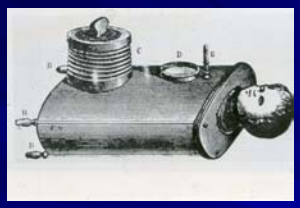
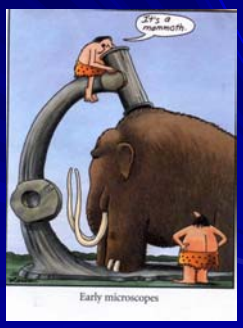


Monitoring Strategies for the Mechanically Ventilated Patient

Terry L. Forrette, M.H.S, RRT

Presentation Overview

- A look back into the future
- What works and what may work
  - What's all the hype about the WOB?
  - Are ventilator graphics really useful?
  - Has the era of non-invasive monitoring finally arrived?

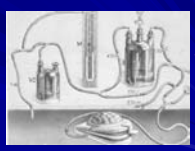


How It All Got Started

Early Monitoring Strategies

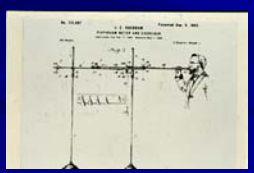
William Withering
1760

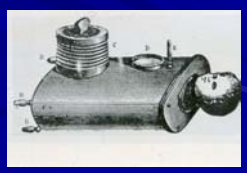
Stephen Hales - 1727



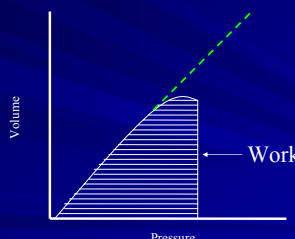
Early Perfusion Monitor

Early Attempts To Monitor WOB





Work: A Basic Feature In All Interactions



Work of Breathing Components

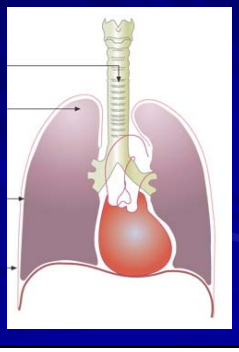
- Patient
  "physiologic"
  - Ventilatory pattern
  - Underlying disease
- Mechanical
  "imposed"
  - Circuit/airway
  - Mode of ventilation

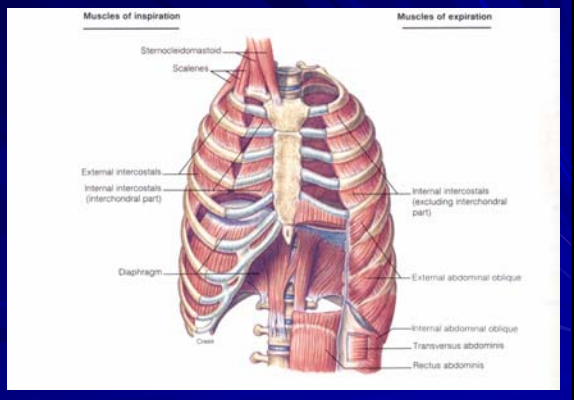
Physiologic Components of Work

Non-elastic work to overcome airway resistance

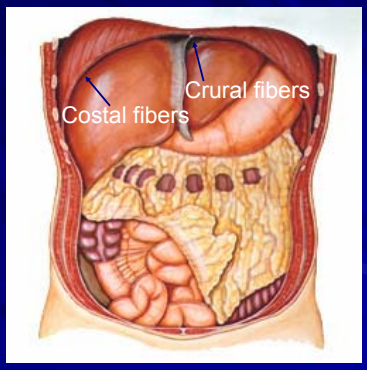
Elastic work to inflate the lungs

Elastic work to expand the thorax



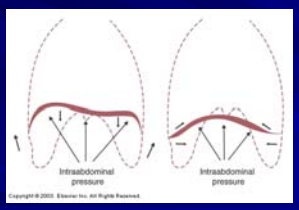


Diaphragmatic Function



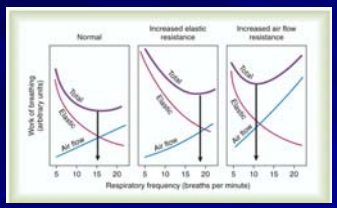
Physical Assessment for WOB

Checking for Paradox and Asynchrony



Determining Respiratory Muscle Function and Expansion

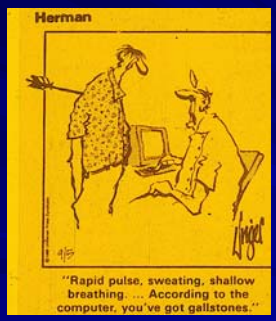
The Influence Of Rate & Tidal Volume On The WOB



