How Do Different Methods of Humidification Affect Drug Delivery to a Simulated Patient Receiving Mechanical Ventilation

Nagel, M,[1] Schloss, J,[2] Doyle, C,[1] Ali, R,[1] Suggett, J,[1] & Coppolo, D[2]
[1] Trudell Medical International, London, ON, Canada [2] Monaghan Medical Corp, Plattsburgh, NY, USA

PURPOSE

Humidity can be introduced to the ventilation circuit via a traditional heated humidifier or a heat and moisture exchange (HME) filter that uses the patient's own moisture from exhalation to maintain humidity during mechanical ventilation. Traditional HMEs remove medication during aerosol delivery and therefore need to be removed from the circuit before providing aerosol therapy. It is desirable to not break the ventilation circuit to reduce the risk of infection or derecruitment.

Therefore, more recently, HMEs have been developed that allow for aerosol delivery without removing the HME from the circuit. By turning a dial on the HME the filter media is bypassed and aerosol can transfer through. This results in a more complicated aerosol transport path and as such will have an effect on the amount of medication delivered to the patient. The purpose of this study was to evaluate how the type of humidification might impact aerosol delivery in a simulated adult ventilator setting and provide information to clinicians when determining dosing.

METHODS & RESULTS

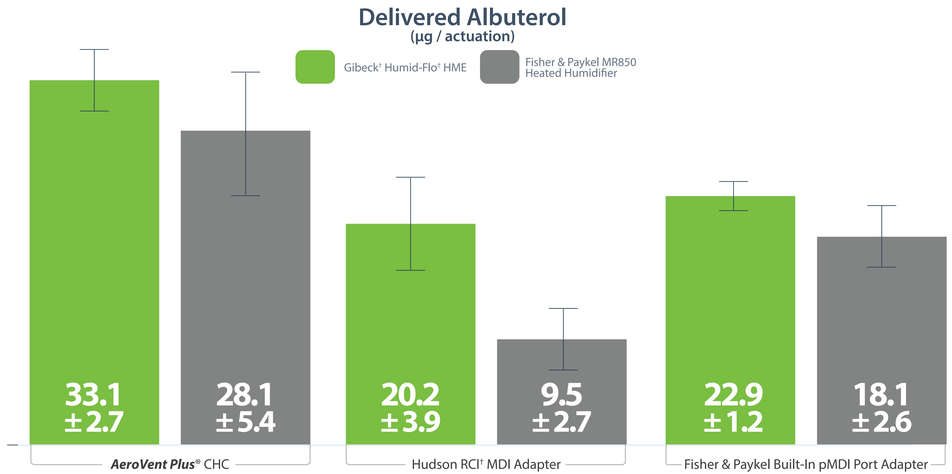
An adult mechanical ventilation circuit (Fisher & Paykel RT210) was humidified with either a traditional heated humidifier (Fisher & Paykel MR850) or using a Gibeck† Humid-Flo† HME (Teleflex Medical) to simulate a ventilated adult model (tidal volume = 500 mL, duty cycle = 33%, rate = 13 breaths/minute) generated using a Dräger Infinity† C500 ventilator. An aerosol collection filter was located at the distal end of the 8.0 mm diameter endotracheal tube (ETT) and coupled to a Dräger SelfTestLung,† simulating the patient. 5 actuations of a Ventolin† pressurized metered dose inhaler (pMDI) were delivered through the device on test, each time followed by 6 complete breathing cycles, shaking the canister between actuations. This procedure (n = 5/device) was performed with three devices; the *AeroVent Plus*® Collapsible Holding Chamber (CHC) (also marketed as *AeroChamber*® *VENT* holding Chamber), the Hudson RCI† MDI Adapter, (both placed in the inspiratory limb) and via the built-in pMDI port adapter within the wye connector of the ventilator circuit. Assay of albuterol recovered from the collection filter was undertaken by HPLC-UV spectrophotometry.

AeroVent Plus® Collapsible Holding Chamber (CHC)

Hudson RCI† MDI Adapter

Fisher & Paykel Built-in pMDI Port Adapter

The *AeroVent Plus*® CHC delivered values of 33.1 ± 2.7 µg and 28.1 ± 5.4 µg for the HME and heated humidifier respectively. In comparison, the Hudson RCI† MDI Adapter delivered 20.2 ± 3.9 µg and 9.5 ± 2.7 µg, and the built-in ventilator circuit pMDI port delivered 22.9 ±1.2 µg and 18.1 ± 2.6 µg. The *AeroVent Plus*® CHC delivered significantly more medication to the distal end of the ETT compared with the other devices (un-paired t-test, $p < 0.001$).



CONCLUSION & CLINICAL IMPLICATIONS

The *AeroVent Plus*® CHC delivered the largest dose of albuterol using either humidification option. Delivery from the Hudson RCI† MDI Adapter was most affected by the humidifier option and was reduced by more than 50% when the heated humidifier was used.

This study demonstrates that the type of delivery device and humidification supplied to the mechanically ventilated patient will influence drug delivery. These data should help support decision making where the intent is to maximize aerosol delivery during mechanical ventilation.

CHEST Conference
October 8 - 11, 2023