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Direct hospitalisation cost of patients with chronic obstructive pulmonary disease, covered by the National Health Insurance at Vinh Phuc General Hospital from 2015 to 2019

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Abstract:

Chronic obstructive pulmonary disease (COPD) is a treatable disease with high prevalence and morbidity, associated with a significant economic burden. This study aimed to investigate the direct hospitalisation costs of patients with COPD covered by the National Health Insurance (NHI) in Vietnam. A retrospective study was conducted at Vinh Phuc General Hospital from 2015 to 2019, involving 1,629 patients. Sociodemographic features, clinical characteristics, and hospitalisation costs were collected. A multivariate generalised linear regression model was used to identify factors associated with hospitalisation costs. The mean total hospitalisation cost per patient was 430.74 USD (SD=618.39). Medication costs accounted for the highest proportion, followed by bed-day, procedures, function tests, imaging diagnosis, functional exploration, examination, and medical supplies. Antibiotics had the highest medication cost, at 99.37 USD (SD=126.24). The average number of hospitalisation days was 10.1, closely related to the direct cost. Age and comorbidities also affected hospitalisation costs.

Keywords: **chronic obstructive pulmonary disease, cost, hospitalisation cost, Vinh Phuc General Hospital.**

Classification numbers: **1.3, 3.2**

1. Introduction

Chronic obstructive pulmonary disease is a major cause of morbidity and mortality worldwide [1, 2]. COPD is the third leading cause of death globally, causing 3.23 million deaths in 2019 [3]. Most detailed information regarding its prevalence, morbidity, and mortality comes from high-income countries, yet 90% of COPD-related deaths occur in low- and middle-income countries [4]. In Vietnam, the prevalence of COPD was 7.1% in 2010, with 10.9% in men and 3.9% in women [5]. COPD imposes a significant burden on the healthcare system, not only due to mortality and disability but also due to substantial economic costs. In the United States, the estimated direct costs of COPD were $32.1 billion in 2010, expected to reach $49.0 billion by 2020 [6]. In China, the direct medical cost of COPD ranged from 72 to 3,565 USD per capita per year, accounting for 33.33 to 118.09% of the local average annual income [7]. In Vietnam, research at Bach Mai Hospital showed mean hospitalisation costs for COPD and acute exacerbations of COPD were 14.36 and 18.3 million VND, respectively [8]. However, most COPD patients are managed at grassroots hospitals, with limited research on its economic impact in Vietnam. This study aimed to (1) explore the demographic and clinical characteristics of the COPD patient population, (2) examine the direct cost of COPD hospitalisation, and (3) identify factors potentially associated with these costs.

2. Methods

2.1. Study design

A retrospective cross-sectional study was designed to estimate the hospitalisation cost of COPD treatment in a grassroots hospital. Medical records of patients with a code of J44 (ICD-10 version) admitted to Vinh Phuc General Hospital between 2015 and 2019 were reviewed. Data on medical costs for COPD were collected for five years following the primary diagnosis. Unit costs during the study period were provided by the hospital's financial department. The direct hospitalisation cost was analysed from the perspective of the healthcare system as the health insurance provider, including costs of medications and materials used in clinical practice for COPD patients covered by NHI. Direct non-medical costs (e.g. travel, accommodation, time) and indirect costs (e.g. lost income or premature death due to the disease) were not included.

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2.2. Subject population

Eligibility criteria included: (1) diagnosed with COPD (ICD-10 code J44), (2) treated at Vinh Phuc General Hospital, and (3) covered by NHI from 1st January 2015 to 31st December 2019.

2.3. Data collection

All hospital discharge papers involved in the analysis were extracted from the hospital management system database. Data collected included sociodemographic features (age, gender, living location), clinical characteristics (treated department, cause of hospitalisation, comorbidities, and duration of hospitalisation), and direct cost components (costs of bed-day, tests, imaging diagnosis, procedures, medication, equipment, and supplies).

2.4. Statical analysis

Data were analysed using R-base software version 4.0.2 and R Studio version 1.3.1073. Descriptive statistics (mean (SD), median (min, max) for numerical variables; and frequency, percent for categorical variables) were used to assess sociodemographic and clinical variables. Inferential statistics assessed differences between patients with and without comorbidities on these variables, including department, cause of hospitalisation, days of treatment, days of treatment for exacerbation, and direct cost with covariance of days of treatment. Chi-square tests were used for department and cause of hospitalisation variables; Wilcoxon tests for days of treatment and days of treatment for exacerbation; and a Gamma regression model with "days of treatment" covariance was selected for the direct hospitalisation cost variable, with results reported with 95% CI.