Titrate Rise Time and Esens with this data

- Restrictive disease favors fast rates with smaller volumes
- COPD patients have less WOB with lower rates and larger volumes

Clinical Assessment



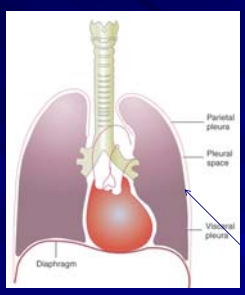
Strength
- NIF >- 20 to 30
- VC- 70- 80 mL/kg/IBW

Endurance
- RR 24- 38 br/min
- V_T 5- 7 mL/kg IBW
- RSBI < 105 br/L
- V_E 200 mL/kg IBW

Patient Comfort

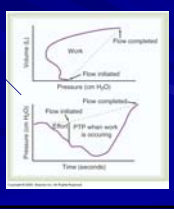
Measuring the WOB

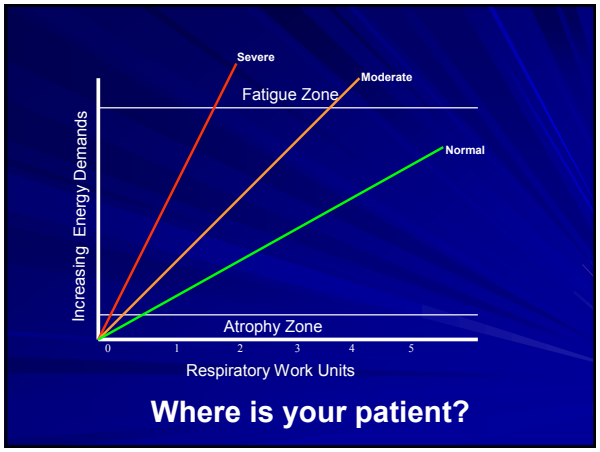
- Calculations
  - Airway/esophageal
  - Oxygen consumption
- Indirect
  - C_{LT}, Raw, VC
  - RSBI, NIF, P_{100}
- Graphics
  - PV and FV loops



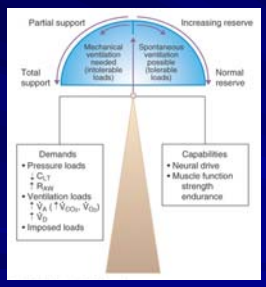
Esophageal Pressure Monitoring

- TTdi – tension time index and indicator of fatigue
- Pdi – trans diaphragmatic to measure work
- Independent measurements of lung and chest wall mechanics





Now It's Time to Let the Patient Do Their Share of the WOB

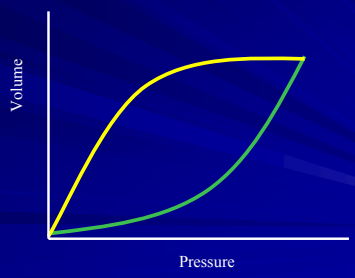


A Picture Is Worth …

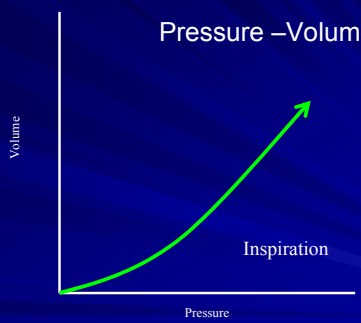
- Graphics – The essentials
- Evaluating lung mechanics
- Determining ventilator settings
- How often are they really used?

