

## Nebulisers for asthma

M J Ward

Nebulisers have been used for many years in asthma but, despite this, surveys have suggested that the understanding of their use by patients, doctors, and nurses is poor.<sup>1</sup>

In hospital nebulisers are often used in surgical as well as medical wards and therefore representative personnel from all wards and specialities should be trained to ensure that the bronchodilator is given correctly. In primary care nurses and doctors must have appropriate training in nebuliser therapy.

At the present time bronchodilators are usually given by nebuliser in acute asthma. In chronic asthma nebulisers are used less frequently, the bronchodilator mostly being delivered by metered dose inhaler or dry powder device.

### Acute severe asthma

Oxygen, corticosteroids, and bronchodilators are widely used in acute asthma (fig 1). Corticosteroids, however, take several hours to work and during this time fast acting bronchodilators can be lifesaving. When bronchospasm is severe, bronchodilators must be given in large doses and a convenient method of achieving this is by simple nebulisation.

### NEBULISED $\beta$ AGONISTS

#### *Indications and advantages*

Because of severe bronchospasm it was thought that bronchodilators given intravenously would be more effective in acute severe asthma. Initial studies reported varying results due to the small numbers of patients producing a result with low power to detect differences between treatments.<sup>2</sup> Comparisons between nebulised  $\beta$  agonists and intravenous aminophylline have shown that nebulised  $\beta$  agonists produce more bronchodilatation than aminophylline alone.<sup>3-5</sup> A meta-analysis of trials investigating the addition of aminophylline to nebulised  $\beta$  agonists also failed to demonstrate significant additional bronchodilatation.<sup>2,3,5-8</sup> Most of these studies, however, investigated only the early effects of intravenous aminophylline. In a recent study nebulised salbutamol and intravenous aminophylline were compared with nebulised salbutamol alone over 24 hours in 21 patients and a greater percentage improvement in peak flow was reported after a few hours in those given aminophylline.<sup>9</sup>

There is therefore no conclusive evidence to support the routine addition of aminophylline to a nebulised  $\beta$  agonist. Moreover, the addition of aminophylline increased the likelihood of cardiac adverse effects, tremor, and hypokalaemia.<sup>3-5</sup>

Nebulised and intravenous  $\beta$  agonist, either by bolus injection or constant infusion, have also been compared. There have been five studies, two of which studied such a small a number of patients that the power was too low to detect any significant difference between treatments.<sup>10,11</sup> The other three studies investigated more patients and had adequate power to detect clinically useful differences. The first from Sweden in 176 patients demonstrated that nebulised treatment with a  $\beta$  agonist (two doses of salbutamol 0.15 mg/kg 30 minutes apart) was superior to a bolus injection of 5  $\mu$ g/kg.<sup>12</sup> The second, in 71 severely ill patients not responding to nebulised treatment, showed that an intravenous infusion of  $\beta$  agonist (12.5  $\mu$ g/kg) produced significantly more bronchodilatation than repeated administration of nebulised salbutamol over a period of 24 hours (three doses of 5 mg given 30 minutes apart).<sup>13</sup> The third study investigated the two treatments in severe acute asthma in patients with a peak flow of less than 150 l/min and found that nebulised treatment produced a greater increase in peak flow and was considered to be clinically superior.<sup>14</sup>

Infused  $\beta$  agonists may or may not therefore have a useful role in producing bronchodilatation in the small group of asthmatic patients who do not respond to nebulised treatment and further large studies are required.

