Neonatal Ventilation

William Bucher RRT-NPS
Lead Therapist
Department of Respiratory Care
Respiratory Clinical Specialist
Women and Children Care Program
Thomas Jefferson University Hospital
Philadelphia, Pennsylvania

Neonatal Ventilation

- Early neonatal ventilation was primarily achieved by pressure ventilation (pressure limited, time cycled)
- Ventilators were not sophisticated
- Smallest TV available in Volume ventilation (minimum was 100 ml)
- More sophisticated ventilators have changed things – much better control and lower TV available

Neonatal Ventilation

- Primary goal for RT during MV is to prevent or reduce lung trauma
- Historically, biggest concern was causing pressure trauma
- In reality, volutrauma is our biggest concern as it creates lung damage that leads to loss of elasticity.

Ventilator Parameters

- In adults, we now ventilate with low TV of 6-8 ml/kg IBW
- Similar for neonates but use 4-6ml/kg IBW
- For neonates, their body weight = IBW
- A 500g baby would have a TV of 2-4 ml

Ventilator Parameters

- AC and SIMV modes most frequently used
- Starting to see a lot more Pressure Regulated Volume Control (in AC or SIMV)
- Just like adults, the pressure needed to deliver TV is based on compliance & resistance
- Respiratory rate – initial rate on traditional ventilator is a "normal" rate which is typically 30-40 bpm. This may vary based on patient condition

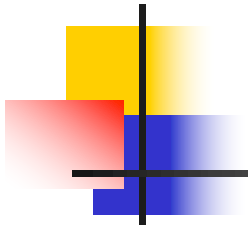
Ventilator Parameters

- FiO2 – use the lowest FiO2 to maintain SaO2 appropriate for neonate
- SaO2 range for infants is different than adults
- Normal PaO2 for infant:
  - 500-1500g is 50-60 mmHg
  - 1500-2500g is 60-70 mmHg
  - > 2500g is 70-90 mmHg
- This means low weight neonates have SaO2 of 88-92% while full term is typically 90-96%

Ventilator Parameters

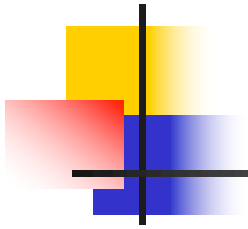
- PEEP – used to increase Functional Residual Capacity (FRC)
- Evaluate lung inflation by auscultation, CXR, etc.
- Avoid overinflation and/or underinflation (both noted by increase in $PaCO_2$ and decrease in PaO_2 due to air trapping)

Controlling PaCO2



- Remember that minute ventilation (TV x VE) is what controls PaCO2
- Tidal Volume is adjusted by set inspiratory pressure in Pressure Control and adjusted by the the set Tidal Volume in Volume Control
- If Pressure Support is in use, remember that it effects the neonate's spontaneous TV. Keep an eye on that volume – sometimes it is higher than the set TV!

Controlling PaO2



- Use PEEP and FiO2 just like in adults
- Very important to wean FiO2 as quickly as possible – neonates are more susceptible to oxygen toxicity than adults.

MAP & Weaning

- Remember that EVERY setting other than ViO2 affects mean airway pressure
- When thinking about weaning a neonate, most will go to some sort of therapy – typically CPAP (Jefferson Health uses Bubble CPAP).
- Try to get MAP to $\leq$ 9 cmH2O and FiO2 < 40%
- When extubating to CPAP, match the CPAP to MAP but remember patient is going from closed to open system and will lose some lung recruitment. May need to increase FiO2

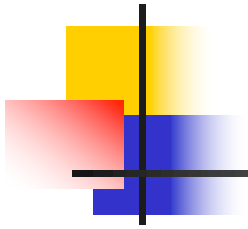
High Frequency Oscillator

- Parameters include MAP, Amplitude, Frequency (hertz) and FiO2
- Volume changes are less than conventional ventilation.
- Alveolar volume is essentially zero!
- How it actually works is really not known!
- Much gentler on lungs!

High Frequency Oscillator

- Basically a glorified CPAP
- MAP provides CPAP level to inflate the lungs to recruit alveoli
- The Delta pressure is what moves the aira in and out but the volume doesn’t reach the aveoli.
- Frequency (rate) is set in hertz. 1 hertz is 60 bpm. Typically set at 10-15 hertz (600-900 bpm)

High Frequency Oscillator



Ventilation

- Determined by the amplitude primarily
- Amplitude (ΔP) generates the tidal volume which is less than anatomical dead space

High Frequency Oscillator

Effect of Frequency

- Ranges from 3hz to 15 Hz
- Decreasing frequency will increase alveolar amplitude, thus increasing ventilation causing PaCO2 to decrease
- Increasing frequency will decrease alveolar amplitude, thus decreasing ventilation causing PaCO2 to rise

High Frequency Oscillator

Oxygenation

- Higher mean airway pressure recruits more alveoli and decreases atelectasis
- Optimal MAP is determined by chest radiograph- inflation to 8-9 ribs
- Utilize FiO2 at lowest level possible

High Frequency Jet Ventilator

- Like the Oscillator, unclear how it actually works!
- Bernoulli's effect is utilized
- Bi-direction ventilation
- Jet ventilator is used in conjunction with conventional ventilator.
- Conventional ventilator provides PEEP (which Jet cannot)

High Frequency Jet Ventilator

- Early on, used conventional ventilator to deliver low PEEP and added sigh breaths
- No longer utilized
- Parameters
  - PIP (set on Jet)
  - PEEP (set on convent. vent and monitored on Jet)
  - RR (set on Jet)
  - FiO2
  - Background breath (sigh breaths)

High Frequency Jet Ventilator

- PEEP is set initially around 6 cmH2O
- RR is typically set at 420 bpm
- PIP is set to deliver good volume (noted by good vibration from nipple line to umbilicus)

High Frequency Jet Ventilator

- Servo
  - Servo any device that senses a change in a condition and compensates for it
- Servo pressure
  - Fluctuates like PIP with patient activity and position

High Frequency Jet Ventilator

- Monitor Servo pressure!
  - Decreased by:
    - Decreased compliance
    - Increased resistance
    - Obstructed ETT
  - Increased by:
    - Increased compliance
    - Decreased resistance
    - Leak in system
  - Increased servo pressure is usually good but, may indicate leak

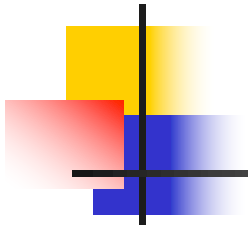
High Frequency Jet Ventilator

Adjustment / Weaning

- Decrease PIP slowly (1-2 cmH2O)
- Decrease PEEP, which controls the MAP, to 8 or less as consistent with oxygenation
- Decrease FiO2 to 30%
- Change to CPAP or NCPAP when PIP < 15 cmH2O and CMV rate at or near CPAP

Wrap Up / Questions

- Remember, volutrauma is the biggest enemy of neonatal ventilation – avoid it at all costs!
- Utilize appropriate TV and FiO2
- HFOV and HFJF are options!



Thank You!!