Delivering Oxygen during Nebulization to Infants and Toddlers

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Introduction

Two hypotheses have been postulated for the continued trickle of asthma deaths [1]. Firstly due to cardiac arrhythmia, which is more common in adults. Secondly, a far more likely hypothesis is that these deaths occur as a result of progressively worsening hypoxemia due to ventilation-perfusion mismatch and alveolar hypoventilation. Management of acute asthma by various authorities recommend oxygen as the first line of treatment and simultaneous treatment with inhaled β_2 -agonists to relieve bronchospasm [2, 3] with repeated doses from metered dose inhalers (MDI) since they are considered equivalent to or better than nebulizers driven by compressed air, which are available in most of our service hospitals [4]. However, most children under 5 years cannot perform the respiratory gymnastics needed to use a MDI and when used with a spacer, many young children might refuse it due to anxiety or are too sick to generate enough respiratory pressure to open the one-way valve on these spacers. In such children, nebulizers are used and these should ideally be oxygen driven since nebulization of β_2 -agonists without oxygen can cause or worsen hypoxemia [1, 5]. The mechanism of this is well documented. β_2 -agonist when nebulized, results in vasodilation by inhibiting hypoxia induced pulmonary vasoconstriction resulting in increased intrapulmonary shunting i.e. increasing perfusion to poorly ventilated lung units and hence ventilation-perfusion mismatch which leads to worsening of hypoxemia. Studies have also documented a significant fall in arterial oxygen saturation in about 50% of the asthmatic children who were treated with salbutamol nebulized with compressed air [5,6]. Oxygen therapy is often delayed during nebulization for 10-15 minutes, hence giving air driven high doses of nebulized salbutamol to children may transiently increase ventilation-perfusion mismatch sufficiently to cause a further critical desaturation, which may result in death.

Method

To overcome this problem we are using a simple modification on the existing air driven nebulizers in the following way : The air inlet on the nebulizer (Pulmo-Aide) can be connected to an oxygen source, such as an oxygen cylinder or oxygen concentrator (Invacare 5) by a simple 'Y' connector so that the nebuliser sucks in oxygen along with air for making aerosol. Using an oxygen analyzer (MaxO₂, Maxtec USA) we have found that oxygen concentration of about 35% can be delivered by a face-mask with a rate of 5 litres/min. Where there are no nebulizers available, or if available do not have easy to attach inlet as mentioned, then in that case, the Cirrus chamber (portion where respiratory solution is kept) can be directly connected to the oxygen cylinder which can deliver aerosols at oxygen flow rates of >7 l/min. After nebulisation the oxygen source can be reconnected to the child's mask.

Method application and Results

We did a trial on 21 severe episodes of asthmatic admissions in paediatric patients over a 1 year period (patients were allowed to enroll in the study on more than one occasion). All patients enrolled received 3 doses of nebulised salbutamol every 20 minutes and one dose of prednisolone (parenteral hydrocortisone to those who vomited or were unable to drink) during the 1st hour of treatment. Eleven of the patients received nebulization with oxygen attached to the inlet of the nebulizers (oxygen group) and the rest ten received nebulization in the conventional way (control group). Pulse oximetry was measured along with clinical severity scales during the treatment. The study population did not differ in age, sex or history of previous asthma admissions. Fall in oxygen saturation of 3-5% was observed during treatment in the control group. The respiratory rate was slightly higher at the end of the treatment with this group. No significant fall (0-1%) was observed in the oxygen group.

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Conclusion

Hypoxemia during nebulization with air-driven nebulizers can easily be prevented by simple addition of oxygen source to the air inlet of available nebulizers as mentioned above, since oxygen has to be given to children in severe attacks of asthma not only before and after but also during treatment with β_2 -agonist. This is important in preventing continued deaths occurring from asthma.

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