

Management of Acute Asthma in children using metered dose inhaler and small volume nebulizer

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Abstract

Objective: To determine whether the administration of β_2 - agonist by Metered Dose inhaler (MDI) with accessory device (AD) is as effective as the administration of β_2 - agonist by small volume nebulizers (SVN) for the treatment of acute asthma.

Methods: A cross sectional study was conducted at Emergency Room (ER) of National Institute of Child Health (NICH), Karachi, between October 2000 to March 2001. This study included 150 children, 6 months and older with a history of wheeze and presenting with an acute asthma exacerbation. Children were categorized into mild, moderate and severe asthma according to medical scoring system. Children were assigned randomly into group A and B to receive standard dose of β_2 - agonist (salbutamol) by MDI/AD (group A) or SVN (group B). Baseline characteristics and asthma severity were recorded. All variables (dyspnoea, use of accessory muscles, cyanosis, respiratory rate, heart rate, blood pressure, oxygen saturation, pulsus paradoxus, and wheeze) and Peak Expiratory Flow Rate (PEFR) in children 5 years and older, were determined at pre and post inhalation therapy.

Results: Both groups did not differ in demographic characteristics. There were no significant differences in outcome measures. In children treated with MDI/ADs and SVNs. PEFR increased significantly in both the groups after completion of treatment, but PEFR was not statistically significant when compared in between groups.

Conclusion: The data suggested that MDI/AD is an effective alternative to nebulizer for the treatment of children with acute asthma exacerbation in the ER (JPMA 56:595;2006).

Introduction

Bronchial asthma is a major public health problem, effecting over a hundred million people worldwide.¹ It is one of the most common paediatric chronic lung disorder^{2,3} universally and also a common respiratory disorder in Pakistan.⁴ The incidence of asthma is rising all over the world, especially in children.^{1,5} Pakistan is no exception⁶ and according to some reports, up to 4% of children attending the out patient department suffers from bronchial asthma.^{1,5} Currently there is little awareness about asthma in most of the developing countries, including Pakistan.¹

Studies over the past decade suggested that morbidity and mortality from asthma are on the rise.⁷⁻⁹

Management of acute asthma in children presents a particular challenge. The first line treatment in the management of acute asthma is inhaled β_2 -agonist (Salbutamol)⁴ and is now the mainstay of treatment. The advantage of inhaled β_2 agonist is effective bronchodilatation and fewer side effects.¹⁰ This not only reduces the adverse effects as compared to oral or parental administration of bronchodilators but also avoid patient discomfort especially in a paediatric population.¹¹ β_2 - agonist may be administered by metered dose

inhaler with accessory devices (MDI/AD) or small volume nebulizers (SVN).

For many years, SVN have been the accepted maintenance therapy for acute asthma. An international study as well as a local study done on adult population⁴ compared MDI / AD and SVN, in acute asthmatic attack have shown that MDI / AD was as effective as SVN.¹² However these in no local paediatric data available. This study was undertaken to evaluate the effectiveness of these two delivery systems for the treatment of acute asthma in children.

Patients and Methods

This cross-sectional study was carried out in the emergency room (ER) of National Institute of Child Health (NICH), Karachi between October 2000 to March 2001.

Children of both genders 6 months to 15 years of age, with acute asthma exacerbation attending the emergency room of this institute were included. Children who required urgent intensive care management, had PEFR values < 20% or > 70%, had oxygen saturation values < 90% in room air, and who had received daily treatment with systematically administered corticosteroids for more than two weeks before being seen in emergency room were excluded from this study. Verbal informed consent was obtained from parents of the children.

After measuring their weight and height, the children were assessed for initial clinical symptoms of dyspnea, chest wall retraction, respiratory rate (RR), heart rate (HR), wheeze, blood pressure (BP), oxygen saturation (SaO₂), Pulsus Paradoxus and peak expiratory flow rate (PEFR) in more than 5 years children, and best of three PEFR results was taken. Children were categorized into mild, moderate and severe acute asthma with the help of total score, according to the medical scoring system shown in Table 1.¹³ These children were then randomly categorized into two treatment groups A and B.

