Nebulisers or spacers for the administration of bronchodilators to those with asthma attending emergency departments?

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\textbf{Summary}

\textit{Background:} Systematic reviews and national guidelines conclude that the nebulised route of administration of bronchodilators has no advantage over the use of a spacer in moderately severe exacerbations of asthma. Whether this recommendation is implemented and whether it might affect use of staff time is unknown.

\textit{Objectives:} To determine the current method of administration of bronchodilators to those with non-life-threatening asthma attending emergency departments (ED) in London, UK and to monitor the implementation of a new policy to administer bronchodilators by spacers in one ED with a special reference to the time taken by nurses to administer the therapy by two different routes.

\textit{Methods:} Thirty-five EDs in Greater London were surveyed regarding their current practice. A time and motion study was then undertaken in one department observing nurses administering bronchodilators in the 3 weeks before and 3 weeks after a departmental policy change to favour the use of spacer devices rather than nebulisers.

\textit{Results:} The majority of EDs (94.3\%) in Greater London were using the nebulised route of administering bronchodilators to the majority of their adult patients. Spacers were more commonly used for the treatment of children (60.3\% of departments using spacers and nebulisers or spacers alone). Over half of the hospitals surveyed (51.4\%) were unaware that the British Guidelines on Asthma Management suggested that outcomes were the same and that there were potential advantages in the use of a spacer for both adults and children. Time and motion studies showed that the use of a spacer took no more nursing time than administration of the bronchodilator via a nebuliser; in fact treatment and set-up time were considerably lower for spacers.

\textit{Conclusion:} Spacer administration of bronchodilators to those with asthma attending EDs utilises less treatment time than use of a nebuliser. A survey of EDs in Greater London has shown that despite guideline conclusions there appears to be little evidence of reduction...
Background

In the UK, 5.2 million people have asthma. Over 76,000 adults and children were admitted to UK hospitals in 2005. Many more attend emergency departments (ED) with exacerbations of asthma, which may present at varying degrees of severity, and many of these are repetitive attendees. Traditionally, the treatment for worsening asthma is the administration of high-dose bronchodilators and, depending on severity, a course of steroid tablets. Several studies and a systematic review have suggested that there is no advantage to the nebulised route compared with multiple actuations from a standard metered dose inhaler (MDI) activated through a spacer device. Reflecting this, the British Guidelines on Asthma Management have for some years highlighted the fact that in children metered dose inhalers and spacers have advantages over nebulisers, and more recently these guidelines have pointed out that for adults there is similarly no evidence that nebulisers are in any way preferable or more effective than bronchodilators administered via a spacer device. However, personal observation suggests that nebulisers still seem widely used, and when those using nebulisers were asked informally why some commented that they thought the use of spacers would be more time consuming. How widely the new recommendations are implemented and potential barriers and advantages associated with such a change have not been studied in the UK. A study 16 years ago in the US suggested potential cost-savings by substituting nebulisers with MDIs and spacers, and suggested that the amount of time spent administering treatment was reduced by using MDIs and spacers and this was also less expensive, especially when the patient was able to self-administer MDI therapy.

Methods

Survey

Thirty-five EDs in the Greater London region were contacted by telephone and asked two questions regarding the current practice for the treatment of acute asthma in both adults and children in their departments. The researcher asked for the specialist registrar (a middle-grade doctor in training to become a specialist emergency physician) or the nurse in charge. Details of the script for the telephone interview are in Appendix, and all were asked if they were aware of the changes that had been made in the British Asthma Guidelines and if they were using spacers in both adults and children. If the first contacted respondent was unable to answer questions about children, the call was transferred to the paediatric department.

Time and motion study

In November 2006, the ED at Charing Cross Hospital London implemented a new policy whereby bronchodilators would be administered to those with severe but not life-threatening asthma, by spacer devices rather than via nebulisers. In the 3 weeks prior to the implementation of this new policy and in the 3 weeks after the policy change, nurses were observed administering bronchodilators and the treatment time recorded. Life-threatening cases were treated in the traditional way with nebulisers, because trials of nebulisers versus spacers have not been undertaken in this group (Figure 1). This was a pragmatic observational study utilising a time and motion observer being a science graduate who observed nurses’ work in the ED. This was carried out at different time slots throughout a 3-week period, before and after the protocol change. During the initial 3-week period 20 patients were observed undergoing treatment, and therefore the same number was observed post protocol change.

Nebulisers were administered via aerosol generated from wall oxygen supplies and all patients observed were adults. Depending on the severity of the patients’ condition, (classified using the British Asthma Guidelines), the medication varied (Figure 1).

