B-type natriuretic peptide as a predictor of severity in admitted patients with acute exacerbation of COPD

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Background patients with acute AECOPD show an abrupt worsening of baseline ventricular function and pulmonary hypertension, using clear predictors or markers for severity in such patients is critical to be early stratified and properly managed.

Aim Assess the value of BNP as A predictor for severity in patients with AECOPD represented by need for intensive care admission, invasive and non-invasive mechanical ventilation, pulmonary hypertension, hospital and 3 months mortality.

Study design Prospective study

Methods A prospective Cohort study in tertiary level hospital conducted on 88 patients with AECOPD and 88 healthy control subjects, patients were divided into 2 subgroups: ICU admitted and ward admitted Patient were subjected to clinical, electrocardiographic, radiological and laboratory evaluation and observation of the clinical course during admission and 3 months following hospital discharge.

Results The study revealed higher BNP in AECOPD patients compared with healthy control subjects and in ICU admitted compared with ward patients (P, 0.001). positive correlation with age, smoking index, Paco2, SPAP, RVD, need for ICU , IMV, hospital stay and overall Mortality (r.coefficient: 0.398, 0.533, 0.605, 0.635, 0.732, -0.617, 0.577, 0.728 0.030, respectivly) ,we revealed negative correlation with ABGs parameters (Pao2, PH and o2 saturation), with r. coefficient of (-0.616, -0.609, -0.630, respectively), linear regression revelled that BNP is significant predictors for ICU admission , ROC curve revealed that BNP more than 425pg/ml had sensitivity , specificity of (70.8% and, 100%) to predict need for ICU admission.

Conclusion BNP may be considered as an accessible, useful, non-invasive and low-cost marker of severity COPD exacerbations.

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Keywords: BNP, COPD, exacerbation, ICU, mortality

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Introduction

Pulmonary hypertension (PH) and heart failure are common comorbidities in patients (of about 20–30%) with stable chronic obstructive pulmonary disease (COPD) [1]. Cardiac dysfunction may trigger exacerbation in up to 25% [2]. Although recognition of cardiac comorbidities is very important for the assessment of severity and prognosis. Similarities in symptoms and signs are a challenge [3]. Echocardiography is useful in confirming heart failure; however, it requires specialized training unavailable in primary care and thus may not be ideal in some settings [4].

B-type natriuretic peptide (BNP) is secreted from the myocardium [5], with a higher level in pulmonary arterial hypertension and hypoxemia presenting a strong correlation with the functional impairment and the hemodynamic sequels [6,7]. BNP is elevated in COPD without heart failure. It has been suggested that it may arise from both left and right heart, chronic hypoxemia, and secondary PH [8,9]; in COPD exacerbation the levels of BNP are greater than in stable patients and the explanation for their rising may be more multifactorial. Accordingly, BNP may accurately reflect and predict the severity of acute exacerbation of chronic obstructive pulmonary disease (AECOPD) [10].

Aim

The aims of the study were to estimate the significance of BNP during AECOPDs as an important marker of severity and as an indicator to suspect patients who will require more aggressive treatment, such as intensive care management, indications for mechanical ventilation (invasive or noninvasive), hospital admission period, and mortality.

Patients and methods

Ethics

The study was accepted by the local ethics committee and signed consent was obtained from all patients or their guardians.

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Patients

This study was conducted at the respiratory department and respiratory critical care unit in three referral medical centers, starting from July 2015 till June 2016. This study was conducted on 88 COPD patients admitted with acute exacerbation (16 women and 72 men), their ages range from 50 to 74 years, and on 88 healthy control participants (22 women and 66 men).The patients were divided into two groups: 40 (45.5%) patients with severe exacerbation admitted in the ward and 48 (54.5%) patients with life-threatening exacerbation admitted in the ICU, six (6.8%) patients died during hospitalization where four (4.5%) patients died within 3 months from the date of discharge.

