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# Assessment of Serum Calcium and Magnesium Levels in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease

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## ABSTRACT

**Background:** Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) are associated with respiratory failure, increased ventilatory requirement and ICU admission. Electrolyte abnormalities, especially hypocalcemia and hypomagnesemia, may worsen airway reactivity and respiratory muscle performance. To assess serum calcium and magnesium levels in patients with AECOPD and evaluate their association with clinical severity indicators, including mMRC grade, NIV requirement and ICU admission.

**Methods:** This single-centre cross-sectional observational study included 60 patients aged >40 years with AECOPD diagnosed according to GOLD criteria. Serum calcium and magnesium were measured at admission. Demographic variables, clinical presentation, arterial blood gases, NIV requirement and ICU admission were recorded. Group comparisons were assessed using analysis of variance, and associations were summarized using correlation coefficients.

**Results:** Mean age was 62.8 +/- 11.7 years; 42 patients (70%) were male. Mean serum calcium was 8.42 +/- 0.65 mg/dL and mean serum magnesium was 2.14 +/- 0.56 mg/dL. Patients requiring NIV had lower magnesium levels than those not requiring NIV (2.09 vs 2.21 mg/dL). ICU-admitted patients had lower calcium (8.33 vs 8.62 mg/dL) and magnesium (2.07 vs 2.29 mg/dL) than non-ICU patients. The decline in electrolyte levels across severity categories was statistically significant for calcium (p=0.04) and magnesium (p=0.03).

**Conclusion:** Lower serum calcium and magnesium levels were associated with more severe AECOPD, NIV requirement and ICU admission. Routine admission electrolyte monitoring may support early risk stratification in emergency care.

**Key-words:** COPD; Acute exacerbation; Calcium; Magnesium; Hypomagnesemia; Non-invasive ventilation; ICU admission

## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive inflammatory airway disease characterized by persistent airflow limitation. Acute exacerbations are clinically important events because they accelerate decline in lung function, increase hospitalization risk and contribute substantially to morbidity and mortality [1].

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In emergency units, early identification of high-risk AECOPD patients is essential for timely escalation of respiratory support and critical care monitoring. Electrolyte disturbances are common during acute respiratory illness and may be driven by hypoxia, acidosis, systemic inflammation, beta-agonist therapy, poor oral intake and comorbid illness. Magnesium is physiologically relevant in AECOPD because it modulates bronchial smooth muscle tone, airway hyperreactivity and neuromuscular transmission [2-5]. Calcium is essential for muscle contraction and cellular signalling, and low calcium may impair respiratory muscle performance [5,6].

In addition to their physiological importance, serum calcium and magnesium levels have gained attention as

 

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potential biomarkers for assessing disease severity in patients presenting with acute respiratory illnesses. Electrolyte disturbances are frequently overlooked during the initial evaluation of AECOPD despite their possible impact on respiratory mechanics and clinical outcomes [6]. Hypomagnesemia has been associated with increased airway resistance, impaired bronchodilation, and reduced effectiveness of respiratory muscle function, all of which may contribute to worsening respiratory distress. Likewise, hypocalcemia can adversely affect skeletal and smooth muscle contraction, potentially impairing diaphragmatic performance and reducing the efficiency of ventilation [7].

Patients with AECOPD often have multiple risk factors for electrolyte imbalance, including advanced age, poor nutritional status, chronic smoking, systemic inflammation, prolonged medication use, and coexisting medical conditions [8]. Furthermore, treatments commonly administered during exacerbations, such as β2-agonists, corticosteroids, and diuretics, may further alter electrolyte homeostasis. Early recognition of these abnormalities may therefore provide valuable clinical information beyond routine respiratory assessment [9].

Despite growing evidence regarding the role of electrolytes in respiratory diseases, data examining their relationship with clinically relevant outcomes such as need for non-invasive ventilation (NIV) and intensive care unit (ICU) admission remain limited, particularly in the Indian population. Identifying simple and cost-effective laboratory parameters that correlate with disease severity may help clinicians improve risk stratification and optimize patient management in emergency settings.

Prior studies have reported low magnesium and other electrolyte disturbances in COPD and AECOPD, with associations between hypomagnesemia, severity of exacerbation and adverse outcomes [10-12]. However, simultaneous evaluation of calcium and magnesium with practical emergency severity indicators such as NIV requirement and ICU admission remains limited. The present study therefore evaluates admission serum calcium and magnesium levels in AECOPD and correlates them with severity markers.

