In Vitro Comparison of Aerosol Characteristics of HFA Albuterol Pressurized Metered Dose Inhaler Formulation from Anti-Static Valved Holding Chambers

D. von Hollen[1], L. Slator[2], R. H. M. Hatley[2], K. Nikander[1]. [1] Philips Respironics, Respironics New Jersey, Inc., Parsippany, New Jersey, USA. [2] Respironics Respiratory Drug Delivery (UK) Ltd, Chichester, West Sussex, UK.

Introduction

Figure 1. The Diamond VHC can be used to optimize delivery from pMDIs.

The valved holding chamber (VHC) has been designed to help improve and optimize delivery for those using pressurized metered dose inhalers (pMDIs).[1] The Diamond VHC (Figure 1; Philips Respironics, Respironics New Jersey, Inc., Parsippany, NJ) is a compact, anti-static VHC designed to facilitate effective aerosol delivery to respiratory patients. The *in vitro* aerosol characteristics of an HFA albuterol sulfate pMDI with a preproduction Diamond VHC were compared with those of the pMDI with an AeroChamber Plus Z-Stat (Z-Stat, Monaghan Medical Corp., Plattsburgh, NY) VHC and the pMDI alone.

Methods

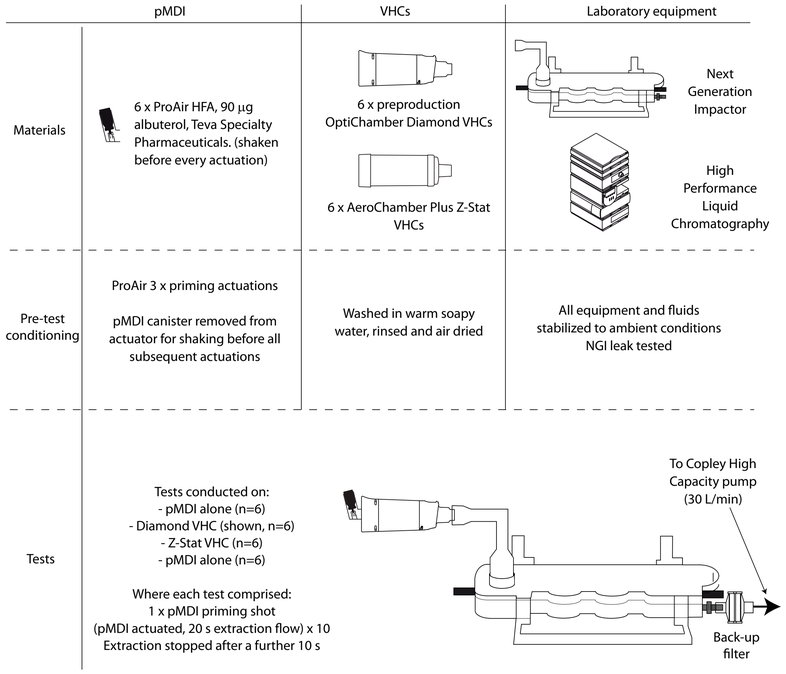

Figure 2. Experimental test method.

After each test, the induction port, back-up filter, NGI cups and VHCs were processed using 10% Acetonitrile solution. CITDAS V3.10 software was used to generate the aerosol characteristics data. The mean emitted dose (drug entering NGI), fine particle dose (amount of drug in NGI ≤ 4.7 µm), fine particle fraction (percentage of emitted dose in particles ≤ 4.7 µm), and Mass Median Aerodynamic Diameter (MMAD) were calculated. The equipment was washed and dried after each drug/VHC test.

Results

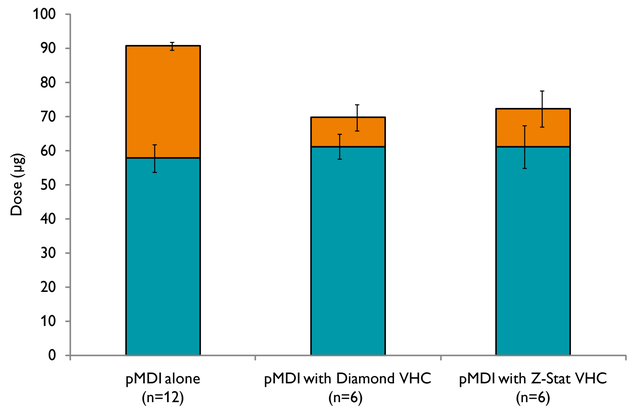

Figure 3. Emitted dose (drug entering the NGI) from the pMDI alone, pMDI with Diamond VHC and pMDI with Z-Stat VHC with the fine particle dose highlighted and the dose in particles > 4.7 µm highlighted. Error bars denote standard deviation about the mean.