Inclusion criteria

According to the guidelines of the Global Initiative for Obstructive Lung Diseases [11]

(1) Severe exacerbations: include two categories as follows.
   (a) Patients without acute respiratory failure: Respiratory rate 20–30/min, hypoxemia improved with venture mask 28–35%, with no hypercapnia.
   (b) Patients with acute respiratory failure but non-life threatening: respiratory rate more than 30/min; using accessory respiratory muscles; no mental changes; hypoxemia improved via Venturi mask 25–30% FiO_2; hypercarbia ($PaCO_2$ increased compared with baseline or elevated 50–60 mmHg).
(2) Life-threatening exacerbations: Respiratory rate more than 30/min; acute mental changes, using accessory respiratory muscles; hypoxemia not improved with oxygen via Venturi mask or requiring FiO_2 more than 40%; $PaCO_2$ elevated in comparison to baseline or higher than 60 mmHg or acidosis (pH<7.25).

Exclusion criteria

(1) Patients with mild and moderate exacerbations that did not necessitate hospital admission.
(2) Patients with other conditions that may affect the level of BNP or life-threatening diseases that affect the prognosis: thromboembolic disease, impaired renal function, patients with significant musculoskeletal disease, history of confirmed left-sided heart failure, myocardial infarction and cardiac arrest before admission, liver cirrhosis, malignancies, severe neurologic disorders, and immunodepression.
(3) Patients with interstitial lung fibrosis, active pulmonary tuberculosis, collagen vascular diseases, and pneumonia.

Study design and methods

A cross-sectional observation study in which the patients were evaluated on admission for:

(1) History and clinical examination, including demographic, clinical, and analytical data, comorbidities, weight, height, smoking condition.
(2) Exacerbation severity categorization, criteria for admission, indications for ICU admission based on 'Global Initiative for Chronic Obstructive Lung Disease [11].'
(3) Chest radiograph, echocardiography, ECG, and routine investigations: liver functions, kidney functions, serum electrolytes, blood glucose test, and CBC.
(4) Arterial blood gas for all patients where hydrogen concentration (pH), carbon dioxide pressure ($PaCO_2$), arterial oxygen pressure (PaO_2), and oxygen saturation (O_2) using a blood gas analyzer system.
(5) Measurement of serum BNP in all patients and control participants: peripheral blood samples were collected in EDTA tubes and calculated by the immunofluorescence assay using the instrument's manufacturer's reagents (Roche Diagnostics, Mannheim, Germany).

Data management and statistics

(1) Statistical package of the social sciences (SPSS version 20.0, IBM, Armonk, New York, United States of America) was used to analyze collected data.
(2) Patient characteristics were described by using means and SD for continuous variables and frequencies with percentages for categorical variables.
(3) Comparisons were assessed by *t*-test or *U*-test for the continuous variables and χ^2-test and Fisher's exact test for the categorical variables.
(4) The Pearson test and the Spearman's rank test were used to estimate the correlations between serum BNP and other variables.
(5) Univariate regression analysis model was used to detect the independent variables and confounding factors.
(6) Multiple stepwise linear regression was used to detect the significant predictors by using the statistically significant variables.

(7) The distribution of BNP in the different patient subgroup and control patients is described using the boxplot; a statistically significant level was considered if *P* is less than 0.05.
(8) The value of BNP as a predictive of severity of exacerbation was studied by assessing the receiver operating characteristic (ROC), sensitivity, specificity, positive, and negative predicted values.

Results

The study included 88 patients and 88 control patients. Table 1 demonstrates the characteristics and demographic data of patients and control patients showing a mean±SD age of 62.9±6.6 and 60.9±9.5 years, respectively, with no significant difference. There were 72 (81.8%) men and 16 (18.2%) women in the patients group compared with 66 (75%) men and 22 (25%) women in control patients with no significant difference. The smoking index was significantly greater in the patient group (52.5±13.7) compared with the control patients (41.0±12). Fifteen (31.2%) patients from the ICU patients received invasive mechanical ventilation (IMV) where 22 (45.8%) received noninvasive mechanical ventilation (NIMV). It was noticed that the serum BNP was higher in the patient than the control group: 204.0 and 61.0 pg/ml for the patients and the control, respectively.