Children of group A (MDI/AD) were treated with salbutamol inhaler (100 microgram / puff) with 2 puffs three times in 1 hour at 20 minutes interval with the help of one way valve accessory device. We used two types of spacers in our study; first one was with mouthpiece spacer, which was used in older children. Other one was babyhaler (with mask), which was used for younger children. Children of group B were treated with SVN with salbutamol solution (0.3 mg/kg). Salbutamol solution with 2 ml Normal Saline in 1 hour with 20 minutes interval, with the help of New Nebulizer type 2 Fleam Nuova S.P.A., Brescia, Italy.

The clinical condition, and PEFR were reassessed at 10 minutes, 20 minutes and 2 hours after completion of treatment. Outcome was categorized as either they had no improvement (still had signs of respiratory distress), slightly improved (some improvement in clinical condition) or

improved (minimal or no signs of respiratory distress).

The data was analyzed on SPSS (Statistical Package for Social Sciences) version 13. The result is given as mean (x), standard deviation (Sd) for continuous variables like, age, weight, height, respiratory rate, blood pressure, PEFR, etc and percentages for categorical variables like gender, clinical condition (dyspnoea, cyanosis, wheeze), severity of attack, outcome etc. To compare proportion / percentage of variables between two treatment groups (MDI/ADs and SVN) Chi square test was used. The means of continuous variable between the groups (MDI/AD and SVN) were analyzed by student's t-test. In all statistical analysis, only p value < 0.05 was considered significant.

Results

A total of 153 children presenting with acute asthma were included in the initial assessment. Out of these, 3 patients were excluded, 2 parents refused to get treatment with MDI / AD and were not interested to fill the Performa and one had oxygen saturation < 90% in room air. The remaining 150 children were enrolled in this study and were randomly assigned into two groups A and B with 84 children in group A and 66 children in group B. Demographic and anthropometric characteristics (age, gender, height and weight) between the two groups did not show any significant difference.

Table 2 shows baseline characteristics of 2 groups including PEFR. On the basis of medical scoring system the children were categorized as severe or mild to moderate acute asthma. Majority of children had severe acute asthma 76.2% in group A and 75.8% in group B. Mild to moderate acute asthma were 23.8% and 24.2% in group A and B respectively. Medical scoring was 10.8 ± 1.9 in group A and in group B 10.7 ± 2.0. PEFR in MDI / AD group was 110 ± 33.8 and 89 ± 26.8 in SVN group at baseline (p = 0.010).

Table 3 shows both groups significantly improved from baseline parameters. The outcome of children included in this study had non-significant p value in all aspects of clinical condition except PEFR at 10 minutes, 20 minutes

Table 1. Medical Scoring System.¹³

| Clinical Condition | 1 | 2 |
|-------------------------------|----------------|--|
| Heart Rate (beat /min) | < 120 | ≥ 120 |
| Respiratory Rate (breath/min) | < 2 SD for age | ≥ 2 SD for age |
| Pulsus paradoxus | < 15 | ≥ 15 |
| Dyspnoea | Absent - Mild | Moderate - Severe |
| Accessory muscles involvement | Absent - Mild | Moderate - Severe |
| Wheeze | Expiratory | Through out Expiration or Expiratory and Inspiratory both. |

Table 2. Baseline characteristics.

