International Journal of Clinical Science and Medical Research
ISSN(print): 2770-5803, ISSN(online): 2770-582X
Volume 06 Issue 05 May 2026
DOI: https://doi.org/10.55677/IJCSMR/V6I5-01/2026, Impact Factor: 8.005
Page No : 129-135


# Nebulized Magnesium Sulfate as an Add-On Therapy in Acute Exacerbations of COPD and Bronchial Asthma: Effects on Early Recovery and Reduced ICU Admission

**Mohammad Abdul Motalib[1*], Monirul Haque[2], Md. Motasim Billah[3], Shamim Ahmed[4], Md. Al Amin Toha[5], Kazi Afsana Islam[6], Umme Sadiya[7]**

[1]Associate Professor, Department of Medicine, Monno Medical College & Hospital, Manikganj, Bangladesh
[2,4]Senior Medical Officer, Department of Medicine, Monno Medical College & Hospital, Manikganj, Bangladesh
[3]Clinical Assistant, Department of Medicine, Monno Medical College & Hospital, Manikganj, Bangladesh
[5]Medical Officer, Department of Medicine, Khawaja Yunus Ali Medical College & Hospital, Sirajganj, Bangladesh
[6,7]Medical Officer, Department of Medicine, Monno Medical College & Hospital, Manikganj, Bangladesh

**ABSTRACT**

**Published Online: May 13, 2026**

**Background:** Acute exacerbations of Bronchial Asthma and Chronic Obstructive Pulmonary Disease (COPD) are common causes of hospital admission and respiratory distress. Nebulized Magnesium Sulfate has bronchodilatory and anti-inflammatory effects and may improve early clinical recovery when used as an adjunct therapy.

**Methods:** This prospective comparative cross-sectional observational study was conducted in the Department of Medicine at Monno Medical College & Hospital, Manikganj, Bangladesh from October 2025 to March 2026. A total of 200 patients with acute exacerbations were enrolled, including 100 asthma and 100 COPD patients. Baseline demographic and clinical parameters were recorded and early clinical recovery within 24 hours after nebulized magnesium sulfate therapy was evaluated. Outcomes included improvement in respiratory parameters, requirement of ICU admission, mechanical ventilation and duration of hospital stay.

**Results:** Among asthma patients (n = 100), the majority were aged 18–30 years (28%), whereas most COPD patients were in the >60 years age group (32%), showing a significant age difference between the groups ($p < 0.001$). Asthma patients were generally younger, while COPD patients were older and more commonly smokers. Improvement in respiratory rate (81% vs 69%), $SpO_2$ (84% vs 73%) and PEFR >20% (76% vs 63%) was significantly higher in asthma patients ($p<0.05$). ICU admission was lower in asthma patients (9%) compared to COPD patients (23%) and the mean hospital stay was shorter (3.7±1.5 vs 4.9±2.1 days). Adverse effects were minimal.

**Conclusion:** Nebulized magnesium sulfate appears to be a safe and effective adjunct therapy that improves early recovery and reduces ICU admission, particularly among asthma patients.

**KEYWORDS:**
Nebulized magnesium sulfate, acute asthma, COPD exacerbation, bronchodilator therapy, ICU admission.

***Corresponding Author:** Mohammad Abdul Motalib*

***Cite this Article:** Motalib, M.A., Haque, M., Billah, Md. M., Ahmed, S., Md. Al A., Islam, K.A., Sadiya, U. (2026). Nebulized Magnesium Sulfate as an Add-On Therapy in Acute Exacerbations of COPD and Bronchial Asthma: Effects on Early Recovery and Reduced ICU Admission. International Journal of Clinical Science and Medical Research, 6(5), 129-135. https://doi.org/10.55677/IJCSMR/V6I5-01/2026*

## INTRODUCTION

Acute exacerbations of Chronic Obstructive Pulmonary Disease (COPD) and Bronchial Asthma are common causes of emergency hospital admissions and contribute significantly to respiratory morbidity and mortality worldwide [1]. These conditions are characterized by airflow limitation, airway inflammation and increased bronchial hyperresponsiveness, which often lead to episodes of acute worsening of respiratory symptoms such as dyspnea,

wheezing, cough and chest tightness [2]. Acute exacerbations frequently require hospitalization and, in severe cases, admission to intensive care units (ICU), imposing a substantial burden on healthcare systems, particularly in developing countries like Bangladesh [3].

