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FACTORS ASSOCIATED WITH LENGTH OF HOSPITAL STAY IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE HOSPITALIZED FOR ACUTE EXACERBATION

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ABSTRACT

Objective: *To identify factors associated with length of hospital stay in patients with COPD hospitalized for acute exacerbation.*

Subjects and methods: *A prospective cohort study was conducted on 58 patients with COPD admitted for acute exacerbation. Clinical characteristics, comorbidities, symptom burden assessed by the COPD Assessment Test (CAT), and nutritional status were assessed at hospital admission. As LOS showed a right-skewed distribution, a generalized linear model with Gamma distribution and log link was applied; results were expressed as Mean Ratios (MRs).*

Results: *The median length of hospital stay was 9 days (7-11 days). The patients were predominantly elderly men; the proportions of patients classified as COPD group D, with CAT ≥ 10, with comorbidities, and with malnutrition according to SGA-B/C were 55.2%, 81.0%, 60.3%, and 50.0%, respectively. Length of stay was positively correlated with the number of comorbidities, mMRC score, and CAT score. In the final reduced Gamma regression model, absence of comorbidities (MR = 0.79; 95% CI: 0.65-0.95; p = 0.012), CAT < 10 (MR = 0.76; 95% CI: 0.61-0.94; p = 0.014), and higher serum albumin concentration (MR = 0.97 per 1 g/L increase; 95% CI: 0.94-0.99; p = 0.007) were independently associated with shorter hospital stay.*

Conclusions: *Length of hospital stay in patients with acute exacerbation of COPD was associated with symptom burden, comorbidities, and serum albumin concentration. Early assessment of symptoms and nutritional status is necessary for risk stratification and optimization of inpatient management.*

Keywords: COPD, acute exacerbation, length of hospital stay, CAT, albumin.

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1. INTRODUCTIONS

Chronic obstructive pulmonary disease (COPD) is one of the leading causes of health impairment and mortality worldwide, with a rapidly increasing socioeconomic burden in the context of population aging. Acute exacerbations of COPD often result in hospitalization and account for the largest proportion of total treatment costs [1]. Length of hospital stay (LOS) is considered an important indicator reflecting the severity of an acute exacerbation, the effectiveness of care, and short-term prognosis [2], [3].

Several studies have shown that LOS is influenced by multiple factors, including patient characteristics, degree of airflow obstruction, respiratory failure, comorbidities, and severity of the acute exacerbation [4]. Non-invasive ventilation, respiratory infection, and concomitant heart failure are also considered markers of severe exacerbation, requiring intensive treatment and leading to prolonged LOS in patients with COPD [5], [6]. In addition, among hospitalized patients, nutritional status plays an important role but is often overlooked in clinical practice [7]. Impaired nutritional status in hospitalized patients with COPD has been independently associated with prolonged LOS [8, 9]. Some studies in outpatients with COPD have also highlighted the high prevalence of malnutrition and the lack of inpatient data in Vietnam [10].

Although many prognostic factors for LOS in patients with COPD have been reported worldwide, evidence from Vietnam remains limited. Comorbidities, exacerbation severity, nutritional status, and the degree of respiratory failure among hospitalized patients with COPD in the context of hospital-based care and treatment in Vietnam may differ considerably from those in other countries. Therefore, describing and identifying

factors associated with length of hospital stay in Vietnamese patients with acute exacerbation of COPD is necessary to provide a scientific basis for optimizing treatment, risk stratification, and rational use of healthcare resources.

We conducted this study to evaluate factors associated with LOS in patients with COPD hospitalized for acute exacerbation.

2. SUBJECTS AND METHODS

2.1. Subjects

A total of 58 patients with a confirmed diagnosis of acute exacerbation of COPD were consecutively admitted for inpatient treatment at the Respiratory Medicine Center, Military Hospital 103, from September 2020 to May 2021.

- Inclusion criteria: Patients aged ≥ 40 years; with complete data on clinical characteristics, respiratory parameters, and nutritional status from admission to discharge to record LOS and related factors; and who agreed to participate in the study.

