Newport HT50
Ventilator Orientation and Training
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http://www.newportnmi.com/HT50.asp
Objectives

- To become familiar with the operation of the HT50 ventilator
- To become familiar with the different modes of ventilation available
- To become familiar with basic ventilator management
Mechanical ventilation is the process of using devices to totally or partially provide oxygen and carbon dioxide transport between the environment and the pulmonary capillary bed. The desired effect of mechanical ventilation is to maintain appropriate levels of oxygen and carbon dioxide in arterial blood while also unloading the ventilatory muscles.
Respiratory failure is caused by failure to ventilate, characterized by increased arterial carbon dioxide tension, or failure to oxygenate, characterized by decreased arterial oxygen tension.
Definitions

- **Ventilation:** The process that exchanges gases between the external environment & the alveoli. It is the mechanism by which oxygen is carried from the atmosphere to the alveoli & by which carbon dioxide is carried from the alveoli to the atmosphere.

- **Respiratory Failure:** Inability to maintain either the normal delivery of oxygen to the tissues or the normal removal of carbon dioxide from the tissues. Generally, failure is marked by a oxygen level greater than 50 mm Hg &/or a carbon dioxide level greater than 60 mm Hg in otherwise healthy individuals.
Definitions

- **f** – frequency, number of breaths per minute set on the ventilator that will be delivered to the patient
- **Vt** – Tidal volume, amount of air delivered to the patient with each volume breath in ml
- **It** – Inspiratory time, time for each inspiration during a volume breath in seconds
- **PEEP** – Positive End Expiratory Pressure, amount of pressure in the lungs during expiration in cmH$_2$O
Definitions

- **Pressure control** – the amount of pressure (in cmH$_2$O) used to deliver a breath to the lungs
- **Volume control** – the volume delivered (in mls) to the lungs with each breath
- **Pressure support** – the amount of pressure given with each spontaneous breath
Volume Targeted Ventilation

- Set tidal volume (Vt) 5–7 ml/kg
- Inspiratory cycle ends when tidal volume delivered
- Ventilator generates sufficient pressure to deliver set volume
- Independent of airway resistance
- Independent of lung compliance
- High-pressure limit alarm
- Limited current use
- Alveolar stretch injury
Pressure Targeted Ventilation

- Constant inspiratory pressure
- Tidal volume becomes variable
- Affected by airway resistance, lung compliance, patient effort
- Causes of decreased tidal volume
  - Increased resistance
  - Decreased compliance
  - Decreased patient effort
  - Low minute ventilation alarm
## Basic Ventilator Types

<table>
<thead>
<tr>
<th>Volume Control (VC)</th>
<th>Pressure Control (PC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Controls</strong></td>
<td><strong>Controls</strong></td>
</tr>
<tr>
<td>Rate</td>
<td>Rate</td>
</tr>
<tr>
<td>PEEP</td>
<td>PEEP</td>
</tr>
<tr>
<td>FiO₂</td>
<td>FiO₂</td>
</tr>
<tr>
<td>Inspiratory Time</td>
<td>Inspiratory Time</td>
</tr>
<tr>
<td>Tidal Volume</td>
<td>Peak Inspiratory Pressure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Relative Advantages/Disadvantages</strong></th>
<th><strong>Relative Advantages/Disadvantages</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Known tidal volume (Vt)</td>
<td>No guarantee of tidal volume (Vt)</td>
</tr>
<tr>
<td>Risk for barotrauma</td>
<td>Pressure limited</td>
</tr>
<tr>
<td></td>
<td>Decreases risk of barotrauma</td>
</tr>
</tbody>
</table>
The Newport HT50 ventilator is a compact, versatile and durable machine. It is relatively simple to use and has a long battery life. All of these qualities make it useful for emergency situations.

The State of Alaska has distributed a number of these vents to facilities in Alaska and keeps a stockpile for use in an emergency.

This course will familiarize a health care provider with basic knowledge of respiratory management with the functions of the HT50.
Pressure manometer

Alarm silence button

Manual breath button

Negative pressure required to cycle the ventilator by the patient

Amount of positive pressure at the end of each breath

Amount of pressure given with each spontaneous breath

Breath per minute delivered to patient

On/off button
Newport HT50 Orientation

Time in seconds for each breath

f = breaths per minute delivered by ventilator

Volume control – the volume used to deliver a breath to the lungs

Pressure control – the amount of pressure used to deliver a breath to the lungs
Flow rate

High pressure alarm

Low pressure alarm

High volume alarm

Low volume Alarm

Assist control mechanical ventilation

Synchronized Intermittent ventilation

Spontaneous breathing

Inspiratory to expiratory ratio
Calibration Procedure for Exhalation Valve Prior to Ventilator Use:

1. Always connect the HT50 to AC power when performing the exhalation valve calibration.

2. Connect the HT50 patient breathing circuit to the ventilator. Connect the patient connection (exhalation valve) of the breathing circuit to an adult (500 mL) test lung or occlude the patient connection.

