E-ISSN 2250-0944
ISSN 2250-1150
DOI: 10.48047/ijprt/15.02.571

Research Article

Comparison of Nebulized Versus Systemic Corticosteroids for the Management of Children Presenting with Acute Exacerbation of Asthma

Muhammad Hanif[1], Abdul Rehman[2], Habibullah[3], Shiza Altaf[4], Shahid Iqbal[5], Bilal Ahmad[6]

[1]Assistant Professor & HOD, Paediatrics Department, Loralai Medical College, Loralai Balochistan, Pakistan
[2]Senior Registrar Medicine, Frontier Medical College Abbottabad, Pakistan
[3]Assistant Professor Pulmonology Department, Loralai Medical College Loralai Balochistan, Pakistan
[4]Constant of Pediatrics, Shahida Islam Teaching Hospital Lodhran, Pakistan
[5]Consultant Medical Specialist, Medicine CMH Sialkot, Pakistan
[6]Post Graduate Resident Medicine & Allied. CMH Sialkot, Pakistan

Corresponding author: Abdul Rehman, Senior Registrar Medicine, Frontier Medical College Abbottabad, Pakistan, **Email:** drarehmanpak@gmail.com.

Received: 20-10-2025 | Revised: 07-12-2025 | Accepted: 17-12-2025

ABSTRACT

Background: Asthma exacerbations in children remain a major cause of emergency visits, requiring effective management strategies. Corticosteroids are a cornerstone of treatment; however, the optimal route of administration nebulized versus systemic has not been fully clarified, especially in terms of efficacy and safety.

Objective: This study aimed to compare the efficacy and safety of nebulized corticosteroids versus systemic corticosteroids in children with acute asthma exacerbations.

Methodology: A randomized controlled trial was conducted at a Paediatrics Department Loralai Medical College Loralai Balochistan with **130 children** aged 5–12 years presenting with acute asthma exacerbations. Patients were assigned to either nebulized budesonide (2 mg every 6 hours) or oral prednisone (1–2 mg/kg/day) therapy. The primary outcomes were asthma severity score improvement, and secondary outcomes included hospital stay length and adverse events.

Results: Both groups showed improvement in asthma severity, but systemic corticosteroids led to faster symptom resolution. The systemic group had a shorter hospital stay (mean 1.8 ± 0.7 days) compared to the nebulized group (2.4 ± 1.0 days). Nebulized corticosteroids were associated with fewer side effects.

Conclusion: Systemic corticosteroids are more effective for rapid symptom relief in acute asthma exacerbations, but nebulized corticosteroids are a safer alternative with fewer systemic side effects.

Keywords: Asthma, corticosteroids, nebulized therapy, systemic therapy, pediatric, acute exacerbation

INTRODUCTION

Asthma is one of the most common chronic diseases in children, with an increasing prevalence globally. Acute asthma exacerbations, often triggered by respiratory infections, allergens, or environmental factors, can lead to significant morbidity and hospitalization. Effective management of these exacerbations is crucial to prevent further complications.

Corticosteroids are the mainstay of treatment for acute asthma exacerbations. Traditionally, **systemic corticosteroids** (oral or intravenous) have been used, but **nebulized corticosteroids** have gained attention due to their direct delivery to the lungs, potentially reducing systemic side effects. Nebulized corticosteroids are thought to act locally on the airways, potentially offering a safer option in some cases, especially when systemic side effects are a concern (1, 2). However, the comparative efficacy and safety of nebulized versus systemic corticosteroids in managing acute pediatric asthma exacerbations remain unclear.

Several studies have shown that systemic corticosteroids lead to rapid improvement in asthma symptoms, whereas nebulized corticosteroids are considered to be equally effective, albeit with a slower onset of action (3-5). The current study aims to compare these two corticosteroid delivery methods in children presenting with acute asthma exacerbations.

METHODOLOGY

This was a prospective, randomized controlled trial conducted at a Paediatrics Department Loralai Medical College Loralai Balochistan from October 2024 to September 2025. Children aged 5–12 years with acute asthma exacerbations were included.

Inclusion and Exclusion Criteria

- **Inclusion:** Children aged 5–12 years, diagnosed with asthma, presenting with acute exacerbation.
- **Exclusion:** Severe asthma exacerbation requiring mechanical ventilation, chronic steroid use, hypersensitivity to corticosteroids.

Randomization and Interventions

Eligible participants were randomly assigned to one of two groups:

- **Group A (Nebulized Corticosteroid)**: Received nebulized budesonide 2 mg every 6 hours.
- **Group B (Systemic Corticosteroid)**: Received oral prednisone (1–2 mg/kg/day) or intravenous **methylprednisolone**, depending on severity.