Pressure - Volume Curves

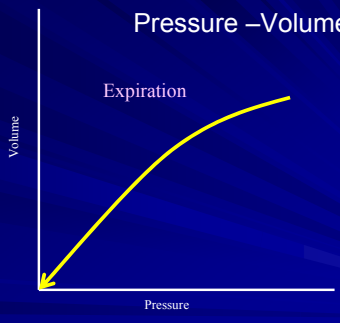
A Two Dimensional View



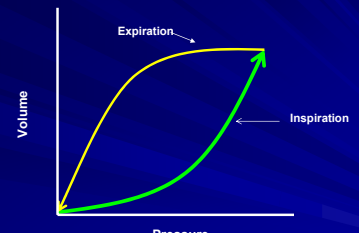
Pressure –Volume Curve

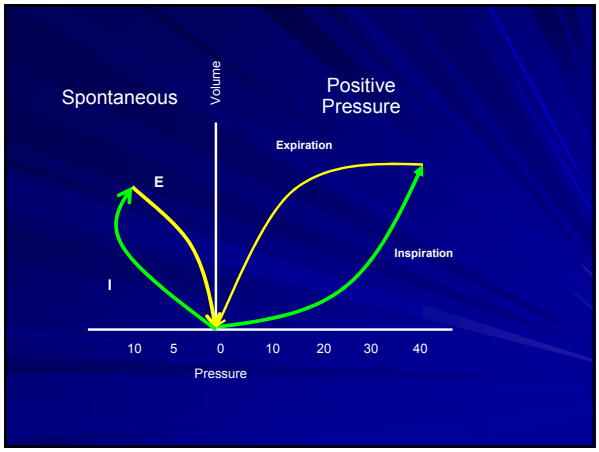


Pressure –Volume Curve

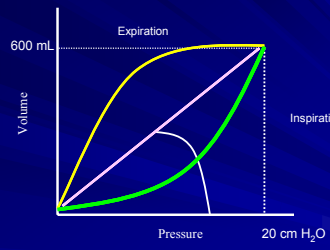


Pressure –Volume Curve



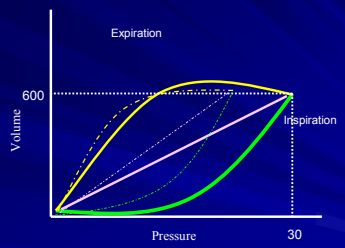


Normal Compliance



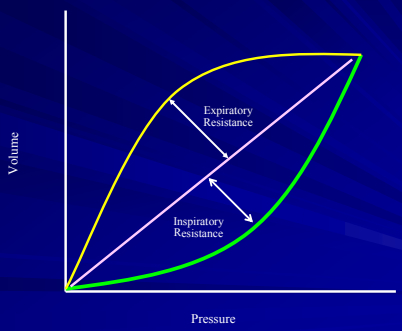
C = volume ÷ pressure
= 600 ÷ 20
= 30 mL/cmH_2O

Decreased Compliance

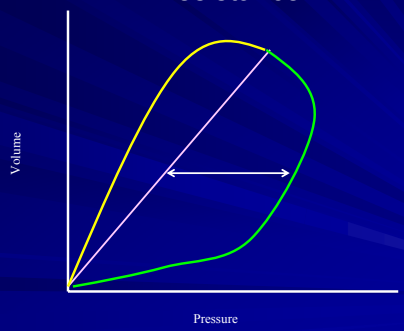


C = volume ÷ pressure
= 600 ÷ 30
= 20 mL/cm H_2O

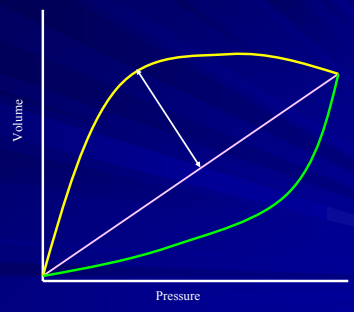
Airways Resistance



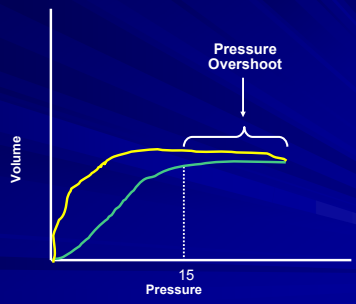
Increased Inspiratory Resistance



Increased Expiratory Resistance

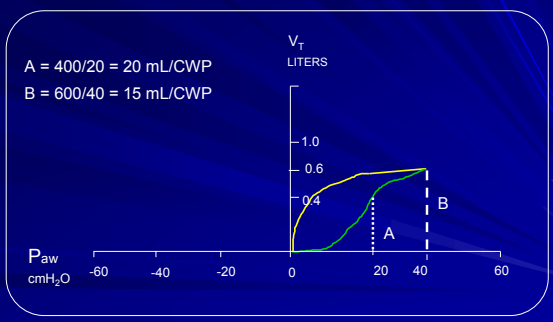


Inflection Points: What Do They Represent?

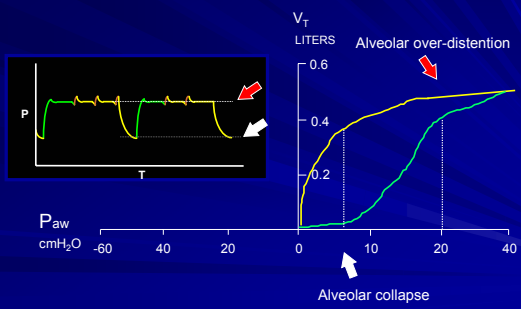


Maximizing PIP Levels

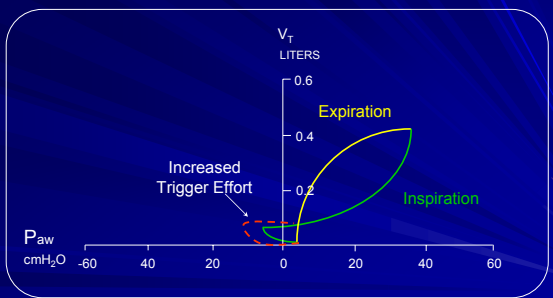
A = 400/20 = 20 mL/CWP
B = 600/40 = 15 mL/CWP