## MATERIALS AND METHODS

**Study design-** This was a hospital-based cross-sectional observational study conducted in the Department of Emergency Medicine, Dr. B.R. Ambedkar Medical College and Hospital, Bangalore, from 1 July 2025 to 31 December 2025. The study included 60 patients diagnosed with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria. After obtaining approval from the Institutional Ethics Committee, eligible patients presenting to the Department of Emergency Medicine with symptoms suggestive of acute exacerbation of COPD were screened for inclusion. Patients fulfilling the GOLD diagnostic criteria for AECOPD and meeting the eligibility criteria were enrolled consecutively after obtaining informed consent. A detailed clinical history, including age, sex, smoking status, duration of COPD, previous exacerbations, and comorbid conditions, was recorded. A thorough physical examination was performed, and vital parameters such as pulse rate, respiratory rate, blood pressure, and oxygen saturation ($SpO_2$) were documented at admission.

Arterial blood gas (ABG) analysis was carried out as part of routine clinical assessment to determine pH, $PaO_2$, $PaCO_2$, and bicarbonate levels. Venous blood samples were collected within the first 24 hours of admission under aseptic conditions for estimation of serum calcium and magnesium levels using standard laboratory methods. The severity of dyspnea was assessed using the Modified Medical Research Council (mMRC) grading scale. Patients were managed according to institutional protocols for AECOPD, and clinical outcomes including requirement of non-invasive ventilation (NIV) and admission to the intensive care unit (ICU) were recorded. The measured serum calcium and magnesium levels were subsequently analyzed in relation to disease severity indicators and clinical outcomes.

### Inclusion Criteria

1. Patients aged more than 40 years**.**
2. Diagnosed cases of chronic obstructive pulmonary disease (COPD) according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria.
3. Patients presenting with acute exacerbation of COPD (AECOPD) characterized by worsening respiratory symptoms requiring additional treatment.
4. Patients willing to participate and providing written informed consent.

 

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**Exclusion Criteria**

1. Patients with chronic kidney disease, which may independently affect serum calcium and magnesium levels.
2. Patients with chronic liver disease.
3. Patients with any malignancy or active cancer.
4. Patients receiving calcium, magnesium, or other electrolyte supplementation before admission.
5. Patients on long-term diuretic therapy known to influence electrolyte balance.

**Statistical Analysis-** Detailed history, clinical examination, vital parameters, $SpO_2$, arterial blood gas values, NIV requirement and ICU admission were recorded. Serum calcium and magnesium levels were measured at admission using standard laboratory methods. Continuous variables are presented as mean +/- SD; categorical variables as number and percentage. Pearson correlation was used for association analysis. One-way ANOVA was used to compare electrolyte levels across severity groups; $p<0.05$ was considered statistically significant.

**RESULTS**

Table 1 describes the demographic and smoking characteristics of the 60 patients included in the study. The mean age of the participants was 62.8 ± 11.7 years, indicating that AECOPD was more common among older adults. Most patients (60%) were above 60 years of age. Males constituted the majority of the study population (70%), while females accounted for 30%. Regarding smoking status, current smokers represented the largest group (56.7%), followed by former smokers (23.3%) and non-smokers (20%). These findings suggest that AECOPD predominantly affects elderly males and is strongly associated with a history of smoking.

**Table 1:** Baseline Demographic Profile and Smoking Status of the Study Population

| Parameter | Value |
|---|---|
| Mean age, years | 62.8 +/- 11.7 |
| Age >60 years | 36 (60%) |
| Male | 42 (70%) |
| Female | 18 (30%) |
| Current smokers | 34 (56.7%) |
| Former smokers | 14 (23.3%) |
| Non-smokers | 12 (20%) |

Table 2 presents the clinical symptoms observed among patients with AECOPD. Dyspnea was the most common symptom, reported by all patients (100%), highlighting its importance as a cardinal feature of exacerbation. Cough was present in 83.3% of patients, while sputum production was observed in 73.3%, indicating frequent airway inflammation and mucus hypersecretion. Wheeze was noted in 66.7% of cases, reflecting airflow obstruction. Fever was the least common symptom, occurring in 33.3% of patients, suggesting that infection may have contributed to exacerbation in a subset of patients. Overall, respiratory symptoms predominated in the study population.

**Table 2:** Clinical Presentation of Patients with Acute Exacerbation of COPD (AECOPD) (n = 60)

| Clinical variable | Number (%) |
|---|---|
| Dyspnea | 60 (100%) |
| Cough | 50 (83.3%) |
| Sputum production | 44 (73.3%) |
| Wheeze | 40 (66.7%) |
| Fever | 20 (33.3%) |

Table 3 shows the distribution of patients according to the severity of dyspnea assessed using the mMRC grading scale. Grade 3 dyspnea was the most common, affecting 43.3% of patients, followed by Grade 4 in 33.3% and Grade 2 in 23.3% of patients. The predominance of Grades 3 and 4 indicates that most patients presented with moderate to severe breathlessness during acute exacerbation. These findings suggest a substantial symptom burden and impaired functional status among the study population, reflecting the clinical severity of AECOPD at the time of hospital presentation.

