High Frequency Ventilation Outline
Part A

1. How is this ventilator classified?

2. Ventilator Concept (brief theory of operation and features)
   - What in the World is a Phasitron?
   - Operator Set Parameters
   - Variable Parameters
   - Indications
   - Contraindications

3. An overview of the device (an in-service) including an explanation of the modes of ventilation and how to set them up (what knobs to turn)
   - Ventilator Overview and Controls
   - Ventilation and Oxygenation
     - Ventilation
     - Oxygenation
   - Clinical Application Conclusion

4. Ventilator Circuit set up, Functional Checks. Ventilation….where do you start? Use with Nitric Oxide
   - Set up and Functional Check
     - Set-up Procedure
     - Functional Check
   - High Frequency with Nitric Oxide

5. Which disease processes do best with what ventilator settings and why
   - Strategies for Clinical Management
6. Clinical things to look for and be aware of during flight when using this device

7. Why is this device so useful on transport and how has using this device changed things for your transport team, and the way you care for the patient during transport.

8. Discuss how the device can be mounted or positioned during transport (configurations)

9. Provide “clinical tips” regarding use of this device (tips that make things easier or less complicated)

10. Are there any special considerations when integrating this device into your transport program (education, mounting/configuration issues, regulations, calibration, maintenance)
High Frequency Ventilation

1. How is this ventilator classified?

The ventilator is classified as a pneumatically powered, pressure limited, time cycled, high frequency flow interrupter.

2. Ventilator Concept (brief theory of operation and features)

Compared to conventional ventilators this ventilator delivers high frequency breaths. With the unique Phasitron, which is the mechanical/physiological interface, these breaths are precisely delivered to selected pressures. (see below).

Exhalation is passive, to a selected operator programmed baseline.

-What in the World is a Phasitron?
  - The Phasitron is the Mechanical/Physiological interface.
  - The Phasitron is a sliding venturi that acts as both the inhalation and exhalation valve.
  - As gas is pulsed through the jet orifice, humidified and blended gases are entrained through the entertainment port and delivered to the patient at programmed limits.
  - As amplitude is reached and the lungs are inflated, backpressure is reflected to the venturi results in a decrease in flow, this is known as fluidic clutching.
  - The Phasitron also allows for “Oscillatory Equilibrium” which is, during the inspiratory phase the desired amplitude is reached, inspiratory and expiratory volumes equalize, further enhancing diffusion and the mixing of gases.
-Operator Set Parameters
  • Amplitude
  • High Frequency Rate
  • FIO2
  • Mean Airway Pressure ((P\textsubscript{aw}),

-Variable Parameters
  • Flow
  • Volume

-Indications
  • Respiratory failure
  • Significant air leak syndrome
  • Failing conventional ventilation

-Contraindications
  • Untrained individual managing ventilator

3. An overview of the device (an in-service) including an explanation of the modes of ventilation and how to set them up (what knobs to turn)
• **Air/Oxygen Blender**

• **Operational Pressure Knob (Not Shown)**
  Adjusts the working pressure of the ventilator.
  Set to 40-45 psi.
  Integrated into the incubator.

• **Multimeter**
  Displays the following parameters when a pressure is detected:
  - Frequency
  - Mean Airway Pressure
  - Time on patient
• **Frequency Control**  
  Controls high frequency rate from 200-700bpm with an automatic I:E ratio.

• **Amplitude**  
  Determines the amplitude of the high frequency breaths.

---

**-Ventilation and Oxygenation**

• **Ventilation**  
  - Control over arterial PCO2 is achieved by manipulating delivered volumes and less on frequency changes.  
  - Know the physiology of the machine as well as the disorder you are treating.  
  
  \[ HF = \dot{V}CO_2 = (V_T)^2 \times f \]

  - Amplitude: small changes in tidal volume are very powerful  
  - Decrease oscillatory frequency, the lower the high frequency rate the greater the inspiratory time the more high frequency volume delivered.

*Make one change at a time and wait for stabilization before making subsequent changes.*
**Oxygenation**
- Control over arterial PO2 is achieved by the manipulation of mean airway pressure and or FiO2.

- A near linear relationship exists between lung volume and oxygenation. The parameters that will have the most effect over oxygenation in order of importance are:
  - Increase FiO2 to increase alveolar pO2 in both CMV and HFV
  - Increase mean airway pressure (P\textsubscript{aw}).
    - Normal mean lung volume is proportional to mean airway pressure
    - Tidal volumes are so small, need to have optimal lung volumes or expansion
    - Fine line with lung volume. Major short-term impact of excessive lung volume may be impaired blood flow and trauma.
  - Amplitude (tidal volume)-effects ventilation
    - Not much affect on O2 except if patient has atelectasis or patchy infiltrates may open up lung and improve oxygenation i.e. MAS or pneumonia.
    - Using amplitude to improve oxygenation usually means P\textsubscript{aw} is to low.
  - Increase Pulse Frequency
    - High frequencies produce a greater mean airway pressure
    - Faster you go, more likely to air trap
    - Increased rate in air trapping disorder will decrease oxygenation due to air trapping.