Standard management of acute exacerbations of COPD and bronchial asthma includes oxygen therapy, inhaled bronchodilators such as beta-2 agonists and anticholinergic agents, systemic corticosteroids and antibiotics when indicated [4]. Despite these treatments, some patients experience delayed clinical recovery and may progress to respiratory failure requiring ICU care or mechanical ventilation [5]. Therefore, identifying effective adjunct therapies that can enhance bronchodilation and accelerate clinical improvement remains an important clinical objective [6].

Magnesium Sulfate has gained attention as a potential adjunct therapy in the management of acute respiratory exacerbations due to its bronchodilatory and anti-inflammatory properties [7]. Magnesium acts as a natural calcium antagonist, inhibiting smooth muscle contraction and reducing acetylcholine release at neuromuscular junctions, thereby promoting relaxation of bronchial smooth muscles [8]. Additionally, magnesium may reduce airway inflammation and improve mucociliary clearance, which may contribute to improved airflow and symptom relief in patients with obstructive airway diseases [9].

Previous clinical studies have demonstrated that intravenous magnesium sulfate may improve lung function and reduce hospitalization in severe asthma exacerbations [10,11]. More recently, nebulized magnesium sulfate has been explored as an alternative route of administration, as it allows direct delivery to the airway with fewer systemic adverse effects [2]. Some randomized trials and observational studies have suggested that nebulized magnesium sulfate may enhance the bronchodilatory effects of conventional nebulized bronchodilators and improve respiratory parameters such as peak expiratory flow rate (PEFR) and oxygen saturation [12]. However, the overall evidence remains inconsistent, particularly in patients with COPD exacerbations and further clinical evaluation is required [13].

Therefore, the present study was conducted at the Department of Medicine of Monno Medical College & Hospital in Manikganj to evaluate the effectiveness of nebulized magnesium sulfate as an add-on therapy in patients with acute exacerbations of COPD and bronchial asthma. The objective of this study was to assess its impact on early clinical recovery and its potential role in reducing the need for ICU admission among hospitalized patients.

## METHODOLOGY & MATERIALS

This prospective comparative observational study was conducted in the Department of Medicine at Monno Medical College & Hospital, located in Manikganj, Bangladesh, over a six-month period from October 2025 to March 2026. A total of 200 patients admitted with acute exacerbations of chronic obstructive pulmonary disease (COPD) and bronchial asthma were enrolled in the study. Among them, 100 patients were diagnosed with acute exacerbation of bronchial asthma and 100 patients with acute exacerbation of COPD. Patients were selected using a consecutive sampling technique from those admitted to the medicine ward and emergency department during the study period. Diagnosis of COPD and bronchial asthma exacerbation was made based on clinical history, physical examination and relevant investigations. All patients received standard treatment for acute exacerbation including oxygen therapy, nebulized bronchodilators, systemic corticosteroids and antibiotics when indicated. Nebulized magnesium sulfate was administered as an add-on therapy along with standard treatment and patients were monitored for early clinical recovery and need for intensive care unit (ICU) admission.

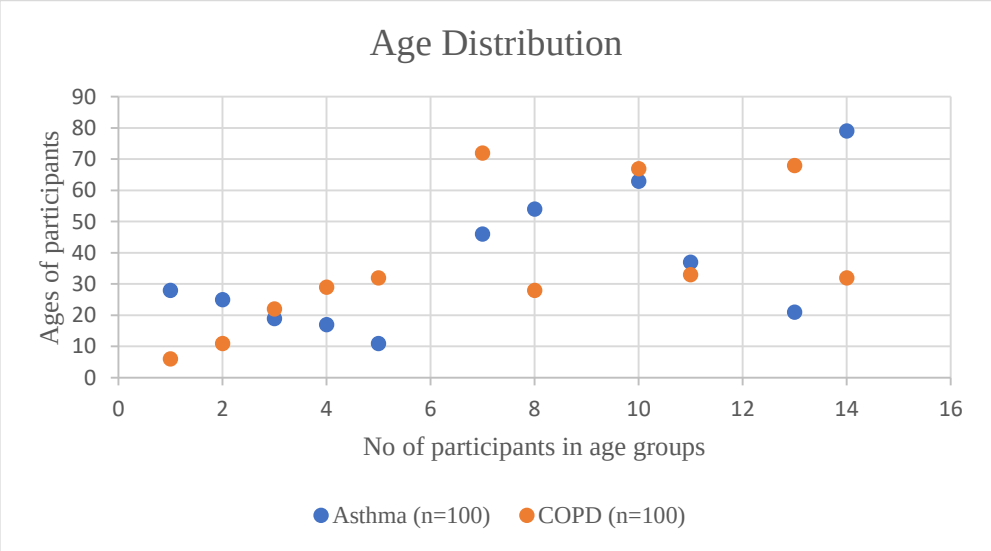
Inclusion criteria were patients aged 18 years or older with clinically diagnosed acute exacerbation of COPD or bronchial asthma who required hospital admission and provided informed consent. Exclusion criteria included patients with severe cardiovascular instability, chronic kidney disease, known hypersensitivity to magnesium sulfate, pregnancy, or those requiring immediate mechanical ventilation at presentation. Baseline demographic data, smoking status, clinical parameters including respiratory rate, pulse rate, oxygen saturation ($SpO_2$) and peak expiratory flow rate (PEFR) were recorded on admission and during follow-up.