Comparisons between the ICU-admitted and the ward-admitted subgroups are studied in Table 2. The age of the patients admitted in the ICU and the ward patients was 64.54±6.043 and 61.00±6.836 years, respectively, with no significant difference. The ICU patients were 38 (79.2%) male patients and 10 (20.8%) female patients while the ward patients were 34 (85%) patients and six (15%) female patients with no significant difference. Highly significant statistical difference was found in the smoking index: 60.29 ±12.313 and 43.20±8.532 for the ICU and the ward patients, respectively. Serum BNP was statistically

Table 1 Baseline characteristics of acute exacerbation of chronic obstructive pulmonary disease patients and control patients (*n*=176)

Variables	Patients (*n*=88)	Control (*n*=88)	*P* value
Age (years)	62.9±6.6	60.9±9.5	0.1
Sex			
Male	72 (81.8)	66 (75.0)	0.74[b]
Female	16 (18.2)	22 (25.0)	
Smoking index (pack-years)[a]	52.5±13.7	41.0±12.6	0.002**
BMI (kg/m^2)	24.1±4.1	24.8±4.98	0.80
BNP (pg/ml)	204.0	61.0	<0.0001**
*PaO_2 (mmHg)	50.95±5.5		
$PaCO_2$ (mmHg)	62.95±4.8		
PH	7.3±0.08		
O_2 saturation %	80.8±5.5		
SPAP (mmHg)	49.8±12.8		
RVD (cm)	3.28±0.84		
Length of hospital stay	8.5±2.8		
Management place			
ICU	48 (54.5)		
Ward	40 (45.5)		
IMV			
No	33 (68.8)		
Yes	15 (31.2)		
NIMV			
No	66 (75.0)		
Yes	22 (25.0)		
Hospital mortality			
No	82 (93.2)		
Yes	6 (6.8)		
Three months mortality			
No	84 (95.5)		
Yes	4 (4.5)		

Quantitative variables are presented as mean±SD or median, *n* (%). BNP, B-type natriuretic peptide; IMV, invasive mechanical ventilation; NIMV, noninvasive mechanical ventilation; O_2, oxygen; $PaCO_2$, partial pressure of carbon dioxide; PaO_2, partial pressure of arterial oxygen; PH, potential hydrogen; RVD, right ventricular diameter; SPAP, systolic pulmonary artery pressure. [a]Pack-years=daily cigarette pack number×years of smoking. [b]Fisher's exact Probability test was used to compare sexes. *P< 0.05 is significant. **P<0.01, highly significant, independent *t*-test or Mann–Whitney *U*-test was used to compare quantitative data according to the normality of data.

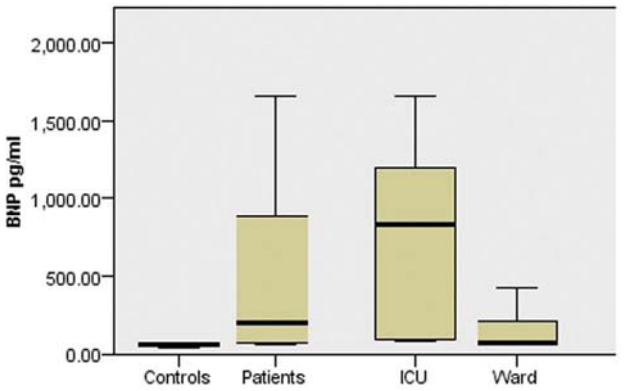
Table 2 Baseline characteristics of the patients admitted in the ICU and ward patients (*n*=88)

Variables	ICU (*n*=48)	Ward (*n*=40)	*P* value
Age (years)	64.54±6.043	61.00±6.836	0.25
Sex			
Male	38 (79.2)	34 (85.0)	0.71[b]
Female	10 (20.8)	6 (15.0)	
Smoking index (pack-years)[a]	60.29±12.313	43.20±8.532	<0.0001**
BMI	24.21±4.149	23.90±4.191	0.76
BNP (pg/ml)	835.0	67.5	<0.0001**
PaO_2	47.58±5.372	55.00±1.487	<0.0001**
$PaCO_2$	73.75±11.284	50.00±4.168	<0.0001**
PH	7.2379±0.05332	7.3775±0.03796	<0.0001**
O_2 saturation	77.13±4.911	85.15±1.725	<0.0001**
SPAP	58±9.217	38±5.94	<0.0001**
RVD	3.42±0.76	3.12±0.7	<0.0001**
Length of hospital stay	10.62±1.884	5.95±1.099	<0.0001**
IMV			
No	33 (68.8)	40 (100.0)	<0.0001**,[c]
Yes	15 (31.2)	0	
NIMV			
No	26 (54.2)	40 (100.0)	0.0005**,[c]
Yes	22 (45.8)	0	
Hospital mortality			
No	42 (87.5)	40 (100.0)	0.24b
Yes	6 (12.5)	0	
Three months mortality			
No	44 (91.7)	20 (100.0)	0.49b
Yes	4 (8.3)	0	

