

Original Research Article

STUDY ON SERUM ELECTROLYTES, CHEST X RAY FINDINGS AND SEVERITY IN COPD PATIENTS AS PER GOLD CRITERIA

Dr. Amit Kumar Asati^{1*}, Dr. Basudev Agrawal², Dr. Leena Bhuarya³

^{1*}Assistant Professor, Dept. of Respiratory Medicine, Shri Shankara Institute of Medical Science, Bhilai, CG

²Dr. Basudev Agrawal, Consultant Radiologist, Shree Narayana Hospital, Raipur, CG

³Consultant Radiologist at Arogya Hospital Raipur, CG

***Corresponding Author:** Dr. Amit Kumar Asati

*Assistant Professor, Dept. of Respiratory Medicine, Shri Shankara Institute of Medical Science, Bhilai, CG

Abstract

Background: COPD is a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, sputum production, exacerbations) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent, often progressive airflow obstruction. Acute exacerbations of COPD (AECOPD) are important episodes in the natural history of the disease as they adversely affect health status, rate of hospitalization, and disease progression.

Materials and Methods: A total number of 160 patients were included in the study. This includes 80 patients of stable COPD and 80 patients of AECOPD of age group of 30 to 60 years. COPD diagnosis was based on history, clinical examination, chest x-ray findings and pulmonary function tests. 5 ml venous blood was drawn from patients; under aseptic precautions with a clot activator tube. Serum was separated by centrifugation and used for the following biochemical analysis. Serum Sodium, Serum Potassium, Serum Chloride, Serum Ionic Calcium were estimated using Electrolyte Analyzer and Serum Magnesium was estimated using automated biochemistry analyser. Two views of chest X-ray (PA and lateral) were performed in each patient. Statistical analysis was analyzed using Student's t-test and Chi-Square test for the correlation of serum electrolyte levels with the severity of disease.

Results: There were significant decrease in the levels of serum sodium, chloride, ionized calcium, and magnesium in acute exacerbation (AE) COPD patients as compared to stable COPD patients ($p < 0.001$). We did not find statistically significant difference in the levels of serum electrolytes with

the severity of the disease. Most common Chest Xray finding in COPD Patient was hyperinflated lungs with low flattened diaphragm.

Discussion and conclusion: The present study evaluated the levels of serum electrolytes, calcium and magnesium in Stable and AECOPD patients and they were further classified based on severity into mild, moderate, severe and very severe using GOLDs Criteria. Abnormal levels of electrolytes such as sodium, potassium, chloride, ionized calcium and magnesium have been linked to higher mortality rates in COPD patients. We found significantly decreased levels of sodium, chloride, magnesium and ionized calcium in AECOPD patients compared to stable COPD patients. Therefore, the present study suggested that serum electrolyte levels help in assess the severity of the disease and provide appropriate treatment. The limitation of the present study is that there may be a correlation between serum electrolyte levels and disease severity; it may not necessarily imply causality. Other factors may be contributing to both the electrolyte imbalance and the disease severity. It is recommended that there should be continuous monitoring of the electrolytes in stable as well as in acute exacerbation (AE) COPD patients and especially in the patients with comorbidities that increases the risk of electrolyte imbalances. Chest X-ray finding like hyperinflated lungs with flattened diaphragm can help support the diagnosis of COPD, but chest X-ray lacks sensitivity in mild COPD cases.

Keywords: chronic obstructive pulmonary disease, GOLD criteria, hyponatremia, hypocalcemia, hypomagnesemia, Chest X-ray.

MANUSCRIPT

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) in general terms pertains to the chronic outflow obstruction that develops due to various reasons, most commonly due to chronic tobacco smoking. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2023 has defined COPD as follows: “COPD is a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, sputum production, exacerbations) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent, often progressive airflow obstruction” [1]. Acute exacerbations of COPD (AECOPD) are important episodes in the natural history of the disease as they adversely affect health status, rate of hospitalization, and disease progression. Various metabolic disorders have been associated with patients of COPD, especially AECOPD. These disorders include hyponatremia, hypokalemia, hypocalcemia, hypomagnesemia, hypophosphatemia, elevated liver enzymes, and uric acid levels, and amongst them, hyponatremia and hypokalemia are the most commonly reported. While hyponatremia develops due to causes like chronic hypoxia, hypercapnia, heart failure, or syndrome of inappropriate antidiuretic hormone secretion (SIADH), hypokalemia primarily develops due to metabolic alkalosis or long-term beta-2 agonist and steroid use [2-4]. Although these are mostly correctible, they are usually overlooked, thus confusing the diagnosis and adding to overall morbidity and mortality. The target of assessment of COPD is to determine the airflow limitation level, its effect on the health of the patient, and risk of future procedures like hospital admissions, the patient’s death, or exacerbations,

to select the right therapy for management. The following things are considered in the assessment of COPD [5-8].

