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Chest X-ray: Is it still important in determining mortality in patients hospitalized due to chronic obstructive pulmonary diseases exacerbation in intensive care unit?

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Abstract:

OBJECTIVE: The present research aims to evaluate the effects of chest X-rays on mortality among patients who were hospitalized due to the exacerbation of chronic obstructive pulmonary disease (COPD) in intensive care unit (ICU) of a secondary care hospital.

MATERIALS AND METHODS: Sixty-three patients (39 males, 60.9%), who were hospitalized in ICU due to COPD exacerbation between December 1, 2011, and December 31, 2012, were retrospectively reviewed in this study. Data, including demographics, smoking history, arterial blood gas measurements, posterior-anterior lung radiography (PALR) findings and mortality, were collected from the medical records.

RESULTS: The mean age of the patients was 70.5 years (standard deviation [SD]: 13.3, range 44–88 years). Of all the cases, 42 (85.7%) had at least one comorbidity. The most common comorbidities were hypertension (34, 53.9%) and heart failure (19, 30.2%). Mean duration of hospital stay was 8 days (SD: 5.7, range: 2–26). Mechanical ventilation support was required in 17 (27%) cases. In total, seven female and four male patients died during hospitalization (17.7%). PALR indicated emphysema in 60.3%, infiltration in 54%, bronchiectasis in 31.7%, and unilateral or bilateral pleural effusion in 27% of the cases. Infiltration and pleural effusion in PALR were more common among the patients who died (died/alived 10/11 vs. 24/52, $P = 0.008$ and 6/11 vs. 11/52, $P = 0.026$, respectively). The multivariate model for mortality showed that only age (odds ratio 0.821, CI: 0.687–0.948, $P = 0.044$) was independently related to mortality.

CONCLUSION: As a basic imaging method, PALR still remains as an important diagnostic tool for COPD patients hospitalized in ICU, and it may contribute to the prediction of mortality.

Keywords:

Chest X-ray, Chronic obstructive pulmonary disease, exacerbation, intensive care unit, mortality, radiology

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Introduction

Chronic obstructive pulmonary disease (COPD) is a preventable and treatable condition characterized by progressive and partially reversible airway obstruction and a leading cause of morbidity and mortality.[1] The majority of patients die at an early age due to the disease itself or its complications.

COPD patients may require in-patient treatment in intensive care units (ICU), particularly during the exacerbation periods. There are several studies investigating

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mortality in this patient group. Mortality in COPD patients was previously associated with old age, arterial oxygen pressure levels, arterial carbon dioxide pressure levels, smoking, mechanical ventilation (MV) requirement, and comorbidities.[2,3]

A limited number of studies have investigated the effects of radiological findings, particularly those observed during exacerbation periods, on the prognosis of COPD patients, which remained underresearched. The available studies investigated the negative effects of the presence of emphysema on computed tomography (CT) of the thorax on prognosis.[4,5] In the present study, we aimed to investigate the impact of posterior-anterior lung radiography (PALR), as an inseparable part of pulmonology practice, on the mortality of COPD patients hospitalized in ICU.

Materials and Methods

This study was designed as a retrospective cohort study. The medical records of 115 patients hospitalized in the secondary ICU of State Hospital due to COPD exacerbation were retrospectively reviewed between December 2011 and December 2012. Patients with lung cancer, acute respiratory distress syndrome, kyphoscoliosis, acute pulmonary embolism, and acute coronary syndrome were excluded from the study. A total of 63 patients, whose medical records included a diagnosis of COPD based on the Global Initiative for Chronic Obstructive Lung Disease diagnostic criteria, were included in the study.[1] COPD exacerbation was defined as the presence of at least two of the following criteria: the presence of dyspnea increased sputum production and increased sputum purulence. Demographic data, complete blood count and biochemistry results, arterial blood gas measurements, radiological findings of the patients and patients who died in ICU were collected from the hospital's electronic record system and patient medical charts. PALR's of the patients obtained on the day of hospitalization were reviewed by two pulmonologists in a blinded manner.[6] Informed consent was not obtained from the patients due to the retrospective design of the study.

Data were analyzed using SPSS software IBM SPSS Statistics, version 20 (NY, USA). Between-group comparisons were performed using the Chi-squared test for categorical and *t*-test for continuous variables. Fisher's exact test was used when the expected value in 25% of the cells in the table was lower than 5 in the Chi-squared test. Regression analysis was performed to assess the relation between mortality and PALR. For statistical comparisons, values of $P < 0.05$ were considered statistically significant.

Results

Of a total of 63 patients included in this study, 39 (60.9%) were male and the mean age of the study group was 70.5 ± 13.3 (range 44–88) years. A history of smoking was reported in 51 (79.7%) patients with a mean history of smoking of 35.4 ± 12.7 pack-years. Of those, 24 patients (37.5%) were ex-smokers. At least, one comorbidity was present in 42 (85.7%) patients. The most common comorbidities, in line of frequency, were as follows: hypertension (53.9%), heart failure (30.2%), diabetes mellitus (15.9%), and gastroesophageal reflux (15.9%). Of all patients, 11 (17.2%) received long-term oxygen therapy and 5 (7.9%) received noninvasive MV therapy (NIMV) at home. The mean arterial blood gas measurements of the patients at the time of hospitalization in ICU are shown in Table 1.