Nurses were observed using nebulisers and the total treatment administration time was recorded, including total nurse time from the time the nurse collected the medication to administration of the medication, further attendances to observe the patient and completion of treatment and dismantling of the equipment. All nurse interactions with the patient were recorded. Observations were made by the same observer using a stopwatch.

The department, implementation and audit of the new policy

The Charing Cross ED is one of 35 in the greater London region, and it serves a densely populated area in West London. Within the department asthma is managed according to the British Asthma Guidelines, and these are used for teaching/training and are widely available within the department on wall charts, etc. Respiratory nurse specialists visit the department on a daily basis to obtain details of patients who have attended and discharged to ensure continuity of care. Staffing levels were 5.4 consultants, 10 middle grade (specialist registrars) and 12 senior house officers (SHOs).

Implementation of the new policy was instituted following full discussion and with the enthusiastic support of the consultants working in the department and the senior nurse manager and pharmacist. Talks regarding the new policy were given to both nursing and medical
Nebulisers or spacers for the administration of bronchodilators?

**PATIENT WITH ASTHMA?**

**CHANGES TO THE WAY IN WHICH WE ADMINISTER BRONchodILATORS**

(This protocol does not apply to patients who are being treated for COPD)

<table>
<thead>
<tr>
<th>Life threatening</th>
<th>Severe Asthma</th>
<th>Moderate Asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Peak expiratory flow (PEF) &lt; 33% of best or predicted</td>
<td>• Peak expiratory flow (PEF) 33-50% of best or predicted</td>
<td>• Peak expiratory flow (PEF) &gt; 50 – 75% of best or predicted</td>
</tr>
<tr>
<td>• SpO₂ &lt; 92%</td>
<td>• Can’t complete sentences in one breath</td>
<td>• Increasing symptoms</td>
</tr>
<tr>
<td>• Silent chest, cyanosis or feeble respiratory effort</td>
<td>• Respiratory rate ≥ 25 breaths/min</td>
<td>• No features of severe asthma</td>
</tr>
<tr>
<td>• Bradycardia, dysrhythmia or hypotension</td>
<td>• Pulse ≥ 110 beats/min</td>
<td></td>
</tr>
<tr>
<td>• Exhaustion, confusion or coma</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TREAT IN THE USUAL WAY WITH NEBULISED BRONchodILATORS etc.**

(Trials of nebulisers versus spacers have not been undertaken in this group)

• 4 – 6 puffs Salbutamol from a metered dose inhaler via a spacer with the inhaler actuated by individual puffs into the spacer, with the patient taking a full breath after each actuation.
• This is followed by 4 puffs of Ipratropium Bromide (20 micrograms) by single actuation followed by an individual deep breath.
• Process repeated every 10 minutes until patient responds to treatment.

**Background - Level One Evidence**

From a Cochrane Systematic Review and meta-analysis of 13 randomised controlled trials of MDIs and spacers versus nebuliser therapy for acute asthma. Admissions showed that MDI + spacers produced outcomes at least equivalent to nebulised therapy and suggested a trend toward fewer side effects and less time in the emergency department in children.

1. Cates C.J. Holding chambers vs nebulisers for beta-agonist treatment of acute asthma.

**NOTE:** Spacer should be left with patient after administration so that it is available for subsequent administrations whether at home, or similarly on the wards, if admitted. Patients on oxygen can be taken off oxygen for the few moments that it takes to administer the bronchodilator, but if there are any concerns about this, the patient should receive oxygen from nasal cannulae at a flow rate of four litres per minute, whilst the bronchodilator is administered. Patients who are admitted: If the patient responds satisfactorily to initial therapy it is anticipated that bronchodilators will continue to be administered in the spacer rather than from a nebuliser after admission to the MAU or a ward.

**Figure 1** A summary of the new protocol; classifications and indications for treatment.

Costs

The materials used were costed by the hospital pharmacy and the supplies department for disposable and medication costs.

Results

Survey

All 35 Greater London hospital EDs that were contacted by telephone responded to our questions. One asked for time to think about the answers and two requested us to phone back because the key member of the staff was currently busy with an emergency.

Of the EDs surveyed, 33/35 (94.3%) confirmed that in adults nebulisers were used for the administration of bronchodilators in non-life-threatening acute asthma, with only 2/35 (5.7%) reporting that they used spacers. Thirty departments (85.7%) commented separately on their treatment of children and 11 of those (36.7%) used spacers routinely, 10 (33.3%) used nebulisers routinely and nine out of the 30 (30%) used both methods of administering bronchodilators, apparently depending upon the clinical situation.

staff and summary charts were widely distributed. Patient information leaflets were made available to give to patients who might previously have attended and been given a nebuliser. The notes of patients with asthma who attended the ED at the Charing Cross Hospital in the 4 weeks following the policy change were audited to assess whether they had been treated with bronchodilators administered via a nebuliser or via a spacer, and if by a nebuliser whether this was due to the patient having life-threatening asthma for whom the new policy did not apply.

