

# ALBUTEROL METERED DOSE INHALER PERFORMANCE UNDER HYPERBARIC PRESSURES



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## 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 compared to normobaric conditions.



Intraoperative picture of patient's right arm after full course of therapy.

## HYPOTHESES

1. The output of chlorofluoro-carbon(CFC) MDIs is the same at therapeutic pressures versus normobaria .
2. The output characteristics of the replacement hydrofluoroalkane (HFA) MDIs are comparable to CFC MDIs at increased pressures.

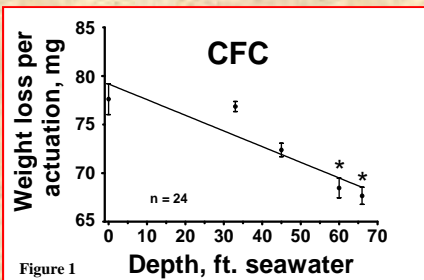


Figure 1

Weight losses per actuation of CFC inhalers at different increased pressures. Asterisks represent means significantly different from 0 fsw. Slope= $-0.161 \pm 0.040$  mg/fsw, intercept= $79.2 \pm 1.9$  mg,  $r^2=0.84$ .

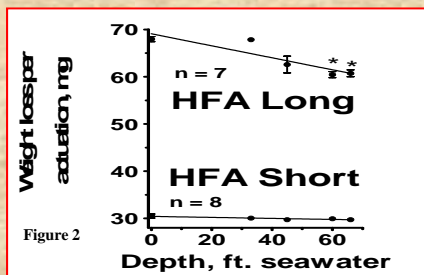


Figure 2

Weight losses per actuation of HFA inhalers at different increased pressures. Asterisks used as in Fig 1. Slopes= $-0.127 \pm 0.038$  and  $-$ ,  $r^2$ 's= $0.79$  and  $0.80$ , respectively.

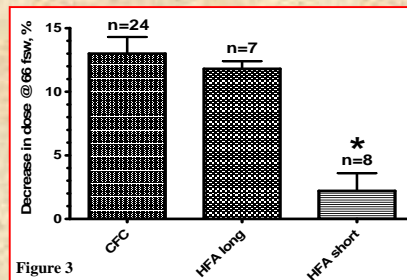


Figure 3

Summary of percent decreases in delivered doses for the three groups of MDIs at 66 fsw compared to 0 fsw. Data are from Figs. 1 and 2. Asterisk indicates the mean is not significantly different from zero ( $p>0.05$ ).

## 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.

## CONCLUSIONS

1. CFC and long canister HFA powered MDIs weight loss per actuation was less at 3 ATA compared to 1 ATA while weight loss by short canister HFA MDIs was not significantly changed with pressure.
2. The mean diameters of nano particles from the CFC and short canister HFA MDIs decreased with pressure whereas the long canister HFA aerosol diameters were not affected.
3. The numbers of nanometer size particles delivered by the short canister HFA MDIs were less affected by pressure than CFC and long canister HFA MDIs.
4. Our hypotheses were not supported by the experiments.

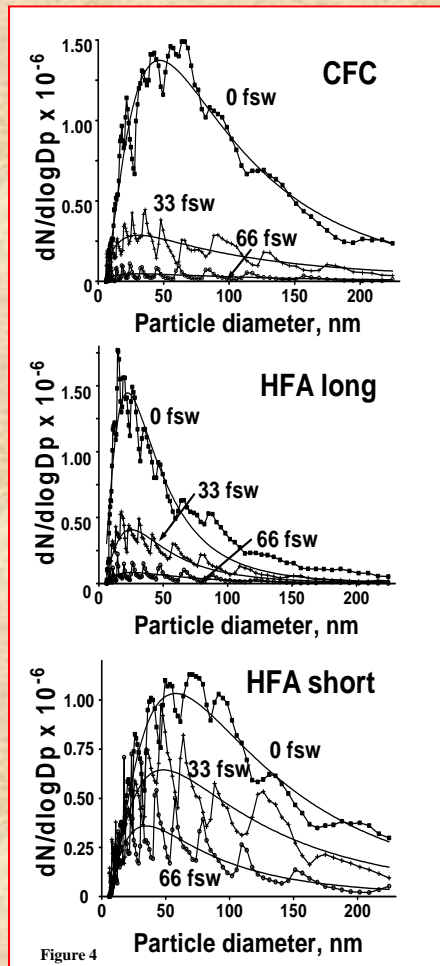


Figure 4

Nanometer size analysis of MDI aerosols. The size distributions of aerosols of representative MDIs from the three groups were measured at 0, 33, and 66 fsw. Lines are non-linear regression fits.