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Original Research Article

Comparative Study of Efficacy of Nebulised Salbutamol Vs Nebulised Adrenaline in Acute Childhood Asthma Upto 5 Yrs of Age

Piyasi Mondal[1], Rajsekhar Maiti[2], Nilanjan Ghosh[3]

[1]Assistant Professor, DCH, DNB (Pediatric Medicine), Department of Pediatric Medicine, Diamond Harbour Government Medical College & Hospital, Harindanga, Newtown, Diamond Harbour, South 24 Parganas, West Bengal, India

[2]Assistant Professor, DCH, MD (Pediatric Medicine), Department of Pediatric Medicine, Diamond Harbour Government Medical College & Hospital, Harindanga, Newtown, Diamond Harbour, South 24 Parganas, West Bengal, India

[3]Associate Professor, MD (Pediatric Medicine), Department of Pediatric Medicine, Diamond Harbour Government Medical College & Hospital, Harindanga, Newtown, Diamond Harbour, South 24 Parganas, West Bengal, India

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Corresponding author: Dr. Piyasi Mondal

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Abstract

Introduction: Acute childhood asthma commonly causes emergency visits and hospital admissions. Rapid bronchodilation is essential to relieve respiratory distress. Salbutamol is widely used, while adrenaline provides bronchodilator and α-adrenergic effects; however, comparative evidence in children up to five years remains limited.

Aims and objectives: To compare the efficacy and adverse effects of nebulised adrenaline versus nebulised salbutamol in children up to 5 years with acute asthma, and to assess whether adrenaline provides any additional clinical benefit over salbutamol.

Materials and Methods: A prospective comparative interventional study was conducted at Vivekananda Institute of Medical Science, Kolkata, over 12 months. Fifty children aged 1–5 years with acute asthma were enrolled from pediatric emergency, inpatient and outpatient departments and equally allocated to two treatment groups.

Results: Among 50 children, 52% were <3 years, 72% were male, and 100% had previous bronchodilator responsiveness. Group A showed heart rate reduction (139.36±12.81 to 129.36±14.35; p=0.0231), wheeze (2.00±0.65 to 0.88±0.73; p<0.0001), and pulmonary score (6.20±1.26 to 3.00±1.52; p=0.046).

Conclusion: Both nebulised salbutamol and adrenaline demonstrated clinical improvement in children with acute asthma, reducing respiratory distress, wheezing, accessory muscle use and improving pulmonary status and oxygenation. Timely treatment, careful severity assessment and continuous monitoring remain essential during acute exacerbations.

Keywords: Acute childhood asthma; Nebulised salbutamol; Nebulised adrenaline; Bronchodilator therapy; Pediatric asthma.

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Introduction

Asthma is a chronic inflammatory disorder of the airways characterized by variable respiratory symptoms and variable expiratory airflow limitation. In children, particularly those below 5 years of age, asthma may present predominantly with recurrent episodes of wheezing, cough, breathlessness and respiratory distress. Diagnosis in this age group can be challenging because objective pulmonary function testing is often difficult to perform reliably, and several other childhood conditions may produce similar symptoms. Nevertheless, recurrent episodes of airflow obstruction with improvement following bronchodilator therapy support the clinical diagnosis of asthma in preschool children.[1,2] Acute exacerbation of asthma is an important cause of emergency department visits, hospitalization and morbidity among children. The severity of an acute episode can vary from mild respiratory symptoms to severe, potentially life-threatening airway obstruction. During an acute exacerbation, bronchial smooth-muscle constriction, airway