Direct hospitalisation cost was separated into three phases according to Circular No. 37/TT-BYT (phase 1: before 1/3/2016; phase 2: from 1/3/2016 to 1/7/2016; and phase 3: after 1/7/2016). The Kruskal-Wallis test and the Wilcoxon test (post hoc, using the Bonferroni method to adjust p-values) examined differences in direct hospitalisation cost between the three phases. Statistical significance was set at 0.05.

A multivariate generalised linear regression model, with Gaussian family and log-link function, identified factors associated with the COPD hospitalisation cost. Based on the purpose of selecting a model to find factors related to the direct cost of treatment and while transforming the "direct treatment costs" variable to log "direct treatment costs," the graph shape of the log variable followed a Gaussian distribution. Therefore, the generalised linear model with the log association function for the output variable following a Gaussian distribution was applied and validated using the normality test of residuals method and statistical significance was acknowledged based on the exponential of coefficients and its 95% CI.

2.5. Ethical approval

The study protocol was reviewed and approved by the Science Committee of Vinh Phuc General Hospital.

3. Results

3.1. Sociodemographic characteristics

A total of 1,629 patients were diagnosed with COPD from 2015 to 2019 at the hospital. The mean age was 71.4 years (SD=11.1), with most patients aged over 40. The majority were male (78.1%) and lived in rural areas (77.3%). More than half of the patients had comorbidities (59.6%, N=971), with hypertension being the most common (44.2%), followed by pneumonia (31.7%), heart failure (18.6%), diabetes (13.3%), and coronary artery disease (4.1%) (Table 1).

Table 1. Demographic and clinical characteristics (N=1,629).

Characteristics	N
Age	
<40 years old	3
≥40 years old	1626
Gender	
Male	1,272 (78.1%)
Female	357 (21.9%)
Place of residence	
Rural	1260 (77.3%)
Urban	369 (22.7%)
Days of treatment	
Mean (SD)	9.57 (5.39)
Median [min; max]	9.00 [0.7; 50.0]
Comorbidity	
No comorbidity	658 (40.4%)
Have 1 comorbidity	638 (39.1%)
Have 2 comorbidities	247 (15.2%)
Have ≥3 comorbidities	86 (5.3%)
Comorbidities (n=971)	
Hypertension	429 (44.2%)
Pneumonia	308 (31.7%)
Heart failure	181 (18.6%)
Diabetes	129 (13.3%)
Coronary artery disease	40 (4.1%)

The majority of patients were treated in the internal medicine department (87.4%), with exacerbation being the primary cause of hospitalisation (90.9%). The average duration of treatment was 9.57 days (SD=5.39). The average number of exacerbations per patient with and without comorbidities was 1.47 and 1.41, respectively. The average number of ICU admissions per patient with and without comorbidities was 1.08 and 1.07, respectively (Table 2).

Table 2. Clinical characteristics of the research sample.

	With comorbidity (N=971)	Without comorbidity (N=658)	Absolute difference 95%CI
Department			
ICU	12.6%	13.7%	-1.1% -5.1-2.8%
Internal	87.4%	86.3%	
Cause of hospitalisation			
Exacerbation	90.9%	94.5%	-3.6% -6.6-(-0.6)%
Others	9.1%	5.5%	
Days of treatment			
Mean (SD)	10.1(5.51)	8.84(5.14)	1.00 1.00-2.00
Median [min; max]	9.00 [0.747; 50.0]	8.00 [0.990; 41.0]	
Days of exacerbation treatment			
Mean (SD)	10.1(5.54)	8.76(5.08)	1.00 1.00-2.00
Median [min; max]	9.00 [1.00; 50.0]	8.00 [0.990; 41.0]	