- Exclusion criteria: Patients with concomitant bronchial asthma, interstitial lung disease, active pulmonary tuberculosis or lung cancer, severe hepatic or renal failure, or a life-threatening emergency condition at admission.

2.2. Methods

- Study design: This was a prospective cohort study. Clinical characteristics, laboratory parameters, and nutritional status were assessed at hospital admission. Patients were followed throughout the course of treatment to evaluate clinical progression and determine discharge.

- Sample size: All patients who met the eligibility criteria were included in the study (n = 58).

- Criteria applied in the study:

+ Confirmed diagnosis of COPD, classification, and assessment of acute exacerbation of COPD were performed according to the 2020 Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, based on clinical symptoms and persistent airflow limitation defined as a post-bronchodilator FEV_1/FVC ratio < 0.70 [11].

+ COPD symptom burden was assessed using the COPD Assessment Test (CAT), an 8-item questionnaire with a total score ranging from 0 to 40, reflecting the severity of symptoms and the impact of COPD; a CAT score ≥ 10 was considered to indicate significant symptoms [11, 12]. Dyspnea severity was evaluated using the modified Medical Research Council (mMRC) dyspnea scale. The number of exacerbations in the year prior to admission was recorded through medical history taking and review of medical records. Pulmonary function parameters collected included FEV_1, FVC, and FEV_1/FVC, where FEV_1 is the forced expiratory volume in the first second, FVC is the forced vital capacity, and FEV_1/FVC is the ratio between these two parameters.

+ Nutritional status was assessed using BMI, classified according to Asian recommendations [13]; the Malnutrition Screening Tool (MST), a two-item screening tool identifying risk of malnutrition when the MST score is ≥ 2 [14]; and the Subjective Global Assessment (SGA), in which category A indicates normal nutritional status and categories B-C indicate malnutrition [15].

+ Length of hospital stay (LOS) was defined as the time interval, measured in days, from hospital admission to the time of discharge indication, when the patient's clinical condition had stabilized. Stability criteria included improvement and no progression of respiratory symptoms, no further need for acute respiratory intervention, stable blood oxygenation or no requirement for low-flow oxygen, and sufficient ability to perform basic self-care according to the hospital treatment protocol [11], [16].

- Ethical considerations: The study was approved by the Ethics Committee/Scientific Council of Vietnam Military Medical University (Decision No. 55-QĐ/HVQY dated January 7, 2021). Patients were fully informed about the study, voluntarily provided written informed consent, and had the right to withdraw from the study at any time. Data were coded, kept confidential, used only for scientific purposes, and did not disclose patient identity. The authors declare no conflicts of interest.

- Statistical analysis: Data were analyzed using SPSS version 26.0. The Shapiro–Wilk test showed that LOS data were non-normally distributed and right-skewed; therefore, analysis was performed using Gamma regression with a log link function, which is appropriate for positive, skewed data with heteroscedasticity [17]. Statistical significance was set at $\alpha = 0.05$.

3. RESULTS

Table 1. General characteristics of the study population

Characteristics (n = 58)	Value
Age, years	68.66 ± 8.75
Male (n, %)	56 (96.6)
Female (n, %)	2 (3.4)

Characteristics (n = 58)	Value
COPD group A (n, %)	3 (5.2)
COPD group B (n, %)	15 (25.9)
COPD group C (n, %)	8 (13.8)
COPD group D (n, %)	32 (55.2)
mMRC score	2.28 ± 0.91
mMRC ≥ 2 (n, %)	47 (81.0)
CAT score	15 [9.75-20.25
CAT ≥ 10 (n, %)	47 (81.0)
Presence of comorbidities, n (%)	35 (60.3)
Number of comorbidities	1 [0-1]
Number of COPD exacerbations/year	2 [1-3]
Number of COPD exacerbations requiring hospitalization	1 [0-2]
Respiratory rate, breaths/min	23 [22-25]
Post-bronchodilator FEV_1, % predicted	49.72 ± 21.13
Blood pH	7.40 [7.30-7.42]
$PaCO_2$ (mmHg)	41 [36-47]
Length of hospital stay, days	9 [7-11]
Values are presented as mean ± standard deviation, median [interquartile range], or n (%).	