inflammation, mucosal edema and increased mucus production contribute to airflow limitation. Therefore, early recognition and prompt treatment are essential to reverse bronchoconstriction, correct hypoxemia and prevent further deterioration.[3,4] The primary objectives in the emergency management of acute childhood asthma are rapid improvement in airflow obstruction, maintenance of adequate oxygenation and prevention of progression to respiratory failure. Assessment should include respiratory rate, heart rate, oxygen saturation, work of breathing, air entry and the presence and severity of wheezing. In children up to 5 years of age, clinical assessment is particularly important because conventional lung-function measurements such as peak expiratory flow and spirometry are generally difficult to obtain during an acute episode.[1,3] Inhaled short-acting β2-adrenergic agonists (SABAs) constitute the principal bronchodilator therapy for acute asthma exacerbations. Salbutamol produces relaxation of bronchial smooth muscle through stimulation of β2-adrenergic receptors and consequently results in rapid bronchodilation. Current international guidance recommends inhaled salbutamol as the initial bronchodilator for acute asthma exacerbations in children 5 years and younger. Depending on the severity of the episode and the child's ability to cooperate, salbutamol may be administered through a pressurized metered-dose inhaler with a spacer or by nebulisation. In severe exacerbations, nebulised therapy may be particularly useful when the child is unable to coordinate inhalation adequately.[3,5] Nebulised salbutamol can be repeated at short intervals during the initial phase of treatment, allowing rapid and repeated delivery of bronchodilator medication. However, frequent or high-dose β2-agonist administration may produce systemic adverse effects, including tachycardia, tremor, agitation, hypokalemia and, in some circumstances, metabolic abnormalities. These potential adverse effects are relevant in young children receiving repeated nebulisation during severe exacerbations.[3,6] Recent evidence also suggests that, when clinically feasible, salbutamol administered through a metered-dose inhaler with a spacer can provide outcomes comparable to nebulisation in many children with acute exacerbations, while potentially reducing treatment time and adverse effects.[7,8] Adrenaline (epinephrine) is another sympathomimetic agent with both α- and β-adrenergic activity. β2-receptor stimulation can produce bronchodilation, whereas α-adrenergic stimulation causes vasoconstriction and may reduce mucosal edema. These pharmacological properties provide a theoretical rationale for its use in acute airway obstruction.

However, systemic cardiovascular effects such as tachycardia, hypertension and palpitations need to be considered, particularly when adrenaline is administered repeatedly or at higher doses.[3,9] Although salbutamol remains the established first-line inhaled bronchodilator for acute asthma, the comparative efficacy of nebulised adrenaline and nebulised salbutamol remains of clinical interest. Earlier comparative trials in children have reported that nebulised adrenaline can produce clinical improvement, although evidence has not demonstrated a consistent advantage over salbutamol. A randomized double-blind pediatric trial comparing nebulised racemic epinephrine with salbutamol found no significant difference in pulmonary improvement, hospital stay, admission or relapse, while minor adverse effects were more frequent with epinephrine.[9] More recent pediatric asthma guidelines continue to emphasize inhaled β2-agonists as the principal initial bronchodilator treatment for acute exacerbations.[3,5] Despite the established role of salbutamol, there remains a need for clinically relevant comparative data concerning alternative nebulised bronchodilator strategies, particularly in younger children. Children below 5 years represent a distinct population because of differences in airway anatomy, disease phenotype, drug delivery, clinical assessment and response to treatment compared with older children. A direct comparison of clinical response, oxygen saturation, respiratory rate, heart rate, wheezing, respiratory distress and requirement for additional therapy may therefore provide useful information regarding the relative efficacy and safety of the two interventions. To compare the efficacy and adverse effects of nebulised adrenaline versus nebulised salbutamol in children up to 5 years with acute asthma, and to assess whether adrenaline provides any additional clinical benefit over salbutamol.

Materials and Methods

Study design: Prospective comparative interventional study.

Place of study: Vivekananda Institute of Medical Science, Kolkata.

Study period: 12 Months.

Study population: The study included 50 children aged 1–5 years with clinically diagnosed acute asthma, recruited from emergency, inpatient, and outpatient pediatric departments, with 25 children in each study arm.

Sample size: A total of 50 Children up to 5 years of age presenting with acute childhood asthma, with 25 children in each study arm.

Inclusion Criteria

- Children aged 1–5 years.
- Children presenting with acute asthma.
- Recurrent episodes of wheezing (minimum 3 attacks).

- Persistent cough not responding adequately to therapy.
- History of nocturnal attacks.
- History of seasonal variation in symptoms.
- Positive family history of asthma.

Exclusion Criteria

- Children with respiratory distress due to causes other than asthma.
- Children with significant congenital or acquired cardiac disease.
- Children with chronic respiratory diseases other than asthma.
- Children with severe systemic illness or other major comorbidities.
- Children with known hypersensitivity to salbutamol or adrenaline.
- Children who had received treatment likely to interfere with the study assessment.