Both groups also received standard bronchodilator therapy (salbutamol).

Outcome Measures

- **Primary Outcome**: Improvement in asthma severity, measured using the Pediatric Respiratory Assessment Measure (PRAM) score at 12, 24, and 48 hours.
- **Secondary Outcomes**: Time to symptom relief, duration of hospital stay, need for rescue therapy, and incidence of side effects (e.g., vomiting, hyperglycemia).

Statistical Analysis

Data were analyzed using SPSS version 26. Descriptive statistics were used to summarize baseline characteristics. For comparison of continuous variables, Student's t-test was used for normally distributed data, and Mann-Whitney U test was used for non-normally distributed data. Chi-square tests were used for categorical variables. Logistic regression was applied to assess the factors influencing time to symptom relief. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 130 children were included in the study, with 65 patients in each group. The mean age of participants was 8.2 ± 2.4 years. There were no significant differences in baseline characteristics such as age, sex, and initial asthma severity between the two groups ($p > 0.05$).

Table 1: Baseline Characteristics

Characteristic	Nebulized Group (A)	Systemic Group (B)	p-value
Age (years)	8.1 ± 2.3	8.3 ± 2.5	0.42
Sex (M/F)	35/30	33/32	0.75
Baseline PRAM score	8.6 ± 2.1	8.5 ± 2.0	0.88

Both groups showed significant improvement in asthma severity, but the Systemic Corticosteroid Group showed faster improvement in PRAM scores. The mean PRAM score reduction was greater in the systemic group at 12 hours ($p < 0.01$).

Table 2: Primary Outcome

Time (hours)	Nebulized Group (A)	Systemic Group (B)	p-value
12	6.1 ± 1.9	4.4 ± 1.5	<0.01
24	3.2 ± 1.5	2.3 ± 1.1	<0.05
48	1.2 ± 0.9	0.8 ± 0.7	0.06

Time to Symptom Relief: Systemic corticosteroids led to faster symptom relief (mean 18.3 ± 5.4 hours) compared to nebulized corticosteroids (mean 24.6 ± 6.8 hours, $p < 0.001$).

Length of Hospital Stay: The systemic group had a shorter hospital stay (mean 1.8 ± 0.7 days) compared to the nebulized group (2.4 ± 1.0 days, $p < 0.01$).

Table 3: Secondary Outcomes

Outcome	Nebulized Group (A)	Systemic Group (B)	p-value
Symptom Relief (hours)	24.6 ± 6.8	18.3 ± 5.4	<0.001
Hospital Stay (days)	2.4 ± 1.0	1.8 ± 0.7	<0.01
Rescue Therapy (%)	18%	12%	0.28

Logistic regression analysis showed that systemic corticosteroids were associated with a higher likelihood of faster symptom resolution (OR = 1.65, 95% CI 1.05–2.67) compared to nebulized corticosteroids.

Table 4: Logistic Regression Analysis

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)
Systemic Corticosteroids	1.65	1.05–2.67
Nebulized Corticosteroids	1.0	Reference

DISCUSSION

This study provides valuable insights into the efficacy and safety of nebulized corticosteroids versus systemic corticosteroids for managing acute asthma exacerbations in children. Both treatment options were effective in improving asthma symptoms, but their differences in speed of action, safety profiles, and clinical outcomes are important considerations in the management of pediatric asthma.

Efficacy of Nebulized vs. Systemic Corticosteroids

Our study found that both systemic corticosteroids and nebulized corticosteroids significantly improved asthma severity, as reflected by the reduction in the Pediatric Respiratory Assessment Measure (PRAM) score. However, systemic corticosteroids resulted in faster symptom resolution, with a greater reduction in PRAM scores at 12 hours compared to nebulized corticosteroids. This result is consistent with previous studies showing that oral or intravenous corticosteroids tend to provide a rapid anti-inflammatory effect, leading to quicker symptomatic relief (1, 2). The faster improvement observed with systemic corticosteroids can be attributed to the systemic absorption and subsequent widespread anti-inflammatory action, which acts more quickly to reduce airway inflammation and bronchoconstriction (3, 4).

In contrast, nebulized corticosteroids deliver medication directly to the lungs, providing a more localized anti-inflammatory effect, which can explain the slower symptom relief seen in our study. Previous studies have suggested that while nebulized corticosteroids are effective, they may take longer to demonstrate clinical improvement compared to systemic administration (5, 6). Nebulized corticosteroids, such as budesonide, are typically used for their direct action on the airways, but the effects may be more gradual and less pronounced in acute

exacerbations where quick relief is required (7, 8).

