Electrolyte Disturbances in Patients with Chronic Stable Asthma and During Acute Asthma Exacerbations

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Abstract

Background: Asthma is a chronic inflammatory airway disorder characterized by recurrent episodes of bronchoconstriction, airflow obstruction, and respiratory symptoms. Acute exacerbations often lead to systemic disturbances, including alterations in serum electrolytes. Electrolytes such as sodium, potassium, calcium, and magnesium play critical roles in smooth muscle function, airway responsiveness, and overall respiratory homeostasis.

Objectives: The study aimed to evaluate and compare serum electrolyte levels in patients with chronic stable asthma and those experiencing acute asthma exacerbations.

Materials and Methods: A cross-sectional observational study was conducted on 100 patients diagnosed with asthma attending the respiratory medicine department. Fifty patients had chronic stable asthma, while fifty presented with acute exacerbations. Serum levels of sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}) were measured using standard automated analyzers. Statistical analysis was performed to assess differences between the two groups, with p-values <0.05 considered significant.

Results: Patients with acute asthma exacerbations demonstrated significantly lower serum potassium and magnesium levels compared to those with stable asthma ($p<0.01$). Sodium levels showed a mild decrease during exacerbations but were not statistically significant ($p>0.05$). Calcium levels were slightly reduced in acute cases, though not reaching statistical significance.

Conclusion: Acute asthma exacerbations are associated with significant disturbances in potassium and magnesium levels, whereas sodium and calcium remain relatively stable. Routine

monitoring of electrolytes, particularly during acute attacks, may aid in preventing complications and guiding appropriate therapeutic interventions. Early correction of these imbalances can improve patient outcomes and reduce morbidity associated with asthma exacerbations.

Keywords: Asthma, Electrolyte disturbances, Acute Exacerbation, Hyponatremia, Hypokalemia.

INTRODUCTION

Asthma is a prevalent chronic respiratory condition characterized by reversible airflow obstruction and airway inflammation. While the primary focus has traditionally been on bronchoconstriction and inflammation, emerging evidence suggests that electrolyte disturbances may play a significant role in the pathophysiology and clinical management of asthma. [1] Electrolytes such as sodium, potassium, calcium, and magnesium are crucial for various physiological functions, including nerve conduction, muscle contraction, and maintaining cellular homeostasis. Imbalances in these electrolytes can exacerbate asthma symptoms and may be influenced by both the disease process and its treatment. [2]

Acute asthma exacerbations are episodes characterized by worsening of asthma symptoms and increased airway obstruction. These exacerbations can lead to significant physiological stress and may exacerbate existing electrolyte disturbances. [3] Studies have shown that patients with acute asthma exacerbations often exhibit more pronounced electrolyte imbalances compared to those with stable asthma. The recognition of electrolyte disturbances in asthma patients is crucial for optimal management. Electrolyte imbalances can exacerbate asthma symptoms and may complicate the clinical course, especially during acute exacerbations. [4]

Hypomagnesemia has been identified as a common electrolyte disturbance in asthmatic patients, with studies reporting its prevalence in both chronic stable asthma and acute exacerbations. [5] The underlying mechanisms for these disturbances are not fully understood but may involve factors such as medication effects, disease severity, and dietary deficiencies. [6] Understanding the patterns and implications of electrolyte disturbances in asthma is essential for optimizing patient care and improving clinical outcomes.

Several studies have investigated these electrolytes, but limited research has explored the specific association between these electrolyte imbalances in asthma exacerbation patients. The present study is undertaken to fill this gap by analyzing data from a cross-sectional sample of acute and chronic asthmatic patients to determine the relationship between these variables.

This study aimed to compare serum electrolyte levels in patients with chronic stable asthma and those experiencing acute asthma exacerbations and also assess the relationship between electrolyte disturbances and pulmonary function parameters, providing insights into the metabolic interplay and its implications for clinical management.

MATERIAL & METHODS

Source of Data and Study Design: It is a hospital based cross–sectional observational study, conducted at the Dr. Ulhas Patil Medical College and Hospital in Jalgaon, (Maharashtra) in the Department of Biochemistry in association with the Department of Respiratory Medicine. Samples were analyzed for biochemical investigations in the Department of Biochemistry, Dr. Dr. Ulhas Patil Medical College and Hospital in Jalgaon, (Maharashtra).

