Metered-dose inhaler output comparison between a collapsible paperboard holding chamber and two rigid plastic chambers

Carl Okeson, Ph.D., Paul McGowen, RRT

Thayer Medical Corporation, Tucson, Arizona, USA

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Introduction

Valved holding chambers (VHCs) assist many patients with the coordination of pressurized metered-dose inhaler (pMDI) medication delivery. However, when an MDI is actuated into a holding chamber, some fraction of the drug output deposits inside the device, which reduces the dose of drug delivered to the patient, and can change the particle size distribution. Some of this drug loss through plastic holding chambers can be attributed to static attraction between drug particles and the chamber walls. In this study, the MDI drug output and particle size distribution characteristics of three VHCs were compared. The three VHCs evaluated included one collapsible, disposable VHC made from non-static paperboard (LiteAire, Thayer Medical), and two VHCs made from rigid polymer (AeroChamber Plus, Monaghan Medical; and OptiChamber Advantage, Respironics).

Materials and Methods

Albuterol sulfate (Proventil HFA, Key Pharmaceuticals) was used as the test MDI drug throughout this study. For particle size distribution analysis, one of each of the three VHCs (as shown in Figure 1) was attached to an Andersen cascade impactor using a 28.3 L/min vacuum. Each VHC received 15 actuations of Proventil HFA. Drug collected on the impactor plates was eluted with 9 mL of 1 M KCl buffer, and the resulting solutions read via UV/Vis spectroscopy at 276 nm.

Figure 1. AeroChamber Plus, LiteAire, OptiChamber Advantage

Materials and Methods (continued)

For the drug output analysis, five of each of the VHCs (n=5) were evaluated. The testing apparatus (shown in Figure 2) consisted of a USP throat model connected to a ventilator (Harvard Apparatus) simulating tidal breathing of 750 mL at 12 breaths/min and 1:1 I:E. Each VHC received six MDI actuations, each at the beginning of an inhalation. Drug was collected on a filter downstream of the throat model, was eluted with 18 mL of 1 M KCl buffer, and was read at 276 nm.

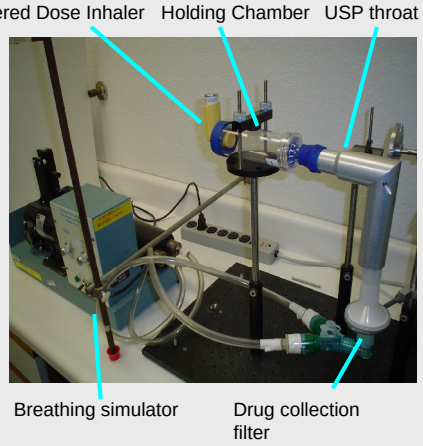

Figure 2. Drug output testing apparatus

Results

The results are summarized in Table 1. The albuterol sulfate particle size distributions from the three VHCs (shown graphically in Figure 3) were similar, with nearly identical MMADs and respirable output fractions. In terms of drug output per actuation (shown graphically in Figure 4), the outputs of the LiteAire (75 ± 7 µg, 69% of 108 µg/actuation canister output) and the AeroChamber Plus (69 ± 4 µg, 64% of canister output) were not significantly different, but were both significantly larger than the output of the OptiChamber (57 ± 3 µg, 53% of canister output).

Results (continued)

Holding Chamber Comparisons	LiteAire	AeroChamber Plus	OptiChamber
Cost (US$)	$2.95	$10.30*	$10.30*
Chamber volume (mL)	160	150	218
Mass Median Aerodynamic Diameter (MMAD) (µm)	2.5	2.5	2.5
% of drug mass in respirable range (MMAD < 4.7 µm)	94%	95%	95%
Drug mass delivered per actuation (µg)	75 ± 7	69 ± 4	57 ± 3**
% of 108 µg/actuation canister output delivered by device	69%	64%	53%**

*Unit price from Tri-anim

**Significantly lower than the other two VHCs tested; p < 0.05

Table 1. Results Summary

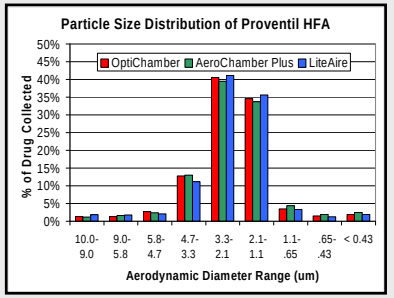

Figure 3. Particle size distributions of albuterol sulfate (Proventil HFA)

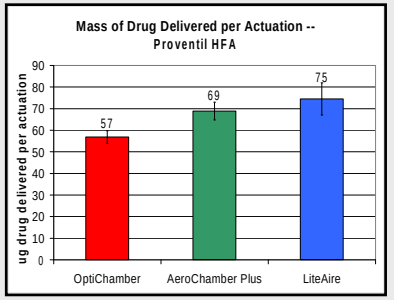

Figure 4. Mass of albuterol sulfate delivered per MDI actuation (108 µg/dose from canister alone)

Conclusions

Under the conditions tested, the paperboard LiteAire provided drug delivery performance that was either statistically equivalent to or superior to the rigid plastic VHCs evaluated. Based on these results, the LiteAire appears to offer an effective, lower cost alternative to plastic holding chambers, particularly for single-patient, single-use applications.