of Breathing

RESPIRATORY MUSCLE FUNCTION

EFFECTS OF HYPERINFLATION