1. Severity of the abnormalities of the spirometry
2. Signs and symptoms of the patient
3. Proper history of patients of moderate and severe exacerbations
4. Comorbidities

Based on FEV1 post-bronchodilator, COPD is divided into four stages.

Table No 1: Shows the Classification of COPD stages based on severity [6].

GOLD Stage	Severity	Spirometry
I	Mild	FEV1/FVC <0.7 and FEV1 \geq 80% predicted
II	Moderate	FEV1/FVC <0.7 and FEV1 \geq 50% but <80% predicted
III	Severe	FEV1/FVC <0.7 and FEV1 \geq 30% but <50% predicted
IV	Very Severe	FEV1/FVC <0.7 and FEV1 <30% predicted

OBJECTIVES OF THE STUDY:

The objectives of our study include,

- a) To estimate and compare the serum electrolyte levels in stable COPD and acute exacerbation (AE) COPD patients.
- b) To correlate the serum electrolyte levels with the severity of COPD using GOLD criteria (2023).
- c) To identify the common chest X-ray findings in COPD patients.

METHODOLOGY

a. Source of Data and Study Design: It is a case control study, conducted in the Department of Respiratory Medicine in collaboration with radiology department of our tertiary care hospital (Shri Balaji Institute of Medical Science, Raipur, CG).

Cases: Patients with a diagnosis of AECOPD as defined by a case with a prior diagnosis of COPD who presents with an increase in respiratory symptoms (cough, expectoration, or breathlessness), who require a change in medications and/or hospital admission.

Controls: Patients with stable COPD defined as patients with a prior diagnosis of COPD who did not have any exacerbations in the last four weeks.

We included a total of 160 patients with stable (no=80) and AECOPD (n=80) who were previously diagnosed. The diagnosis of COPD was based on history, clinical examination, chest-X-ray findings and pulmonary function tests.

b. Inclusion Criteria:

- Clinically diagnosed stable and AECOPD patients.
- Age between 30 to 60 years (both male and female).
- Patients who are willing to participate in the study.

- c. Exclusion Criteria:** Patients with Diabetes Mellitus (DM), Hypertension, Cardiovascular Disease, Thyroid Dysfunction, Renal Disease (such as acute renal failure, chronic kidney disease), Pregnant and lactating women, Alcoholic were excluded from the study.
- d. Sample Collection:** 5 ml venous blood was drawn from patients; under aseptic precautions with a clot activator tube. Serum was separated by centrifugation and used for the following biochemical analysis. Serum Sodium, Serum Potassium, Serum Chloride, Serum Ionic Calcium were estimated using Unicorn Lyte 5 Analyzer and Serum Magnesium was estimated using Dimension EXL 200. Two views of chest X-ray (PA and lateral) were performed in each patient in both controls and cases.
- e. Statistical Analysis:** All the data was presented in number % percentage. Mean and Standard Deviation were used to determine the data. Student's t-test was used for the comparison of serum electrolyte levels in stable and acute exacerbation (AE) COPD patients. Chi-square test was used for the correlation of serum electrolyte levels in stable COPD patients. A p-value less than 0.05 were considered statistically significant.

RESULTS

A total number of 160 patients were included in the study. This includes 80 patients of stable COPD and 80 patients of AECOPD of age group of 30 to 65 years. The stable COPD group included 58 males and 22 females and in AECOPD group, 60 were males and 20 were females.

Table No 2: Shows Distribution of Variables in Stable and AECOPD Patients.

Variables	Stable COPD	AECOPD	P- Value
Age (years)	59.2 ± 5.68	61.23 ± 3.76	NS
Sodium (mmol/L)	143.14 ± 2.41	134.3 ± 4.86	HS
Potassium (mmol/L)	3.98 ± 0.47	4.3 ± 0.52	NS
Chloride (mmol/L)	106.62 ± 3.61	98.4 ± 5.77	HS
Ionized Calcium (mmol/L)	1.22 ± 0.17	0.69 ± 0.2	HS
Magnesium (mg/dL)	2.14 ± 0.27	1.64 ± 0.36	HS

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

It is evident from the table no 1 that there were decreased levels of sodium, chloride, ionized calcium and magnesium levels in AECOPD patients compared to stable COPD patients, which were statistically highly significant (p -value < 0.00001). There were no statistically significant differences in the levels of potassium between the two groups.