Quantitative variables are presented as mean±SD or median, *n* (%). BNP, B-type natriuretic peptide; IMV, invasive mechanical ventilation; NIMV, noninvasive mechanical ventilation; O_2, oxygen; $PaCO_2$, partial pressure of carbon dioxide; PaO_2, partial pressure of arterial oxygen; RVD, right ventricular diameter; SPAP, systolic pulmonary artery pressure. [a]Pack-years=daily cigarette pack number×years of smoking. [b]Fisher's exact probability test was used to compare sexes. [c]χ^2-Test. **P<0.01, highly significant, independent *t*-test or Mann–Whitney *U*-test was used to compare quantitative data according to the normality of data.

higher in ICU patients (835.0 pg/ml) compared with ward patients (67.5 pg/ml) *P* value less than 0.001. Table 2 shows high differences between the ICU and the ward subgroups regarding blood gas parameters: PaO_2, $PaCO_2$, pH, and SaO_2: 47.58±5.372 and 55.00 ±1.487, 73.75±11.284 and 50.00±4.168, 7.2379 ±0.05332, 7.3775±0.03796, and 77.13±4.911and 85.15±1.725, respectively. There are also highly significant differences between the ICU and the ward patient subgroups regarding systolic pulmonary artery pressure (SPAP) (mmHg) and right ventricular diameter (RVD) (cm): 58±9.217 and 38±5.94, 3.42 ±0.76 and 3.12±0.7, respectively (Table 2). The length of hospital stay, and indication for IMV and NIMV were seen higher significantly in the ICU group compared with the patient group (Table 2); there were no significant differences regarding hospital mortality and 3 months mortality between the ICU and the ward patients with a *P* value of 0.24 and 0.49, respectively. Figure 1 illustrates a boxplot showing a highly significant difference (P<0.0001) distribution of BNP (pg/ml) for all patients, controls, ICU patients, and ward patients

Figure 1



A boxplot distribution of BNP (pg/ml) in controls, all ICU-admitted patients and ward-admitted patients. **P=0.0001. BNP, B-type natriuretic peptide.

Table 3 shows the correlations between BNP levels and relevant variables in all patients; there was a strong association represented by highly significant positive correlation with age (r=0.398 with P=0.007) and smoking index (r=0.533 with P<0.0001). The table also showed a significant negative correlation with

Table 3 Correlations between B-type natriuretic peptide levels and the relevant variables in patients with acute exacerbation of chronic obstructive pulmonary disease

	Correlation coefficient (*r*)	*P* value
Age (years)	0.398	0.007**
Sex (male 1, female 2)	–0.104	0.501
Smoking index (pack-years)	0.533	<0.0001**
BMI	–0.055	0.724
PaO_2	–0.616	<0.0001**
$PaCO_2$	0.605	<0.0001**
PH	–0.609	<0.0001**
O_2 saturation	–0.630	<0.0001**
SPAP	0.635	<0.0001**
RVD	0.732	<0.0001**
Management place (ICU 1, ward 2)	–0.617	<0.0001**
IMV (yes 1, no 0)	0.557	<0.0001**
NIMV (yes 1, no 0)	0.122	0.428
Length of hospital stay	0.728	<0.0001**
Hospital mortality (yes 1, no 0)	0.251	0.101
Three months mortality (yes 1, no 0)	0.151	0.328
Overall mortality (yes 1, no 0)	0.30	0.049*

Pearson or Spearman ρ correlation coefficient tests were used according to the type of variables. BNP, B-type natriuretic peptide; IMV, invasive mechanical ventilation; NIMV, noninvasive mechanical ventilation; O_2, oxygen; $PaCO_2$, partial pressure of carbon dioxide; PaO_2, partial pressure of arterial oxygen; PH, potential hydrogen; RVD, right ventricular diameter; SPAP, systolic pulmonary artery pressure. *P< 0.05 is significant. **P<0.01, highly significant.

