

Albuterol metered dose inhaler performance under hyperbaric pressures

Garry A. Johnson¹, Veera R. Gutti², Sudarshan K. Loyalka², Kenneth A. O'Beirne¹, Steven K. Cochran¹, Hollis M. Dale¹, George R. Kracke^{1*}

¹Department of Anesthesiology and Perioperative Medicine and Jefferson C. Davis Hyperbaric Medicine Center, University of Missouri School of Medicine, Columbia, MO 65212; ²Nuclear Science and Engineering Institute and Particulate Systems Research Center, University of Missouri, Columbia. MO 65211.

*Corresponding author: Department of Anesthesiology and Perioperative Medicine, University of Missouri School of Medicine, Columbia, MO 65212, krackeg@missouri.edu, tel: 573-882-2756, FAX:573-882-2226.

INTRODUCTION: The stimulus for this presentation was an asthma attack suffered on the first dive by a victim of a severe industrial electrical burn. The patient's response to albuterol metered dose inhaler (MDI) treatment given at depth was felt to have been poor. We thus wondered what the output of these devices (chlorofluorocarbon or CFC) was at therapeutic depth versus normobaria. As the current MDIs were being phased out of use we also wondered what the comparable output characteristics of the replacement MDIs (hydrofluoroalkane or HFA) would be.

MATERIALS AND METHODS: The dose and aerosol particle size and number delivered by MDIs were measured in a hyperbaric chamber at pressures ranging from one atmosphere absolute (1 ATA, 0 feet of seawater, fsw, 101 kPa) to three ATA (66 fsw, 304 kPa). Mass delivered was measured by a Sartorius B120 analytical balance, and particle size analysis by a TSI 3080L electrostatic classifier with a TSI 3776 ultrafine condensation particle counter.

RESULTS: Dose delivery per actuation by CFC and long canister HFA powered MDIs was 13±1% and 12±1% less, respectively, at 3 ATA compared to 1 ATA. However, dose delivery by short canister HFA MDIs was not significantly

changed with pressure. The geometric mean diameters of nano particles from the CFC and short canister HFA MDIs decreased from 50 nm at 0 fsw to 32 nm at 66 fsw whereas the long canister HFA aerosol diameters were not affected. The numbers of nanometer size particles delivered at 66 fsw were only 4-7% of those delivered at 0 fsw for the CFC and long canister HFA MDIs; whereas for the short canister HFAs it was 26%.

CONCLUSIONS: The doses of albuterol and the sizes and numbers of aerosol particles emitted from albuterol MDIs actuated in a hyperbaric environment vary by canister type; CFC MDI loss is probably unimportant.