Short reports

Assessment of a new device for delivering aerosol drugs to asthmatic children

I G C HODGES, A D MILNER, AND G M STOKES

Department of Child Health, Medical School, Queen's Medical Centre, Nottingham

SUMMARY A new device, known as the aero-chamber, for delivering aerosol drugs was compared with a standard aerosol inhaler in asthmatic children aged between 5 years 3 months and 13 years 10 months. The study was conducted under double-blind conditions using fenoterol, a β 2 stimulant, as the active agent and a placebo. Response to treatment was assessed by measuring the peak expiratory flow rate before and after each inhaler. Seven of 10 children had greater mean improvements in peak expiratory flow rates when receiving the active drug from the aerochamber. The aerochamber offers a method for administering a whole range of canistered packaged drugs to children unable to use the standard inhalers.

Conventional pressurised aerosol devices administering metered doses of bronchodilator drugs present certain problems to the young asthmatic child. Co-ordinating activation of the aerosol with inspiration is the main difficulty, and often results in little of the active agent getting to its site of action. A considerable proportion of the dose is deposited in the mouth and pharynx.^{1,2} Even when used correctly the proportion of the drug administered that reaches the lower respiratory tract is about 5 to 10%.³

Attempts have been made to design delivery systems for administering aerosol drugs that overcome the problems of co-ordination and oral deposition.^{4,5} It is possible to decrease oral deposition by attaching tubes of various lengths and diameters to the activator⁶ allowing further evaporation of the aerosol vapour after the initial flash of propellant liquid and by reducing initial droplet velocity.⁷ Incorporating an inhalation valve into the system allows the patient to separate inhalation from activation thereby overcoming the problem of co-ordination often encountered by asthmatic children. This study was designed to compare a conventional aerosol delivery system alone delivering a

β 2 stimulant with one attached to an extension tube with an inhalation valve for asthmatic children. The attachment is known as the aerochamber.

Method

Children between ages 5 and 14 years with perennial asthma who required regular daily β 2 stimulants—such as salbutamol—for the control of asthma were entered into the trial. Each child was given two standard metered dose inhalers, one delivering a placebo, the other 0.2 mg fenoterol, a β 2 stimulant, per activation. The inhalers were labelled A and B under double-blind conditions. The new aero-chamber device was attached to either inhaler A or inhaler B. The trial inhalers were used at a set time each day when the child would normally inhale a β 2 stimulant for relief of wheezing. For the rest of the day the children received their regular treatment, but no β 2 stimulant was given during the 4 hours before using the inhalers. The inhalers were always used in a set order, A first followed by B. Before using aerosol A each child recorded the best of three peak expiratory flow efforts using a mini Wright peak flow meter. The child then took two puffs from aerosol A and recorded the peak expiratory flow rate (PEFR) immediately after and 10 minutes later. Aerosol B was then used, the child inhaling two metered doses and again recording the PEFR as before. The initial combination was used for a total of 3 weeks, the child then returning to the respiratory unit. The aerochamber was then transferred to the other inhaler. The child repeated the recordings for a further 3 weeks always starting with aerosol A.

A few children under age 6 years used the aero-chamber attached to both an aerosol delivering fenoterol and placebo, under single-blind conditions. PEFR was measured using a Wright's low range peak flow meter before and 10 minutes after each inhalation.

The aerochamber (Figure) consists of a plastic cylinder 7 cm in length and 3.5 cm in diameter with

Figure Aerochamber with a standard metered dose inhaler attached.

a port at one end into which a standard metered dose inhaler and nozzle is inserted. At the other end is the inhalation valve and exhalation port. The device was designed and initially tested on adults by M Newhouse at McMaster University.⁸

To use the aerochamber the child releases a single metered dose from the aerosol into the aerochamber. The mouth piece of the aerochamber is then inserted into the child's mouth and the child inhales slowly from the chamber. The inhalation should take place within 10 seconds of activating the device. Should the child blow into the mouth piece the position of the inhalation valve and exhalation port directs the air away from the enclosed chamber.

At the start of the trial each child was taught how to use both the standard metered dose inhaler and the aerochamber device correctly. Fully informed parental consent was obtained for each child.

Patient details. Ten children aged 5 years 3 months to 13 years 10 months (mean 9½ years) completed the trial. The children were using regular daily β 2 stimulant. Nine received their β 2 stimulant via a rotahaler and one via a metered dose inhaler. Five were receiving inhaled steroids, 4 via a rotahaler, and 1 via a metered dose inhaler. Five children were using sodium cromoglycate. Nine children used the trial aerosols at about 1700 hours, one child used them at 0800 hours.

Results

Seven of the 10 children had greater mean improvements in PEFR when the active drug was administered using the attached aerochamber than with the standard device alone (Table 1). In 2 of the children the differences reached statistical significance using Student's *t* test (P 0.001 and 0.002). The 3 remaining children produced better results using the standard inhaler. The improvement was significant in two (P 0.001 for both), but not in the one child aged

Table 1 Mean group improvements in PEFR l/min 10 minutes after inhaling 0.4 mg fenoterol and placebo both from the aerochamber and standard inhaler

	Peak expiratory flow rate (l/min)			
	Fenoterol	Range	Placebo	Range
Standard inhaler	55.2	17.2 to 77.3	3.5	-15.2 to +32.4
Aerochamber attached	57.7	39.6 to 100.9	10.5	-1.6 to +43.5

Table 2 Improvement in PEFR expressed as a percentage of expected before and after inhaling placebo and fenoterol from an aerochamber

Age	Initial	Placebo	Fenoterol
3 years 7 months	75	79	108
4 years 1 month	87	91	104
4 years 4 months	80	76	104
5 years 2 months	88	91	103
5 years 2 months	93	90	127
5 years 9 months	91	88	106
Mean	85.6	85.8	108.7

13 years 10 months who had previously received aerosol therapy. Eight of the 10 children preferred the aerochamber to the standard aerosol alone.

