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Evaluation of Cardiac Dysfunction in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease Using Routine Investigations and Cardiac Biomarkers

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Abstract

Background Chronic Obstructive Pulmonary Disease is a major cause of morbidity and mortality worldwide and is frequently associated with cardiovascular comorbidities such as ischemic heart disease, heart failure, arrhythmias, and hypertension. AECOPD (Acute Exacerbations of Chronic Obstructive Pulmonary Disease) may precipitate or unmask underlying cardiac dysfunction, which significantly influences prognosis and mortality. Early identification of cardiac involvement using routine investigations and cardiac biomarkers is therefore important for improving clinical outcomes. This study aimed to evaluate evidence of cardiac dysfunction in patients admitted with acute exacerbation of COPD using routine investigations and cardiac biomarkers, particularly N-terminal pro-B-type natriuretic peptide (NT-proBNP). ***Methods:*** This prospective observational study was conducted in the Department of Pulmonary, Critical Care and Sleep Medicine at Cosmopolitan Hospital, Trivandrum. A total of 200 patients admitted with acute exacerbation of COPD and no previous history of cardiac disease were included. Demographic details, clinical history, smoking status, and comorbidities were recorded. Routine investigations, including ECG, chest X-ray, arterial blood gas analysis, and cardiac biomarkers such as NT-proBNP, troponin, and CPK-MB, were performed. Patients with abnormal findings underwent echocardiographic evaluation. Statistical analysis was carried out using SPSS software, and the diagnostic performance of NT-proBNP was evaluated using ROC curve analysis. ***Results :***Among the 200 patients studied, 45.5% had elevated NT-proBNP levels and 49% showed echocardiographic abnormalities. ROC curve analysis demonstrated that NT-proBNP had significant diagnostic value for detecting cardiac dysfunction with a cut-off value of 1024 pg/ml (AUC = 0.851, sensitivity 81.63%, specificity 77.92%, $p < 0.0001$). Increased NT-proBNP levels were significantly associated with longer duration of hospitalization ($p = 0.03$), increased CCU stay ($p = 0.01$), greater requirement of respiratory support, and higher mortality. Out of the 200 patients, 192 (96%) recovered and were discharged, while 8 patients (4%) died during hospitalization. Higher NT-proBNP levels were significantly associated with mortality ($p < 0.0001$). ***Conclusion:*** Cardiac dysfunction is common in patients with acute exacerbation of COPD and is often subclinical. NT-proBNP is a useful and reliable biomarker for early detection of cardiac involvement in these patients. Elevated NT-proBNP levels are associated with increased hospital stays, greater need for respiratory support, and higher mortality. Early evaluation of cardiac dysfunction using biomarkers and routine investigations can improve patient management and clinical outcomes.

Keywords: COPD Exacerbation, Cardiac Dysfunction, NT-proBNP, Cardiac Biomarkers, Echocardiography, Respiratory Failure.

INTRODUCTION

Chronic obstructive pulmonary disease is a major global health problem and is one of the leading causes of morbidity and mortality worldwide. The disease is characterized by persistent respiratory symptoms and progressive airflow limitation resulting from airway and alveolar abnormalities caused by exposure to harmful particles or gases, most commonly cigarette smoke. The global burden of COPD continues to increase due to population ageing and continued exposure to risk factors such as tobacco smoke, environmental pollution, and occupational exposures.[1]

COPD frequently coexists with several systemic comorbidities, among which cardiovascular diseases are the most common and clinically significant. Cardiovascular conditions such as ischemic heart disease, heart failure, arrhythmias, and hypertension occur more frequently in COPD patients compared to the general population and significantly affect prognosis

and survival.[2] Studies have reported that the prevalence of chronic heart failure among COPD patients ranges from 10% to 46%, particularly in elderly individuals.[3] These comorbidities contribute substantially to hospital admissions, healthcare costs, and mortality in COPD patients.

Acute exacerbations of COPD represent episodes of worsening respiratory symptoms requiring additional therapy and often hospitalization. During these exacerbations, physiological stress, hypoxemia, systemic inflammation, and increased pulmonary artery pressure may precipitate cardiac dysfunction or unmask previously undiagnosed heart disease.[4] Differentiating cardiac dysfunction from respiratory deterioration in COPD exacerbations is clinically challenging because symptoms such as dyspnea and fatigue overlap between pulmonary and cardiac conditions.

Cardiac biomarkers have emerged as useful tools in identifying cardiac involvement during AECOPD. Among these, BNP (B-type Natriuretic Peptide) and its inactive fragment N-terminal pro-B-type natriuretic peptide (NT-proBNP) are released in response to ventricular wall stress and pressure overload.[5] Elevated NT-proBNP levels have been reported in patients with acute exacerbations of COPD and are associated with increased risk of cardiac dysfunction, longer hospital stays, and higher mortality.[6]

Early identification of cardiac dysfunction using routine investigations and cardiac biomarkers may help improve diagnosis, risk stratification, and management of patients with AECOPD. Therefore, this study aims to evaluate cardiac dysfunction in patients with acute exacerbation of COPD using routine investigations and cardiac biomarkers.

