Mechanical Ventilation with HIE

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

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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

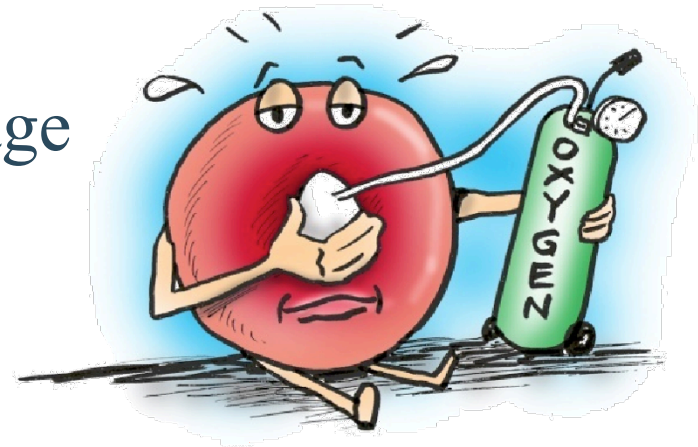
Within the normal range (40-55 mmHg)

(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 CO_2 production.
- Hypothermia can reduce CO_2 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.)

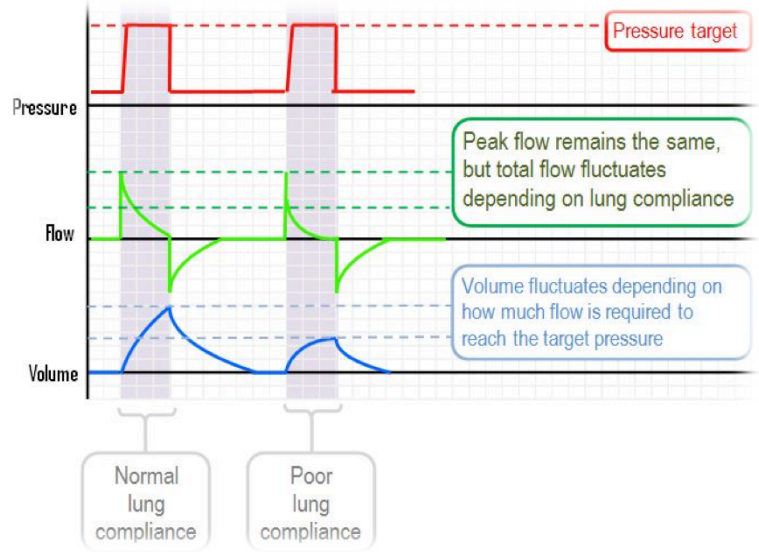
Modes of Ventilation (PB840)

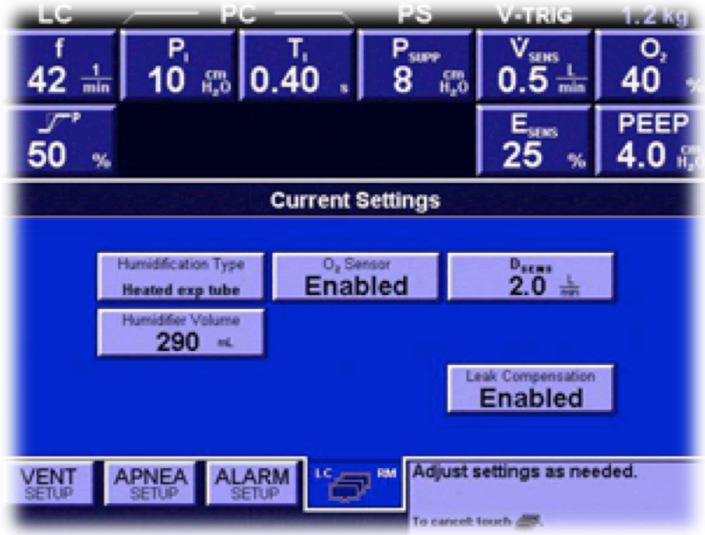
- Pressure Control (PC)
- Volume Control Plus (VC+)
- Pressure Support (PS)
- Volume Support (VS)
- CPAP Mode
- High Frequency Oscillator

Pressure Control Ventilation (PCV)