| Characteristics | | MDI/AD Group (n=84) | SVN Group (n=66) | p-value |
|-------------------------------|--------------|------------------------|------------------|---------|
| Type of Asthma | Intermittent | 30 (35.7%) | 19 (28.8%) | 0.288 |
| | Mild | 19 (22.6%) | 14 (21.2%) | |
| | Moderate | 25 (29.8%) | 23 (34.8%) | |
| | Severe | 10 (11.9%) | 10 (15.2%) | |
| Clinical Condition: | | | | |
| Respiratory Rate (breath/min) | Mean ± S.D. | 52 ± 14.8 | 50 ± 3.8 | 0.509 |
| Heart Rate (beat/min) | Mean ± S.D. | 125 ± 15.8 | 127 ± 18.7 | 0.149 |
| Blood Pressure: | | | | |
| Systolic (mm of Hg) | Mean ± S.D. | 107 ± 11.9 | 104 ± 10.7 | 0.125 |
| Diastolic (mm of Hg) | Mean ± S.D. | 74 ± 8.7 | 73 ± 9.9 | 0.637 |
| SaO2 (%) | Mean ± S.D. | 91 ± 1.6 | 92 ± 1.8 | 0.903 |
| Dyspnoea | Moderate | 18 (21.4%) | 12 (18.2%) | 0.619 |
| | Severe | 66 (78.6%) | 54 (81.8%) | |
| Cyanosis | ABS | 52 (61.9%) | 48 (72.7%) | 0.156 |
| | Yes | 32 (38.1%) | 18 (27.3%) | |
| Pulses Paradoxus | < 15 | 24 (28.6%) | 18 (27.3%) | 0.700 |
| | 15 | 60 (71.4%) | 48 (72.7%) | |
| Wheeze | Mild-Mod. | 21 (25.0%) | 14 (21.3%) | 0.305 |
| | Severe | 61 (72.6%) | 47 (71.2%) | |
| | Silent | 2 (2.4%) | 5 (7.6%) | |
| PEFR | Mean ± S.D. | 110 ± 33.8 | 89 ± 26.8 | 0.010 |
| Medical Scoring | Mean ± S.D. | 10.8 ± 1.9 | 10.7 ± 2.0 | |
| Severity of attacks | Mild to Mod. | 20 (23.8%) | 16 (24.2%) | 0.896 |
| | Severe | 64 (76.2%) | 50 (75.8%) | |

* Significant (P<0.01)

Table 3. Outcomes (after treatment).

| Characteristics | | MDI/AD Group (n=84) | SVN Group (n=66) | p-value | |
|-------------------------------|-------------|------------------------|---------------------|------------|-------|
| Clinical Condition: | | | | | |
| Respiratory Rate (breath/min) | Mean ± S.D. | 30 ± 9.2 | 31 ± 10.9 | 0.133 | |
| Heart Rate (beat/min) | Mean ± S.D. | 107 ± 16.4 | 110 ± 15.7 | 0.188 | |
| Blood Pressure: | | | | | |
| Systolic (mm of Hg) | Mean ± S.D. | 94 ± 10.7 | 95 ± 10.8 | 0.617 | |
| Diastolic (mm of Hg) | Mean ± S.D. | 64 ± 8.2 | 65 ± 8.9 | 0.503 | |
| Dyspnoea | Mild | 72 (85.7%) | 49 (74.2%) | 0.082 | |
| | Moderate | 11 (13.1%) | 12 (18.2%) | | |
| | Severe | 1 (1.2%) | 5 (7.6%) | | |
| Cyanosis | ABS | 84 (100%) | 66 (100%) | | |
| Pulses Paradoxus | < 15 | 81 (96.4%) | 61 (92.4%) | 0.236 | |
| | ≥ 15 | 3 (3.6%) | 5 (7.6%) | | |
| Wheeze | Mild | 56 (66.7%) | 49 (74.2%) | 0.127 | |
| | Moderate | 27 (32.1%) | 14 (21.2%) | | |
| | Silent | 1 (1.2%) | 3 (4.5%) | | |
| PEFR | 10 minutes | Mean ± S.D. | 134 ± 37.5 | 113 ± 30.8 | 0.010 |
| | 20 minutes | Mean ± S.D. | 162 ± 44.6 | 132 ± 41.6 | 0.010 |
| | 2 hours | Mean ± S.D. | 210 ± 64.3 | 174 ± 46.2 | 0.010 |
| Medical Scoring: 10 minutes | Mean ± S.D. | 10 ± 1.7 | 10 ± 1.8 | - | |
| | 20 minutes | Mean ± S.D. | 9 ± 1.6 | 9 ± 1.6 | - |
| | 2 hours | Mean ± S.D. | 7 ± 1.0 | 7 ± 1.4 | - |
| Outcome: | Discharged | 80 (95.2%) | 59 (89.4%) | 0.185 | |
| | Admitted | 4 (4.8%) | 7 (10.6%) | | |