**Table 3:** Distribution of Patients According to Modified Medical Research Council (mMRC) Dyspnea Grade (n = 60)

| mMRC grade | Number (%) |
|---|---|
| Grade 2 | 14 (23.3%) |
| Grade 3 | 26 (43.3%) |
| Grade 4 | 20 (33.3%) |

 

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Table 4 summarise the clinical, arterial blood gas, and electrolyte characteristics of patients with AECOPD. The mean respiratory rate was elevated (25 ± 4 breaths/min), while mean $SpO_2$ was reduced (87 ± 5%), indicating significant respiratory compromise. Arterial blood gas analysis showed respiratory acidosis with elevated $PaCO_2$ (50 ± 9 mmHg) and reduced pH (7.33 ± 0.05). Mean serum calcium and magnesium levels were 8.42 ± 0.65 mg/dL and 2.14 ± 0.56 mg/dL, respectively. Patients requiring NIV or ICU admission had lower calcium and magnesium levels. The progressive decline in electrolyte levels with increasing severity was statistically significant (calcium p=0.04; magnesium p=0.03).

**Table 4:** Clinical, Arterial Blood Gas, and Electrolyte Profile of Patients with AECOPD (n = 60)

| **Parameter** | **Mean +/- SD** |
|---|---|
| Pulse rate, beats/min | 100 +/- 12 |
| Respiratory rate, breaths/min | 25 +/- 4 |
| Systolic BP, mmHg | 130 +/- 16 |
| Diastolic BP, mmHg | 80 +/- 9 |
| SpO2, % | 87 +/- 5 |
| pH | 7.33 +/- 0.05 |
| PaCO2, mmHg | 50 +/- 9 |
| PaO2, mmHg | 60 +/- 11 |
| HCO3-, mEq/L | 25 +/- 3 |

| **Electrolyte** | **Mean +/- SD** | **Range** |
|---|---|---|
| Serum calcium | 8.42 +/- 0.65 mg/dL | 7.0-9.8 |
| Serum magnesium | 2.14 +/- 0.56 mg/dL | 1.1-3.2 |

| **Parameter** | **No NIV** | **NIV** |
|---|---|---|
| Calcium, mg/dL | 8.47 | 8.39 |
| Magnesium, mg/dL | 2.21 | 2.09 |

| **Parameter** | **Non-ICU** | **ICU** |
|---|---|---|
| Calcium, mg/dL | 8.62 | 8.33 |
| Magnesium, mg/dL | 2.29 | 2.07 |

| **Parameter** | **Baseline/least severe** | **NIV** | **ICU** | **p-value** |
|---|---|---|---|---|
| Calcium, mg/dL | 8.47 | 8.39 | 8.33 | 0.04 |
| Magnesium, mg/dL | 2.21 | 2.09 | 2.07 | 0.03 |

Fig. 1 illustrates the mean serum calcium and magnesium concentrations among patients stratified by clinical severity (No NIV/Non-ICU, NIV, and ICU). Mean calcium levels showed a gradual decline with increasing disease severity, decreasing from approximately 8.6 mg/dL in the No NIV/Non-ICU group to 8.4 mg/dL in the NIV group and 8.2 mg/dL in the ICU group. Similarly, mean magnesium levels decreased from about 2.3 mg/dL in the No NIV/Non-ICU group to 2.1 mg/dL in both the NIV and ICU groups. These findings suggest a trend toward lower serum calcium and magnesium levels among patients with more severe clinical presentations.

 

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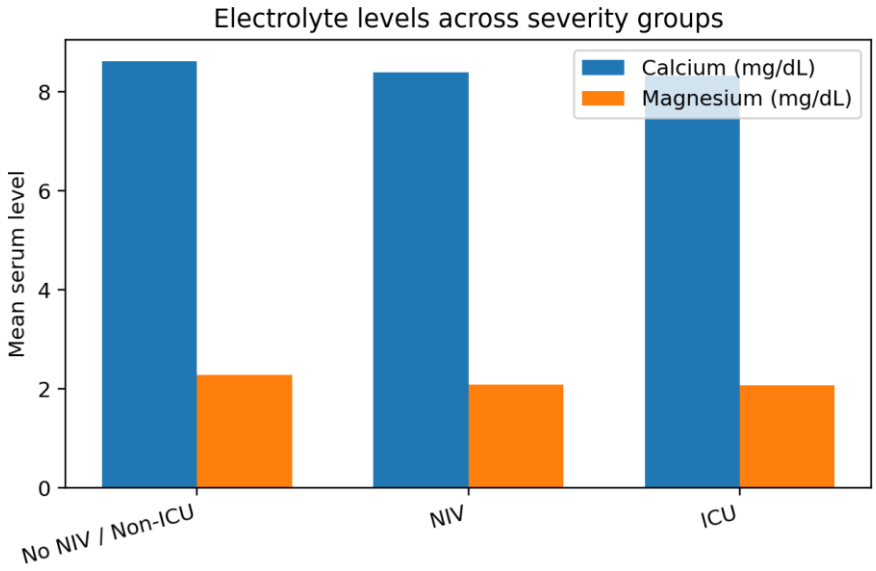