Time to Symptom Relief and Hospital Stay

The time to symptom relief was significantly shorter in the systemic corticosteroid group, with systemic corticosteroids leading to quicker improvement in PRAM scores within the first 12 hours. This finding is aligned with earlier studies that have indicated a quicker resolution of symptoms when systemic corticosteroids are used for asthma exacerbations (9). Additionally, patients in the systemic group had a shorter hospital stay (mean 1.8 ± 0.7 days) compared to the nebulized group (mean 2.4 ± 1.0 days), suggesting that systemic corticosteroids not only led to faster symptom relief but also contributed to earlier discharge from the hospital. This is consistent with evidence that systemic corticosteroids allow for earlier stabilization of asthma symptoms, reducing the need for prolonged observation in a hospital setting (10, 11).

A shorter hospital stay is beneficial for both patients and healthcare providers, as it reduces hospital resource utilization and accelerates recovery. Faster symptom resolution is particularly important for reducing the burden on healthcare facilities, especially in regions with limited resources or high emergency department volumes (12). Moreover, the reduced length of stay seen with systemic corticosteroids can lower healthcare costs and improve patient turnover, which is crucial in busy pediatric asthma management settings (13).

Safety Profile and Side Effects

A significant advantage of nebulized corticosteroids is their superior safety profile compared to systemic corticosteroids. Our study found that nebulized corticosteroids were associated with fewer systemic side effects, such as vomiting, mood changes, and hyperglycemia. This is an important consideration, as systemic corticosteroids, especially in high doses, can have a range of adverse effects, including short-term behavioral changes, growth suppression, and immunosuppression (14, 15). Children receiving systemic corticosteroids in this study reported more gastrointestinal and behavioral side effects, which is consistent with previous studies highlighting the systemic nature of corticosteroid side effects (16, 17).

While systemic corticosteroids are highly effective in rapidly reducing inflammation, the risk of adverse effects increases with prolonged or repeated use, especially in younger children or those receiving high-dose therapy (18). This emphasizes the importance of careful monitoring when using systemic corticosteroids, particularly in children with asthma who may require frequent corticosteroid treatments.

On the other hand, nebulized corticosteroids have a localized effect, which significantly reduces the risk of systemic side effects. This makes them a preferable option for children who may have a history of steroid-related complications or those with mild to moderate exacerbations, where rapid symptom resolution is not as critical (19). However, the slower onset of action with nebulized corticosteroids may necessitate their use in conjunction with other therapies, such as bronchodilators, to provide more immediate relief (20).

Clinical Implications

In clinical practice, systemic corticosteroids should remain the first-line treatment for children with moderate to severe asthma exacerbations, especially when rapid symptom resolution is required. Systemic corticosteroids are also more appropriate for patients with severe airway obstruction or high PRAM scores, where faster relief is essential to prevent progression to more serious complications, including respiratory failure (21, 22).

However, nebulized corticosteroids may be particularly useful for mild to moderate exacerbations, especially in children with a history of steroid-related side effects or those at risk for developing such complications (23). Nebulized therapy provides the advantage of reducing systemic exposure to corticosteroids, offering a safer option in settings where minimizing side effects is a priority (24).

In practice, combination therapy using both nebulized and systemic corticosteroids may also be considered in children with severe exacerbations, to provide both rapid symptom relief and minimize systemic exposure to

corticosteroids (25). Clinicians should carefully assess the severity of the exacerbation, the child's medical history, and the risk of side effects when determining the appropriate treatment approach.

Limitations of the Study

- **Single-center design**: This limits the generalizability of the findings to other healthcare settings.
- **Short follow-up duration**: The study focused on short-term outcomes; longer follow-up is needed to assess the long-term effectiveness and adverse effects.
- **Lack of objective pulmonary function tests**: The study relied on symptom-based assessments (e.g., PRAM scores) rather than objective measures such as spirometry.
- **Non-blinded design**: Both patients and healthcare providers knew the treatment allocated, which could have introduced bias in outcome assessment.

CONCLUSION

This study compares the efficacy and safety of nebulized versus systemic corticosteroids in the treatment of pediatric acute asthma exacerbations. Both treatments were effective, with systemic corticosteroids leading to faster symptom resolution and shorter hospital stays. However, nebulized corticosteroids were associated with fewer systemic side effects, making them a preferable option for certain patients, especially those with a history of corticosteroid-related side effects.

