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The effect of handling techniques on electrostatic charge on spacer devices: a correlation with in vitro particle size analysis

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Abstract

It has been suggested that the output of drugs from large volume spacer devices is affected by the static charge retained within the device. This study correlated the static voltage measured on large volume spacer devices with the particle size distribution of a bronchodilator. The effect of five handling techniques on this relationship was studied; an inverse relationship between respirable fraction (RF) and static voltage was confirmed. Elimination of static in the local environment, and pre-washing in soapy water resulted in the highest RFs. Reducing static on spacers should maximise drug delivery to patients and may result in improved drug efficacy.

Keywords: Spacers; Handling techniques; Static charge; Respirable fraction

Spacer devices are used in conjunction with metered dose inhalers (MDIs) to counteract difficulties with the manual co-ordination procedure required to provide effective treatment (Newman, 1991). Spacer devices have also been shown to increase the amount of drug reaching the lungs, whilst decreasing oropharyngeal deposition (Newman et al., 1984). Recent evidence suggests that drug delivery from spacer devices is critically affected by static charge. Lining the spacers with anti-static spray (O'Callaghan et al., 1993), and wiping the external surface with an anti-static or damp cloth (unpublished observations) have been shown to increase the RF value. This study aimed to correlate static charge with particle size data for a range of different handling techniques.

The particle size distribution of salbutamol delivered through a large volume spacer was assessed. The spacers were handled using five different methods shown in Table 1. For each regimen, the experiments involved measurements of three replicate canisters. For Regimen E, the impinger was placed underneath a static eliminator (Meech®, model 971) while actuating the device.

A High Precision Multistage Liquid Impinger (HPMLI, Copley Instruments) (US Pharmacopeia, 1993) comprising a 'throat' and four impaction stages was used to determine the particle

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Table 1
Handling techniques

Regimen	Handling technique
A	Spacer untreated before use; handled without gloves
B	Spacer untreated before use; handled with disposable latex gloves
C	Spacer pre-washed with tap water and allowed to air-dry for 24 h before use; handled with disposable latex gloves
D	Spacer pre-washed in soapy water for 15 min, rinsed in tap water, and allowed to air-dry for 24 h before use; handled with disposable latex gloves
E	As Regimen B but with a static eliminator in operation during the shot firing stage

size distribution of salbutamol from Salbulin® MDIs (100 μg per actuation, 3M Healthcare) delivered through a large volume spacer (Volumatic®, Allen and Hanburys). The aerodynamic diameters of particles trapped in each section of the impinger were approximately: Throat > 25 μm; Stage 1, 13–25 μm; Stage 2, 6.8–13 μm; Stage 3, 3.1–6.8 μm; Stage 4, < 3.1 μm. The RF was taken to be the percentage of drug recovered from stages 3 and 4. The same HPMLI operating at a flow rate of 60 l min^{-1} was used throughout the investigation. Salbutamol concentrations in the washings from each stage were determined using an ultraviolet spectrophotometer (Pye Unicam P8735/50) at a wavelength of 278 nm. One-hundred shots (sufficient to give an adequate UV absorbance) were fired into the HPMLI in each experiment. Each MDI was primed using a different actuator prior to use and the first 10 shots were discarded. The static voltage on the outside surface of the spacer was recorded in reproducible positions at the nozzle end, the middle and the actuator end, using a Meech® static locator model 980. These measurements were recorded after each batch of 10 shots.

The mean RF for each handling technique is shown in Fig. 1. Handling the spacers with gloves (Regimen B) gave the lowest mean (± S.D.) RF of 11.1 ± 4.7% whilst the use of the eliminator (Regimen E) produced the highest mean RF of 34.3 ± 8.2%. Pre-treatment of the spacers with increasingly more lengthy washing procedures (Regimens C and D) resulted in increments in the

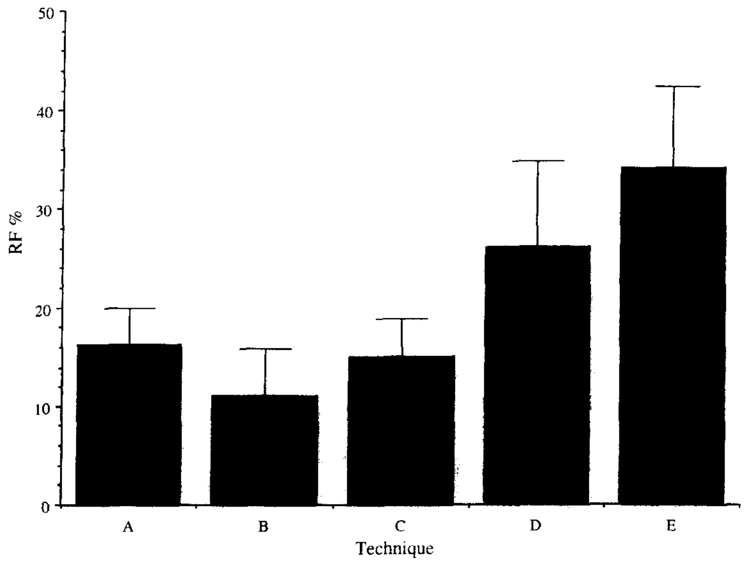

Fig. 1. Handling techniques of spacer devices and their effect on the mean ± S.D. respirable fraction (RF) of salbutamol.

