Complete Delivery of Medication from a Valved Holding Chamber to the Lungs of a Small Child is Affected by Chamber Capacity: A Laboratory-Based Investigation

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RATIONALE

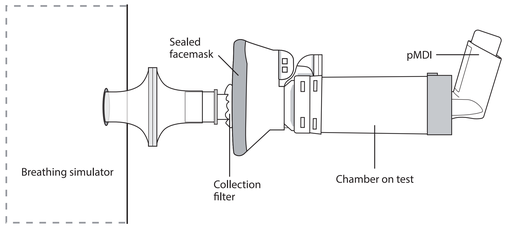
- Inhaled corticosteroid medication is the gold standard for the treatment of underlying inflammatory disease associated with asthma in children
- Large volume Valved Holding Chambers (VHCs) have capacities greater than can be emptied in a single breath, especially for infants and small children
- This laboratory-based study compared the behavior of widely prescribed large and small volume VHCs for the delivery of Pressurized Metered Dose Inhaler (pMDI)-delivered Fluticasone Propionate (FP)

MATERIALS & METHODS

Volumatic† chamber with infant mask
GlaxoSmithKline Inc.

AeroChamber Plus* Flow-Vu* Antistatic VHC with child facemask
Trudell Medical International

- VHCs ($n = 3$ devices/group); 3 replicates/device
  - Large volume 750 mL Volumatic† VHC
  - Smaller volume 149 mL ***AeroChamber Plus* Flow-Vu**** antistatic VHC
- Each VHC was connected to a breathing simulator (ASL 5000, Pittsburgh, PA) mimicking a tidally breathing small child
  - Tidal volume = 155 mL,
  - Rate/min = 25
  - Inspiratory : Expiratory ratio 1:2



- To minimize leakage, facemasks were sealed with a silicone plate
- The plate had a 22mm opening to allow an aerosol filter to collect medication delivered to the exit of the chamber on test
- 1 actuation of FP (50 µg/actuation) was delivered to the chamber on test, and the mass collected on the filter after 1 complete breathing cycle ($n = 3$ replicates) was assayed by HPLC-UV spectrophotometry
- The procedure was repeated after 2, 3, 5, 8 and 10 breathing cycles

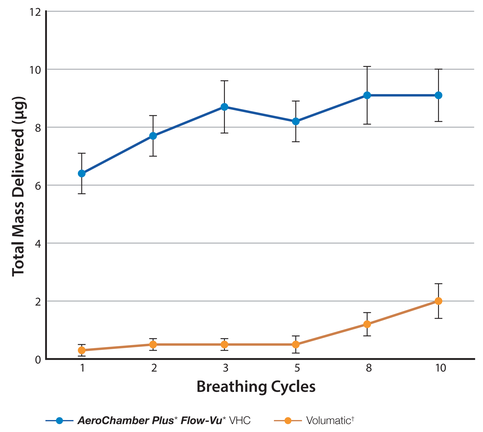
RESULTS

Total Mass of FP Recovered for Different Numbers of Breathing Cycles

mean ± SD

Breathing Cycles	*AeroChamber Plus* Flow-Vu** VHC with Child Mask	Volumatic† VHC with infant facemask
1	6.4 ± 0.7	0.3 ± 0.2
2	7.7 ± 0.7	0.5 ± 0.2
3	8.7 ± 0.9	0.5 ± 0.2
5	8.2 ± 0.7	0.5 ± 0.3
8	9.1 ± 1.0	1.2 ± 0.4
10	9.1 ± 0.9	2.0 ± 0.6

Total Mass of FP Recovered for Different Numbers of Breathing Cycles



- Very little FP was delivered from the Volumatic† VHC for the first five breathing cycles, and only 2.0 ± 0.6 µg/actuation was obtained after 10 cycles
- In contrast, even after the first breathing cycle, 6.4 ± 0.7 µg/actuation was delivered by the smaller ***AeroChamber Plus* Flow-Vu**** antistatic VHC, which plateaued at around 9 µg/actuation from 3 breathing cycles

CONCLUSIONS

- Although other factors such as VHC materials and facemask fit might be contributing to the reported large differences in drug delivery performance, clinicians should be aware that the internal capacity of a VHC has a marked effect on the delivery of medication
- An effective VHC should be able to maintain the availability of medication for inhalation in cases where multiple inhalations may be required to empty, as is often the case with small children

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