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

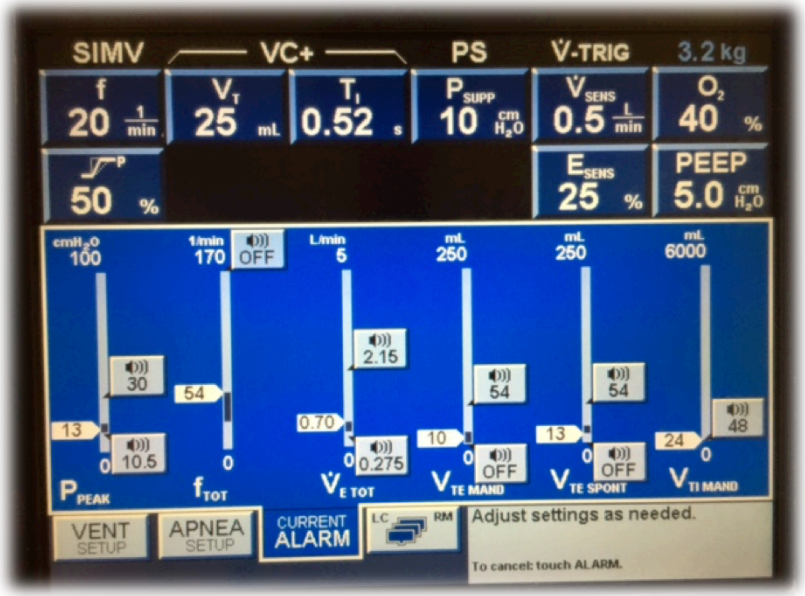
- Decelerating flow waveform -even distribution of ventilation
- Advantage:
  - ✓ Limiting pressure
  - ✓ Preferred method when there are leaks in the breathing system





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:

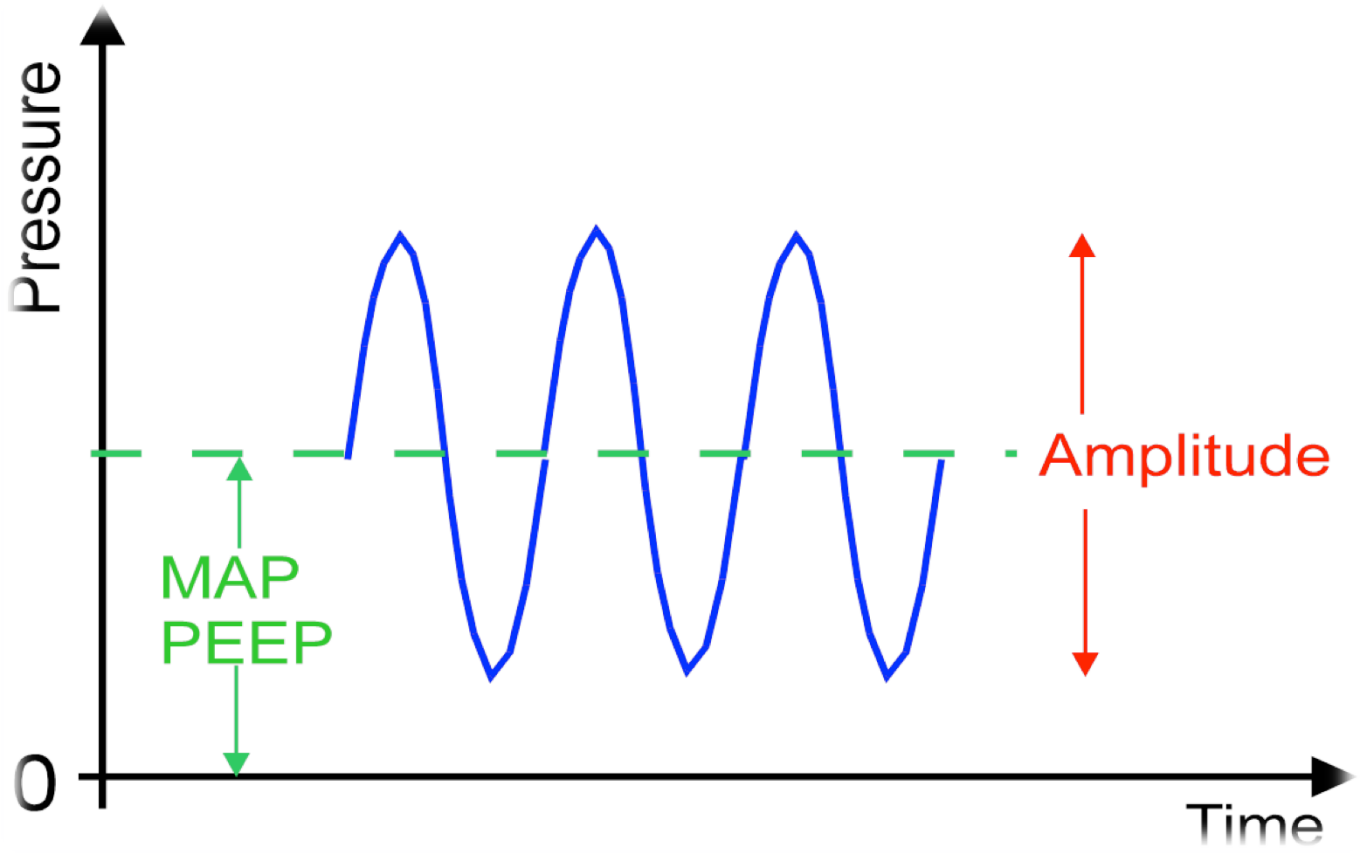
✓ Maintain open lung volume

✓ Optimize oxygenation

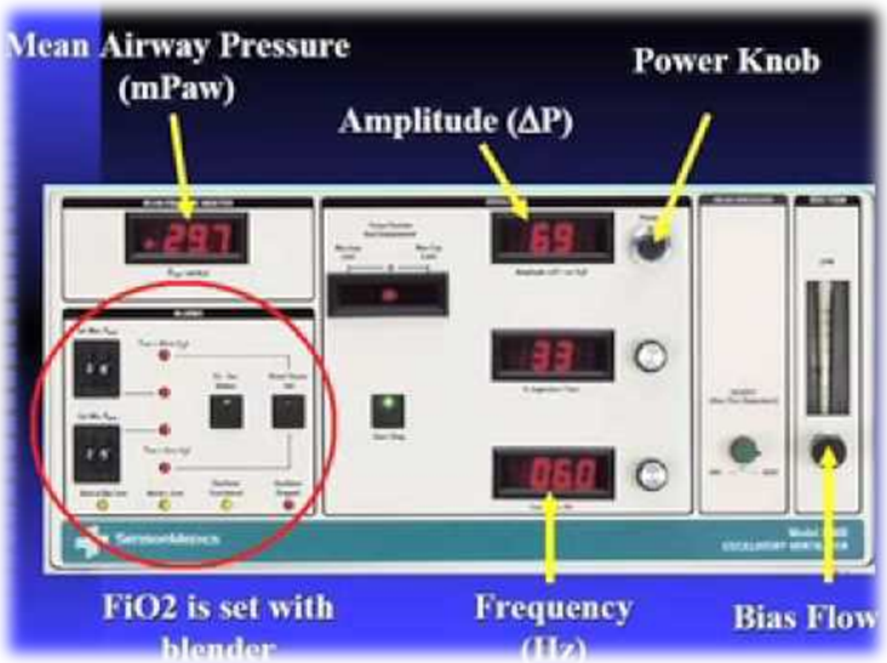
✓ Combined with a technique that utilizes very high respiratory rates to deliver small tidal volumes

✓ Remove CO2

Combined Parameters of HFO



Oxygenation vs Ventilation

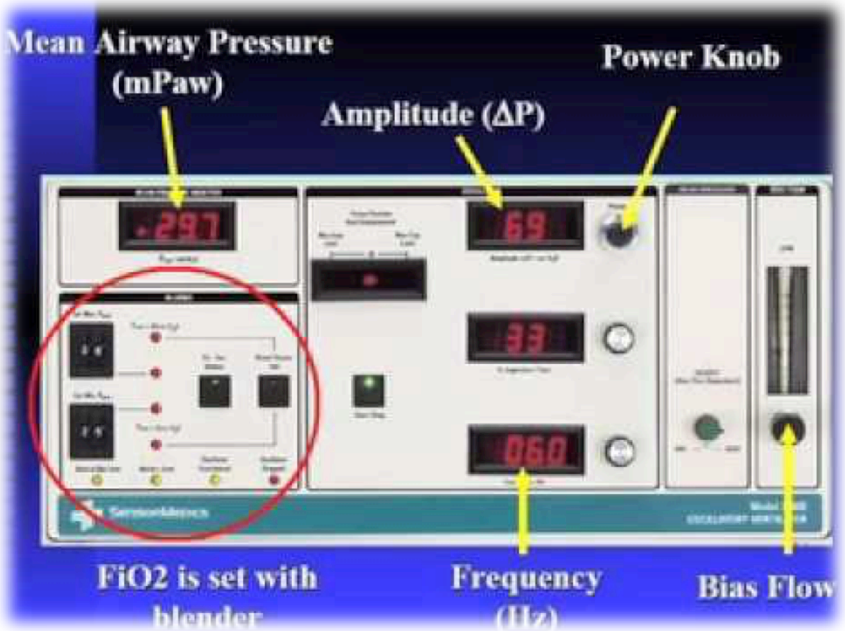


- **The Mean Airway** Pressure (Paw) is used to inflate the lung and optimize the alveolar surface area for gas exchange. Paw = Lung Volume
- **Amplitude**: Tidal Volume or Size of the Shake/Wiggle
- **Frequency**: Rate or Number of Shakes/Wiggles
- Hertz (1 Hz = 60 cycles / minute)

