Challenges in Neonatal Ventilation

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Conflict of Interest

- Nihon Kohden
- Draeger
Overview

- What does the literature tell us?
- Challenges with implementing the recommendations
  - Soft Recommendations
  - Airway Leaks
  - Tidal Volume Accuracy/Flow Sensors
Current Evidence

- Long term effects of invasive ventilation
  - Hyperventilation with hypocapnea causes cystic brain lesions and Periventricular Leukomalacia
  - Hypercapnea increases the risk of intraventricular hemorrhage.
  - Ventilation with low PIP and PEEP can lead to atelectrauma and VILI
  - Bronchopulmonary Dysplasia
Current Evidence

- MV increases both cerebral pressure and fluctuations in cerebral and venous flow velocities

- Elevated levels of inflammatory cytokines found with lung injury are also believed to cause white matter damage
Current Evidence

- Routine suctioning and repositioning of ETT changes cerebral hemodynamics and oxygenation
Current Evidence

- **Neurodevelopmental Disorder Risks with Mechanical Ventilation**
  - 10 year retrospective review of follow-up info for ELBW infants born between 1998-2001
    - MV for ≥ 15 days increases the risk for CP and ADHD even without significant neonatal brain damage
    - No correlation to Autism Spectrum Disorders or intellectual disability
    - Recommend developing brain-protective respiratory support strategies in response to real-time hemodynamic and oxygenation changes

NIV when able

- SUPPORT Trial:
  - 35% of 24-28 wk randomized to CPAP arm required intubation in the delivery room
  - 83% required intubation as some point during the trial
  - Major causes were:
    - Poor gas exchange
    - Increased WOB
    - Apnea
    - Need for surfactant

- Avoid hypo and hypercapnia
Current Evidence

- How we ventilate and each setting we choose makes a bit difference
  - Mode
  - PEEP
  - I-Time
Current Evidence

Control vs Assist

- Control Mode – lend to stable oxygenation and ventilation

- Assist modes allow patients to trigger controlled breath on their own.

- Advantages of assist modes:
  - Lower and more consistent airway pressures → less intracranial pressure swings
  - Increased patient comfort → less sedation & quicker extubation times
  - Greater synchrony → less gas trapping & air leaks
  - Improved oxygenation & ventilation
To Synchronize or not?

- Advantages of synchronized assist modes are:
  - Larger more consistent tidal volumes
  - Greater oxygenation and ventilation
  - Lower WOB
  - Lower respiratory rate
  - no difference in mortality
Current Evidence

❖ Volume vs Pressure

- RCT volume vs pressure (target 5-8ml/kg) as initial strategy in pre-term neonates with RDS
- Volume control group had shorter ventilation time (p<.001)
- Volume control had trend toward lower BPD (p=0.09)

Current Evidence

❖ Volume vs Pressure

▪ 2010 Cochrane Review – included 12 RCTs comparing volume targeted ventilation and pressure control.

▪ Volume targeted ventilation reduced the following outcomes compared to pressure ventilation:
  
  • Death or CLD – NNT 8
  • Pneumothorax – NNT 17
  • Hypocarbia – NNT 4
  • PVL or grade 3-4 IVH – NNT 11

▪ Various volume targeted modes were used therefore none can be considered superior
Current Evidence

**PEEP**

- Several animal studies have suggested that reducing tidal volume and using appropriate PEEP can reduce lung injury
  - Wada et al. J Appl Physio 1997

- Recruitment maneuvers in NICU mostly occur with HFV not CMV. Evidence suggest it could be helpful in determining appropriate PEEP as well as reduce lung injury
  - Rimensberger et al. Crit Care Med 1999
Current Evidence

- **Inspiratory Time**
  - Too short or too long inspiratory times contribute to asynchrony.
  - 2004 Cochrane meta-analysis on the affects of I-Time on air leak, BPD and mortality.
    - Long I-Time (> 0.50s) associated with increased rates of air leak and mortality before discharge
    - No difference in rates of BPD
    - Studies included in review were prior treatment with:
      - Antinatal steroid
      - Surfactant administration
      - Newer ventilation strategies
Current Evidence

- I-Time Too Long
Challenges

- Proximal Flow Sensors
- Large Airway Leaks
- Too many options
- When to admit defeat
  - If you are not growing, you are not ventilating well
Challenges

- Ventilator recognition and ability to synchronize with patient effort
  - Proximal Flow sensors
    - Extra weight
    - Mechanical dead space
    - Alarms and additional disconnects
Challenges

- **Large Airway Leaks**
  - Inaccurate Vt
  - Inability to volume ventilate
  - Unable to maintain FRC
  - Reduced ability to trigger / asynchrony
  - Auto-triggering

- **Leak Compensation**
  - Adds flow to circuit to maintain PEEP

- **How much leak is too much?**
Challenges

- Remember the basics of ventilation and lung injury
  - Use enough PEEP
  - Don’t over distend
  - Utilize Graphics to assist
Challenges

During CMV, there are swings between the zones of injury from inspiration to expiration.
Challenges
Challenges

- **When to Trach**
  - Murthy et al sought to determine risk of death or tracheostomy in infants with sBPD referred to regional NICUs
  - Primary outcome death or tracheostomy before discharge
  - performed a retrospective cohort of infants with sBPD born <32wks in 2010 and 2011 from the children’s Hospital Neonatal Database.
  - sBPD was defined as:
    - Need for FiO2 > 30%
    - Nasal cannula > 2 lpm
    - or
    - Positive pressure at 36 wks CGA
Challenges

- **When to Trach**
  - Results – all associated with risk of death or tracheostomy:
    - Later gestational age at birth
    - Later age at referral for pulmonary management
    - Mechanical ventilation at time of referral
    - Clinically diagnoses with PHTN
    - Systemic corticosteroids after referral
    - Occurrence of blood stream infection after referral

Recap

- Consistent tidal volumes (4-5 cc/kg)
- Appropriate I-Time
- Appropriate PEEP
- Permissive Hypercapnia
- Brain-supportive respiratory strategies
More Questions

- How do we determine the best PEEP level?
- How much airway leak is acceptable?
- When is the best time to intubate?
- What are brain-supportive respiratory strategies?
- Should nutrition play a bigger role?
- Future research need to look at total patient not just short term ventilation.
Questions?