PaO2, PH, and O2 saturation (r=–0.616, –0.609 and 0.630, respectively) and a positive correlation with $PaCO_2$ with an r coefficient of 0.605. The study also showed a highly significant positive correlation with SPAP, RVD with an r. coefficient of 0.635 and 0.732, respectively with P value less than 0.0001. There was a strong association between BNP and management place, indication for IMV, the period of hospital admission and the overall mortality with an r coefficient of –0.617, 0.577, 0.728 0.030, respectively, with a P value of 0.0001. In contrast there was no significant correlation with sex, BMI, NIMV, hospital mortality, and 3 months mortality.

Predictors of ICU admission and mortality

Multivariate linear regression analysis (Table 4) revealed that PaO_2, $PaCO_2$, pH, management place, SPAP, IMV, NIMV, and length of hospital stay were significant predictors for hospital mortality but only low O_2 saturation and RVD were significant predictors for 3 months mortality. It also showed that sex, smoking index, BNP, pH, O_2 saturation, and length of hospital stay remained significant predictors for the need for ICU admission. Univariate analysis (Table 5) showed that smoking index, BNP, PaO_2, $PaCO_2$, pH, O_2 saturation, SPAP, RVD, and length of hospital stay were significant predictors for the need for ICU admission.

Table 4 Significant predictors of ICU admission, hospital, and 3 months mortality in acute exacerbation of chronic obstructive pulmonary disease patients using multivariate linear regression analysis model with backward elimination (*n*=88)

Variables	Unstandardized coefficients		Standardized coefficients	*t*	*P* value
	B	SE	β		
Predictors of hospital mortality					
PaO_2	–0.041	0.013	–0.878	–3.022	0.005**
$PaCO_2$	0.016	0.007	0.930	2.437	0.020*
PH	–3.014	1.067	–0.996	–2.825	0.007**
Management place	–1.028	0.277	–2.031	–3.710	0.001**
SPAP	0.017	0.006	0.679	2.639	0. 007**
IMV	–1.028	0.277	–1.861	–3.710	0.001**
NIMV	–0.445	0.144	–0.764	–3.082	0.004**
Length of hospital stay	0.076	0.027	0.842	2.851	0.007**
Predictors of 3 months mortality					
O_2 saturation	–0.015	0.005	–0.390	–2.747	0.009**
RVD	0.015	0.008	0.791	2.527	0.020*
Predictors of ICU admission					
Sex	0.145	0.065	0.112	2.235	0.032*
Smoking index	–0.010	0.003	–0.264	–2.806	0.008**
BNP (pg/ml)	0.001	0.000	0.617	5.076	<0.0001**
PH	–2.952	0.793	–0.494	–3.721	0.001**
O_2 saturation	–0.048	0.013	–0.525	–3.685	0.001**
SPAP	0.053	0.006	0.762	5.692	<0.0001**
RVD	0.061.	0.015	0.253	3.351	0.001**
Length of hospital stay	0.067	0.020	0.378	3.368	0.002**

BNP, B-type natriuretic peptide; O_2, oxygen; $PaCO_2$, partial pressure of carbon dioxide; PaO_2, partial pressure of arterial oxygen; RVD, right ventricular diameter; SPAP, systolic pulmonary artery pressure. *P<0.05, significant. **P<0.01, highly significant.