Hospitalized patients with acute exacerbation of COPD had a mean age of 68.66 ± 8.75 years and were predominantly male (96.6%). Clinically, COPD group D accounted for 55.2% of patients. The mean mMRC score was 2.28 ± 0.91, with 81.0% of patients having an mMRC score ≥ 2. The median CAT score was 15 [9.75-20.25], with 81.0% of patients having a CAT score ≥ 10. Comorbidities were recorded in 60.3% of patients. The median number of exacerbations per year was 2 [1-3], and the median number of exacerbations requiring hospitalization was 1 [0-2]. Post-bronchodilator FEV_1 was 49.72 ± 21.13% predicted.

Table 2. Nutrition-related characteristics

Characteristics (n = 58)	Value
Height (m)	1.61 ± 0.05
Weight (kg)	51.38 ± 8.07
BMI (kg/m²)	19.74 ± 3.02
BMI < 18.5 kg/m² (n, %)	23 (39.7)
BMI 18.5-23 kg/m² (n, %)	25 (43.1)
BMI > 23 kg/m² (n, %)	10 (17.2)
MST score	0 [0-2]
MST ≥ 2 (n, %)	20 (34.5)
SGA-B/C (n, %)	29 (50.0)
Protein (g/L)	67.70 [64.37-72.53]
Albumin (g/L)	37.43 ± 4.95
CRP (mg/L)	9.12 [2.11-31.35]
Glucose (mmol/L)	6.45 [5.19-8.10]
Values are presented as mean ± standard deviation, median [interquartile range], or n (%).	

Patients had a low mean BMI of 19.74 ± 3.02 kg/m², of whom 39.7% were underweight (BMI < 18.5 kg/m²), while only 17.2% had BMI > 23 kg/m². The prevalence of malnutrition risk according to MST ≥ 2 was 34.5%, whereas malnutrition according to SGA-B/C was observed in 50.0% of patients. The mean serum albumin concentration was in the low-to-normal range at 37.43 ± 4.95 g/L.

Table 3. Spearman correlations between length of hospital stay and selected factors

Variables (n = 58)	r	p
Age, years	0.141	0.260
Male sex, 0/1	-0.130	0.297
Number of comorbidities	0.332	0.006
Number of COPD exacerbations in the year	-0.088	0.483
Number of COPD exacerbations requiring hospitalization	0.017	0.892
mMRC score	0.327	0.007
CAT score	0.285	0.020
White blood cell count (G/L)	0.175	0.193
Glucose (mmol/L)	0.033	0.793
Serum albumin (g/L)	-0.238	0.070
Serum protein (g/L)	-0.061	0.645
Serum CRP (mg/L)	0.106	0.400
Blood pH	0.072	0.577
$PaCO_2$ (mmHg)	-0.132	0.306
Post-bronchodilator $FEV_{1,}$ % predicted	0.125	0.350
BMI (kg/m²)	-0.020	0.872
MST score	0.066	0.597

Variables significantly correlated with LOS included the number of comorbidities (r = 0.332; p = 0.006), mMRC score (r = 0.327; p = 0.007), and CAT score (r = 0.285; p = 0.020). Serum albumin, CRP, serum protein, and $PaCO_2$ showed trends toward association but did not reach statistical significance. Variables not associated with LOS included age, sex, BMI, MST score, and FEV_1.

Table 4. Gamma regression model with log link between length of hospital stay and selected associated factors

Variables (n = 58)	B	MR = e^B	95% CI for MR	p
Model 1 (full model)				
Female sex (vs. male)	0.167	1.18	0.80-1.75	0.405
Absence of comorbidities (vs. presence)	-0.185	0.83	0.68-1.02	0.082
CAT < 10 (vs. ≥ 10)	-0.468	0.63	0.48-0.83	0.001
Number of exacerbations in the year (per 1 episode)	-0.022	0.98	0.88-1.09	0.700
Albumin (per 1 g/L)	-0.042	0.96	0.93-0.99	0.004
CRP (per 1 mg/L)	0.000	1.00	0.998-1.003	0.697
Arterial blood pH	0.122	1.13	0.08-16.75	0.929
$PaCO_2$ (per 1 mmHg)	-0.005	0.99	0.98-1.01	0.464
Post-bronchodilator FEV_1, % predicted (per 1%)	0.004	1.00	0.998-1.01	0.111
BMI (per 1 kg/m²)	-0.019	0.98	0.93-1.03	0.435
Model 2 (reduced model)				
Absence of comorbidities (vs. presence)	-0.242	0.79	0.65-0.95	0.012
CAT < 10 (vs. ≥ 10)	-0.279	0.76	0.61-0.94	0.014
Albumin (per 1 g/L)	-0.034	0.97	0.94-0.99	0.007
MR: mean ratio, indicating the ratio of mean length of hospital stay between groups; MR < 1 indicates a reduction in length of hospital stay, whereas MR > 1 indicates an increase in length of hospital stay				

