HUMIDIFICATION AND AEROSOL DELIVERY DURING MECHANICAL VENTILATION USING CAPILLARY FORCE VAPORIZATION (C-FORCE™)

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BACKGROUND

- To compare a device using capillary force vaporization[1] (Hydrate™; Pari Respiratory Equipment, Midlothian, VA) to conventional humidification systems during mechanical ventilation.

METHODS

- The C-Force™ was integrated into a modified ventilator circuit to measure water vapor delivery. The device consists of a water pump and a heater plate designed to sit at the Y-piece. The heater plate was set at 130°C. The water pump rate was adjusted to achieve a Y-piece temperature of 35°C, as measured by a thermocouple from a conventional humidification system. A condenser tube was used to condense and measure some of the water vapor generated (Figure 1).

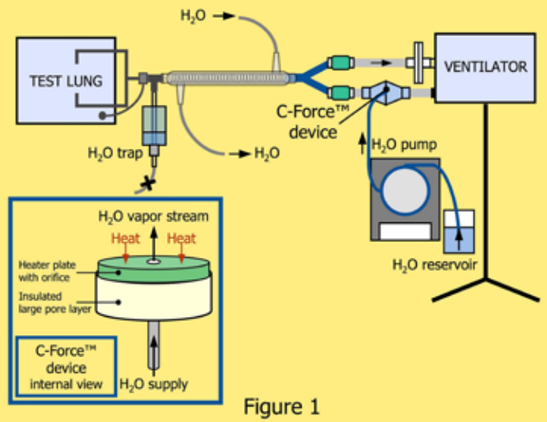

Figure 1

- Hygrometric measurements were made and used to determine the absolute humidity (AH) of the gas which escaped the condenser. Using the AH, the amount of water vapor which escaped the condenser was calculated. This allowed us to determine the amount of water delivered. The same was done for a non-heated wire (NHWH) and heated wire humidifier (HWH). In addition, we measured the amount of water each device consumed from its water reservoir in order to determine device efficiency (water delivered / water consumed). Experiments were performed using three different ventilators (Drager 4 NeoFlow, Puritan Bennett 7200, T-Bird AVS III) and two different breathing patterns (V_t=750, RR=15 and V_t=400, RR=15). Aerosol delivery was determined by nebulizing radiolabeled albuterol with an AeroTech II nebulizer. Each humidification device was evaluated with the PB7200 (breath actuated nebulization, V_t=750, RR=15). An inhaled mass (IM) filter was placed at the end of the ETT to determine albuterol that would be delivered to a patient expressed as percentage of nebulizer charge.

RESULTS

- As shown in figure 2, C-Force™ delivered 15.0±2.0, 15.7±0.8, and 8.7±0.5 mL water/hr at V_t=400, and 30.7±0.3, 28.9±1.0, and 16.9±1.2 mL water/hr at V_t=750 using the Drager, PB7200 and T-Bird ventilators respectively. C-Force™ performance was similar to NHWH and superior to HWH except for the T-Bird.

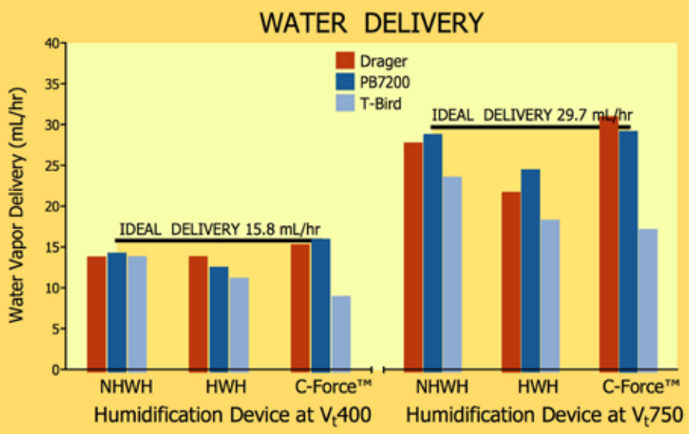

Figure 2

- Figure 3 shows the efficiency for each device. HWH and C-Force™ had similar efficiencies while using the Drager and PB7200 ventilators. Both were more efficient than NHWH. Efficiency was reduced when using the T-Bird and C-Force™ in combination.

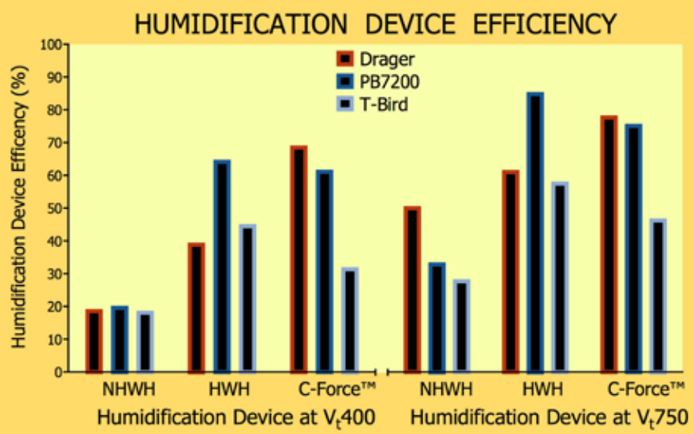

Figure 3

- Inhaled mass as a percent of neb charge was 9.5±1.6, 13.7±0.9, and 16.0±1.2 % for the NHWH, HWH, and C-Force™ respectively (Figure 4).

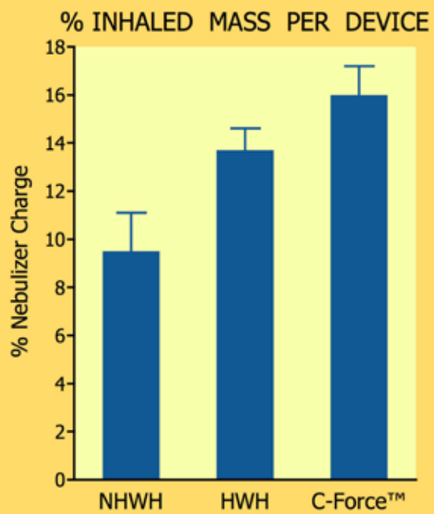

Figure 4

CONCLUSIONS

- ✓C-Force™ is an effective method for humidifying a ventilator circuit.
- ✓C-Force™ eliminates inspiratory line condensation, uses sterile water efficiently, and provides greater aerosol delivery during humidification use when compared to conventional systems.
- ✓Humidification device performance is reduced due to bias flow (T-Bird ventilator).

REFERENCES:
[1]RDD Europe 2005, Vol 1, (2005): pp 229-232

SUPPORTED IN PART BY:
Pari Respiratory Equipment, Midlothian, VA