**Clinical Application Conclusion**

- In the face of a difficult clinical scenario with worsening ventilation and or oxygenation, complete assessment of the patient should be made to find the cause for V/Q inequalities.

<table>
<thead>
<tr>
<th>Ventilation</th>
<th>Oxygenation</th>
<th>Perfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lungs over-distended</td>
<td>FiO2</td>
<td>Blood volume to low</td>
</tr>
<tr>
<td>Alveolar hypoventilation</td>
<td>Sepsis</td>
<td>Ventilator induced hypovolemia</td>
</tr>
<tr>
<td>Secretions</td>
<td></td>
<td>Low hematocrit</td>
</tr>
<tr>
<td>Edema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronchoconstriction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumothorax</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Why is High frequency ventilation if Necessary?
  - Change in regionalization of care
  - Availability of HFV
  - Availability of NO
  - Decrease in number of ECMO centers
  - Severity of cardiopulmonary dysfunction

4. **Ventilator Circuit set up, Functional Checks.**

Ventilation….where do you start?
-HF with Nitric Oxide
- Set up Phasitron and tubing
- Place NO adapter with tubing on Phasitron
- Set desired HFV settings
- Set up Aeronox
- When the system flush is complete, connect delivery and sample line to nitric adapters
- Adjust NO to desired level
- PPM will fluctuate with any change in ventilator settings.

5. Which disease processes do best with what ventilator settings and why

- Strategies for Clinical Management
  - **Hyaline Membrane Disease / Diffuse Alveolar Disease in the Preterm**
    - Mean airway pressure: 1-2 cm H2O > conventional ventilation
    - Frequency: 500 bpm
    - Amplitude: Chest wall movement
  
  - **Diffuse Alveolar Disease in the Term / Near Term**
    - Mean airway pressure: 2-4 cm H2O > conventional ventilation
    - Frequency: 500 bpm
    - Amplitude: Chest wall movement
  
  - **Pneumonia / Sepsis (focal pneumonia)**
    - Mean airway pressure: equal to or 1 cm H2O < conventional ventilation
    - Frequency: 380-420 bpm
    - Amplitude: Chest wall movement
  
  - **Meconium Aspiration (with air trapping)**
    - Mean airway pressure: equal to conventional ventilation
    - Frequency: 350-400 bpm
    - Amplitude: Good chest wall movement
  
  - **Meconium Aspiration (diffusely hazy)**
    - Mean airway pressure: 2-5 cm H2O > conventional ventilation
    - Frequency: 350-500 bpm
- Amplitude: Good chest wall movement

- Pulmonary Hypoplasia (uniform)
  - Mean airway pressure: equal to conventional ventilation. Advance 1 cm H2O until oxygen saturation increases
  - Frequency: 500 bpm
  - Amplitude: Minimal chest wall movement

- Pulmonary Hypoplasia (non-uniform)
  - Mean airway pressure: equal to or 1-2 cm H2O > conventional ventilation
  - Frequency: 500 bpm
  - Amplitude: Chest wall movement

- Severe Air Leak in the Preterm (PIE)
  - Mean airway pressure: 1 cm H2O < conventional ventilation
  - Frequency: 500 bpm
  - Amplitude: Minimal chest wall movement

- Gross Air Leak in the Preterm
  - Mean airway pressure: equal to or 1 cm H2O > conventional ventilation
  - Frequency: 500 bpm
  - Amplitude: Chest wall movement

- Gross Air Leak in the Term / Near Term
  - Generally poor inflation
  - Mean airway pressure: 1-2 cm H2O > conventional ventilation
  - Frequency: 500 bpm
  - Amplitude: Chest wall movement

- Persistent Pulmonary Hypertension of the Neonate
  - Mean airway pressure: equal to conventional ventilation
  - Frequency: 350-420 bpm
  - Amplitude: Adjust amplitude for alkalosis if needed

6. Clinical things to look for and be aware of during flight when using this device

-CXR after stabilized on HF
  - Aeration, rib expansion
    - Check where liver is, rib spacing
  - Make sure ETT is secure before moving patient
  - Difficult to assess chest wiggle “on the road”... TCM is nice, I-stat
  - P\textsuperscript{aw} can drift if patient compliance changes
  - Watch vent settings closely while plugging and unplugging from hospital/aircraft/ambulance

7. Why is this device so useful on transport and how has using this device changed things for your transport team, and the way you care for the patient during transport.

-pneumatically driven, no EMI interference
- small and lightweight
- gas consumption
- compatible with NO
- decrease barotrauma
- improve pt stability
- patients already on HFV easier to move

8. Discuss how the device can be mounted or positioned during transport (configurations)

9. Provide “clinical tips” regarding use of this device (tips that make things easier or less complicated)

- carry spare parts
- Grease “O” rings when cleaning tubing and putting phasitron back together
- Peep valves break easily, we replace them yearly
- not able to achieve chest wiggle, PIP etc... change diaphragm
- Frequency does not always read out when on test lung start w/ballpark, adjust on patient.
- One adjustment may change other settings.
- 2.0 ETT, may need to really increase settings to effectively oxygenate/ventilate patient.

10. Are there any special considerations when integrating this device into your transport program? (education, mounting/configuration issues, regulations, calibration, maintenance)