In the full model, CAT < 10 and serum albumin concentration were significantly associated with length of hospital stay, whereas the remaining variables did not reach statistical significance. Comorbidity showed a trend toward association but did not reach the level of statistical significance. In the reduced model, three variables-absence of comorbidities, CAT < 10, and serum albumin-continued to show significant associations with length of hospital stay.

4. DISCUSSION

This study showed that length of hospital stay (LOS) among hospitalized patients with COPD was mainly associated with symptom burden at admission, as assessed by CAT, comorbidities, and serum albumin concentration. These factors reflect the systemic nature of COPD and have been recognized as prognostic indicators during acute exacerbations.

In the analyses, CAT < 10 was clearly associated with shorter hospital stay. This association was maintained in both the full and reduced models (Table 4). This finding is consistent with previous studies showing that symptom burden is a strong predictor of LOS in acute exacerbation of COPD, as CAT provides a more comprehensive reflection of the impact of the disease on daily activities and quality of life than individual symptom scales [3].

Comorbidities also showed an independent association with LOS in the reduced model, highlighting the role of comorbidity burden in prolonging inpatient treatment. This finding is consistent with previous reports indicating that comorbidities, particularly cardiovascular diseases and metabolic disorders, increase the risk of prolonged hospitalization in patients with acute exacerbation of COPD [6].

In addition, serum albumin was a consistently significant biological and nutritional marker, with lower concentrations associated with longer hospital stay. This is consistent with meta-analyses showing that low albumin is an adverse prognostic marker in patients with COPD, reflecting both malnutrition and systemic inflammation [9]. Conversely, pulmonary function parameters (%FEV_1), arterial blood gas indices, BMI, and CRP did not show independent associations with LOS in the multivariable model. This is in line with studies suggesting that systemic factors often have greater practical predictive value than respiratory parameters alone in the context of acute exacerbation [4, 8].

A strength of this study is the use of a Gamma regression model with a log link function, which was appropriate for the distribution of LOS, and the presentation of results as mean ratios, allowing for intuitive clinical interpretation. However, several limitations should be acknowledged, including the

small sample size, imbalanced sex distribution, simple coding of comorbidities as present or absent, and the fact that albumin is not a specific nutritional marker. In addition, this study did not adjust for treatment-related factors during hospitalization.

In summary, the findings emphasize the role of symptom burden, comorbidities, and biological-nutritional status in predicting length of hospital stay among hospitalized patients with COPD. These results reinforce the concept that COPD is a systemic disease requiring comprehensive assessment and intervention from the time of hospital admission.

5. CONCLUSIONS

This study of 58 patients with acute exacerbation of COPD treated as inpatients at the Respiratory Medicine Center, Military Hospital 103, showed that the median length of hospital stay was 9 days. The study population consisted mainly of elderly men, most of whom were classified as COPD group D, had high symptom burden according to mMRC and CAT, and showed relatively high proportions of comorbidities and malnutrition.

Length of hospital stay was positively correlated with the number of comorbidities, mMRC score, and CAT score. In the Gamma regression model with a log link function, the factors independently associated with length of hospital stay included comorbidities, CAT score, and serum albumin concentration. Patients without comorbidities, those with CAT < 10, and those with higher serum albumin levels had significantly shorter hospital stays.

These findings highlight the importance of early assessment of symptoms and nutritional status for risk stratification and optimization of inpatient management in patients with COPD.

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