Data were collected using a structured data collection sheet and analyzed using Statistical Package for the Social Sciences (SPSS) version 25. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency and percentage. Comparisons between groups were performed using the independent sample t-test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

**Table I: Baseline demographic characteristics of the study population (n = 200)**

| Variables | Asthma (n=100) | COPD (n=100) | p value |
|---|---|---|---|
| Age group (years) | | | |
| 18–30 | 28 (28.0%) | 6 (6.0%) | <0.001 |
| 31–40 | 25 (25.0%) | 11 (11.0%) | |
| 41–50 | 19 (19.0%) | 22 (22.0%) | |
| 51–60 | 17 (17.0%) | 29 (29.0%) | |
| >60 | 11 (11.0%) | 32 (32.0%) | |
| Gender | | | |
| Male | 46 (46.0%) | 72 (72.0%) | 0.002 |
| Female | 54 (54.0%) | 28 (28.0%) | |
| Residence | | | |
| Rural | 63 (63.0%) | 67 (67.0%) | 0.52 |
| Urban | 37 (37.0%) | 33 (33.0%) | |
| Smoking history | | | |
| Present | 21 (21.0%) | 68 (68.0%) | <0.001 |
| Absent | 79 (79.0%) | 32 (32.0%) | |



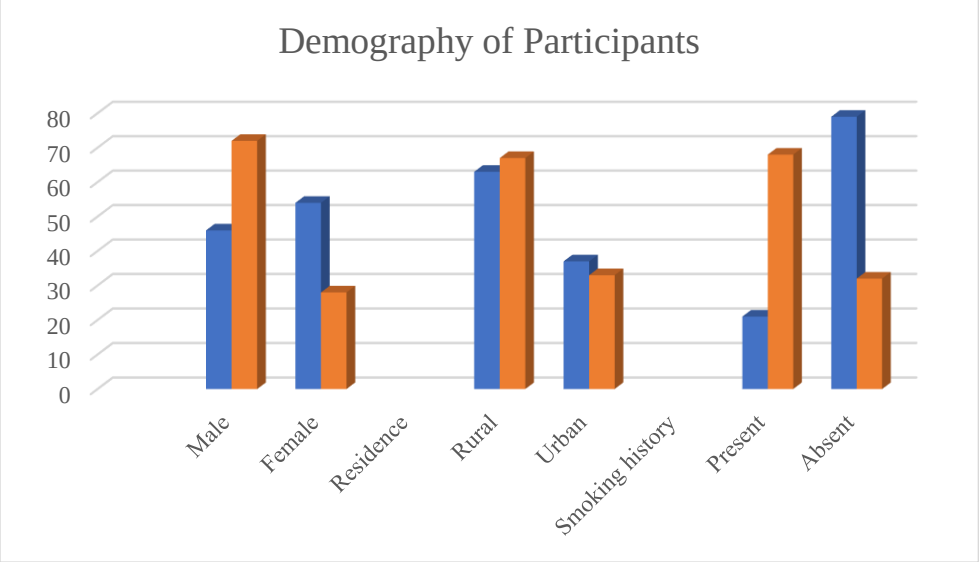



Table I shows the baseline demographic characteristics of the study population (n = 200). Among asthma patients (n = 100), the majority were aged 18–30 years (28%), whereas most COPD patients were in the >60 years age group (32%), showing a significant age difference between the groups ($p < 0.001$). Male participants were more common in the COPD group (72%) compared to the asthma group (46%), while females predominated among asthma patients (54%) ($p = 0.002$). Most participants in both groups were from rural areas (63% in asthma and 67% in COPD), with no statistically significant difference ($p = 0.52$). Smoking history was significantly higher among COPD patients (68%) compared to asthma patients (21%) ($p < 0.001$).