3. Press the *On/Standby* button once to enter *Settings* condition.

4. Press the *Manual Inflation* button once, then again within three seconds.
5. The HT50 will start the EZ Cal and the ventilator will automatically test the exhalation valve. If it passes the test, the messages “Cal Completed”, then “Press ON to Vent” will be displayed.

5a. If the test fails, the message “Cal Failed” will be displayed

5b. Press the *Silence/Reset* button

5c. Check the integrity of the circuit, connections and test lung, then press the *Manual Inflation* button twice to initiate calibration again

6. When calibration is finished, adjust patient settings appropriately, then press *On/Standby* to begin ventilation.
Assist /Control Mandatory Ventilation (A/C)

- A\C can be used in either pressure or volume mode.
- The patient will receive the number of breaths set on the frequency display plus the patient can trigger an assisted breath.
- Patient will receive either the volume or pressure set with each mandatory or triggered breath.
Assist Control

- Frequency
- Patient Trigger 2-4
- PEEP
- Vt 4-8 ml/kg
- AC Control
- Adjust your settings up or down
- I:E Ratio
- On/off button
- Set Your Alarms High & Low

- Set Your Alarms High & Low
Synchronized Intermittent Mandatory Ventilation (SIMV)

SIMV – mandatory ventilation and patient’s spontaneous breaths are synchronized with the patient's respiratory cycle; if the patient makes no respiratory effort, the machine automatically delivers breath based on the rate set on the ventilator.
SIMV/PS Control

- **Patient trigger**
- **PEEP**
- **Pressure support**
- **Tidal Volume**
- **I-Time**
- **frequency**
- **SIMV mode**
- **Set Your Alarms High & Low**
- **Adjust your settings up or down**
- **On/off button**
Spontaneous Mode

- Patient will trigger the ventilator at the pressure support you have set at whatever rate he wants. Vt will vary as patient’s compliance changes.
CPAP Mode

- Patient trigger Set 2-4
- PEEP
- Pressure Support
- High Pressure Alarm

Adjust your settings up or down

Spontaneous Mode
- **f**: infant = 20–30 Breaths Per Minute (bpm)
- **f**: child = 16–20 bpm
- **f**: teen = 12–16 bpm
- **Vt** = 4–8 ml/kg using either pressure or volume ventilation
- **PEEP** = 5 cmH₂O
- **FiO₂** = 100%
- Pressure support to achieve desired **Vt**
- **It** = 0.4–0.6 seconds
Endotracheal tubes in small children are uncuffed, because of the anatomic differences of the larynx.

In adults, the vocal cords form the narrowest portion of the larynx and trachea, necessitating stabilization of the tube with a cuff.

In small children, the cricoid ring is the narrowest portion, and its circular lumen stabilizes the tube without the need for a balloon cuff.
# Endotracheal Tube Sizes

## Color-Coded Length - Base Resuscitation Tape

<table>
<thead>
<tr>
<th>Color</th>
<th>Weight (kg)</th>
<th>ET-tube (mm)</th>
<th>ET Insertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pink (Small Infant)</td>
<td>6–7</td>
<td>3.5 uncuff</td>
<td>10.5–11</td>
</tr>
<tr>
<td>Red (Infant)</td>
<td>8–9</td>
<td>3.5 uncuff</td>
<td>10.5–11</td>
</tr>
<tr>
<td>Purple (Toddler)</td>
<td>10–11</td>
<td>4.0 uncuff</td>
<td>11–12</td>
</tr>
<tr>
<td>Yellow (Small Child)</td>
<td>12–14</td>
<td>4.5 uncuff</td>
<td>13.5</td>
</tr>
<tr>
<td>White (Child)</td>
<td>15–18</td>
<td>5.0 uncuff</td>
<td>14–15</td>
</tr>
<tr>
<td>Blue (Child)</td>
<td>19–23</td>
<td>5.5 uncuff</td>
<td>16.5</td>
</tr>
<tr>
<td>Orange (Large Child)</td>
<td>24–29</td>
<td>6.0 cuff</td>
<td>17–18</td>
</tr>
<tr>
<td>Green (Adult)</td>
<td>varies</td>
<td>6.5 cuff</td>
<td>18.5–19.5</td>
</tr>
</tbody>
</table>

**If you want a cuffed ET-Tube Subtract 0.5 size down 4.5 uncuffed = 4.0 cuffed**

**#* ET Tube placement may vary - Chest X-Ray to verified placement**

Information from AHA-PALS
To control pH and pCO$_2$, you manipulate the minute ventilation, therefore you adjust the respiratory rate and tidal volume.