**Fig. 1:** Mean calcium and magnesium levels across increasing clinical severity

## DISCUSSION

This study found that lower serum calcium and magnesium levels were associated with more severe AECOPD. The trend was consistent across clinically meaningful outcomes: patients requiring NIV had lower magnesium, and ICU-admitted patients had lower calcium and magnesium than non-ICU patients. The group differences were statistically significant for both calcium and magnesium. The biological plausibility is strong. Magnesium deficiency may promote bronchoconstriction, airway hyperresponsiveness and respiratory muscle fatigue, while calcium disturbances may affect neuromuscular function and diaphragmatic performance [5,13]. These mechanisms are relevant during AECOPD, where respiratory workload and ventilatory demand are increased.

The present findings are consistent with studies by Dasgupta *et al*., Makwana *et al*. and Shah *et al*., who reported lower magnesium levels in acute exacerbations and associations with disease severity [1,6,8]. Similar electrolyte derangements have also been described in COPD cohorts by Nair et al., Rathi and Siddiqui *et al*. [2,7]. Interventional support for magnesium's role in obstructive airway disease comes from Skorodin *et al.,* who reported improved airflow parameters after magnesium sulfate administration in COPD exacerbations [9,14].

The observed correlations were weak, which may reflect the modest sample size, single-centre design and the multifactorial nature of AECOPD severity. Nonetheless, the directionally consistent decrease in both calcium and magnesium across NIV and ICU strata supports their use as simple adjunctive risk markers rather than standalone prognostic tests [11,15]. The findings of this study suggest that measurement of serum calcium and magnesium levels at admission is a simple, inexpensive, and widely available investigation that may assist in the initial assessment of patients with AECOPD. Lower magnesium levels were associated with greater disease severity and may help identify patients at increased risk of requiring ventilatory support. Correction of electrolyte abnormalities should be considered as part of comprehensive AECOPD management while taking renal function and institutional treatment protocols into account [16,17]. However, serum electrolyte levels should be interpreted alongside other clinical parameters, including oxygen saturation, arterial blood gas findings, work of breathing, and associated comorbidities. This study has several limitations. The relatively small sample size and single-centre design may limit the generalizability of the findings to broader populations. As a cross-sectional study, causal relationships between electrolyte abnormalities and disease severity cannot be established. Ionized calcium levels, which may provide a more accurate assessment of calcium status, were not measured. Additionally, the study did not include longitudinal follow-up or mortality outcomes. The absence of patient-level data also precluded multivariable regression modelling and receiver

 

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operating characteristic (ROC) curve analysis to determine the independent predictive value of serum calcium and magnesium levels [18].

## CONCLUSIONS

Serum calcium and magnesium levels were reduced in more severe AECOPD and were associated with NIV requirement and ICU admission. Routine monitoring of these electrolytes at admission may help emergency physicians identify high-risk patients early and optimize supportive management. Larger prospective studies with patient-level data and follow-up outcomes are recommended to validate these findings and determine clinically useful cut-off values. These findings highlight the potential utility of serum calcium and magnesium as readily available biochemical markers for assessing the clinical severity of AECOPD in emergency settings. Incorporating electrolyte evaluation into routine admission assessment may facilitate earlier identification of patients at risk for respiratory deterioration and intensive care requirements. Future multicentre studies with larger sample sizes and longitudinal follow-up are needed to establish definitive prognostic thresholds and evaluate whether correction of electrolyte abnormalities can improve clinical outcomes and reduce healthcare burden.

## CONTRIBUTION OF AUTHORS

**Research concept:** Anand BS, Nagendra Prasad, Akhilesh Kumar A
**Research design:** Anand BS, Nagendra Prasad
**Supervision:** Anand BS
**Materials:** Anand BS, Nagendra Prasad, Akhilesh Kumar A
**Data collection:** Anand BS, Nagendra Prasad, Akhilesh Kumar A
**Data analysis and interpretation:** Anand BS, Nagendra Prasad, Akhilesh Kumar A
**Literature search:** Akhilesh Kumar A, Anand BS
**Writing article:** Anand BS, Nagendra Prasad, Akhilesh Kumar A
**Critical review:** Anand BS, Nagendra Prasad
**Article editing:** Anand BS, Nagendra Prasad, Akhilesh Kumar A
**Final approval:** Anand BS, Nagendra Prasad, Akhilesh Kumar A

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