**Table II: Comparison of baseline clinical parameters on admission**

| Clinical parameters | Asthma (Mean ± SD) | COPD (Mean ± SD) | p value |
|---|---|---|---|
| Respiratory rate (breaths/min) | 30.8 ± 4.3 | 29.6 ± 4.7 | 0.07 |
| Pulse rate (beats/min) | 103.4 ± 11.2 | 101.9 ± 10.6 | 0.34 |
| $SpO_2$ (%) | 90.3 ± 3.9 | 88.8 ± 4.6 | 0.01 |
| PEFR (% predicted) | 48.7 ± 12.1 | 44.9 ± 11.5 | 0.03 |
| Systolic BP (mmHg) | 122.6 ± 13.4 | 125.2 ± 14.1 | 0.18 |

Table II compares the baseline clinical parameters of asthma and COPD patients on admission. The mean respiratory rate was 30.8 ± 4.3 breaths/min in asthma patients and 29.6 ± 4.7 breaths/min in COPD patients, showing no significant difference ($p = 0.07$). Similarly, the mean pulse rate was 103.4 ± 11.2 beats/min in asthma and 101.9 ± 10.6 beats/min in COPD ($p = 0.34$). However, the mean oxygen saturation ($SpO_2$) was significantly higher in asthma patients (90.3 ± 3.9%) compared to COPD patients (88.8 ± 4.6%) ($p = 0.01$). The mean PEFR (% predicted) was also higher among asthma patients (48.7 ± 12.1) than COPD patients (44.9 ± 11.5), which was statistically significant ($p = 0.03$). In contrast, the mean systolic blood pressure was 122.6 ± 13.4 mmHg in asthma and 125.2 ± 14.1 mmHg in COPD, with no significant difference ($p = 0.18$).

**Table III: Comparison of early clinical recovery after nebulized magnesium sulfate therapy**

| Clinical outcome | Asthma (n=100) | COPD (n=100) | p value |
|---|---|---|---|
| Improvement in respiratory rate within 24 hours | | | |
| Improved | 81 | 69 | 0.048 |
| Not improved | 19 | 31 | |
| Improvement in $SpO_2$ within 24 hours | | | |
| Improved | 84 | 73 | 0.045 |
| Not improved | 16 | 27 | |
| Improvement in PEFR (>20%) | | | |
| Yes | 76 | 63 | 0.039 |
| No | 24 | 37 | |