AIMS AND OBJECTIVES

The study aimed to evaluate patients presenting with acute exacerbation of COPD (Chronic Obstructive Pulmonary Disease) for the presence of cardiovascular disease using clinical evaluation, routine investigations, and cardiac biomarkers including NT-proBNP, and to institute appropriate therapy to improve treatment outcomes. The objectives were to detect overt or subclinical cardiac disease in admitted AECOPD patients and to assess treatment outcomes by analyzing duration of CCU stay, length of hospital stay, need for respiratory support (oxygen therapy, non-invasive ventilation or mechanical ventilation), complications during hospitalization, and final outcomes such as recovery with discharge or death.

MATERIALS AND METHODS

Study Design

This study was designed as a prospective observational study involving follow-up of patients admitted with acute exacerbation of COPD who had no prior history of cardiac disease. The study was conducted in the Department of Pulmonary, Critical Care and Sleep Medicine at Cosmopolitan Hospital Pvt Ltd, Pattom, Trivandrum. Patients presenting with acute exacerbation of COPD to the outpatient department or casualty, or those admitted to the hospital were recruited for the study. The study was carried out over the period from October 2014 to August 2016.

Inclusion and Exclusion Criteria

The study included all patients with COPD who were admitted with acute exacerbation or respiratory failure and had no prior history of cardiac disease, provided they gave informed consent to participate in the study. Patients who were admitted but died before proper investigation and assessment could be completed, as well as those who did not provide consent for participation, were excluded from the study.

Sample Size Calculation

Among COPD patients, the prevalence of CAD is 38.67%, hypertension is 53.3%, and arrhythmias are 12.67% (Cosmopolitan Hospital, Trivandrum, statistics). United States Veterans Administration (VA) hospital, the prevalence of CAD in COPD patients was **33.6%.**

35% prevalence was taken to calculate sample size.

Sample size calculation formula

$$n = \frac{4(100-p)}{D2}$$

D is the precision factor =10 – 20 % of p p is anticipated proportion of the event. Here p = 35%, D = 7 (taken 20% of p)

Hence, the sample size was 186, plus 10% extra to compensate for any fallouts.

A total of 200 acute exacerbations of COPD patients with no past history of cardiac illness were recruited for the study**.**

Data Collection Procedure

Eligible patients admitted with acute exacerbation of COPD and no prior history of cardiac disease were screened immediately after admission. Demographic details and clinical history, including smoking status, comorbidities, and current medications, were recorded using a structured proforma. Routine investigations such as SpO_2 measurement, chest X-ray, ECG, arterial blood gas analysis, and blood tests including haemoglobin, renal function tests, electrolytes, cardiac

biomarkers (NT-proBNP, troponin T/I, CPK-MB), and liver enzymes were performed. NT-proBNP was measured using enzyme-linked fluorescent assay (ELFA), while troponin and CPK-MB were analyzed using electrochemiluminescence immunoassay. Patients with abnormal ECG or biomarker findings underwent cardiology evaluation and echocardiography. Clinical progress during hospitalization, including the need for oxygen therapy, non-invasive ventilation, mechanical ventilation, duration of CCU and hospital stay, complications, and final outcomes (recovery or death), was recorded.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 21 and MedCalc software version 12.7.0.0. NT-proBNP was used as the primary biomarker to detect cardiac dysfunction, particularly cardiac failure. The diagnostic performance of NT-proBNP was evaluated using ROC (Receiver Operating Characteristic) curve analysis, and the AUC (Area under the Curve) along with corresponding p-values was calculated to determine statistical significance. Additional statistical analyses including independent t-test, ANOVA, and multiple regression analysis were performed to assess the relationship between NT-proBNP levels and other clinical variables. The study population was further categorized into three age groups, and age-specific cut-off values for NT-proBNP were derived. The optimal cut-off values were determined based on the Youden index to achieve the best sensitivity and specificity. Primary and final outcomes were also analyzed using the above statistical methods.

RESULTS

Table 1: Age Distribution of Patients with Acute Exacerbation of COPD

Age Group (in years)	Number of Patients	Percentage
<50	12	6%
50–59	38	19%
60–69	78	39%
70–79	56	28%
≥80	16	8%
Total	**200**	**100%**

Table 1 illustrates the age distribution of patients admitted with acute exacerbation of COPD. The majority of patients were in the 60–69 years age group, followed by the 70–79 years group, indicating that COPD exacerbations were more common among elderly individuals.

