

VENTILATOR AEROSOL DELIVERY DEVICE DOSE COMPARISON

Information derived from the following study:

In Vitro Performance of a New Collapsible Holding Chamber (CHC) for the Delivery of Aerosolized Medication by Pressurized Metered-Dose Inhaler (pMDI) to Patients on Mechanical Ventilation



INTRODUCTION

It is desirable not to break the ventilation circuit during the delivery of aerosols to patients while on mechanical ventilation. The **AeroVent®** collapsible holding chamber (CHC) (Monaghan Medical Corp., Plattsburgh, NY) was developed several years ago to combine the benefit of a holding chamber when expanded with the convenience of being able to collapse the device when not in use, thereby minimizing water trapping. The present *in vitro* evaluation of a new version (**AeroVent Plus™** CHC), in which the pMDI canister receptacle has been offset from the CHC axis to reduce internal impaction, and which can also accept GlaxoSmithKlein pMDI canisters having a dose counter provides comparative data with other in-line adapters.

The technique of administering aerosol treatment to a mechanically-ventilated patient should be simple and avoid disconnecting the circuit.¹ Traditional methods of delivering aerosol to ventilated patients include nebulizers and MDIs with a type of add-on device. Metered-dose inhalers provide several advantages over nebulizers including ease of administration, reliability of dosing and freedom from contamination. With proper technique of administration, a MDI serves as an effective, convenient and safe method for delivering bronchodilator aerosols in mechanically-ventilated patients.²

However not all add-on devices provide the same amount of medication to the patient.³ Unlike chambers, ports and adapters do not allow for full aerosol plume development. MDIs in conjunction with a “spacer device” have shown to result in a four-to-five-fold greater delivery of aerosol than MDIs actuated into an in-line device that lacks a chamber.^{1,4,5} Furthermore, studies have shown that the “**AeroVent®** spacer yielded significantly higher inhaled mass” than a dual-spray device and a unidirectional built-in nozzle.⁶

This report compares albuterol mass output among six (6) different devices when measured at the distal end of the endotracheal tube. It will show which device provides the most drug mass (μg) per actuation.

This report describes comparative testing among:

- **AeroVent Plus™** CHC
- Airlife₊ MiniSpacer₊
- Optivent₊ VHC
- RTC 24-V ventilator adapter
- Ballard suction catheter with pMDI port
- Hudson ventilator adapter