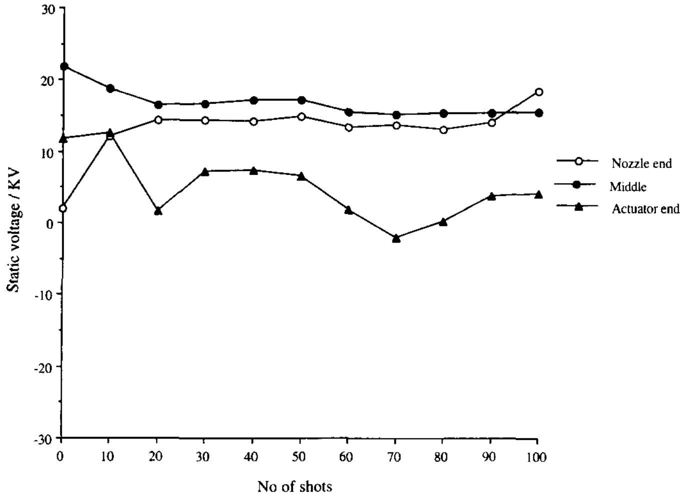

Fig. 2. Graph showing the mean static voltage on areas of a spacer device after various numbers of actuations from an MDI (untreated spacer — Regimen B).

mean RF (15.0 ± 3.8% — Regimen C and 26.1 ± 8.8% — Regimen D) compared with the untreated spacer (Regimen B).

Measurement of surface static voltage using the hand-held probe produced fluctuating readings. Example traces are shown for Regimens B and E in Figs. 2 and 3, respectively. Whilst high positive voltage was present for untreated spacers (Regimen B), use of the eliminator, as expected, resulted in virtually zero voltage during the course of the experiment. Correlation of the mean RF values with the static voltage recorded at the mid-point of the spacer after 50 shots for each regimen showed an inverse relationship (Fig. 4).

The output of drug from spacer devices has been shown to be affected by the electrostatic charge present on the walls of the spacer; this charge can have a profound effect on the behaviour of the aerosol cloud within the holding chamber (O'Callaghan et al., 1993) resulting in deposition of aerosol droplets on the walls of spacer devices. The present study has shown that simple variation in handling techniques altered the charge on the spacer walls and that the static voltage had an inverse relationship with the mean RF; high positive static charge gave the lowest RF whilst neutralization of the charge by using a static eliminator gave the highest RF. It was interesting to note that handling untreated spacers without gloves resulted in a lower static charge and higher RF, and this may indicate an earthing effect as the naked fingers touched the spacer walls. In vitro studies that assess particle size distribution of products delivered through spacer devices should take into consideration how spacer devices are handled during the procedures since a slight variation in handling can result in critical changes to subsequent RF data.

In the present investigation, previously unused spacers were evaluated. Barry and O'Callaghan (1994) have investigated the output of salbutamol from both 'new' (previously unused) and 'old' spacers; the charge being much greater on the new spacers. The present investigation suggests that washing spacers prior to use 'primes' the spacers and that the more complex the washing procedures, the greater the degree of 'priming'. Patients will undoubtedly handle their spacers in a variety of ways which will charge their spacers to variable degrees and, in turn, affect drug availability. Whether differences in handling will ultimately have a clinically significant effect is unknown.

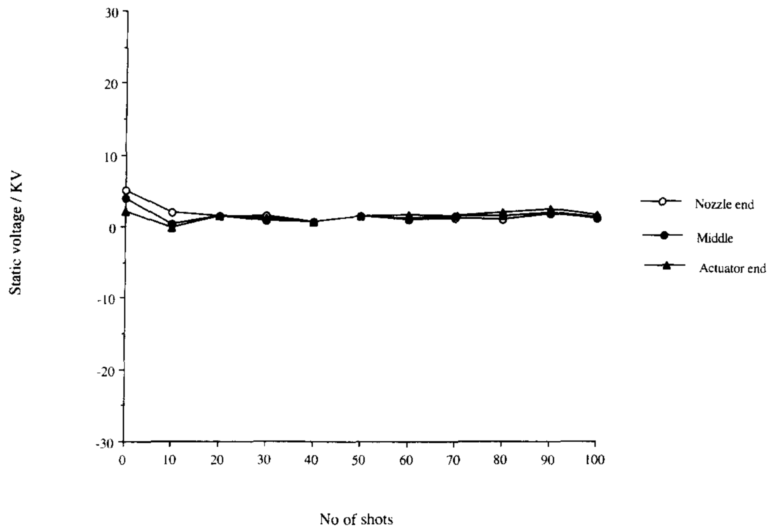

Fig. 3. Graph showing the mean static voltage on areas of a spacer device after various numbers of actuations from an MDI (with eliminator — Regimen E).

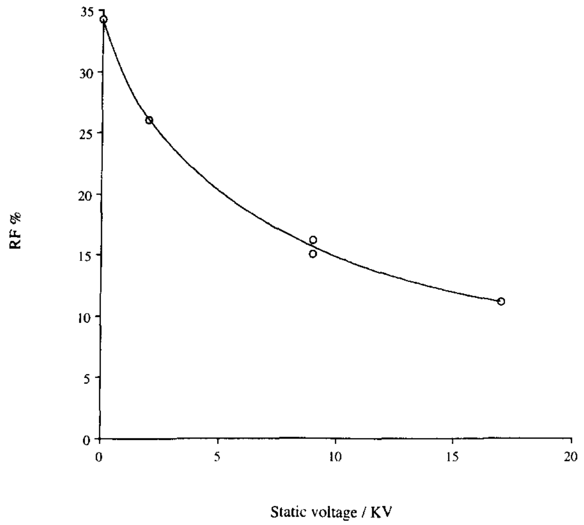

Fig. 4. Correlation between respirable fraction (RF) and static voltage measured at the mid-point of the spacer after 50 shots from a salbutamol MDI.

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