The PALR of the patients taken on the day of hospitalization in ICU were reviewed. The findings of lung radiographs of two groups are shown in Table 1. In total, 38 (60.3%) patients had emphysema, 34 (54%) had infiltration, 17 (27%) had pleural effusion, and 20 (31.7%) had bronchiectasis [Table 1]. Some cases had tuberculosis sequel and cardiomegaly. When the PALR findings were compared between the alived and died groups, infiltration and pleural effusion were found to be more common in the died group ($P = 0.008$ and $P = 0.026$, respectively) [Table 1]. Other PALR findings were not significantly associated with the mortality [Table 1].

The mean duration of stay in ICU was 8 ± 5.7 days (range 2–26). In total, 51 (79.7%) patients received NIMV during hospitalization. In addition, 17 (26.6%) COPD patients required invasive MV. Of all patients included in this study, 11 (17.7%) died during ICU stay. The mean age of the alived patients was lower than the mean age of the patients who died (alived 68.6 ± 13.4 years and died 82.7 ± 6.4 years, $P = 0.003$). Moreover, duration of stay in ICU was significantly different between the alived and died groups (8.5 ± 1.9 and 22.9 ± 9.6, $P = 0.023$) [Table 1].

The multivariate model for mortality was performed including the variables of the age, gender, pH, PCO_2, PO_2, emphysema, infiltration, and pleural effusion. This model showed that only age (odds ratio 0.821, $P = 0.044$) was independently related to mortality [Table 2].

Discussion

This study revealed that infiltration and pleural effusion on PALR of COPD patients hospitalized in ICU due to COPD exacerbation were related to mortality. However, a similar relation was not observed with emphysema, bronchiectasis, cardiomegaly, or apical fibrotic lesions. In patients hospitalized with COPD exacerbations, the

Table 1: Demographic characteristics, blood gas measurements and posterior-anterior lung radiography findings of the all cases, alived and died groups

	All cases (*n*=63)	Alived (*n*=52)	Died (*n*=11)	*P*
Age	70.5 (13.3)	68.6 (13.4)	82.7 (6.4)	0.003
Female/male	24/39	18/34	6/5	>0.05
Smoking history				
Exsmoker	27 (42.8)	22 (43.1)	5 (45.6)	>0.05
Smoker	24 (38.1)	20 (38.6)	4 (36.4)	
Nonsmoker	12 (19.1)	10 (18.3)	2 (18.2)	
Comorbidities, *n* (%)	42 (85.7)	33 (73.3)	7 (77.8)	>0.05
Use of oxygen concentrator at home, *n* (%)	11 (17.2)	9 (17.3)	2 (18.2)	>0.05
Use of NIMV* at home, *n* (%)	5 (7.9)	4 (17.3)	1 (9.1)	>0.05
Duration of hospitalization, day	8.0 (5.7)	8.5 (1.9)	22.9 (9.6)	0.023
pH	7.36 (0.1)	7.36 (0.1)	7.33 (0.1)	>0.05
paO_2	84.1 (28.5)	82.4 (25.3)	92.6 (1.8)	>0.05
$PaCO_2$	50.5 (19.2)	50.4 (18.7)	50.8 (22.5)	>0.05
Emphysema	38 (60.3)	32 (61.5)	6 (54.5)	>0.05
Infiltration	34 (54)	24 (46.2)	10 (90.9)	0.008
Bronchiectasis	20 (31.7)	11 (21.6)	6 (54.5)	0.026
Pleural effusion	17 (27)	16 (30.7)	4 (36.4)	>0.05
Cardiomegaly	12 (19)	14 (26.9)	3 (27.3)	>0.05

*NIMV. Data were shown as *n* (%) or mean (SD). NIMV: Noninvasive mechanical ventilation therapy, pH: Power of hydrogen, PaO_2: Partial pressure of oxygen, mmHg, $PaCO_2$: Partial pressure of carbon dioxide, mmHg, SD: Standard deviation

Table 2: Predictive factors for mortality in hospitalized in intensive care unit for exacerbation of chronic obstructive pulmonary disease patients

Factors	OR (95% CI)	*P*
Age	0.821 (0.687-0.948)	0.044
Male gender	1.172 (0.349-3.927)	0.797
Emphysema	1.010 (0.964-1.058)	0.654
Infiltration	0.692 (0.201-2.382)	0.560
Pleural effusion	2.521 (0.842-7.549)	0.098
pH	2.372 (0.737-7.637)	0.148
pO_2	0.426 (0.768-2.309)	0.388
pCO_2	1.932 (0.433-8.627)	0.148

pH: Power of hydrogen, PaO_2: Partial pressure of oxygen, pCO_2: Partial pressure of carbon dioxide, OR: Odds ratio, CI: Confidence interval

radiological findings obtained during their stay at both ICU and pulmonology ward are highly important. On the other hand, transferring patients to radiology units for thoracic CT scans may pose a vital risk to clinically unstable patients. Bed-side imaging modalities, such as PALR, may guide the clinicians in terms of treatment approach. We, therefore, believe that the demonstration of the relation between PALR findings and prognosis is important.