3.2. Average hospitalisation cost

The mean total cost for patients with COPD is illustrated in Table 3. The total cost was 430.74 USD (SD=618.39). The mean cost for patients with comorbidities (494.71 USD (SD=742.07)) was higher than for those without comorbidities (342.46 USD (SD=349.71)). The average duration of treatment for these two groups was 10.10 days and 8.84 days, respectively. After accounting for the effect of the "days of treatment" variable, the mean cost for the group without comorbidities was 0.847 times that of the group with comorbidities, a statistically significant difference (95% CI: 0.796-0.905). The mean cost of an ICU admission was 1138.69 USD (SD=1394.58), higher than the average cost for exacerbation treatment at 435.01 USD (SD=622.65). The mean costs for patients with 1, 2, and more than 3 comorbidities were 426.48, 558.68, and 780.45 USD, respectively. The highest average cost of treatment among patients with comorbidities was for pneumonia, at 699.42 USD per treatment, followed by diabetes, hypertension, heart failure, and coronary artery disease with averages of 580.01, 498.98, 481.92, and 398.33 USD, respectively.

Table 3. Direct cost of chronic obstructive pulmonary disease treatment.

Unit: USD*

	Mean	SD	Median	Min	Max
Mean total of patient					
Population (N=1629)	430.74	618.39	285.31	11.73	9254.53
With comorbidity (N=971)	494.71	742.07	310.47	22.90	9254.53
Without comorbidity (N=658)	342.46	349.71	252.47	11.73	3441.66
Ratio between 2 groups: with and without comorbidity				0.847 with 95%CI 0.796-0.905	
Mean cost per ICU admission					
Population (N=212)	1138.69	1394.58	720.74	26.19	9254.53
With comorbidity (N=122)	1484.14	1641.93	1074.72	26.19	9254.53
Without comorbidity (N=90)	665.30	754.86	303.65	30.32	3441.66
Mean cost per exacerbation treatment					
Population (N=1505)	435.01	622.65	290.00	11.73	9254.53
With comorbidity (N=883)	503.24	754.86	315.17	22.90	9254.53
Without comorbidity (N=622)	341.18	343.31	259.72	11.73	3441.66
Cost for group of patient with comorbidity					
1 comorbidity (N=638)	426.48	533.09	305.36	22.90	5288.30
2 comorbidities (N=247)	558.68	908.39	307.49	43.07	9254.53
More than 3 comorbidities (N=86)	780.45	1300.75	385.53	81.88	8273.63
Hypertension (N=429)	498.98	784.72	302.80	23.16	8273.63
Pneumonia (N=308)	699.42	1108.84	361.23	26.87	9254.53
Heart failure (N=181)	481.92	742.07	308.34	43.07	7676.57
Diabetes (N=129)	580.01	908.39	321.14	75.91	7676.57
Coronary artery disease (N=40)	398.33	631.18	263.99	61.84	4200.79

*The currency used was the US dollar (US dollar exchange rate on January 2020; 1 USD=23,193 VND.

3.3. Cost categories

In general, the percentages of bed-day cost, procedures, imaging diagnosis, and functional tests all increased from phase 1 to phase 3. The differences in direct cost between phase 1 vs phase 2 and phase 1 vs phase 3 were statistically significant ($p<0.05$). Medication costs accounted for the highest proportion of hospitalisation costs (over 50%) in all phases. The highest rate of medication cost was for antibiotics, with a mean of 99.37 USD (SD=126.24). Equipment and supplies costs had the lowest percentage, at less than 1% (Table 4, Fig. 1).

Table 4. Medication cost categories.

Unit: USD.

	Average medication cost				
	Mean	*SD*	*Median*	*Min*	*Max*
Patients hospitalised due to exacerbation					
Bronchodilators	17.95	22.94	11.86	0	344.17
Antibiotic	99.37	126.24	63.12	0	1313.55
Corticosteroid	23.16	15.05	21.66	0	102.78
Other drugs	37.66	66.96	20.21	0	955.31
Patients hospitalised due to other causes					
Bronchodilators	13.73	20.26	3.75	0	73.78
Antibiotic	107.47	207.27	49.04	0	1223.99
Corticosteroid	21.11	16.42	18.21	0	81.03
Other drugs	55.02	102.35	22.90	0	528.83
Total population					
Bronchodilators	17.70	22.82	11.43	0	344.17
Antibiotic	99.80	131.78	62.69	0	1313.55
Corticosteroid	23.07	15.14	21.45	0	102.78
Other drugs	38.60	69.52	20.26	0	955.31