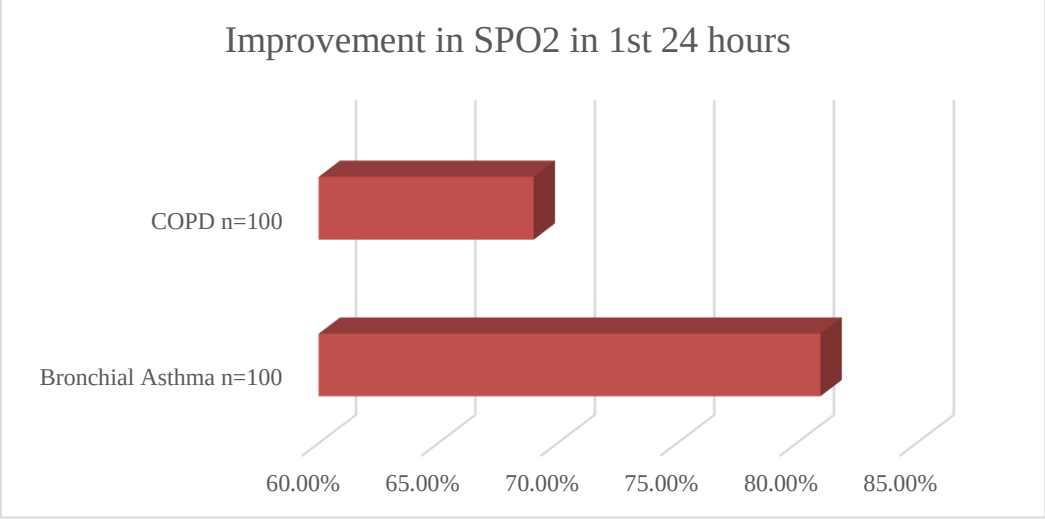


Table III presents the comparison of early clinical recovery following nebulized magnesium sulfate therapy among asthma and COPD patients. Improvement in respiratory rate within 24 hours was observed in 81% of asthma patients and 69% of COPD patients, which showed a statistically significant difference (p = 0.048). Similarly, improvement in oxygen saturation ($SpO_2$) within 24 hours occurred in 84% of asthma patients compared to 73% of COPD patients (p = 0.045). Improvement in PEFR greater than 20% was also more frequent among asthma patients (76%) than COPD patients (63%), which was statistically significant (p = 0.039).

**Table IV: Comparison of clinical outcomes and ICU admission**

| Outcomes | Asthma (n=100) | COPD (n=100) | p value |
|---|---|---|---|
| ICU admission | | | |
| Required | 9 | 23 | 0.006 |
| Not required | 91 | 77 | |
| Need for mechanical ventilation | | | |
| Yes | 4 | 12 | 0.032 |
| No | 96 | 88 | |
| Hospital stay (days) | 3.7 ± 1.5 | 4.9 ± 2.1 | 0.001 |
| Adverse effects of magnesium sulfate | | | |
| Mild hypotension | 3 | 5 | 0.54 |
| Nausea | 7 | 9 | |
| None | 90 | 86 | |

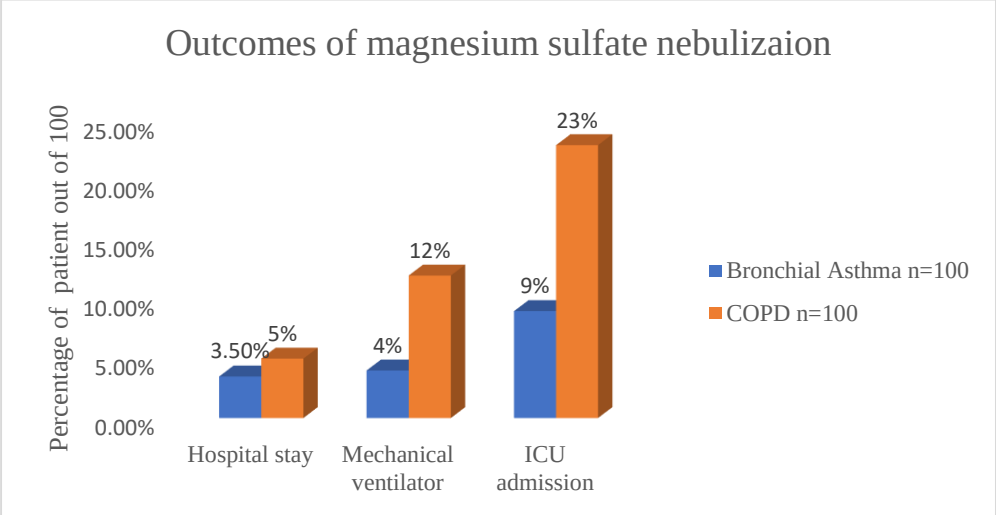



Table IV shows the comparison of clinical outcomes between asthma and COPD patients following nebulized magnesium sulfate therapy. ICU admission was significantly lower in asthma patients, with 9% requiring ICU care compared to 23% of COPD patients (p = 0.006). Similarly, the need for mechanical ventilation was higher in the COPD group (12%) than in the asthma group (4%) (p = 0.032). The mean duration of hospital stay was significantly shorter among asthma patients (3.7 ± 1.5 days) compared to COPD patients (4.9 ± 2.1 days) (p = 0.001). Regarding safety outcomes, mild hypotension was observed in 3% of asthma patients and 5% of COPD patients, while nausea occurred in 7% and 9%, respectively, with no statistically significant difference (p = 0.54).

**DISCUSSION**

Acute exacerbations of Bronchial Asthma and Chronic Obstructive Pulmonary Disease (COPD) are major causes of emergency department visits and hospital admissions worldwide. Effective early management is essential to reduce complications, improve respiratory function and prevent ICU admission. The present comparative study evaluated the effect of Magnesium Sulfate nebulization as an add-on therapy in patients with acute exacerbations of asthma and COPD. Our findings demonstrated significant improvement in clinical recovery parameters, particularly among asthma patients, along with a reduction in ICU admissions.