#### *Dosage*

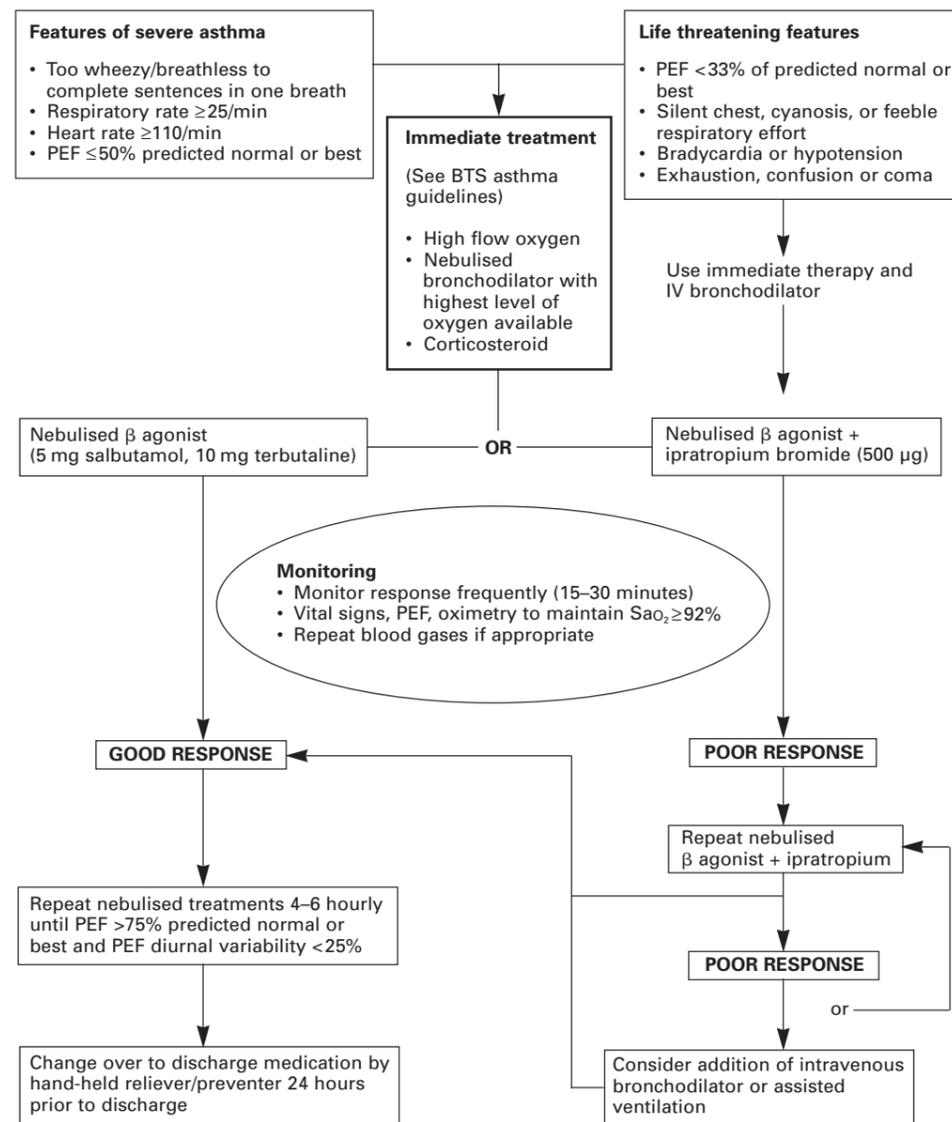
No controlled study has been carried out to determine the dose of  $\beta$  agonist to nebulise in acute asthma and practice therefore varies with doses ranging from 2.5 mg to 10 mg. Small doses are used in less severe asthma and it cannot be assumed that such doses will be adequate in severe asthma. Single doses of 5 mg salbutamol by simple nebulisation may produce only slight relief of airflow obstruction in acute asthma.<sup>15</sup> A response to a nebulised  $\beta$  agonist should be apparent within 10-15 minutes of inhaling the drug, and if this is not the case further doses should be given until an adequate response is produced. This policy usually relieves symptoms but, if it fails, other therapeutic measures such as intravenous therapy or assisted ventilation should be considered.

#### *Side effects*

Treatment with nebulised  $\beta$  agonists in acute severe asthma is very safe but the large doses employed may cause tremor and tachycardia. Caution should be advised in the elderly and in those with known myocardial disease as angina has been precipitated in susceptible individuals.<sup>16</sup> Serious problems with nebulised  $\beta$

King's Mill Hospital,  
Mansfield Road,  
Sutton-in-Ashfield,  
Nottinghamshire  
NG17 4JL, UK  
M J Ward

Correspondence to:  
Dr M J Ward.



This flow chart should be used in conjunction with published asthma guidelines.