Sensitivity and specificity of B-type natriuretic peptide

Table 6 and Fig. 2 illustrate the ROC of the serum BNP to predict the indication for ICU admission showing the area lying under the ROC curve of 0.869 (95% confidence interval: 0.733–0.951), used to obtain the optimal cutoff point of BNP levels as a predictor for ICU admission (with a maximal specificity and sensitivity). In an optimal cutoff point of 425 pg/ml, the sensitivity was 70.8%, specificity was 100%, positive predictive value was 100%, and the negative predictive value was 74.1% ($P<0.0001$). The ROC of BNP levels for the prediction of the need for IMV (Table 6 and Fig. 2) showed also that the area lying under the ROC curve of 0.814 (95% confidence interval: 0.668–0.915), we noticed that the cutoff point of more than 780 pg/ml had a sensitivity of 69.2% and a specificity of 90.3%, with a positive predictive value of 75% and the negative predictive value was (87.5%) ($P=0.0001$). The role of BNP as a predictor for hospital and 3 months after discharge mortality is studied in Table 6, revealing that BNP with a cutoff point of 980 and 1545 pg/ml, respectively, had a sensitivity of 66.7 and 50%, respectively, and specificity of 87.8 and 87.6, respectively, *P* value: 0.148 and 0.552, respectively.

Table 5 Significant predictors of ICU admission in acute exacerbation of chronic obstructive pulmonary disease patients using univariate analysis (*n*=44)

Variables	F	*P* value
Smoking index	27.483	<0.0001**
BNP (pg/ml)	25.769	<0.0001**
PaO_2	35.707	<0.0001**
$PaCO_2$	79.314	<0.0001**
PH	96.226	<0.0001**
O_2 saturation	48.279	<0.0001**
SPAP	34.215	<0.0001**
RVD	92.354	<0.0001**
Length of hospital stay	95.758	<0.0001**

BNP, B-type natriuretic peptide; O_2, oxygen; $PaCO_2$, partial pressure of carbon dioxide; PaO_2, partial pressure of arterial oxygen; RVD, right ventricular diameter; SPAP, systolic pulmonary artery pressure. **$P<0.01$, highly significant.

Discussion

COPD is considered as a leading cause of mortality and morbidity with rising prevalence during the past years [12]. The development of PH in COPD develops when the airflow limitation is severe and is accompanied by chronic hypoxemia as a result of small pulmonary arterioles vasoconstriction and synthesis of endothelin from endothelial cells [13]. Pathogenesis for PH in COPD includes chronic hypoxia, emphysema, systemic and pulmonary inflammation, and capillaries destruction associated with hyperinflation [14,15]. COPD comorbidities include respiratory acidosis, ischemic heart disease, cardiomyopathy, and heart failure with cor pulmonale [16].

The result of this study showed that the serum BNP level is significantly elevated in admitted COPD patients in comparison to control patients (median: 204.0 vs. 61.0 pg/ml, $P<0.0001$). Moreover, patients admitted in the ICU had a higher BNP level compared with patients admitted in wards (median: 835.0 vs. 67.5 pg/ml, $P<0.0001$). Stolz *et al*. [9] studied COPD patients in exacerbation and after recovery and noticed that the level of BNP was greater during the exacerbation in comparison to the period following treatment, explaining the drop in BNP by the improvement of hypoxemia during recovery. It was observed that some COPD patients developed higher PH during acute respiratory failure of up to 20 mmHg above the baseline that improves after the treatment of the exacerbation [17]. The secretion of BNP is triggered by the following mechanisms: hypoxemia, PH, cor pulmonale, hyperinflation, left ventricular dysfunction, valvular dysfunction, and associated inflammation [18].