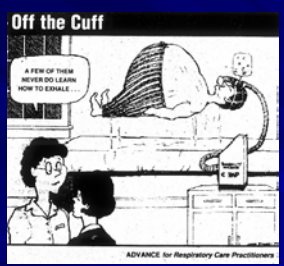
Upper And Lower Inflection Points



Increased Trigger Effort

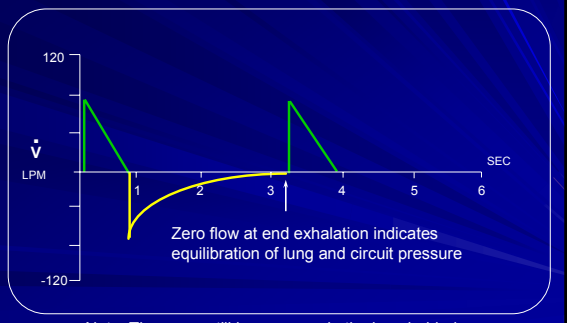


AutoPEEP



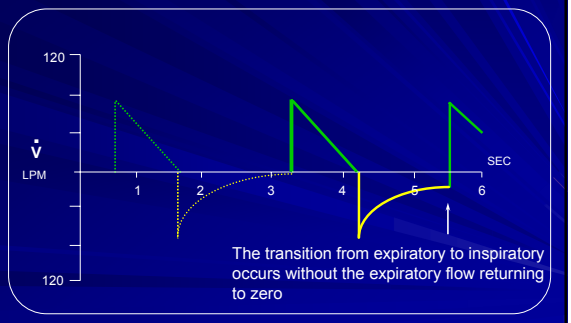
- Measures trapped air not reflected by Paw or PEEP
- Influences WOB, hemodynamics and lung mechanics
- Often essential in some modes of ventilation

Detecting Auto-PEEP

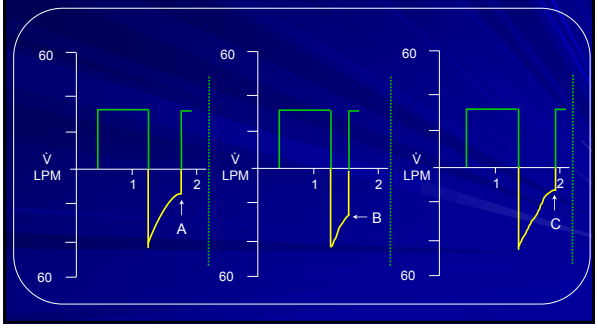


Note: There can still be pressure in the lung behind airways that are completely obstructed

Detecting Auto-PEEP

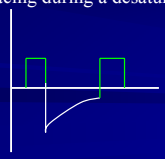


Auto-PEEP



AutoPEEP Case Study - 1

Mrs. KT suffered a CHI following an automobile accident. While being ventilated in VC, using AC, she showed erratic exhaled volumes, changes in BP, and required frequent sedation. ABG's showed moderated hypoxemia, with mild hypercapnia. Pulse oximetry was unstable and periods of desaturation were noted when the patient's exhaled V_T's became erratic. The following represents a typical flow-time tracing during a desaturation episode.



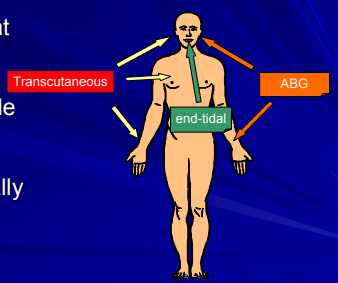
This patient was generating AutoPEEP leading to decreased S_PO_2 and erratic exhaled V_T.

Getting Ready For The Future, or Is It Already Here?

- Metabolic gas measurements: One more time!
- Transcutaneous CO_2 monitoring
- What's next?

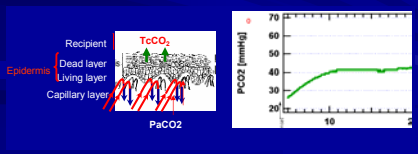
Monitoring Ventilation

- Invasive "gold standard" but what about cost and safety?
- $PetCO_2$ not reliable for NIV or with unstable V/Q
- $TcCO_2$, do we really want to go back there?



Transcutaneous CO2 Monitoring

- Improved response time
- Less frequent site changes
- Fewer membrane issues



Cardiovascular Technologies

Non-Invasive Cardiac Output

Integrated Phonocardiography and ECG

So, What's Next?

- Integration of patient data with real- time physiologic data?
- Moving towards 3 dimensional graphics?
- Combining pulmonary and cardiovascular data in a closed- loop system?

Comments and Questions

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