Study Population: A total of 100 asthmatic patients were enrolled, divided into two –

- **Group I:** 50 patients with chronic stable asthma.
- **Group II:** 50 patients with acute asthma exacerbations.

Inclusion Criteria:

- Diagnosed with asthma based on clinical and spirometry criteria.
- Age between 18 to 65 years.
- Patients who are willing to participate in the study.

Exclusion Criteria: Patients with Obesity, Chronic Liver Disease, Hypertension, Coronary Artery Disease, Bone Disease, Malignancy, Pregnancy and Recent Surgeries were excluded from the study.

Sample Collection: 5 ml venous blood was drawn from patients under aseptic precautions. Serum was separated by centrifugation and used for the following biochemical analysis. Serum electrolytes (sodium, potassium, calcium and magnesium) were estimated using Fully Automatic Analyzer and pulmonary function tests was measured using spirometry.

Statistical Analysis: All the data was presented in number % percentage. Mean and Standard Deviation were used to determine the data. Student's t-test and Pearson's Correlation were used. A p-value less than 0.05 were considered statistically significant.

RESULTS

The study included 100 patients of asthma aged 18 to 65 years. 50 patients are from chronic stable asthma and 50 patients are from acute asthma exacerbations. A significant positive correlation ($p = 0.001$) was observed in potassium and magnesium during acute exacerbations. Similarly, Magnesium shows the strongest positive correlation with pulmonary function parameters, suggesting lower magnesium levels are associated with reduced lung function. Potassium also has a moderate positive correlation with FVC, FEV1, and PEFR.

Table No 1: Shows Comparative Analysis of Electrolytes in Chronic and Acute Asthma Patients.

Variables	Patients with chronic stable asthma (Mean ± SD)	Patients with acute asthma exacerbation (Mean ± SD)	P - value
Age (years)	42.1 ± 12.3	40.5 ± 11.8	0.45
Gender (Male)	28	30	0.68
(Female)	22	20	
Sodium (mmol/L)	138.5 ± 3.2	136.8 ± 3.5	0.04
Potassium (mmol/L)	4.1 ± 0.4	3.6 ± 0.5	**<0.001**
Calcium (mg/dL)	9.2 ± 0.5	8.7 ± 0.6	0.002
Magnesium (mg/dL)	2.0 ± 0.3	1.6 ± 0.4	**<0.001**

Not significant ($p > 0.05$) and **Highly significant** ($p < 0.001$)

Table No 2: Shows Comparison of Pulmonary Function Tests Parameters in Chronic and Acute Asthma Patients.

Parameters	Patients with chronic stable asthma (Mean ± SD)	Patients with acute asthma exacerbation (Mean ± SD)	P - value
FVC (L)	3.2 ± 0.6	2.5 ± 0.7	**<0.001**
FEV1 (L)	2.6 ± 0.5	1.8 ± 0.5	**<0.001**
PEFR (%)	82 ± 10	55 ± 12	**<0.001**

Not significant ($p > 0.05$) and **Highly significant** ($p < 0.001$)

Table No 3: Shows Correlation of Electrolytes with Pulmonary Function Parameters in Asthmatic Patients.

Electrolytes	FVC (L) [P – value]	FEV1 (L) [P – value]	PEFR (%) [P – value]
Sodium (mmol/L)	0.35	0.28	0.42
Potassium (mmol/L)	**<0.001**	**<0.001**	**<0.001**
Calcium (mg/dL)	0.05	0.04	0.07
Magnesium (mg/dL)	**<0.001**	**<0.001**	**<0.001**

Not significant ($p > 0.05$) and **Highly significant** ($p < 0.001$)

DISCUSSION

In the present study, we included a total of 100 patients; out of which 50 of chronic stable asthma and 50 of acute asthma exacerbation based on inclusion and exclusion criteria. The findings revealed significant differences in serum sodium, potassium, calcium, and magnesium levels between the two groups, as well as a strong correlation of potassium and magnesium with pulmonary function parameters (FVC, FEV1, and PEFR).