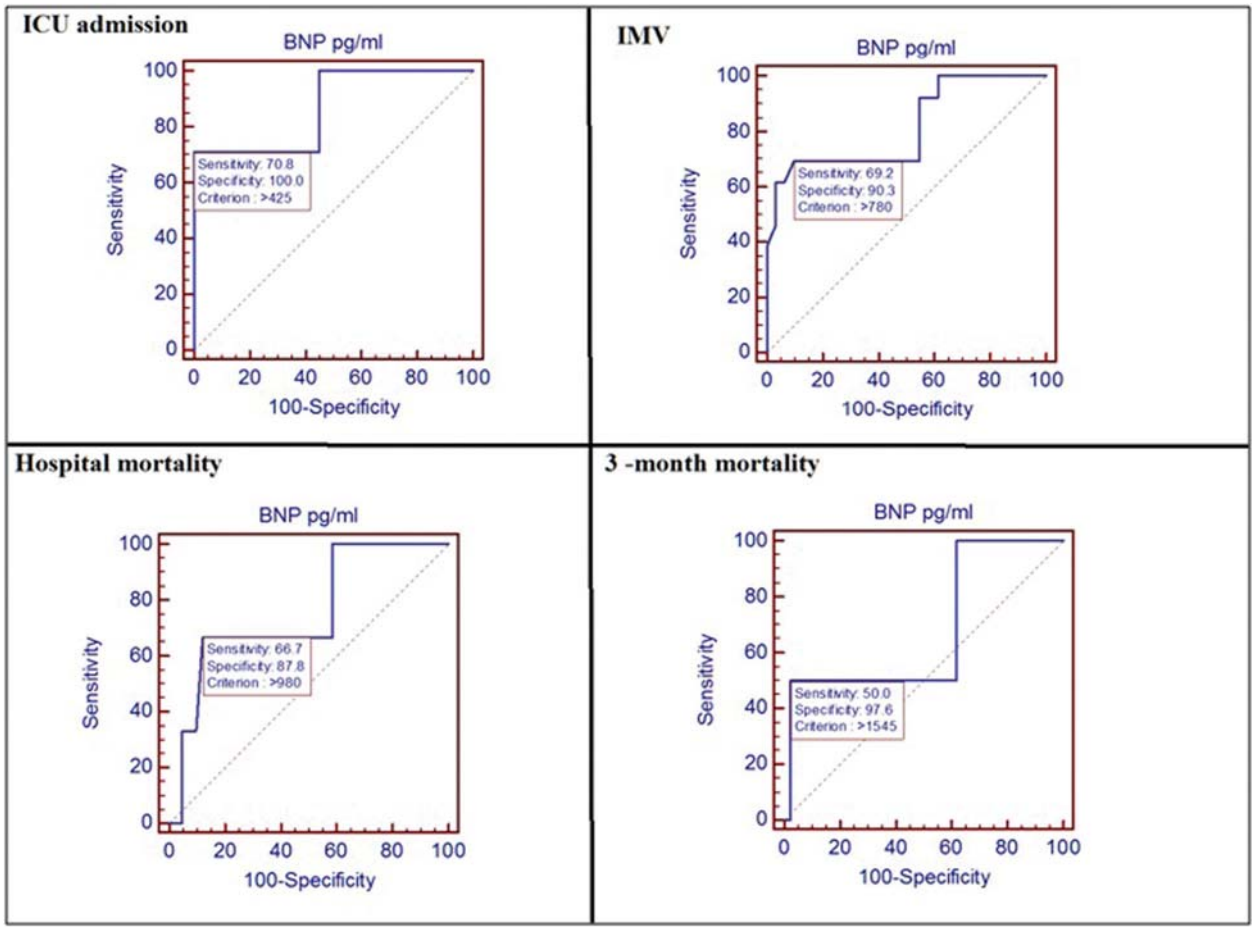
In this study, we demonstrated a significant correlation with blood gas parameters (PaO_2, $PaCO_2$, O_2 saturation) and echocardiographic data (SPAP and RVD), The results of our study are in agreement with the results of the Chi *et al*. [19] study

Table 6 Receiver operating characteristic curves result of B-type natriuretic peptide levels to predict ICU admission, invasive mechanical ventilation, hospital mortality, and 3 months mortality

	Cutoff point	AUC	Sensitivity	Specificity	PP value	NP value	95% CI	*P* value
ICU admission	>425	0.869	70.8	100	100	74.1	0.733–0.951	<0.0001**
IMV	>780	0.814	69.28	90.3	75	87.5	0.668–0.915	0.0001**
Hospital mortality	>980	0.752	66.7	87.8	28.6	97.3	0.599–0.870	0.148
3 months mortality	>1545	0.679	50.0	97.6	50	97.6	0.521–0.811	0.552

AUC, area under the curve; BNP, B-type natriuretic peptide; CI, confidence interval; ROC, receiver operating characteristic. **P< 0.01 is highly significant.