Standardized Methodology

A prospective randomized interventional study was conducted among children aged 1–5 years presenting with acute childhood asthma. Eligible children were randomly assigned to two treatment groups, Group A and Group B, with 25 children in each group. Group A received nebulised salbutamol at 0.15 mg/kg body weight, with a minimum dose of 1 mg, diluted with normal saline to a total volume of 3 mL, while Group B received nebulised adrenaline at 0.1 mL/kg body weight of 1:10,000 solution, similarly diluted to 3 mL. Nebulisation was administered using an oxygen flow of 8 L/min, and three doses were given at 20-minute intervals. Data were collected systematically by assessing heart rate, respiratory rate, oxygen saturation (SpO_2), wheeze, accessory muscle activity, and pulmonary score. SpO_2 was recorded at baseline and 20 minutes after the first, second, and third doses. Wheeze and accessory muscle involvement were assessed using standardized scoring criteria.

Pulmonary severity was evaluated using respiratory rate, wheezing, and accessory muscle activity, with the overall score used to determine clinical severity. Following completion of the third nebulised dose, respiratory rate, pulmonary score, wheeze score, and accessory muscle score were reassessed. The recorded clinical and physiological parameters were used to evaluate and compare treatment response between the two intervention groups.

Study Variable

- Heart rate (beats/min)
- Respiratory rate (breaths/min)
- Accessory muscle score
- Wheeze score
- Pulmonary score

Statistical Analysis: Data were recorded on a predetermined proforma using a randomized data collection approach and analyzed using Instat-3 statistical software, employing appropriate statistical tests such as the unpaired two-sample t-test and Chi-square test.

Result

Table 1: Demographic characteristics of children included in the study

	Category	Number	Percentage (%)	p-value
Age group	<3 years	26	52	0.777
	≥3 years	24	48	
Gender	Male	36	72	0.002
	Female	14	28	
History of response to bronchodilator	Present	50	100	<0.001
	Absent	0	0	

Table 2: Distribution of Children According to Recurrence of Wheezy Episodes

	Category	Number	Percentage (%)
Recurrence of wheezy episodes	<3 episodes	7	14
	>3 episodes	43	86

Table 3: Comparison of clinical and physiological parameters at different time intervals

	Group	0 min Mean ± SD	20 min Mean ± SD	p-value	40 min Mean ± SD	p-value	60 min Mean ± SD	p-value	Initial vs Final p-value
Heart rate (beats/min)	A (n=25)	139.36 ± 12.81	138.16 ± 14.51	0.053	133.96 ± 13.95	0.0363	129.36 ± 14.35	0.0231	0.1282
	B (n=25)	144.40 ± 8.27	143.72 ± 8.61	—	139.48 ± 9.10	—	136.36 ± 9.30	—	—
Respiratory rate (breaths/min)	A (n=25)	60.60 ± 6.75	59.04 ± 7.06	0.087	54.00 ± 6.72	0.0422	49.04 ± 11.36	0.04	—
	B (n=25)	58.44 ± 3.95	56.96 ± 4.58	0.085	51.04 ± 5.02	—	47.76 ± 5.48	—	—
Accessory muscle score	A (n=25)	1.64 ± 0.65	1.52 ± 0.65	0.2478	1.44 ± 0.65	0.0907	1.16 ± 0.65	0.033	0.0033
	B (n=25)	1.76 ± 0.69	1.76 ± 0.60	0.004	1.52 ± 0.77	0.018	1.04 ± 0.73	—	—
Wheeze score	A (n=25)	2.00 ± 0.65	1.72 ± 0.68	0.331	1.20 ± 0.58	0.002	0.88 ± 0.73	0.002	<0.0001
	B (n=25)	1.92 ± 0.64	1.92 ± 0.64	0.6245	1.84 ± 1.07	—	1.68 ± 0.75	—	—
Pulmonary score	A (n=25)	6.20 ± 1.26	5.76 ± 1.33	0.2204	4.24 ± 1.29	0.009	3.00 ± 1.52	0.001	0.046
	B (n=25)	5.92 ± 1.28	5.88 ± 1.46	0.7774	4.68 ± 1.28	—	3.00 ± 1.32	—	—
Oxygen saturation (%)	A (n=25)	93.64 ± 2.88	94.04 ± 2.11	0.3074	95.32 ± 3.18	0.2902	96.74 ± 2.12	0.2797	0.2655
	B (n=25)	93.24 ± 2.64	93.60 ± 2.11	0.5064	94.88 ± 3.33	0.5566	95.96 ± 3.15	0.5879	—