Previous studies evaluated thoracic CT findings in COPD patients during the stable or exacerbation period of the disease. Several studies established a relation between emphysema and mortality. Cheng *et al*. investigated the thoracic CT images of 103 COPD cases. The presence of emphysema in COPD patients was associated with the poor prognosis during acute exacerbation periods. They reported a correlation between emphysema and the modified Medical Research Council and COPD Assessment Test scores of the patients recorded at 3-month follow-up.[4] In a study reported by Haruna *et al*. in 2010, thoracic CT images of 251 COPD patients were reviewed, and a relation was found between emphysema, age, pulmonary function tests, and mortality.[7] However, contrary findings were reported by some other studies. In a previous study we reported in the Turkish Thoracic Journal in 2013, we evaluated mortality among hospitalized COPD patients and did not establish emphysema as a risk factor for mortality in this patient group.[8] The present study also did not demonstrate a relation between emphysema and mortality, which may be explained by the use of different methods to diagnose emphysema. In the present study, we used direct radiographs as the most basic radiological assessment tool, whereas the previous studies investigated radiological findings in COPD were mostly based on thoracic CT images. We also believe that the small size of our patient population might have influenced our results, which is one of the limitations of this study. There are also some studies that reported a relation between parenchymal infiltration and morbidity in patients with acute COPD exacerbations.[9,10] Similarly, in the present study, the presence of infiltration as demonstrated by PALR of patients hospitalized in ICU with COPD exacerbation was associated with poor prognosis. The presence of infiltration in PALR primarily suggests an infection. The prolonged hospital stay in this patient group can be due to infiltration, in other words, infection. We also evaluated the infectious parameters and sputum culture findings of the patients included in this study, but we did not share the results as there was missing information.

We did not find any study in the relevant literature that demonstrated a relation between pleural effusion and mortality in COPD patients hospitalized in ICU due to an exacerbation. In the present study, pleural effusion was more common among the patients who died. However, unilateral or bilateral sidedness of the effusion did not significantly affect the mortality. An explanation for this may be because the patients' number was even lower when the cases were separated as those that had unilateral and bilateral fluid. Pleural effusion may occur in the presence of several diseases other than lung disease. In our study population, there was no relationship between pleural effusion and comorbidities.

In a study performed by Jairam *et al.*, 6,406 cases were followed-up for a mean duration of 4.4 years, and the risk of exacerbations that required hospitalization and death increased by 4.6- and 5.9-fold, respectively, in patients with emphysema.[11] However, a similar relationship was not found with serious bronchiectasis. In this study, the presence of bronchiectasis did not increase the risk of mortality.

The mean age of patients who were hospitalized in ICU due to COPD exacerbation and died during the follow-up period was higher than the mean age of survivors in this study. Duration of hospital stay was also longer among the patients who died. Several studies previously pointed out that old age as a risk factor for patients hospitalized with COPD exacerbations.[7,12,13] In addition to the higher mean age of patients who died, the previous studies that investigated mortality among COPD patients hospitalized in ICUs reported the prolonged duration of hospital stay in this patient group.[8,14]

Some studies reported that mortality increased with increasing number of comorbidities. While in the present study, comorbidities were not significantly different between the patients who died and the survivors. In addition, there are studies that demonstrated a relation of mortality with decreased pH and PaO_2 and increased PCO_2 in arterial blood gas measurements. Neither the comorbidities nor the ABG measurements were not associated with a significant difference in this study. This study was conducted in a secondary healthcare institution, whereas patients with multiple comorbidities and more severe cases may be referring to the ICUs of tertiary hospitals.

This study has some limitations. While PALRs of the patients were interpreted by two experienced pulmonologists, a radiologist was not consulted in this study. The number of included cases was limited. Nevertheless, we should highlight that this was the highest possible number of patients to be included, as there are limited beds in ICUs of secondary hospitals. Finally, cases with missing data were excluded from the analyses due to the retrospective nature of the study.

Conclusion

The presence of infiltration and pleural effusion in PALR of was associated with poor prognosis in COPD patients hospitalized in ICU due to a COPD exacerbation. Therefore, we believe that chest radiography remains as an important diagnostic tool for patients hospitalized in ICUs due to COPD exacerbation. We, therefore, intended to highlight the importance of chest radiography as one of the most fundamental radiological investigations we routinely use for the diagnosis and monitoring of patients in our daily practice.

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Conflicts of interest
There are no conflicts of interest.

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