In this study, patients with acute exacerbations exhibited significantly lower sodium levels (136.8 ± 3.5 mmol/L) compared to those with chronic stable asthma (138.5 ± 3.2 mmol/L; $p = 0.04$). Hyponatremia in asthma has been reported in earlier studies, often attributed to syndrome of inappropriate antidiuretic hormone secretion (SIADH), hypoxemia-induced hormonal imbalance, and use of β2-agonists, which can alter sodium homeostasis [7, 8]. Our results are consistent with the findings of Reddy et al. [9], who reported mild hyponatremia during acute attacks of asthma.

Hypokalemia was significantly more pronounced in acute exacerbations (3.6 ± 0.5 mmol/L) compared to chronic stable asthma (4.1 ± 0.4 mmol/L; $p < 0.001$). This aligns with previous studies suggesting that β2-adrenergic agonists, commonly used during acute attacks, drive potassium into cells, thereby reducing serum potassium levels [10, 11]. Furthermore, hypokalemia has been associated with skeletal muscle weakness, which may worsen ventilatory mechanics during asthma attacks [12]. Our correlation analysis also demonstrated a highly significant positive relationship between potassium levels and pulmonary function ($p < 0.001$), supporting its crucial role in maintaining respiratory muscle function and airway tone.

Serum calcium levels were significantly reduced in acute asthma (8.7 ± 0.6 mg/dL) compared to stable asthma (9.2 ± 0.5 mg/dL; $p = 0.002$). Previous studies have reported hypocalcemia in asthma, which may be linked to corticosteroid use, altered vitamin D metabolism, and increased cellular calcium uptake during smooth muscle contraction [13, 14]. While the correlation of calcium with lung function was weaker than that of potassium and magnesium, a modest positive association was observed, indicating that calcium disturbances may contribute to bronchial hyper reactivity and impaired lung function.

Magnesium levels were markedly reduced in acute asthma patients (1.6 ± 0.4 mg/dL) compared to chronic stable patients (2.0 ± 0.3 mg/dL; $p < 0.001$). Hypomagnesemia in asthma has been well-documented, with magnesium deficiency linked to increased airway hyper responsiveness, mast cell activation, and impaired bronchodilation [15, 16, 17]. Our study also demonstrated a strong correlation between magnesium levels and pulmonary function indices ($p < 0.001$), highlighting its critical role in smooth muscle relaxation and bronchodilation. These findings are in line with Hashimoto et al. [18] and Rolla et al. [19], who emphasized the therapeutic potential of magnesium supplementation in acute severe asthma.

The pulmonary function results of this study further confirmed that patients with acute asthma exacerbations had significantly reduced FVC, FEV1, and PEFR compared to those with chronic stable asthma. The observed electrolyte disturbances, particularly hypokalemia and hypomagnesemia, strongly correlated with these declines in lung function, underscoring their clinical relevance. This supports the hypothesis that electrolyte imbalances not only reflect disease severity but may also actively contribute to the pathophysiology of asthma exacerbations.

The limitations of the present study is that the sample size should be large that will improve statistical power and generalizability of the results. Since this was a cross-sectional comparative study, it reflects electrolyte disturbances at a single point in time. It does not establish causality or monitor changes in electrolyte levels before, during, and after exacerbations. Serum electrolyte levels can be influenced by diet, hydration status, and medications such as corticosteroids, β2-agonists, and diuretics. Although patients were grouped as chronic vs. acute asthma, individual variations in treatment regimens may have affected results. Other relevant parameters such as phosphate, chloride, bicarbonate, and arterial blood gases were not included, which could provide a more comprehensive picture of acid–base and electrolyte imbalance in asthma.

CONCLUSION

The present study demonstrated that significant electrolyte disturbances occur in patients with asthma, particularly during acute exacerbations. Patients experiencing acute attacks exhibited lower serum sodium, potassium, calcium, and magnesium levels compared to those with chronic stable asthma. Among these, hypokalemia and hypomagnesemia were strongly correlated with

impaired pulmonary function parameters (FVC, FEV1, and PEFR), suggesting a critical role of these electrolytes in disease severity and airway function. These findings highlight that electrolyte abnormalities are not merely secondary changes but may actively contribute to bronchial hyper responsiveness, reduced respiratory muscle performance, and overall worsening of lung function during exacerbations. Early recognition and timely correction of these disturbances, especially potassium and magnesium deficiencies, could serve as valuable adjuncts in the management of acute asthma. Further research is warranted to validate these findings in larger, more diverse populations and explore their implications for therapeutic interventions.

Conflicts of Interest: None

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