Neonatal Mechanical Ventilation  
Retargeting Volume Ventilation

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The speaker has signed a disclosure form and indicated he has no significant financial interest or relationship with the companies or the manufacturer(s) of any commercial product and/or service that will be discussed as part of this presentation.

Session Summary

In this session the speaker will provide a review of concepts involved in ventilator associated lung injury, the role of tidal volume control, as well as the evidence for the use of volume targeted ventilation in neonatal ventilation.

Session Objectives

Upon completion of this presentation, the participant will be able to:

- recognize ventilator associated lung injury;
- understand the role of long volume in lung injury;
- know the difference between volume targeted ventilation and pressure regulated;
- be acquainted with literature about volume targeted ventilation;
- understand the practical aspects of the use of VTV;
- give examples of VTV.

References


Session Outline

See presentation handout on the following pages.
NEONATAL MECHANICAL VENTILATION RETARGETING VOLUME VENTILATION

AMIR M KHAN, MD

Modes of ventilation

<table>
<thead>
<tr>
<th>TCPL</th>
<th>VC</th>
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</thead>
<tbody>
<tr>
<td>Rate</td>
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<tr>
<td>PIP</td>
<td>Fixed</td>
</tr>
<tr>
<td>PEEP</td>
<td>Fixed</td>
</tr>
<tr>
<td>TV</td>
<td>Variable</td>
</tr>
<tr>
<td>I-time</td>
<td>Fixed</td>
</tr>
<tr>
<td>Flow</td>
<td>Decelerating</td>
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</table>

Barotrauma vs Volutrauma

- Animal studies showed that VILI occurred more with higher pressures.
- Occurred with higher lung volume when high pressures were kept constant.
- Occurred with large volume with negative pressure ventilation.
- Permissive Hypercapnea

Lung Volume and injury

- There are 2 injury zones during mechanical ventilation:
  - Low lung volume ventilation tears adhesive surfaces
  - High lung volume ventilation over-distends, resulting in volutrauma

Common Issues in Pressure Limited Ventilation

- Stable PIP but highly variable tidal volumes
- Risk of hypoventilation
- Risk of overdistention and subsequent lung injury

Pressure limited ventilation

- Things that can be done to control TV in pressure regulated ventilation
  - Manual control
  - Volume targeted ventilation
Volume targeted ventilation

- Some feed control of pressure to control the volume delivered
- Maintain decelerating flow characteristics
- Allow control of I-time
- Allow peak pressure control

Potential Advantages of using Volume targeted ventilation

- A more stable tidal volume in the face of changing compliance, resistance and changing ET-tube leak
  - Should produce a more stable PaCO₂
- Reduction in lung injury from overdistension
  - Less volume trauma
- Reduced peak inspiratory pressures where the patient is making a significant contribution to VT
  - May reduce barotrauma
- As the patient's lungs improve and compliance increases, e.g. following surfactant therapy, peak inspiratory pressure is weaned automatically
Modes of ventilation

<table>
<thead>
<tr>
<th>Mode</th>
<th>TCPL Rate</th>
<th>VG Rate</th>
<th>PRVC Rate</th>
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<td>Fixed</td>
<td>Fixed</td>
</tr>
<tr>
<td>PIP</td>
<td>Fixed</td>
<td>Variable but max limited</td>
<td>Variable but max limited</td>
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<tr>
<td>PEEP</td>
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<tr>
<td>TV</td>
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<td>Expiration</td>
<td>Inspiration</td>
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VTV and death

VTV - BPD

VTV and failure of ventilation

VTV- Duration of IPPV
**VTV- Oxygen need during IPPV**

**VTV and hypocarbia**

**VTV- hypercarbia**

**VTV - PDA**

**VTV - Any airleak**

**VTV - Pneumothorax**
VTV- Grade III/IV IVH

<table>
<thead>
<tr>
<th>Study</th>
<th>VTV–GrIII/IV</th>
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<th>Weight</th>
<th>FrGas</th>
<th>VTV–GrIV</th>
<th>Weight</th>
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<tr>
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<td>53</td>
<td>0.017</td>
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</tr>
</tbody>
</table>
| Severe IVH or PVL

Volume targeted ventilation—literature
- Singh et al jped 2006
- Mean time to reach primary outcome (AaDO2-100mmHg or MAP of <8 for 12 hours) was 21 (95% CI 17-24) hours in the VC group versus 58 (95% CI 42-74) (p=0.03) in <1000gms group. Overall there was trend towards faster weaning in VC. 23 vs 33

Volume targeted ventilation—VG
- Indications:
  - Virtually any infant requiring mechanical ventilation, especially when:
    - Lung mechanics are likely to change
    - The patient has a variable respiratory effort, periodic breathing or apnea

- Contraindications:
  - Cannot be successfully used if endotracheal tube leak is >40%
  - VG better than PRVC in small infants

Indications and Contraindications of using Volume Guarantee
- Indications:
  - Virtually any infant requiring mechanical ventilation, especially when:
    - Lung mechanics are likely to change
    - The patient has a variable respiratory effort, periodic breathing or apnea

- Contraindications:
  - None
  - (Cannot be successfully used if endotracheal tube leak is >40%)
How to start VG or PRVC

- Choose the targeted volume
  - 4-6 ml/kg Premature
  - Less than 3 ml/kg may be problematic
  - 6-8 ml/kg Term and older
- Select Maximum PIP (may be 30-35 CWP)
- Choose the rate and PEEP and I-time

Starting a Newborn Infant on VG

- Choose desired ventilation mode: SIMV, SIPPV (A/C) or PSV
- Activate VG Option by depressing < On > button

Adjusting VTV and weaning

- Good practice to check physical chest movements and chest x-rays
- Adjust rate mostly to affect CO2
- Increase volume if on high rate
- Decrease volume once better if higher than usual
- Should be extubatable once on low rate

VTV trouble shooting

- VT not delivered (Drager)
  - Max pressure or I-time or flow too low
  - Check for plug in the ET tube, bad position
  - Air leak too much
  - Also assess compliance related issues

VTV trouble shooting

- PRVC-High CO2 or work of breathing
  - Adjust TV because measured at inspiratory block and may not be accurate in small patients. New versions will have sensor at the Wye
- PRVC not available in neonatal mode on Avea. Lowest TV is 30ml (5-6kg)

Birth weight 0.65Kg
Birth weight = 0.79kg

Birth weight = 0.70kg