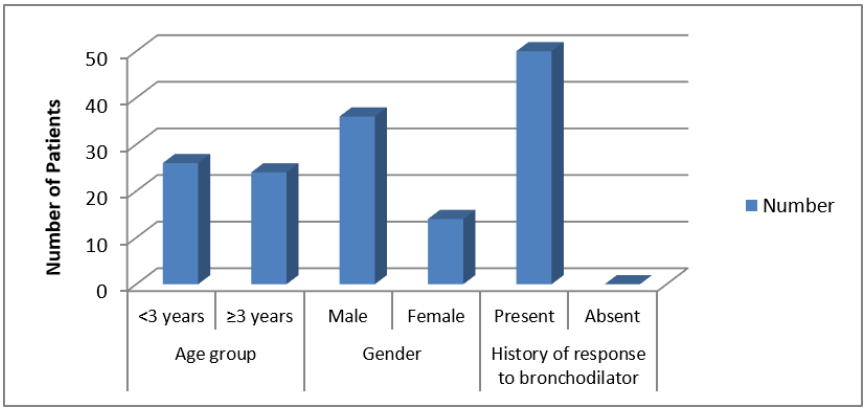


Figure 1: Demographic characteristics of children included in the study

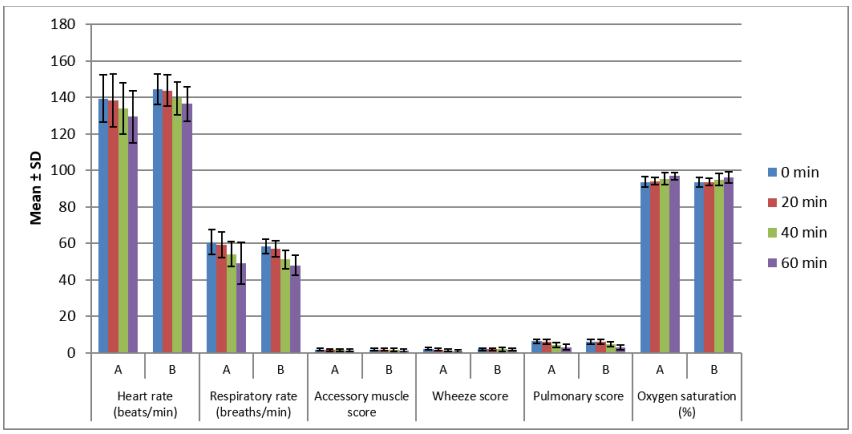


Figure 2: Comparison of clinical and physiological parameters at different time intervals

Demographic Characteristics of Children Included in the Study

Results

Among the 50 children included in the study, 26 (52.0%) were aged <3 years, while 24 (48.0%) were aged ≥3 years. Regarding gender distribution, 36 (72.0%) were male and 14 (28.0%) were female. All 50 children (100.0%) had a history of responsiveness to bronchodilator therapy during previous attacks. The age distribution was not statistically significant (p=0.777), whereas gender distribution showed a statistically significant male predominance (p=0.002). The history of bronchodilator responsiveness was also statistically significant (p<0.001).

Interpretation: The study population showed a relatively similar distribution between the two age groups, with a slight predominance of children aged <3 years. A marked male predominance was observed, and all children had a previous history of response to bronchodilator therapy.

Distribution of Children According to Recurrence of Wheezy Episodes

Results: Among the 50 children with childhood asthma, 7 (14.0%) had recurrence of wheezy episodes <3 times, whereas 43 (86.0%) had recurrence of wheezy attacks >3 times.

Interpretation: The majority of children (86.0%) had more than three recurrent wheezy episodes, indicating that recurrent wheezing was a common clinical feature among the study population.

Comparison of Clinical and Physiological Parameters at Different Time Intervals

Results

In Group A, mean heart rate decreased from 139.36 ± 12.81 beats/min at baseline to 129.36 ± 14.35 beats/min at 60 minutes, with p=0.0231 at 60 minutes and p=0.1282 for the initial-versus-final comparison. In Group B, heart rate decreased from 144.40 ± 8.27 to 136.36 ± 9.30 beats/min. Respiratory rate in Group A decreased from 60.60 ± 6.75 to 49.04 ± 11.36 breaths/min, with p=0.040 at 60 minutes, while in Group B it decreased from 58.44 ± 3.95 to 47.76 ± 5.48 breaths/min. Accessory muscle score decreased from 1.64 ± 0.65 to 1.16 ± 0.65 in Group A (p=0.0033) and from 1.76 ± 0.69 to 1.04 ± 0.73 in Group B. Wheeze score decreased from 2.00 ± 0.65 to 0.88 ± 0.73 in Group A, with a highly significant initial-versus-final difference (p<0.0001), while Group B showed a decrease from 1.92 ± 0.64 to 1.68 ± 0.75. Pulmonary score decreased from 6.20 ± 1.26 to 3.00 ± 1.52 in Group A (p=0.046) and from 5.92 ± 1.28 to 3.00 ± 1.32 in Group B. Oxygen saturation increased from 93.64 ± 2.88% to 96.74 ± 2.12% in Group A and from 93.24 ± 2.64% to 95.96 ± 3.15% in Group B.