Figure 1 Flow chart for management of acute severe asthma in adults.

agonists are, however, very rare. The evidence that nebulised  $\beta$  agonists may aggravate hypoxaemia is not convincing and recent studies suggest that the treatment does not produce any significant falls in arterial oxygen saturation.<sup>15,17</sup> No deterioration in hypoxaemia was recorded in 32 hypoxaemic patients admitted with acute severe asthma to whom nebulised salbutamol was given in doses ranging from 1.5 mg to 5 mg using an air compressor.<sup>15</sup> In domiciliary practice lack of oxygen to drive a nebuliser should not preclude giving  $\beta$  agonist.

#### NEBULISED ANTICHOLINERGIC DRUGS

##### Indications and advantages

In acute severe asthma nebulised ipratropium bromide alone is not as good a bronchodilator

as a nebulised  $\beta$  agonist alone.<sup>18</sup> Early studies with combined ipratropium bromide and  $\beta$  agonist were performed in small numbers of patients but most reported more bronchodilatation than with  $\beta$  agonist alone. In two large studies on 56 and 148 patients with acute asthma significant differences between the treatments were recorded with the combination producing significantly greater bronchodilatation in the first four hours of treatment than that following a  $\beta$  agonist alone,<sup>18,19</sup> particularly in those with very severe asthma (forced expiratory volume in one second (FEV<sub>1</sub>) <1.0 litre or peak expiratory flow <140 l/min) in whom the mean FEV<sub>1</sub> improved by 55.6% with the combined treatment and 38.9% with the  $\beta$  agonist alone.

A meta-analysis of the use of a nebulised  $\beta$  agonist and ipratropium bromide in acute

asthma has suggested that, on average, ipratropium produces a mean increase in the peak expiratory flow rate of 44 l/min (95% confidence interval 17 to 61) more than that produced by  $\beta$  agonist alone.<sup>20</sup> These have been short term studies and therefore the optimum duration of this combined treatment is not known.

#### Dosage

A cumulative dose response study in only six patients suggested that 0.5 mg nebulised ipratropium produced a maximum bronchodilator response in patients with acute severe asthma.<sup>21</sup> Following this small study an investigation comparing 0.5 mg with 1.0 mg nebulised ipratropium in acute asthma found no difference in the mean rise in peak flow between the treatments,<sup>22</sup> and this has led to the recommended dose of 0.5 mg.

#### Side effects

Prolonged pupillary dilatation and loss of accommodation can occur if ipratropium is sprayed directly into the eye. This complication can lead to acute glaucoma in adults and may happen if nebuliser solutions are given with a face mask rather than a mouthpiece. Similar adverse reactions are not likely in children.<sup>23</sup> It is unusual for nebulised ipratropium to cause urinary problems, but when high doses are repeatedly nebulised in susceptible individuals this may precipitate urinary retention. Nebulised ipratropium has no detrimental effect on arterial hypoxaemia and does not affect cardiac rate.<sup>22</sup>

Paradoxical bronchoconstriction has been reported, but very rarely. At first this was thought to be due to the hypotonicity of the nebuliser solution,<sup>24</sup> and then to preservatives in the solution.<sup>25</sup> Nebuliser solutions are now isotonic and preservative free but the problem may still arise and the treatment should be withdrawn if the patient does not respond in the expected manner. Paradoxical bronchoconstriction can occur with any nebulised drug.

#### CHANGE OVER FROM NEBULISER TO HAND HELD INHALER

Patients should not be discharged from hospital until their medication has been changed to that which they will be taking at home. This change should then be monitored for 24 hours to ensure that the asthma does not deteriorate once the nebuliser treatment has been stopped. The change over should not take place until the peak expiratory flow rate (PEFR) is at least 75% of the predicted value or of the best level and a diurnal variability of less than 25% (diurnal variability = highest PEFR – lowest PEFR/highest PEFR  $\times$  100 in each 24 hours).<sup>26,27</sup>

#### FURTHER RESEARCH

Conflicting reports indicate that further areas for research in acute asthma include the possible use of spacing devices attached to metered dose inhalers instead of nebulisers.<sup>28–30</sup> Also, there have been few investigations to determine the best treatment for those asthmatic patients who do not respond to initial treatment with nebulised  $\beta$  agonists. Many studies have been conducted in emergency departments and have only investigated treatments for up to two or four hours. Further research is required to determine the best ways of treating acute asthma during the first 24–48 hours after admission and ways of preventing readmission with further acute attacks. The role of nebulised corticosteroid in acute asthma will no doubt be investigated.

