Mechanical Ventilation with HIE

Types and Modes of Ventilation
In neonates with Hypoxic-Ischemic Encephalopathy

Ganna Zalevska, RRT, BS
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Overview of Topics:

- Goals of Mechanical Ventilation
- Types of Ventilators
- Modes
- Settings
- Advantages and Disadvantages of Modes
- Nitric Oxide
Brain and HIE

- Uses 15% of body’s energy
- Does NOT store or hold energy
- Depends on constant O2 supply
Goals of Mechanical Ventilation

- Achieve and maintain adequate pulmonary gas exchange
- Minimize the risk of lung injury
- Reduce patient work of breathing (WOB) and
- Optimize patient comfort
Goals of CO2 for patients with HIE

Within the normal range (40-55 mmHg)
(Note: higher PaCO2 may be appropriate for certain infants with significant ventilator requirements)

• Infants who have suffered a hypoxic-ischemic insult will have resultant changes in metabolism that lead to less CO2 production.
• Hypothermia can reduce CO2 production as well.
Goals of PO2 for patients with HIE

- Keep PaO$_2$ in the range of 50-100 mmHg to prevent hyperoxic injury
- Avoid over ventilation
- ABG post resuscitation, manage ventilator to obtain goal PaO$_2$ and PaCO$_2$
Types of Ventilators used at UFHealth Shands

- Puritan Bennet 840 (most common)
- Sensory Medics 3100 A, 3100B (oscillator)
- Others (LTV, Trilogy, Baby Pack, MRI transport vent, etc.)
Modes of Ventilation (PB840)

- Pressure Control (PC)
- Volume Control Plus (VC+)
- Pressure Support (PS)
- Volume Support (VS)
- CPAP Mode
- High Frequency Oscillator
Pressure Control Ventilation (PCV)

- Pressure limited, time cycled ventilation that delivers a minimum minute ventilation

- Decelerating flow waveform - even distribution of ventilation

- Advantage:
  - Limiting pressure
  - Preferred method when there are leaks in the breathing system
Volume Control Plus

- Dual Mode – “Best of Both Worlds”

- Volume targeted pressure limited ventilation

- Clinician sets “Desired Volume” – ventilator delivers the smallest amount of pressure during any given breath to achieve the set volume
Pressure Support

- Patient must have intact respiratory drive (breathing spontaneously)
- Patient’s inspiratory effort is assisted by the ventilator at a preset level of inspiratory pressure
- Parameters Set: PS level/ PEEP/ FiO2/ Rise time/ Expiratory Termination/ Sensitivity level
- Advantages:
  - improves patient comfort
  - decreases ventilatory work
  - decreases respiratory rate
Volume Support (VS)

- Only for spontaneously breathing patients who still need partial support

Advantages:
- ✔ facilitate the weaning process from ventilator
- ✔ helps achieve a desired tidal volume using variable pressure support that depends on patient need
CPAP (Continuous Positive Airway Pressure)

- Keeps alveoli open and improves oxygenation by reducing the amount of blood shunted through atelectatic areas while the infant breathes spontaneously
- Prevents upper airway collapse
- Constant flow
- Decreases WOB
- Improves gas exchange
- Reduces apnea
- Increases Functional Residual Capacity (FRC)
- Improves oxygenation
What is High Frequency Oscillator?

- Defined by FDA as a ventilator that delivers more than 150 breaths/min.
- Delivers a small tidal volume, usually less than or equal to anatomical dead space volume.

**Advantages:**

- Maintain open lung volume
- Optimize oxygenation
- Combined with a technique that utilizes very high respiratory rates to deliver small tidal volumes
- Remove CO2
Combined Parameters of HFO
Oxygenation vs Ventilation

- **The Mean Airway** Pressure (Paw) is used to inflate the lung and optimize the alveolar surface area for gas exchange. Paw = Lung Volume

- **Amplitude**: Tidal Volume or Size of the Shake/Wiggle

- **Frequency**: Rate or Number of Shakes/Wiggles
  - Hertz (1 Hz = 60 cycles / minute)
Theory of Operation

- **Oxygenation:**
  - Mean Airway Pressure (Paw) and the FiO₂

- **Ventilation:**
  - Amplitude/ΔP and the Frequency/Hertz
Frequency

- Lower frequencies have a larger volume displacement
- Improved CO\textsubscript{2} elimination
RN vs RT

Why do poop when you can do P.E.E.P. instead?

Oh, you must work in a hospital too.

Original crude med-e-card humor from The Happy Hospitalist Blog