Table No 2: Shows Correlation of Serum Electrolyte Levels with the Severity of Disease.

Variables	Mild	Moderate	Severe	Very Severe	P Value
Hyponatremia	0	2	0	0	0.23116
Normal	3	33	30	8	
Hypernatremia	0	2	1	1	
Hypokalemia	1	1	1	1	

Normal	2	36	30	8	0.17545
Hyperkalemia	0	0	0	0	
Hypochloremia	0	2	1	0	0.55708
Normal	4	34	31	8	
Hyperchloremia	0	0	0	0	0.63616
Hypocalcemia	1	13	7	6	
Normal	4	21	22	6	0.55708
Hypercalcemia	0	1	0	0	
Hypomagnesemia	0	2	1	0	0.55708
Normal	4	30	31	12	
Hypermagnesemia	0	0	0	0	

#Not significant ($p > 0.05$)

It is evident from the table 2 that levels of serum electrolytes did not show statistically significant correlation with the severity of COPD as per GOLD criteria ($p > 0.05$).

Table no.3: Chest X-ray findings in COPD patients

Chest X-ray finding	No. of patients	Percentage
Hyperinflated lungs and low flattened diaphragm	104	65
Pruning of peripheral vasculature	32	20
Obtuse costophrenic angle	80	50
Tubular shaped heart	40	25
Increased retrosternal air space	77	48
Normal	32	20

As in table no.3, it was observed in current study that hyperinflated lungs with flattened diaphragm was the most common chest X-ray finding, present in 65% of patients. Obtuse costophrenic angle and increased retrosternal air space were common findings too (observed in 50% and 48% patients respectively). Less common findings were pruning of peripheral vasculature and tubular shaped heart. Even, normal chest X-ray was observed in 20% of patients.

DISCUSSION

In the present study, we included a total of 160 patients based on inclusion and exclusion criteria. These patients were divided into 80 stable COPD group and 80 AECOPD group. The mean age (years) in stable COPD and AECOPD patients was 54.2 ± 5.68 years and 56.23 ± 6.74 years respectively. The ratio of males was high as compared to females in stable COPD and AECOPD patients. Das P et al (2010) also showed the high ratio of males as compared to females in AECOPD (47: 17) and control group (15: 5) [9].

We evaluated serum levels of sodium, potassium, chloride and ionized calcium in both the groups. The normal reference ranges used for these parameters were serum sodium is 135 – 145 mmol/L, potassium is 3.5 – 5.3 mmol/L, Chloride is 97 – 110 mmol/L, Ionized Calcium is 1.1 – 1.32

mmol/L, and magnesium is 1.6 - 2.4 mg/dL respectively. We found statistically significant decreased levels of serum sodium, chloride, ionized calcium and magnesium in AECOPD patients as compared to stable COPD patients ($p < 0.001$). We found no statistically significant difference in the levels of serum potassium in AECOPD patients as compared to stable COPD patients ($p > 0.05$).

In concordance with our findings, Maklad SF et al (2019) find significantly abnormal levels of serum electrolyte (sodium, potassium, magnesium and chloride) levels in AECOPD patients as compared to healthy controls. During AECOPD, lungs experience increase in mucus production, tightening of passages of airway and inflammation is triggered by immunological defense system activation in the body. Hyponatremia is developed due to hypercapnia, hypoxia, renal insufficiency, respiratory acidosis, SIADH are some factors responsible for it. Hypomagnesemia cause muscle fatigue as it is involved in muscle tones maintenance and contraction of muscle. Hypochloremia is caused due to respiratory acidosis with metabolic alkalosis and chronic hypercapnia [10].

Rathore HK et al (2020) reported low serum levels of sodium, potassium, chloride, and magnesium in patients of AECOPD compared to stable COPD. Hypercapnia and Chronic hypoxia as a result of primary lung pathology, renal or cardiac failure, malnutrition, respiratory acidosis, use of steroids and bronchodilators, and SIADH may also contribute to hyponatremia in COPD patients. Patients with COPD are predisposed to electrolyte imbalance [11].

Sreekumar A et al (2021) also reported that low serum levels of magnesium had an association with COPD exacerbation [12]. It has been found that increasing hypoxemia during AECOPD causes intracellular magnesium ions to be depleted [13]. In this study, we also found no significant correlation between serum electrolyte levels and severity of disease in stable COPD patients.