To control pO$_2$, you manipulate the oxygen delivery and the VQ match, therefore you adjust the FiO$_2$ and the mean airway pressure (PEEP and PIP).
### Ventilator Management Guideline Table

<table>
<thead>
<tr>
<th>Increase in:</th>
<th>pCO₂</th>
<th>PO₂</th>
<th>Mean Airway Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FiO₂</strong></td>
<td>no change</td>
<td>increase</td>
<td>no change</td>
</tr>
<tr>
<td><strong>Rate</strong></td>
<td>decrease</td>
<td>usually no change</td>
<td>increase</td>
</tr>
<tr>
<td><strong>Peak Inspiratory Pressure / Tidal Volume</strong></td>
<td>decrease</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td><strong>Inspiratory Time</strong></td>
<td>usually no change</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td><strong>PEEP</strong></td>
<td>usually no change</td>
<td>increase</td>
<td>increase</td>
</tr>
</tbody>
</table>
**pCO₂**

- **pCO₂ Too High:**
  - Patient’s minute ventilation is too low
  - Increase rate (f) or Vt or both
  - If using Pressure Control (PC) ventilation, increase PIP
  - If PIP too high, increase the rate instead

- **pCO₂ Too Low:**
  - Minute ventilation is too high
  - Lower either the rate (f) or Vt
pO2

- Decrease the FiO₂
- When FiO₂ is less than 40%, decrease the PEEP slowly to 3–5 cm H₂O

- Increase either the FiO₂ or the Mean Airway Pressure (MAP)
- Try to avoid FiO₂ > 70%
- Increasing the PEEP is the most efficient way of increasing the MAP
- Can also increase the Inspiratory time (I–time) to increase the MAP (in PC)

pO2 High:

pO₂ Too Low:
**PIP Too High**

- Decrease the PIP (PC) or the Vt (VC)
- Increase the I–time (VC)
- Change to another mode of ventilation

Generally, pressure control achieves the same Vt at a lower PIP than Volume Control

- If the high PIP is due to high airway resistance, generally the lung is protected from barotrauma unless air–trapping occurs
Acute Deterioration

DIFFERENTIAL DIAGNOSES

- Pneumothorax
- Right mainstem intubation
- Pneumonia
- Pulmonary edema
- Loss of airway
- Airway occlusion
- Ventilator malfunction
- Mucus plugging
- Air leak
Acute Deterioration

- Tracheal shift
  - Pneumothorax
- Wheezing
  - Bronchospasm
  - Mucus plugging
  - Pulmonary edema
  - Pulmonary thromboembolism
Acute Deterioration

- Asymmetric breath sounds
  - Pneumothorax
  - Mainstem intubation
  - Mucus plugging with atelectasis

- Decreased breath sounds bilaterally
  - Tube occlusion
  - Ventilator malfunction
  - Loss of airway
Complications

- Pulmonary
  - Barotrauma
  - Ventilator–induced lung injury
  - Nosocomial pneumonia
  - Tracheal stenosis
  - Tracheomalacia
  - Pneumothorax
Complications

- High-inspired concentrations of oxygen (fraction of inspired oxygen \([\text{FiO}_2]\) > 0.5) result in free-radical formation and secondary cellular damage. These same high concentrations of oxygen can lead to alveolar nitrogen washout and secondary absorption atelectasis.
The heart, great vessels, and pulmonary vasculature are subject to the increased intrathoracic pressures associated with mechanical ventilation. The result is a decrease in cardiac output due to decreased venous return to the right heart (dominant), right ventricular dysfunction, and altered left ventricular distensibility.
Renal, Hepatic, and Gastrointestinal Effects

- Gastrointestinal
  - Ileus
  - Hemorrhage
  - Pneumoperitoneum
- Renal
  - Fluid retention
- Nutritional
  - Malnutrition
  - Overfeeding
Extubation

Prerequisites to extubation include:
1) A good cough/gag (to allow the child to protect their airway)
2) NPO about 4 hours prior to extubation (in case the trial of extubation fails and reintubation is required)
3) Minimize sedation
4) Adequate oxygenation on 40% FiO₂ with CPAP (or PEEP) = 4
5) The availability of someone who can reintubate the patient, if necessary
6) Equipment available to reintubate the patient, if necessary
7) Disease process is resolving
Alarm Settings

- Adjust high and low tidal volume (Vt) alarms 10% above and below the average values for Vt
- Adjust high and low pressure alarms 5 cmH₂O above and below the peak airway pressure (shown on the pressure manometer)
Further Information

- Consult the ventilator instruction manual or guide for more information.
- Respiratory therapists from either Providence Alaska Medical Center: (907) 212–2633 or the Alaska Native Medical Center: (907) 729–1931 are available at any time for a consultation about the HT50 or any emergency ventilation questions.
http://www.newportnmi.com/HT50.asp

The Newport website provides a comprehensive interactive guide for the HT50. Click on the tab at the bottom of the page above titled *Interactive guide*
This course was brought to you by the MEP–P (Medical Emergency Preparedness – Pediatrics) Project, and was funded by a grant from the federal government to the state of Alaska to increase preparedness for Alaska’s children.
QUESTIONS?