The dose emitted from each device comprised of the fine particle dose (particles ≤ 4.7 µm) and the dose in particles > 4.7 µm in diameter. Although the emitted dose for the pMDI alone was greater than for the pMDI VHC combinations, Figure 3 shows that the majority of this difference was derived from a difference in particles > 4.7 µm in diameter. Therefore the VHCs retained a large proportion of particles over 4.7 µm in size, which would otherwise have been deposited in the throat and upper stages of the impactor.
The dose delivery characteristics of the aerosols from the two pMDI VHC combinations were comparable.

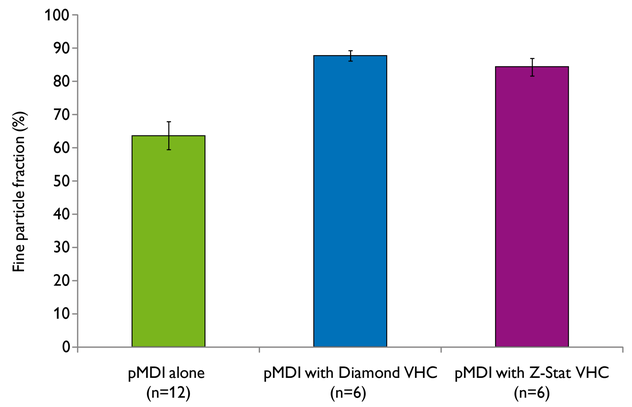

Figure 4. Fine particle fraction (percentage of the emitted dose in particles ≤ 4.7 µm) from the pMDI alone, pMDI with Diamond VHC and pMDI with Z-Stat VHC. Error bars denote standard deviation about the mean.

When the results are expressed in terms of fine particle fraction (the percentage of the emitted dose in particles ≤ 4.7 µm) as in Figure 4, aerosol delivery from the pMDI alone is shown to be less efficient than from the pMDI VHC combinations for the delivery of drug to the lungs. That is, the proportion of the total aerosolized drug that would be expected to penetrate the upper airways and deposit in the conducting and alveolated airways is higher for the pMDI VHC combinations compared with the pMDI alone.[2]

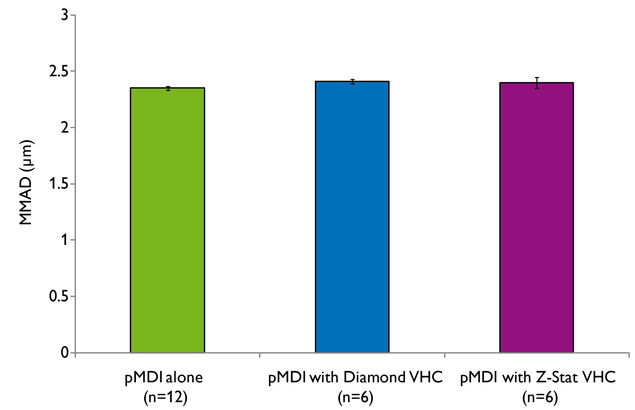

Figure 5. Mass Median Aerodynamic Diameter of the aerosol from the pMDI alone, pMDI with Diamond VHC and pMDI with Z-Stat VHC. Error bars denote standard deviation about the mean.

The MMAD of aerosols from each device was similar.

Discussion

The fine particle dose from the pMDI alone and pMDI VHC combinations was similar, but the emitted dose was higher for the pMDI alone, meaning a greater amount of drug was delivered in larger particles that would be expected to deposit in the throat and upper airways.[2] The aerosol delivery characteristics from the two pMDI VHC combinations were comparable.

Conclusions

- The fine particle dose and MMAD was similar between the pMDI alone and the pMDI VHC combinations.
- The fine particle fraction was higher using a pMDI VHC combination than the pMDI alone due to the fact that the VHC acts as a filter for large particles, which could reduce the oropharyngeal deposition in patients using a pMDI.

References

1) Virchow J.C., Crompton G.K., Dal Negro R., Pederson S., Magnan A., Seidenberg J., Barnes P.J. Importance of inhaler devices in the management of airway disease. Respir Med. 2008;102:10-19.
2) Heyder, J., Gebhart, J., Rudolf, G., Schiller C.F., Stahlhofen, W. Deposition of particles in the human respiratory tract in the size range of 0.0005 – 15 µm. J Aerosol Sci. 1986; 17(5):811-815.

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