Table 2: Sex Distribution of Study Population

Gender	Number of Patients	Percentage
Male	96	48%
Female	104	52%
Total	**200**	**100%**

Table 2 shows the sex distribution among the study population. Females constituted a slightly higher proportion of patients admitted with acute exacerbation of COPD compared to males.

Table 3: Significant Smoking Exposure

Smoking Exposure	Number of Patients	Percentage
Active Smoking	82	41%
Passive Smoking	92	46%
No Smoke Exposure	26	13%
Total	**200**	**100%**

Table 3 shows the distribution of smoking exposure among patients. Most male patients were active smokers, whereas females commonly had passive smoke exposure, indicating smoking as an important risk factor in COPD.

Table 4: Major Symptoms in Acute Exacerbation of COPD

Symptom	Percentage
Dyspnea	92%
Cough	88%
Expectoration	72%
Fever	36%
Chest Pain	21%

Table 4 observes the clinical symptoms among patients admitted with acute exacerbation of COPD. Dyspnoea and cough were the most common presenting symptoms, followed by expectoration.

Table 5: Major Investigation Findings in Study Population

Investigation Finding	Percentage
T-wave abnormality (ECG)	21%
ST segment changes	11%
Hyperinflated lung field (X-ray)	35.5%
Lung opacities	35%
Respiratory acidosis (ABG)	48.5%
Respiratory acidosis with metabolic alkalosis	19.7%

Table 5 summarizes important investigation findings among the study population. The most common ECG change was T-wave abnormality, while hyperinflated lung fields and lung opacities were the most frequent chest X-ray findings. The most common ABG abnormality was respiratory acidosis**.**

Table 6: Echocardiographic Findings in AECOPD Patients

Echocardiographic Finding	Percentage
Echocardiogram positive	49%
Cor pulmonale with pulmonary hypertension	22.28%
Diastolic dysfunction	16%
Regional wall motion abnormality (RWMA)	14.2%

Table 6 illustrates the echocardiographic findings among patients with acute exacerbation of COPD. Nearly half of the patients showed echocardiographic abnormalitie**s,** with cor pulmonale and pulmonary arterial hypertension being the most common findings**.**

Table 7: ROC Analysis of NT-proBNP and Final Outcome

ROC Analysis		
Parameter	**Value**	
Cut-off value	**1024 pg/ml**	
Area Under Curve (AUC)	**0.851**	
Sensitivity	**81.63%**	
Specificity	**77.92%**	
P value	**<0.0001**	
Final Outcome		
Outcome	**Number**	**Percentage**
Recovered and discharged	192	96%
Death	8	4%
Total	**200**	**100%**

Table 7 shows the diagnostic performance of NT-proBNP in detecting cardiac dysfunction using ROC curve analysis. A cut-off value of 1024 pg/ml showed good sensitivity and specificity**.** The final outcome analysis revealed that 96% of patients recovered and were discharged**,** while 4% died during hospitalization**.**

DISCUSSION

Chronic obstructive pulmonary disease is a progressive respiratory disorder frequently associated with systemic comorbidities, particularly cardiovascular diseases. Acute exacerbation of COPD may precipitate or reveal underlying cardiac dysfunction due to hypoxemia, systemic inflammation, increased pulmonary vascular resistance, and right ventricular strain. The present study evaluated the presence of cardiovascular involvement in patients admitted with acute exacerbation of COPD using routine investigations and cardiac biomarkers.

In the present study, the majority of patients were in the 60–69 years age group (39%), followed by the 70–79 years group (28%), suggesting that COPD exacerbations occur predominantly in elderly individuals. Similar observations were reported by Mannino and Buist[7] who stated that the prevalence and severity of COPD increase with advancing age due to cumulative exposure to risk factors and progressive decline in lung function. Likewise, Høiseth et al.[6] also reported that most patients hospitalized with acute COPD exacerbations were older than 60 years.

In this study, female patients constituted 52% of cases, slightly higher than males (48%). This finding may be explained by exposure to passive smoking and indoor air pollution, particularly from biomass fuel combustion. Salvi and Barnes[8] reported that COPD among non-smoking women in developing countries is frequently associated with indoor air pollution from biomass fuel exposure.

Smoking exposure was identified as a major risk factor in this study. Active smoking was present in 41% of patients and passive smoking in 46%. Cigarette smoking remains the most significant etiological factor in COPD. According to the GOLD (Global Initiative for Chronic Obstructive Lung Disease report (1), tobacco smoking is the primary risk factor responsible for the development and progression of COPD worldwide.

Dyspnoea and cough were the most common presenting symptoms in the present study, occurring in 92% and 88% of patients respectively, followed by expectoration. These findings are consistent with the observations of Vestbo et al.,[9] who reported that dyspnoea, chronic cough, and sputum production are the most characteristic symptoms of COPD and are frequently exacerbated during acute episodes.