Interpretation: Both groups demonstrated progressive improvement in respiratory and clinical parameters over 60 minutes, including reductions in heart rate, respiratory rate, accessory muscle use, wheeze and pulmonary scores, along with improvement in oxygen saturation. Several within-group changes were statistically significant, particularly for accessory muscle and wheeze scores.

Discussion

In the present study, 52.0% of children were aged <3 years and 48.0% were ≥3 years, with no significant difference in age distribution (p=0.777), while a significant male predominance was observed, with males comprising 72.0% and females 28.0% (p=0.002). The predominance of younger children and males is consistent with the recognized pattern of recurrent wheezing and asthma presentations in early childhood. Cloutier et al. emphasized that asthma assessment in younger children relies substantially on clinical history, symptom patterns and treatment response because objective lung-function testing is often difficult in this age group.[11] All children in the present study had a previous history of responsiveness to bronchodilator therapy, supporting the clinical relevance of bronchodilator response in the assessment of preschool wheezing. Lee et al. reported that repeated clinical assessment of respiratory rate, work of breathing, wheezing and oxygenation is important during emergency management of pediatric asthma exacerbations.[12] In the present study, 86.0% of children had more than three recurrent wheezy episodes, indicating a predominantly recurrent pattern of respiratory symptoms. Manti S et al. similarly described asthma exacerbations as a frequent cause of urgent healthcare utilization in children and highlighted the importance of structured assessment and timely bronchodilator treatment.[13] Following treatment, both groups demonstrated progressive improvement in respiratory parameters.

In Group A, respiratory rate decreased from 60.60 ± 6.75 to 49.04 ± 11.36 breaths/min, while in Group B it decreased from 58.44 ± 3.95 to 47.76 ± 5.48 breaths/min. Accessory muscle scores also decreased in both groups, with a significant initial-versus-final difference in Group A (p=0.0033). Similarly, wheeze scores decreased from 2.00 ± 0.65 to 0.88 ± 0.73 in Group A (p<0.0001), while Group B showed a reduction from 1.92 ± 0.64 to 1.68 ± 0.75. Pollock M et al. reported that inhaled short-acting bronchodilators are effective in improving clinical outcomes during acute childhood asthma exacerbations, supporting the improvement observed after nebulised therapy in

the present study.[14] Pulmonary scores also decreased from 6.20 ± 1.26 to 3.00 ± 1.52 in Group A (p=0.046) and from 5.92 ± 1.28 to 3.00 ± 1.32 in Group B, while oxygen saturation increased from 93.64 ± 2.88% to 96.74 ± 2.12% and from 93.24 ± 2.64% to 95.96 ± 3.15%, respectively. Arakawa H et al. emphasized repeated assessment of clinical severity, oxygenation and response to bronchodilator therapy during acute pediatric asthma management.[15] Overall, the present findings demonstrate progressive clinical improvement in both groups over 60 minutes, reflected by reductions in heart rate, respiratory rate, accessory muscle use, wheezing and pulmonary scores, together with improved oxygen saturation. However, these are primarily within-group observations and should not be interpreted as demonstrating superiority of one treatment over the other without direct between-group statistical comparisons at each assessment point.

Conclusion

The present study concludes that both nebulised salbutamol and nebulised adrenaline were associated with clinical improvement in children with acute childhood asthma. Improvement was observed in respiratory distress, wheezing, accessory muscle use, pulmonary status and oxygenation following treatment. The findings indicate that both therapies can produce beneficial clinical responses during acute exacerbations, although the magnitude and pattern of response may vary between treatment groups. Overall, careful assessment of clinical severity, continuous monitoring and timely administration of appropriate bronchodilator therapy remain important in the management of acute childhood asthma.

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