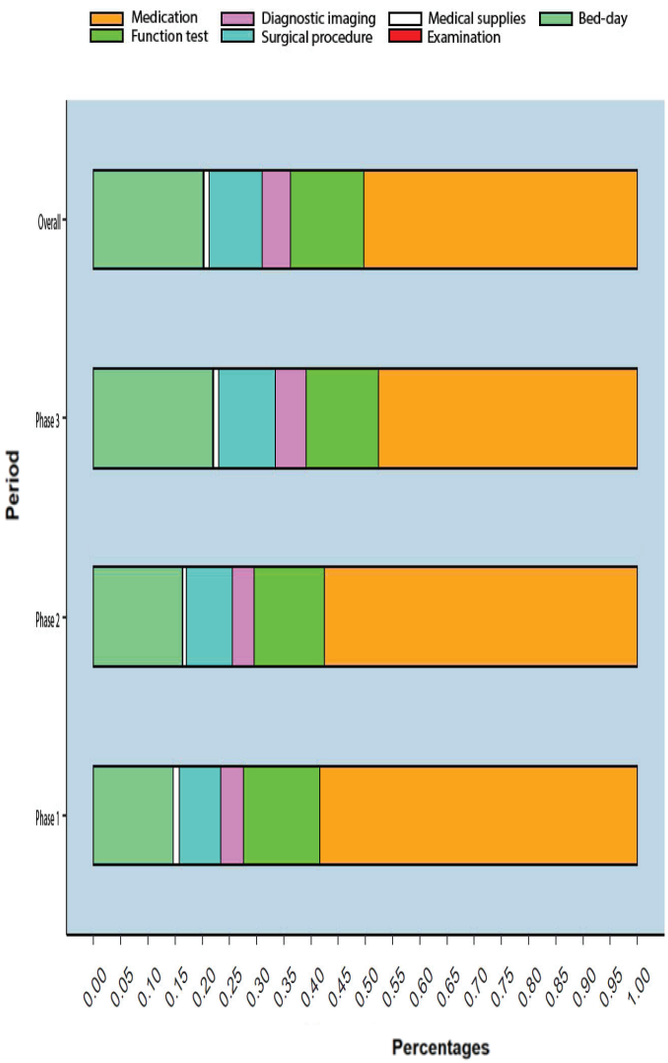

Fig. 1. Distribution of cost components according to phases.

3.4. Associated factors with chronic obstructive pulmonary disease hospitalisation cost

In the multivariate regression model (Table 5), female patients had a mean hospitalisation cost 0.823 times that of male patients (95% CI: 0.766-0.884). Urban patients had hospitalisation costs 0.845 times that of rural patients (95% CI: 0.797-0.897). Patients treated in the internal medicine department had treatment costs 0.400 times that of patients admitted to ICU (95% CI: 0.377-0.425). Patients without comorbidity had an average cost 0.840 times that of patients with coexisting conditions (95% CI: 0.778-0.996). With each year's increase in age, the mean cost increased by 1.001 times (95% CI: 0.998-1.003), and with each additional day of treatment, the average cost of treatment increased by 1.061 times (95% CI: 1.059-1.063).

Approximately 95% CI of the variables "gender", "place of residence", "department classification", "days of treatment", and "comorbidity" did not contain value 1, indicating these variables correlate with the total cost of treatment. There was no correlation between the variables "age", "cause of hospitalisation" and total cost of treatment.

Table 5. Results from multivariate regression analysis.

Independent variables	Exp (regression coefficient)	95%CI
Gender (Female vs male)	0.823	0.766-0.884
Place of residence (Urban vs rural)	0.845	0.797-0.897
Age	1.001	0.998-1.003
Cause of hospitalisation (Others vs exacerbation)	1.071	0.979-1.172
Department classification (Internal vs ICU)	0.400	0.377-0.425
Days of treatment	1.061	1.059-1.063
Comorbidity (without vs with)	0.840	0.778-0.906
Diabetes	0.801	0.747-0.858
Hypertension	0.783	0.743-0.825
Heart failure	0.999	0.930-1.074
Coronary artery disease	0.890	0.772-1.026
Pneumonia	0.721	0.680-0.764

4. Discussion

The study was conducted at Vinh Phuc General Hospital from 2015 to 2019. The results showed that the mean age of patients covered by NHI was 71.4 (SD=11.1), with most patients over 40 years old (99.8%). This result was consistent with previous studies conducted at Dong Nai and Bach Mai Hospitals in Vietnam [8, 9]. COPD is thus a chronic and progressive disease with symptoms commonly expressed in those aged over 40.