Electrocardiographic abnormalities were commonly observed in the present study. T-wave abnormalities were present in 21% and ST segment changes in 11% of patients. ECG abnormalities in COPD may indicate myocardial ischemia, right ventricular strain, or pulmonary hypertension. Similar findings were reported by Rutten et al.,[10] who emphasized that cardiovascular abnormalities are common but often underdiagnosed in patients with COPD.
Radiological evaluation in the present study showed hyperinflated lung fields in 35.5% of patients and lung opacities in 35% of patients. Hyperinflation is a typical radiological feature of COPD resulting from airflow obstruction and air trapping. Similar findings were described by Celli and MacNee[11] in their study on the diagnosis and management of COPD.

ABG (Arterial Blood Gas) analysis in the present study revealed respiratory acidosis in 48.5% of patients, indicating severe exacerbation associated with ventilatory failure. Soler-Cataluña et al.[12] also reported that severe exacerbations of COPD are frequently associated with respiratory acidosis and are associated with increased morbidity and mortality.

Echocardiographic abnormalities were observed in 49% of patients in the present study, with cor pulmonale and pulmonary hypertension being the most common findings (22.28%). COPD leads to chronic hypoxia and pulmonary vasoconstriction, eventually resulting in pulmonary hypertension and right ventricular dysfunction. Chaouat et al.,[13] reported a significant prevalence of pulmonary hypertension among patients with advanced COPD.

Cardiac biomarkers played an important role in detecting cardiac dysfunction in the present study. NT-proBNP levels were elevated in 45.5% of patients, and ROC curve analysis demonstrated good diagnostic accuracy with an AUC of 0.851, a sensitivity of 81.63%, and a specificity of 77.92% at a cut-off value of 1024 pg/ml. NT-proBNP is released in response to ventricular wall stress and is widely used for the diagnosis of heart failure. Similar findings were reported by Høiseth et al.,[6] who demonstrated that elevated NT-proBNP levels in COPD exacerbations were associated with increased mortality and prolonged hospital stays.

The present study also showed that patients with elevated NT-proBNP levels required longer CCU stays, prolonged hospitalization, and greater respiratory support, including non-invasive ventilation and mechanical ventilation. Similar results were reported by Chang et al. [14] who found that cardiac biomarkers such as NT-proBNP are significant predictors of poor outcomes in patients with acute exacerbation of COPD.

Regarding clinical outcomes, 192 patients (96%) recovered and were discharged, whereas 8 patients (4%) died during hospitalization. Elevated NT-proBNP levels were associated with higher mortality in the present study. Similar observations were reported by McCullough et al.[15] who demonstrated that elevated natriuretic peptide levels are associated with increased risk of cardiac dysfunction and mortality.

The findings of the present study indicate that cardiovascular dysfunction is common among patients with acute exacerbation of COPD and may often remain subclinical. Early evaluation using routine investigations such as ECG, echocardiography, and cardiac biomarkers like NT-proBNP can help in early detection of cardiac involvement and guide appropriate management, thereby improving patient outcomes.

Limitations

The Present study has certain limitations. NT-proBNP testing is not routinely available in all healthcare institutions, which may limit its widespread use in evaluating patients with acute exacerbation of COPD. Occasional testing in laboratories may also result in false positive or false negative reports, affecting diagnostic accuracy. Although the test showed good diagnostic value in this study, the sensitivity was 82% and specificity was 78%, indicating that a proportion of cases may be missed during screening and diagnosis. Therefore, further improvement in sensitivity and specificity is required for the test to be considered an ideal gold standard investigation. Additionally, early testing is likely to provide more accurate results; however, many patients present to the hospital after a few days of exacerbation and may have already received treatment elsewhere, which could influence the biomarker levels and affect the study findings.

CONCLUSION

In this study, 200 patients admitted with acute exacerbation of COPD and no prior history of cardiac disease were evaluated using routine investigations and cardiac biomarkers to detect underlying cardiac involvement. Among the various parameters assessed, NT-proBNP and echocardiography were found to be statistically significant in identifying cardiac dysfunction in these patients, whereas parameters such as SpO_2, chest X-ray, troponin T/I, CPK-MB, PCO_2, HCO_3^-, SGPT, and SGOT were not significantly associated with cardiac disease. Elevated NT-proBNP levels were also significantly associated with longer duration of CCU stay, increased hospital stay, and greater need for respiratory support. Furthermore, analysis of the final outcomes showed that higher NT-proBNP levels were associated with increased mortality. These findings suggest that NT-proBNP, along with echocardiography, is a valuable tool for early detection of cardiac dysfunction in patients with acute exacerbation of COPD and may help guide appropriate management and improve clinical outcomes.

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