Use of a special inhaler attachment in asthmatic children

R ELLUL-MICALLEF, F MORÉN, K WETTERLIN, AND K C HIDINGER

From the Department of Medicine, University of Kuwait, and AB Draco, Research and Development Laboratories, Lund, Sweden

ABSTRACT Asthmatics often find difficulties in using an aerosol inhaler correctly as they are unable to co-ordinate the release of a bolus of drug to coincide with an inspiratory effort. This is especially the case with children. The addition of a special attachment to an ordinary inhaler overcame this problem. Twelve asthmatic children produced significantly better PEFR measurements when 0.25 mg terbutaline sulphate was administered via an inhaler with the attachment than when an ordinary inhaler was used alone.

A problem not infrequently faced by doctors when treating asthmatic patients is the inability of some patients to use a pressurised aerosol correctly.¹⁻³ Difficulties often arise with patients being unable to co-ordinate the release of a bolus of drug from the aerosol with inspiration. Such a problem is present to an even greater extent in children.

There is evidence which shows that only between 10-25% of the dose of drug administered from a pressurised aerosol actually gets into the lungs.⁴⁻⁵ The greater part of the drug is swallowed after deposition in the mouth and as a result of mucociliary clearance, and may be absorbed from the gastrointestinal tract.⁶⁻⁸ The availability of an inhaled drug to the airways depends largely on droplet size, provided the aerosol inhaler is properly used. It is known that droplet size from a pressurised aerosol is

dependent on the formulation and the time for evaporation of the propellant.⁹ In a previous study it was shown that the deposition of drug in the mouth could be significantly reduced as the distance from the inhaler orifice to the mouth was increased simply by attaching a tube to the inhaler.¹⁰ The present study was designed to find out whether the attachment of a special tube called a "spacer" when attached to an inhaler would facilitate its use by asthmatic children and whether the presumed increase in availability of the drug would result in better pulmonary function.

Patients and methods

Twelve children all suffering from extrinsic bronchial asthma agreed to participate in the study (table). Informed consent was obtained

Table Summary of data on study patients

Patient	Age (yr)	Sex	Duration of asthma (yr)	FEV ₁ Predicted (ml)	FEV ₁ Initial (ml)	FEV ₁ Post-inhalation (ml)
1	11	M	7	1400	975	1225
2	11	M	9	1650	1150	1450
3	7	M	6	1250	875	1100
4	10	F	7	1400	950	1150
5	10	F	6	1800	1200	1500
6	7	F	5	1350	800	950
7	8	M	4	1250	850	1100
8	7	M	1	1300	900	1150
9	9	M	6	1600	1150	1350
10	7	F	2	1300	850	1000
11	9	M	5	1600	1050	1200
12	7	M	6	1400	1050	1250

Address for reprint requests: Dr R Ellul-Micallef, Department of Medicine, PO Box 5969, Kuwait, Arabia.

from their parents. All children attended an outpatient clinic on four separate occasions at approximately weekly intervals. On the first visit their reversibility to a bronchodilator was determined by measuring their forced expiratory volume in one second (FEV_1). On the subsequent visit skin testing was carefully carried out by means of the prick technique using Bencard's solutions, blood was taken for a haemoglobin estimation and absolute eosinophil count, and where possible sputum was sent for bacteriological examination. During both these visits the children familiarised themselves with a peak flow meter. On the next two visits the children were randomly allocated in a cross-over manner to inhale 0.25 mg of terbutaline sulphate (Bricanyl R) delivered in one puff from an ordinary inhaler or from one attached to the special "spacer" provided. The spacer consisted of a collapsible tube which could be easily and tightly attached to the inhaler. Figures 1 and 2 show the tube in diagrammatic form when collapsed and when ready for use. Its volume is about 750 ml. Valves have been included in the

Fig 1 Drawing of inhaler attached to collapsed spacer.

Fig 2 Drawing of inhaler attachment to spacer when ready for use.

design of the spacer in such a way as to allow the subject to breathe comfortably through the spacer mouthpiece. The peak expiratory flow (PEFR) was measured in all instances by the author using a Wright peak flow meter for children; the instrument was calibrated regularly against a rotameter.¹¹ Measurements were recorded immediately before, 5, 20, and 60 minutes later. The best of three successive efforts was recorded each time. Statistical significance has been tested for by means of Student's *t* test.¹² When readings of peak flow around the maximum of the children's meter were obtained, an adult meter, similarly calibrated, was used.

Results

There was excellent co-operation from all the children, most of whom were very interested in the spacer. There was good reversibility of their airway obstruction after a bronchodilator as shown by their FEV_1 values in the table. All children had markedly positive skin reactions to at least three of the allergens with which they were tested. Haemoglobin values were all normal and bacteriological examination of the sputum failed to reveal any pathogens when it was carried out. Chest radiographs were all normal except in patient 3 where a minor deformity of the rib cage was present.

All 12 children showed a statistically significant improvement in the PEFR values compared to pre-treatment measurements on the three occasions when measured, both when the inhaler was used alone and when it had the spacer attached to it ($p < 0.001$). Figure 3 shows the effect of inhaled terbutaline when this was administered by the two different methods. The mean peak effect occurred 20 minutes after drug administration in both cases. When the inhaler was used on its own, the peak value for PEFR was 181 ± 6 l/mm⁻¹ (mean $\pm$ SEM); after attachment of the spacer the corresponding values were 206 ± 6 l/mm⁻¹ (mean $\pm$

Fig 3 Mean increase in PEFR and standard error of mean at intervals after administration of 0.25 mg terbutaline sulphate by inhalation.
○—○ = actuator. ●—● = actuator provided with collapsible tube.

SEM). The values obtained when the spacer was attached were significantly greater when measured 20 and 60 minutes after therapy ($p < 0.001$, $p < 0.01$).

Discussion

The increased distance from the inhaler to the mouth allowed deceleration of the aerosol particles and increased the time available for evaporation of the propellant. Lower velocity and smaller particle size are known to result in diminished impaction.¹³ Previous work has shown that least drug impaction in the device and mouth occurred when the particles from a pressurized aerosol are collected in a large defined volume. Collecting the particles in such a volume before inhalation means that the drug aerosol can be inhaled with a greater part of the inspiratory volume. Valves were adapted to the spacer to control the airflow for inhalation and exhalation allowing the aerosol particles to be carried only by the inspiratory flow from the spacer.¹⁴ The need to co-ordinate the release of the drug from the inhaler to inspiration is

eliminated. This is of obvious advantage to children as well as to adults who have difficulties in using an inhaler properly. The great majority of children were unable to use the inhaler in the proper way. The investigator had to actuate the inhaler for them in the inspiratory phase. No such problems arose when the spacer was attached to the inhaler.

Pulmonary function changes after the drug therapy in bronchial asthma seem to be related to the initial degree of airway obstruction¹⁵ and on whether this degree of obstruction was reached via a path of improvement or deterioration.¹⁶ Although there were differences in the initial values of PEFR when the drug was delivered from an ordinary inhaler and when a spacer was attached, these were small and not statistically significant ($0.5 > p > 0.1$). On both occasions all 12 children suffered from a moderate degree of asthma. Adding the spacer to the inhaler allowed the children to use the inhaler without any help and resulted in significantly better pulmonary function.

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