Valved Holding Chamber Angle Can Affect Pressurized Metered Dose Inhaler Medication Delivery Efficiency

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RATIONALE

- It is tacitly assumed that the patient inhaling their medication from a Pressurized Metered Dose Inhaler (pMDI) via a Valved Holding Chamber (VHC) align the long axis of the chamber perfectly with the horizontal axis of the mouthpiece component of the inhaler, such that the inhaler canister is upright.
- A commonly encountered error is to direct the pMDI-VHC combination towards the tongue or roof of the mouth, and this misalignment can often be achieved by displacing the chamber axis away from being aligned with the inhaler mouthpiece.
- This laboratory study evaluated 3 widely prescribed VHCs with their long axes inclined by 45° upwards and downwards, representing likely extremes in user orientation.

MATERIALS AND METHODS

- The following VHCs were evaluated (n=5/group):
  - AeroChamber Plus™ Flow-Vu™
  - Tipshaler® VHC
  - Volumatic®
- A filter was located at the mouthpiece of the VHC to capture the emitted aerosol.
- The filter was then coupled to a breathing simulator (ASL5000, IngMar Medical, Pittsburgh, PA, USA) to mimic the following tidal-breathing patient categories:
  - Small Child Simulation
    - Inspiratory:expiratory ratio = 1:2
    - Tidal volume = 155-mL
    - Number of breathing cycles/min = 25
    - Inspiratory:expiratory ratio = 1:2
  - Adult Simulation
    - Inspiratory:expiratory ratio = 1:2
    - Tidal volume = 500-mL
    - Number of breathing cycles/min = 13
    - Inspiratory:expiratory ratio = 1:2
- In Part 1 of the investigation, the long-axis of the VHC was initially orientated 45° upward from horizontal (inhaler raised).
- In Part 2, the long-axis was orientated 45° downward.
- 5 doses of Salbutamol pMDI were delivered at 30-s intervals.
- The emitted mass from the pMDI-VHC combination was determined using HPLC.

RESULTS

Small Child Simulation

- In the small child simulation, changes in emitted mass from 45° up to 45° down orientations were insignificant with both AeroChamber Plus™ Flow-Vu™ VHCs (1.13%, paired t-test, p=0.07) and Tipshaler® (-14%, p=0.04). However, the decrease for the Volumatic® group was significant (-48%, p=0.004).

Adult Simulation

- There was no orientation effect in the adult simulation, with the AeroChamber Plus™ Flow-Vu™ VHCs (0.7%, p=0.77).
- However, the emitted mass changed significantly by +24% and -28% with the Tipshaler® (p<0.004) and Volumatic® (p=0.019) VHCs.
- The emitted mass from the AeroChamber Plus™ Flow-Vu™ VHC was consistent independent of VHC angle.

CONCLUSIONS

- Clinicians should be aware that the output from some VHCs can change with VHC orientation, most likely due to the effect of gravity on less responsive mechanical inhalation valves.

Graphs showing the emitted mass of Salbutamol from different VHC orientations are included.