In this study, younger age groups were more common among asthma patients, while COPD patients were predominantly

older. The majority of asthma patients were aged 18–30 years (28%), whereas 32% of COPD patients were above 60 years, showing a statistically significant difference. Similar demographic patterns have been reported in clinical guidelines and observational studies, where asthma frequently affects younger individuals while COPD is more prevalent among older populations with long-standing exposure to risk factors such as smoking. The ICS/NCCP asthma guidelines described by Agarwal R et al. also noted that asthma commonly presents in younger age groups, whereas COPD is typically diagnosed in older adults with chronic airway damage [14]. Furthermore, smoking history in our study was significantly higher among COPD patients (68%) compared to asthma patients (21%), which is consistent with the well-established association between smoking and COPD development.

Baseline clinical parameters in our study showed comparable respiratory and hemodynamic status between the two groups. However, oxygen saturation was significantly lower among COPD patients (88.8 ± 4.6%) compared to asthma patients (90.3 ± 3.9%) and PEFR values were also slightly lower in COPD patients. Similar findings have been described by Guthrie A, who reported that COPD exacerbations often present with more persistent hypoxemia due to chronic airflow limitation and gas exchange abnormalities [15].

The primary objective of this study was to evaluate early clinical recovery following nebulized magnesium sulfate therapy. Our results showed significant improvement in respiratory parameters within 24 hours. Improvement in respiratory rate occurred in 81% of asthma patients compared with 69% of COPD patients. Likewise, improvement in oxygen saturation was observed in 84% of asthma patients versus 73% of COPD patients, while 76% of asthma patients demonstrated greater than 20% improvement in PEFR compared with 63% of COPD patients. These results suggest that nebulized magnesium sulfate enhances bronchodilation and airway relaxation, leading to faster symptom relief. The beneficial bronchodilatory effects of magnesium in acute asthma have also been discussed by Kling S and Kinser D, who reported that magnesium can inhibit calcium-mediated smooth muscle contraction and reduce airway hyperresponsiveness during acute attacks [16,17].

Another important finding of the present study was the reduced requirement for ICU admission among asthma patients. Only 9% of asthma patients required ICU admission, compared to 23% of COPD patients and the need for mechanical ventilation was also lower among asthma patients (4% vs 12%). These findings are consistent with previous clinical observations that early and effective bronchodilator therapy can prevent progression to respiratory failure. Kleerup EC highlighted that prompt management of severe asthma attacks significantly reduces the need for intensive care support [18]. Similarly, studies discussed by Villa-roel C et al. emphasize the importance of aggressive early treatment in acute asthma and COPD exacerbations to prevent complications [19].

Hospital stay duration was also significantly shorter among asthma patients (3.7 ± 1.5 days) compared to COPD patients (4.9 ± 2.1 days). Shorter hospital stays indicate faster recovery and reduced healthcare burden. The role of aerosolized therapies in improving airway drug delivery has been highlighted by Abdelrahim ME et al., who emphasized that nebulized medications provide direct airway action and can enhance therapeutic outcomes in acute respiratory conditions [20].

Regarding safety outcomes, adverse effects of nebulized magnesium sulfate in this study were minimal. Only small proportions of patients experienced mild hypotension (3% in asthma and 5% in COPD) or nausea (7% and 9%, respectively) and these differences were not statistically significant. Previous pharmacologic reviews, including those summarized by Barnes N, have similarly reported that magnesium sulfate is generally well tolerated when used in appropriate doses for airway diseases [21].

## LIMITATIONS OF THE STUDY

This study had several limitations that should be considered while interpreting the findings. First, the study was conducted at a single tertiary care center, Monno Medical College & Hospital, which may limit the generalizability of the results to other healthcare settings in Bangladesh. Second, the study duration was relatively short (six months) and long-term outcomes after discharge were not assessed.

## CONCLUSION

The present study demonstrates that nebulized Magnesium Sulfate as an add-on therapy can significantly improve early clinical recovery in patients with acute exacerbations of Bronchial Asthma and Chronic Obstructive Pulmonary Disease. The therapy was associated with better improvement in respiratory parameters, reduced need for ICU admission and shorter hospital stay, particularly among asthma patients. These findings suggest that nebulized magnesium sulfate may be a useful and safe adjunct in the management of acute obstructive airway exacerbations, especially in resource-limited hospital settings.

**Financial support and sponsorship**

No funding sources.

**Conflicts of interest**

There are no conflicts of interest.

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