For the audit, notes of relevant patients were identified from the ED electronic register. Information regarding diagnosis was recorded by several different methods; either by patients’ complaint recorded by the receptionist, or by the complaint as recorded by the triage nurse (for example, shortness of breath, unwell, sore throat, cough etc.), or by the final diagnosis. Our audit of the department register therefore included searches under all of these categories so that a patient who attended and was classified as a “viral illness” but was triaged as “short of breath” and subsequently diagnosed with asthma would be included in the audit. An attempt was then made to recover all notes which had been scanned into the departmental computer system concerning patients with these relevant diagnoses.
Eighteen out of 35 (51.4%) hospitals surveyed stated that they were unaware that the current guidelines suggested equivalent outcomes using spacers, but many did comment that they knew that it was a good practice for children to be treated by using spacers but they had not realised that this practice also extended to adults. Seventeen departments (48.6%) reported that they were aware of the guidelines’ recommendations but, nevertheless, 15 of these (88.2%) continued to administer bronchodilators to the majority via nebulisers and not by using spacers.

**Time and motion study**

Twenty patients were observed receiving treatment before the protocol change and 20 patients in the 3 weeks afterwards. These patients were selected by the researcher operating similarly timed shifts during the 3 weeks pre- and post-protocol change. The total treatment time using a spacer was 123 s (median \( n = 20 \), IQR 92.5–188.25), compared with a total time using nebulisers of 1194 s (median, \( n = 20 \), IQR 806.75–1724.5, \( p < 0.001 \)). This information is summarised in Figure 2, and the total treatment time was measured from when the nebuliser was switched on, or when the first puff was taken from the spacer, until the end of the treatment in either case, and was clearly less using a spacer. The total time that the nurse spent with the patient during the two treatments was not significantly different (spacers 155.5 s [IQR 122.75–227.25] and nebulisers 134.5 s [IQR: 95.5–178.25, \( p = 0.38 \)]. However, the set-up time was significantly reduced (spacers taking 23 s [IQR: 13.75–43.5], nebulisers 98.5 s [IQR: 74–134], \( p < 0.001 \)) (Figure 3).

**Audit**

Audit of the notes of 58 patients (mean age 34.7 (SD 17.2 years) 23 male and 35 female)—who attended the department with out-of-control asthma in the 4 weeks after the protocol change—revealed that 25.9% of patients were given nebulisers without clinical indication after the protocol was introduced. Thirty (51.7%) of the patients were treated appropriately either with a spacer or were appropriately nebulised because they had a life-threatening disease (four patients). Nine (15.5%) of the patients either did not require treatment, were given inhalers alone (the patients having requested an inhaler as their own had finished), or treatment was only recorded as “salbutamol given”, i.e. it was not possible to determine the method of administration.

**Costs of implementation of the protocol**

The costs of disposables and medication for each of these methods based upon the departmental protocol and expressed per single treatment and per 20 treatments are shown in Table 1.

The total cost for one treatment with a nebuliser with 5 mg salbutamol and 500 mcg ipratropium was £1.11 [£1.63/US$2.20] (excluding oxygen or air needed).

Total cost for one treatment using an MDI and spacer with 600 mcg salbutamol and 80 mcg ipratropium was £4.80 (£7.06/US$9.53).

**Discussion**

This study demonstrates that the nebulised route of administering bronchodilators is still the dominant route...
for the treatment of adults attending EDs with out-of-control asthma in London, and whilst there has been a shift towards the use of spacers in the treatment of children, this is by no means complete. The reasons why the nebulised route is still used is not known but it is likely to reflect a long-term practice, and this study suggests a lack of awareness of the evidence which suggests no benefit from this route of administration. We had suspected that a perception of greater nurse time being necessary with use of a spacer than with use of a nebuliser might represent one reason for non-implementation of the guidelines recommendation and for that reason undertook the time and motion study. The methodology, whilst widely used, has limitations in that the nurse knows that they are being observed, but this would apply equally to observation of both methods of administering the bronchodilator. In this study the observer was not blinded to the purpose of the study and this is similarly a potential source of error. It also seems likely that the results could have been distorted in part by a habit of leaving the patient “on the nebuliser” even when all solution has been aerosolised, which was probably the explanation for one patient taking over 20 min to receive their bronchodilator. Despite these limitations, it seems reasonable to conclude that we can reassure those considering implementation of a new policy that it will not involve nurses in a more time-consuming task.