Figure 2



Receiver operating characteristics (ROC) result of BNP predict ICU admission, IMV, hospital mortality and 3 months mortality. BNP, B-type natriuretic peptide; IMV, invasive mechanical ventilation.

which assessed the COPD patients in different stages of and reported high significant correlation between BNP serum level and systolic PAP and $PaCO_2$. In contrast Stolz *et al.* [9] showed that there was not any significant correlation between the level of serum BNP and PaO_2, $PaCO_2$, or oxygen saturation, explaining that missing correlation by the absence of other triggering factors that increase BNP release. Mallwany *et al.* [20] found no significant association between NT-pro BNP level and both PaO_2 and $PaCO_2$ explaining their finding by oxygen supplementation during the time of admission. Same results were seen by another study by Bando *et al.* [21] attributing their results to oxygen supplementation as well. Lang *et al.* [22] found significant inverse correlation between BNP and the PaO_2 only.

Diagnosis of cor pulmonale and pulmonary artery hypertension in COPD patients is very important for prognosis assessment and the indication for long-term oxygen, as cardiac catheterization is an invasive technique and echocardiography is difficult because of tachypnea and hyperinflation; so our results support the use of BNP as an indicator for PH and right ventricle dilatation and accordingly for the prediction of bad prognosis.

We also revealed a close correlation between BNP and ICU admission. Linear regression analysis demonstrated that BNP is an independent strong predictor for ICU admission ($P<0.0001$). The ROC curve revealed that BNP more than 425 pg/ml had a sensitivity of 70.8% while the specificity is 100% for ICU admission with a positive predictive value of 100%, but the negative predictive value was70%. In our study, we found a strong correlation with the indication for IMV, hospitalization period, and overall mortality with no significant correlation with hospital mortality and 3 months mortality. The ROC curve showed that BNP more than 780 pg/ml had a sensitivity and specificity of 69.2 and 90.3%, respectively, to predict the indication for IMV while BNP more than 980 pg/ml had a sensitivity of 66.7%, while the specificity is 87.8%, as a predictor for hospital

mortality and BNP more than 1545 pg/ml had a sensitivity of 50% and the specificity is 87.6%, for 3 months after discharge mortality. Our study showed results similar to Stolz *et al*. [9] who failed to predict short-term and long-term mortality rates in AECOPD patients, while in contrast Hoiseth *et al*. [23], who found that BNP is considered significant and independent predictor of mortality in AECOPD, but we should consider that they did not exclude patients with a history of previous heart failure from their study.

The poor correlation and weak sensitivity between BNP and hospital mortality could be attributed cautiously to many factors including: low patient numbers, reduced statistical power, high-risk factors, IMV complications, hospital-acquired infections, and comorbidities in COPD as causes for death rather than cor pulmonale and severe PH while the poor correlation to the 3 months mortality may be attributed to the short period of follow-up.

Conclusion

BNP may be used as an available, valuable, low-cost, and noninvasive predictor for the severity grading of COPD exacerbations. BNP is higher in hospital-admitted patients with AECOPD and in patients admitted to the ICU, in patients that indicated IMV, length of hospitalization, BNP may be considered a significant predictor for ICU admission, indication for invasive mechanical ventilation, and long periods of hospitalization.

Limitations and weakness

The low number of studied patients and the short period for follow-up limited the accuracy of estimated results.

Recommendations

Large sample studies are needed to evaluate the value of BNP-guided management for AECOPD to improve prognosis, outcome, length of hospitalization, and mortality.

Acknowledgements

Naser K. Abdelnaby was responsible for the design and for conducting the research, collection of cases matching with the inclusion criteria, collection of results, sending results for statistical analysis, analysis of results, and writing the discussion. Hassan A. Shabana was responsible for the collection of cases matching with the inclusion criteria, collection of results, and analysis of results. Waleed R. Arafat was responsible for collecting cases matching with the inclusion criteria, collection of results, and analysis of results. This work studies the status of BNP during COPD exacerbations and whether it is affected by the severity of COPD itself or the current severity of COPD exacerbation. The work is conducted in the Chest Diseases Department Cairo University and Department of Chest Diseases, Faculty of Medicine, Beni Suef University.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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