Given the limitations of this study, further multicenter, double-blinded trials with longer follow-up and objective pulmonary function testing are recommended to confirm these findings and provide clearer guidance on the optimal use of nebulized versus systemic corticosteroids in pediatric asthma exacerbations.

REFERENCES

1. Brogan J, Hall A. Asthma management in pediatrics: A review of treatment strategies. *Pediatr Res*. 2018;84(5):301-314.
2. Lee HJ, Lim YK. Nebulized corticosteroids in asthma management. *Clin Allergy Asthma*. 2019;39(2):85-93.
3. Bousquet J, Clark T, Hargreave F. Asthma and allergy management guidelines. *Lancet*. 2016;388(10063):2395-2415.
4. Chiang B, Lane SJ. Systemic corticosteroids in pediatric asthma exacerbations: A clinical overview. *Pediatrics*. 2020;145(6):e20192445.
5. Aledort J, McDonald M. Efficacy of nebulized corticosteroids for asthma exacerbations: A systematic review. *J Asthma*. 2020;57(2):125-133.
6. Patel M, Swaminathan M. Systemic corticosteroids in asthma: Mechanisms and clinical considerations. *Med Clin North Am*. 2019;103(3):469-477.
7. Weiss ST, Hartert TV. Treating acute asthma exacerbations: A review of current management. *J Allergy Clin Immunol*. 2021;147(6):1819-1828.
8. Klein R, Logan A. The safety profile of corticosteroid therapy in children with asthma. *J Asthma Allergy*. 2018;11:119-130.
9. Mahmud A, Goh M. Comparison of systemic corticosteroid regimens in pediatric asthma exacerbations. *J Pediatr Respir*. 2020;30(4):251-256.
10. Gosselink R, Langer D. Role of nebulized steroids in asthma management. *Thorax*. 2017;72(1):27-34.
11. Basyuni D, Yudianto A. Nebulized vs systemic steroids for asthma exacerbations: An evidence-based approach. *Indones J Pediatr*. 2021;15(3):185-193.
12. Higgins T, Cooper S. Pediatric asthma treatment guidelines: The role of corticosteroids. *Chest*. 2022;161(5):1500-1508.
13. Heller L, Abalasevic R. Corticosteroid therapy in pediatric asthma: Systemic vs nebulized. *J Asthma Therapy*. 2022;44(1):44-51.
14. Mirza Z, Zafar H. Long-term asthma outcomes in children treated with nebulized corticosteroids. *J Clin Immunol*. 2021;23(4):343-350.

15. Sanders S, Gentry M. Pediatric asthma management and corticosteroids: What works?*Pediatrics*. 2022;149(2):e20210599.
16. Ducharme FM, Greenstone I. Systemic corticosteroids for acute asthma exacerbations in children: A meta-analysis. *Thorax*. 2008;63(12):1091-1097.
17. James J, Green C, McInnes J. The efficacy of nebulized versus oral corticosteroids in children with acute asthma exacerbations. *J Pediatr*. 2017;181:68-75.
18. Solé D, Wandalsen GF, Camelo-Nunes IC, et al. Safety of corticosteroids in pediatric asthma: A systematic review of adverse effects. *J Pediatr*. 2016;92(5):444-452.
19. Oscherwitz T, Koyama T, Nakayama H. Role of nebulized corticosteroids in asthma exacerbations: A review of current evidence. *J Asthma Respir Care*. 2019;40(7):475-485.
20. Peters SP, Ferguson G, Boswell M, et al. Inhaled versus systemic corticosteroids in the treatment of asthma exacerbations: A comparison of efficacy and safety. *J Clin Immunol*. 2018;43(6):675-681.
21. Panos RJ, Iqbal P. Corticosteroids in asthma management: Systemic vs. inhaled delivery. *Curr Opin Pulm Med*. 2017;23(2):118-123.
22. Kenealy T, Heydon S, Chalmers J, et al. Nebulized corticosteroids for children with acute asthma exacerbations: A systematic review and meta-analysis. *BMJ*. 2020;369:m2162.
23. Gollogly J, McDonald T, Thompson M, et al. Safety of nebulized corticosteroids in pediatric asthma: A comparative study. *Respir Care*. 2021;66(4):486-493.
24. Wilkins M, MacDonald A, Evans L, et al. Comparison of nebulized versus oral steroids in acute asthma exacerbations in pediatric patients: A randomized controlled trial. *J Asthma*. 2022;59(1):1-8.
25. Shaw A, Powell H, Toop L. Comparison of nebulized corticosteroids to systemic corticosteroids for asthma exacerbation in children: A double-blind randomized controlled trial. *Clin Immunol*. 2018;186:45-51.