#### Chronic asthma and brittle asthma

Nebulised bronchodilators may be given to relieve symptoms in patients with chronic persistent wheeze or to those with sudden catastrophic severe (brittle) asthma. The use of nebulisers without proper assessment and supervision is potentially dangerous.

Some patients with severe chronic airflow obstruction who remain symptomatic despite treatment with inhaled reliever and high dose inhaled preventer derive benefit from inhaling a bronchodilator in a large dose.<sup>31</sup> Historically this has been done by nebuliser. In many cases, however, this may not be necessary as 4–6 puffs of a metered dose inhaler fitted with a spacer device with tidal breathing produces the same result.<sup>29,30</sup>

In some patients, however, a nebuliser is still considered and then it is important that guidelines for the treatment of chronic asthma are followed.<sup>26,27</sup> Such guidelines include advice before prescribing the nebuliser:

- (1) Is the diagnosis correct? Is the airway obstruction significantly reversible?
- (2) Has the inhaler technique been checked and has a large volume spacer been tried?
- (3) Has a large dose of bronchodilator via a spacer device been used?
- (4) Is the patient complying with regular anti-inflammatory therapy?
- (5) An initial home trial should be undertaken to determine if worthwhile bronchodilatation is obtainable.

An increase in bronchodilatation without unacceptable side effects should be demonstrated, preferably with a home trial for at least two weeks with monitoring of peak flow. Not every patient will benefit from high dose nebulised treatment and an increase in mean baseline peak flow of 15% or more should be demonstrated. Peak flow should be measured for two weeks on standard treatment and then for two weeks on nebulised treatment. Peak flow measurements should be taken twice daily before nebulisation on rising and going to bed. In addition, a peak flow measurement should be taken 30 minutes after treatment in the morning.

A few asthmatic patients develop sudden severe asthma attacks within minutes or a few

hours despite little instability of asthma in the preceding days. They require treatment with a high dose of a  $\beta$  agonist, often by nebuliser (salbutamol 5 mg, terbutaline 10 mg).<sup>26,27</sup>

If a nebuliser is prescribed clear instructions must be given. Patients should not attempt to treat acute attacks at home without seeking help. Oral and written instructions should be given to the patient on the method and frequency of use, and the action to be taken in the event of worsening asthma and treatment failure. Supervision should include peak flow monitoring to assess response to treatment. Patients must be given an education programme by a suitably trained doctor or nurse detailing how to use and maintain a nebuliser.

An education programme should include:

- (1) Written instructions on the dose of bronchodilator and frequency of use, and what to do in an emergency or if the asthma deteriorates despite treatment. Patients should have clear instructions not to attempt to treat an acute attack at home without seeking help.
- (2) Demonstration of how to use a nebuliser, with the first dose given under supervision.
- (3) How to maintain and look after the nebuliser.
- (4) Regular follow up arranged at an asthma clinic to be seen by a doctor or trained nurse or physiotherapist.

The dose of  $\beta$  agonist to use in chronic asthma is usually 2.5 mg salbutamol or 5 mg terbutaline, producing adequate bronchodilatation with few side effects related to systemic absorption.<sup>32</sup> The dose of ipratropium bromide is usually 500  $\mu$ g.

A few patients with severe chronic asthma may require maintenance oral prednisolone in addition to a high dose inhaled corticosteroid. This often leads to systemic adverse effects of skin thinning, purpura, and weight gain. The effects of adding nebulised budesonide (2–8 mg/day) has been studied in this group of patients and it is suggested that budesonide can reduce the requirement for oral corticosteroid. Of 42 patients treated with this combination 37 had side effects attributed to oral prednisolone, all of which were much reduced after 12 weeks of treatment.<sup>33</sup> The study, however, did not compare the addition of nebulised budesonide with an increased dose of budesonide by metered dose inhaler, and was not placebo controlled. Further work is required in this area.

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