The economic benefits of the use of a spacer are harder to discern. If the spacer were to be used to administer salbutamol alone, a cheaper spacer than that used in this study could be used. However, because patients with more than mild asthma are treated with an anti-cholinergic agent in addition to a beta-agonist, a spacer device which accommodates both types of metered dose inhalers is necessary and these tend to be more costly. If a patient were to be given a single-patient-use spacer to receive a single treatment in the casualty department it would increase the expense, but for many patients using a pressurised MDI a spacer represents an optimal way of them also taking their preventative therapy and the patient can thus be given the spacer for the administration of inhaled steroids after their attendance in the ED. Similarly, those admitted to hospital can retain the spacer used in the ED when transferred to the ward. The policy regarding the method of administering the bronchodilator thus does however need to be consistent from the ED to the medical admissions unit to the respiratory ward.

In 2005, 77,150 patients were admitted to the hospital in the UK,1 and the median duration of admission in adults is 3 days (hospital episode data, 2005/2006). They are likely to receive bronchodilators as a minimum of four times a day, and over this time period with this therapeutic regimen the costs of the spacer rapidly equal the use of a nebuliser and indeed could lead to savings (Table 1).

Audit of compliance with the new policy in this study suggested a number of breaches and others have suggested that failure to implement guidelines often represents health professionals not knowing of the content of the guidelines, not believing the recommendation, doubting their ability to deliver the recommendation or the health professional making a change but then falling back into old habits.8 Reinforcing education and re-audit is likely to be necessary, but further study may also be necessary to try and elucidate further why new recommendations in this field are not implemented.

### Conflict of interest statement

None of the authors have any conflicts of interest related to this study.

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**Table 1** Summary of costs for nebulisers and spacers.

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<thead>
<tr>
<th></th>
<th>Nebuliser</th>
<th>Spacer</th>
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<tbody>
<tr>
<td><strong>Total cost for 1 treatment with 1 patient</strong></td>
<td>Disposables = £0.97 Medication = £0.14 Total = £1.11 (Disposables include: Chamber £0.50, Oxygen mask £0.35, Tubing £0.12)</td>
<td>Disposables = £4.70 Medication = £0.10 Total = £4.80 (Disposables include: AeroChamber £4.70)</td>
</tr>
<tr>
<td><strong>Total cost for 10 treatments with 1 patient</strong></td>
<td>Disposables = £9.70 Medication = £1.40 Total = £11.10</td>
<td>Disposables = £4.70 Medication = £1.00 Total = £5.70</td>
</tr>
<tr>
<td><strong>Total cost for 20 treatments with 1 patient</strong></td>
<td>Disposables = £19.40 Medication = £2.80 Total = £22.20 (£32.70/US$44.07)</td>
<td>Disposables = £4.70 Medication = £2.00 Total = £6.70 (£10.01/US$13.50)</td>
</tr>
</tbody>
</table>

Table 1 provides a summary of the costs incurred for both methods of bronchodilator administration. The disposables used and the different forms of the medications used in each mode are summarised, and demonstrate that over the course of 20 treatments the MDI plus spacer is 70% less expensive than nebulisers. Only the AeroChamber was stocked following the change in policy as this is the only spacer available in the UK, which fits a variety of metered dose inhalers. It also takes up less room in a department than some other large-volume spacers, which do not fit all of the inhaler devices.
Acknowledgements

We are very grateful to Drs. H. Millington, F. Probst, F. Moore and G. Barnett for introducing the new policy and for so willingly allowing us to monitor its implementation. We would like to thank Professor P Gibson (Newcastle, Australia) for his advice and guidance on the study.

Appendix. Telephone survey

These calls took place between 8.30 and 9.30 am during the time course of the project.

Call script

“Good morning, my name is Naomi Mason and I’m working with Professor Partridge at Imperial College. We are doing a survey of Emergency departments with regard to treatment of acute asthma. I was wondering if I could speak to the Registrar or the Nurse in Charge for one minute to ask a couple of questions.

(1) Firstly do you currently use nebulisers or spacers for the treatment of non-life threatening acute asthma in those attending your department and does the same apply to adults as to children?

(2a) If nebulisers are used: Were you aware that the British Asthma Guidelines have recommended that metered dose inhalers plus spacers or nebulisers could be used for the treatment of non-life threatening acute asthma, and that both were equally effective? YES/NO

(2b) If already using spacers: When did you change your policy and is it implemented?

Many thanks for your time.”

Reference