*Significant (P<0.01)

and 2 hours after treatment. RR, HR, BP, cyanosis and pulsus paradoxus had non-significant p values. Dyspnoea and wheeze also had no significant differences. REFR significantly improved after completion of treatment in between the two groups, although no significant difference was seen in PEFR values independently for the two groups.

Discussion

Bronchodilators are routinely administered via inhalation when treating asthmatic crises in children presenting in ER. The devices most frequently employed to treat children are nebulizers. They are, however, uncomfortable, practically for infants^{14,15} require between 15 - 20 minutes to administer the prescribed dose and need an oxygen or compressed air supply in order to generate their spray. The oxygen flow, the distance between face and mask, tidal volume, respiratory rate and patient's inhalation technique result in a variation in deposition in the lower air airways ranging 3 - 13% of the total number of particles available for inhalation.^{14,16}

After the introduction of MDI / AD in the early 1980 numerous studies have shown efficacy, reliability, cost effectiveness and acceptability of MDI / AD for the treatment of acute exacerbation of asthma even in preschool children¹⁷ and in infants.¹⁸ IS MDI can be efficiently employed with patients of all ages, during normal respiration, as long as they are coupled to a spacer.^{14,16} Permitting rapid administration of the medication and are thus better tolerated by small children; furthermore around 20% of the particles which generated reach the lower airways^{14,16,19} and are deposited in a more even and predictable pattern than by nebulizers. Despite these advantages, MDI / AD have not yet substituted nebulizers in majority of emergency services or paediatric hospitals.¹⁴

Rao et al⁴ did a similar study in adults in Pakistan. But there is no local data available comparing both modalities of treatment in children. In our study we included younger children (age < 5 years), who traditionally have not been treated with MDI due to difficulty in administration of medication.²⁰

This study found that both forms of delivering β_2 agonist resulted in similar improvement in clinical examination and objective parameters. A couple of other studies showed significant increase of heart rate after treatment especially in nebulizer group, but in this study there was no significant change in heart rate.^{21,22}

Regarding PEFR, baseline results show slightly higher values in MDI / AD group as compared to SVN group. On comparison this increase in both groups was statistically non significant. Rodrigo et al²² had shown similar results in PEFR in his study.

Pakistan, is a developing country, most of the peripheral hospitals and clinics do not have Nebulizers probably because of economical reasons. The widespread acceptance of nebulization is due to ease of medication administration and proven efficacy. For an MDI alone to be effective, the patient must be able to coordinate inspiration with actuation of the canister. The combination of an MDI with an accessory device offers an alternative in aerosol therapy by eliminating the need for this coordination.²²

Chou et al²⁰ had reported similar result between the nebulizer and MDI/AD groups. However Lin YZ²⁴ reported superior bronchodilation in MDI group compared with the nebulizer group. There were some limitations in our study, while our sample size was larger than other published studies.²⁵

The result of the study showed that MDI / AD and nebulizer treatment were equally effective in treating clinical severity and airway obstruction in children with acute severe asthma.

Conclusion

We concluded that metered dose inhaler with accessory device is an effective alternative to nebulizer for the emergency room treatment of children with asthma exacerbation in developing countries like Pakistan.

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