Theory of Operation

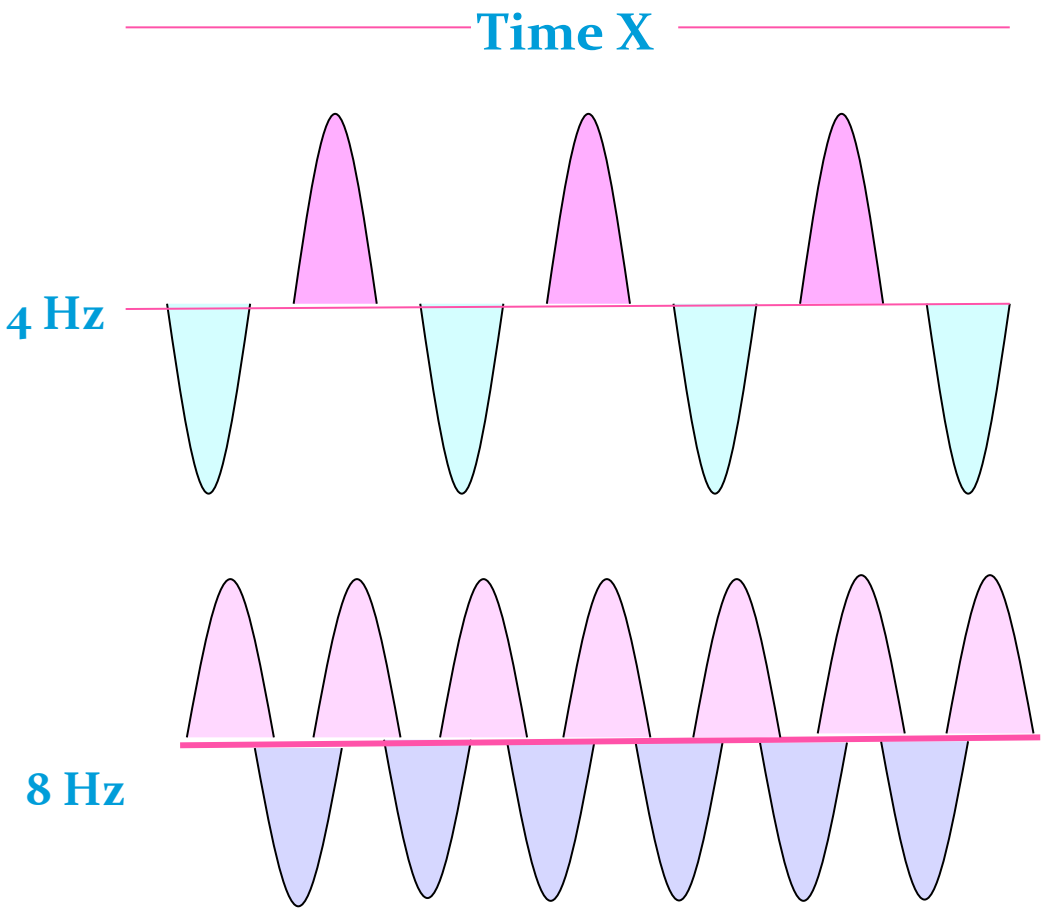
- <u>Oxygenation:</u>
- Mean Airway Pressure
- (Paw) and the FiO_2

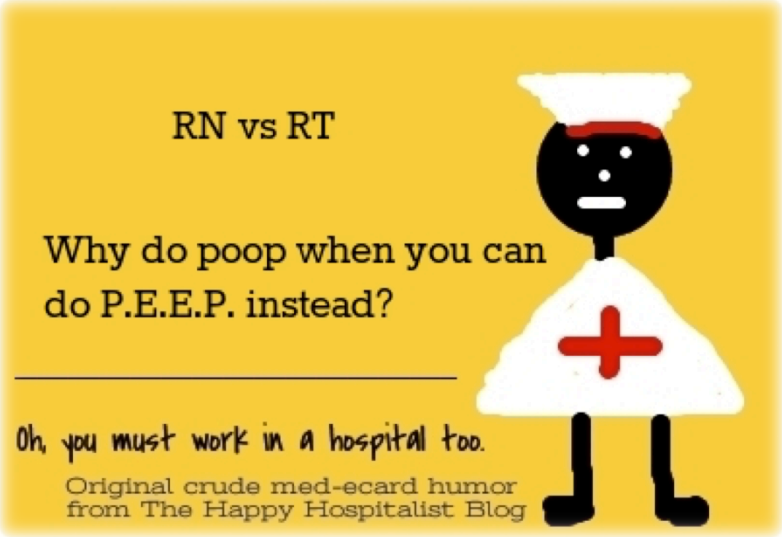
- <u>Ventilation</u> :
- Amplitude/ΔP and the Frequency/Hertz



Frequency

- Lower frequencies have a larger volume displacement
- Improved CO_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-ecard humor from The Happy Hospitalist Blog