In current study, hyperinflated lungs with flattened diaphragm was the most common chest X-ray finding. Obtuse costophrenic angle and increased retrosternal air space were common findings too. These findings are in concordance with the classic study by Thurlbeck and Simon [14].

CONCLUSION

The present study evaluated the levels of serum electrolytes, calcium and magnesium in Stable and AECOPD patients and they were further classified based on severity into mild, moderate, severe and very severe using GOLDs Criteria. Abnormal levels of electrolytes such as sodium, potassium, chloride, ionized calcium and magnesium have been linked to higher mortality rates in COPD patients. We found significantly decreased levels of sodium, chloride, magnesium and calcium in AECOPD patients compared to stable COPD patients. Hyperinflated lungs with flattened diaphragm was the most common chest X-ray finding. Obtuse costophrenic angle and increased retrosternal air space were common findings too in chest X-ray. However, chest X-ray lacks sensitivity and specificity in diagnosis of COPD. Therefore, the present study suggested that serum electrolyte levels help in assess the severity of the disease and provide appropriate treatment. The limitation of the present study is that there may be a correlation between serum electrolyte levels and disease severity; it may not necessarily imply causality. Other factors may be contributing to both the electrolyte imbalance and the disease severity. It is recommended that there should be continuous monitoring of the electrolytes in stable as well as in acute exacerbation (AE) COPD

patients and especially in the patients with comorbidities that increases the risk of electrolyte imbalances

REFERENCES

1. Definition and nomenclature of chronic obstructive pulmonary disease: time for its revision. Celli B, Fabbri L, Criner G, et al. *Am J Respir Crit Care Med.* 2022;206:1317–1325.
2. Hyponatremia and increased exchangeable sodium in chronic obstructive lung disease. Bauer FK, Telfer N, Herbst HH, Austin RC, Hetter B. <https://europepmc.org/article/med/5829378>. *Am J Med Sci.* 1965;250:245–253.
3. Effect of beta 2-adrenoceptor agonists on plasma potassium and cardiopulmonary responses on exercise in patients with chronic obstructive pulmonary disease. Yang CT, Lin HC, Lin MC, Wang CH, Lee CH, Kuo HP. *Eur J Clin Pharmacol.* 1996;49:341–345.
4. Mount BM. *Harrison's Principles of Internal Medicine.* New York, NY: McGraw Hill; 2021. Fluid and electrolyte disturbances.
5. Burge S, Wedzicha JA. COPD exacerbations: definitions and classifications. *Eur Respir J,* 2003; 21(41): 46s–53s.
6. Rabe KF, Hurd S, Anzueto A, Barnes PJ, Buist SA, Calverley P, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. *Am J Respir Crit Care Med.*, 2007; 176 (6): 532-555.
7. Sehatzadeh S. Influenza and pneumococcal vaccinations for patients with chronic obstructive pulmonary disease (COPD): an evidence-based review. *Ont Health Technol Assess Ser,* 2012; 12(3): 1-64.
8. Rashid M H U. Electrolyte Disturbances in Acute Exacerbation of COPD. *J Enam Med Col,* 2019; 9(1): 25-29.
9. Das P, Bandyopadhyay M, Baral K, Paul R, Banerjee AK. Dyselectrolytemia in Chronic Obstructive Pulmonary Diseases with acute exacerbation. *Nig. J. Physiol. Sci.,* 2010; 25(1): 25 – 27.
10. Maklad SF, Basiony FS. Electrolyte disturbances in patients with acute exacerbation of chronic obstructive pulmonary disease. *The Scientific Journal of Al-Azhar Medical Faculty,* 2019; 3(2): 427-431.
11. Rathore HK, Yogi JK, Fiza B, Sinha M, Choudhary M. Evaluation of Serum Electrolytes in Patients of Chronic Obstructive Pulmonary Disease. *Int J Med Res Prof,* 2020; 6(3) 78-81.

12. Sreekumar A, Velayudhan K. Role of serum magnesium in acute exacerbations of chronic obstructive pulmonary disease. *Int J Adv Med*; 2021; 8(4): 505-510.
13. Mohan A, Premanand R, Reddy LN, Rao MH, Sharma SK, Kamity R, Bollineni S. Clinical presentation and predictors of outcome in patients with severe acute exacerbation of chronic obstructive pulmonary disease requiring admission to intensive care unit. *BMC Pulmonary Medicine*, 2006; 6(1): 1-8.
14. Thurlbeck WM, Simon G. Radiographic appearance of the chest in emphysema. *AJR Am J Roentgenol*. 1978 Mar;130(3):429-40. doi: 10.2214/ajr.130.3.429. PMID: 415543.