Monitoring Strategies
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 Monitor WOB
Work: A Basic Feature In All Interactions

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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

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Diaphragmatic Function

- Costal fibers
- Crural fibers

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**Physical Assessment for WOB**
- Checking for Paradox and Asynchrony

**Determining Respiratory Muscle Function and Expansion**

**The Influence Of Rate & Tidal Volume On The WOB**
- 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
  - Vt 5–7 mL/kg IBW
  - RSBI < 105 br/L
  - Ve 200 mL/kg IBW

**Measuring the WOB**
- **Calculations**
  - Airway/esophageal
  - Oxygen consumption
- **Indirect**
  - Rsbi, Nif, P100
- **Graphics**
  - PV and FV loops

**Esophageal Pressure Monitoring**
- **TTdi** – tension time index and indicator of fatigue
- **Pdi** – transdiaphragmatic to measure work
- Independent measurements of lung and chest wall mechanics

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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

Fatigue Zone
Aterophy Zone

Where is your patient?

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

Pressure - Volume Curves

Expiration

Inspiration

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Pressure –Volume Curve

Spontaneous Pressure

Normal Compliance

C = volume + pressure
= 600 + 20
= 30 mL/cm H₂O

Decreased Compliance

C = volume + pressure
= 600 + 30
= 20 mL/cm H₂O

Airways Resistance

Increased Inspiratory Resistance

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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

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Detecting Auto-PEEP

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

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 Vt’s became erratic. The following represents a typical flow-time tracing during a desaturation episode.

This patient was generating AutoPEEP leading to decreased S_o_2 and erratic exhaled Vt.

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?
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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
www.tlforrette.com

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