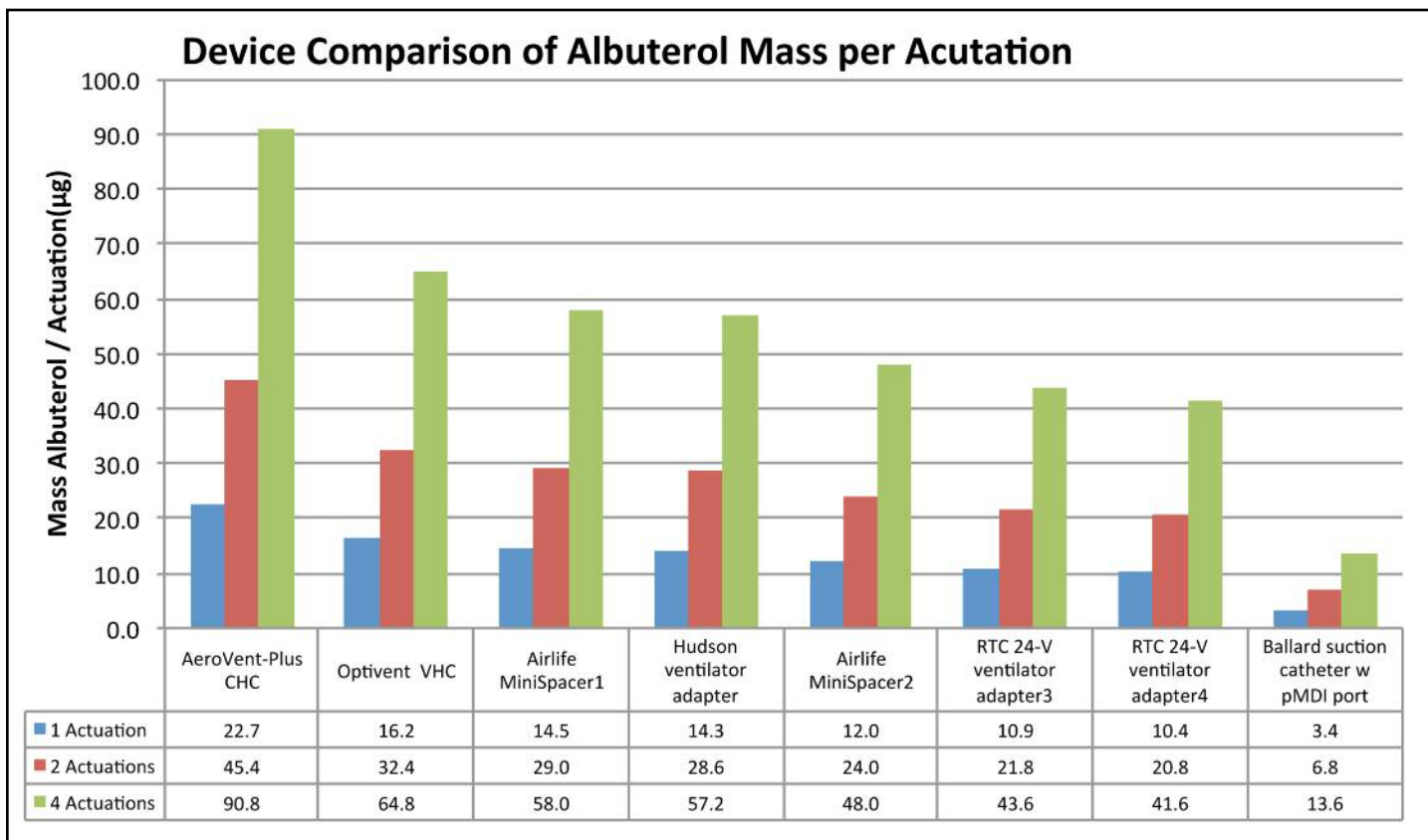
METHODS

The **AeroVent Plus™** CHC (n=5) was inserted in the inspiratory limb of an adult mechanical ventilation circuit with humidifier (Model MR850JHU, Fischer & Paykel, Auckland, NZ). The distal end of the CHC coupled to the wye-connector to which a ballard suction catheter and a 7.0 mm diameter endotracheal tube (ETT) was attached. An aerosol collection filter was located at the distal end of the ETT, and the far-side of the filter was coupled to an adult test lung (Michigan Instruments, Grand Rapids, MI) simulating the patient. The circuit was humidified near to body conditions ($T = 37^{\circ}\text{C}$, 100%RH), and tidal breathing (600-mL, duty cycle = 33%, 10 breaths/min) was simulated by a servo ventilator (Siemens, Sweden, model 900C). 5-actuations of Ventolin® (GSK Canada, 100 μg albuterol ex-valve) were delivered, each time followed by 6-complete breathing cycles, shaking the canister between actuations. Similar measurements (n=5/device) were also performed with the: (a) Airlife₊ dual-spray MiniSpacer₊ (Cardinal Health, Dublin, OH); (b) Optivent₊ (Philips Healthcare, Andover, MA); (c) Adult universal in-line pMDI adapter (model RTC 24-V, Instrumentation Industries Inc., Bethel Park, PA); (d) Ballard suction catheter with pMDI port (Kimberly-Clark Healthcare, Roswell, GA); (e) Hudson₊ ventilator adapter (Hudson RCI, Research Triangle Park, NC); (f) pMDI adapter (Fischer & Paykel). Assay of recovered albuterol was undertaken by HPLC-UV spectrophotometry.



RESULTS

Total mass of albuterol/actuation via each of the devices is summarized in the following chart.



Device	Vent Circuit Tubing
AeroVent-Plus CHC	22 mm in-line, coupled directly to wye connector
Optivent VHC	22 mm coupled directly to wye connector
Airlife MiniSpacer ¹	¹ 22 mm in-line coupled directly to wye connector
Hudson ventilator adapter	22 mm coupled directly to wye connector
Airlife MiniSpacer ²	² 15 mm with adapter direct to ETT
RTC 24-V ventilator adapter ³	³ 22 mm coupled directly to wye connector
RTC 24-V ventilator adapter ⁴	⁴ 15 mm with adapter direct to ETT
Ballard suction catheter w pMDI port	Coupled direct to ETT

CONCLUSIONS

The **AeroVent Plus™** CHC delivered significantly more medication to the distal end of the ETT compared with the other adapters (un-paired t-test, $p < 0.001$).

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