Four children received the active drug via the aerochamber during the first 3-week period; all 4 did better using the aerochamber. Of the 6 remaining children 3 had greater mean improvements using the standard inhaler. The mean pretreatment PEFR was similar for both study periods in all children.

Six children under age 6 years have used the aerochamber with fenoterol and placebo under single blind conditions recording PEFR with a Wright's low range peak flow meter (Table 2). Another child aged 2 years 10 months, who was the youngest assessed, was able to use the aerochamber correctly even though he could not record PEFRs adequately.

Discussion

Our results show that the aerochamber is as effective as the standard metered dose inhaler alone in delivering aerosol drugs to the lower respiratory tract in asthmatic children who have been taught to use both devices correctly. A previous study in adults using radio tracers administered via the metered dose inhaler alone, and with the aerochamber attached, showed that equal amounts of the radio tracer reached the lower respiratory tract from both devices, but oral deposition was reduced 13-fold with the aerochamber attached.⁸

The second part of the trial showed that young children were capable of using the aerochamber

device. Separation of activation and inhalation makes the device suitable for use in young asthmatic children who occasionally find the inhalation of powders unpleasant and the standard aerosol device difficult to use.

We thank the children and their parents for co-operation, and the Asthma Research Council and Boehringer Ingelheim Limited for financial support.

The aerochambers were constructed and supplied by Boehringer Ingelheim Limited.

References

- Orehek J, Gayraud P, Grimaud Ch, Charpin J. Patient error in use of bronchodilator metered aerosols. *Br Med J* 1976; **i**: 76.
- Paterson I C, Crompton G K. Use of pressurised aerosols by asthmatic patients. *Br Med J* 1976; **i**: 76-7.
- Nilson H T, Simonsson B G, Strom B. The fate of ³H-terbutaline sulphate administered to man as an aerosol. *Eur J Clin Pharmacol* 1976; **10**: 1-7.
- Ellul-Micallef R, Morén F, Wetterlin K, Hidingen K C. Use of a special inhaler attachment in asthmatic children. *Thorax* 1980; **35**: 620-3.
- Gomm S A, Keaney N P, Winsey N J P, Stretton T B. Effect of an extension tube on the bronchodilator efficacy of terbutaline delivered from a metered dose inhaler. *Thorax* 1980; **35**: 552-6.
- Morén F. Drug deposition of pressurised inhalation of aerosols. Influence of actuator tube design. *Int J Pharm* 1978; **1**: 205-12.
- Wiener M V. How to formulate aerosols to obtain the desired spray pattern. *J Soc Cosmetic Chem* 1958; **9**: 289-97.
- Corr D, Dolovich M, McCormack D, Ruffin R, Obminski G, Newhouse M. The aerochamber: a new demand-inhalation device for delivery of aerosolized drugs (abstract). *Am Rev Respir Dis* 1980; **121**: Supplement, 123.

Correspondence to Professor A D Milner, Department of Child Health, E Floor, East Block, University Hospital, Queens Medical Centre, Clifton Boulevard, Nottingham NG7 2UH.

Received 15 June 1981

Effect of packed cell volume on blood glucose estimations

C M DACOMBE, R G DALTON, D J GOLDIE, AND J P OSBORNE

Department of Clinical Chemistry and Department of Paediatrics, Southmead Hospital, Bristol

SUMMARY The effect of changes in packed cell volume was studied in two commonly used reagent strip methods (Dextrostix and Reflotest) of measuring blood glucose and in a filter paper blood spot method. It was found that the results with both the reagent strip methods were greatly haematocrit-dependent. Attention is drawn to the possibility of false diagnoses of hypoglycaemia in haemoconcentrated patients and of normoglycaemia in anaemic patients.

The use of reagent strips and reflectance meters for the rapid measurement of blood glucose is now common, particularly for the diagnosis of hypoglycaemia in the neonatal period and for the management of diabetics. However, in both the sick neonate and the uncontrolled diabetic wide fluctuations in packed cell volume (PCV) occur. In particular, in the neonate the PCV may increase to 70% or more. It is therefore important that any method of estimating blood glucose concentration should not greatly depend on PCV.

Previous workers^{1,2} have suggested that the effect of PCV on the glucose results obtained with one

reagent strip/reflectance meter method (Dextrostix/Eyetone) is negligible within the range of 30-50% which they studied. However, this is a fairly narrow range and it is not possible from their results to estimate the effect of more pronounced changes in PCV.

We therefore decided to examine the effect of changes in PCV over a range from 20 to 80% on blood glucose estimations by two widely used reagent strip and reflectance meter methods. We also investigated the effect of PCV on whole blood glucose concentrations measured in filter paper blood spots.³

Material and methods

Dextrostix test strips and an Eyetone meter were provided by the Ames Company and Reflotest strips and a Reflomat meter by the Boehringer Corporation London Ltd. Each system was used strictly in accordance with the manufacturer's instructions, including frequent checks of quality control.

Filter paper blood spot measurements were made using the glucose oxidase method of Wakelin *et al.*³

Sixteen samples of 25-40 ml venous blood from