Our study indicated a higher prevalence of male patients (78.1%) compared to females, consistent with prior research. L. Ekerljung, et al. (2014)'s study [5] in northern Vietnam showed that among individuals aged >50 years, 23.5% of men and 6.8% of women had COPD [5]. According to T.Q. Vo, et al. (2018) [9], COPD prevalence is higher among males, with samples predominantly male (86.0-92.2%). This aligns with the fact that smoking, a major COPD risk factor, is more prevalent among men in Vietnam. Although gender is not a direct factor of disease, which is instead related to smoking habits, the distribution of the disease is indirectly affected by gender.

Most COPD patients had at least one comorbidity (59.6%). Hypertension was the most common (26.3%), followed by pneumonia (18.9%), heart failure (11.1%), diabetes (7.9%), and coronary artery disease (2.5%). Similar findings were reported in studies at Bach Mai Hospital with the rates of hypertension, diabetes mellitus, congestive heart failure, coronary artery diseases, cor pulmonale, and gastroesophageal reflux disease (GERD) being 19.3, 12.3, 15.8, 5.3, 22.8, and 7.0%, respectively [8]. These results correspond to reality, as COPD patients are of advanced age which is associated with these comorbidities due to impaired functioning, especially in cardiovascular and metabolisms.

The mean duration of treatment was 9.57 days (SD=5.39), higher for patients with comorbidities. This aligns with a study at E Hospital, showing a mean duration of 10.77 days [10]. COPD patients had longer treatment durations compared to the overall hospital average of 6 days. The average number of exacerbations per patient was 1.44 (SD=1.11), with a maximum of 10 hospitalisations. ICU admissions averaged 1.08 times (SD=0.266), highlighting the severe burden of COPD, particularly exacerbation management.

Circular No. 37/2015/TTLT-BYT-BTC led to fluctuating treatment costs from 2015 to 2019. The mean direct hospitalisation cost per treatment course was 430.74 USD (SD=618.39), equivalent to 10.01 (SD=14.5) million VND, with minimum and maximum costs of 11.73 and 9254.53 USD (0.28 million and 217 million VND). This cost aligns with another study at 74 Central Hospital, Vietnam (2014), reporting a mean hospitalisation cost of 8.3 million VND [11]. Our mean cost per day was more than 45 USD, about 1 million VND was roughly twofold higher than the cost of COPD at the National Lung Hospital in 2019 (about 0.5 million VND) [12]. The reason for this could be due to many factors such as the difference in prices of medication, changing supplies each year, different service techniques fees, the difference in hospital levels, and disease status of the population. Generally, the hospitalisation cost of COPD is quite incredible, nearly 2.5 times as high as the minimum wage in Vinh Phuc province.

The mean direct hospitalisation cost for exacerbation was 10.2 (SD=17.7) million VND with a duration of treatment of 9.54 (SD=5.34) days. This result was nearly 2 times higher than the mean cost per day of treatment in a study at the National Lung Hospital (0.507 million VND/day) [12] while 2 times lower than that of the study conducted at Bach Mai Hospital (the mean cost was 18.3 million VND at

2.1 million VND/day) [8]. Meanwhile, our figure was quite similar to another study at E Hospital, which showed that the average direct treatment cost for exacerbation of COPD was 9.1 million VND [10]. The differences between health systems and rates among hospitals and countries made it difficult to directly compare our results and those from other hospitals. However, collectively, the hospitalisation cost for exacerbation could cause an economic burden for patients and their families as well as for society. COPD exacerbation requires effective disease control and management, as well as prevention to reduce hospitalisation costs.

Medication costs accounted for the highest proportion of hospitalisation costs (over 50%) in all phases according to Circular No. 37/2015/TTLT-BYT-BTC. Our research result was similar to the research conducted in Bach Mai Hospital, which showed that the medication cost accounted for the highest proportion (53.9% of total cost) [8]. Another study showed that the spending on medications, blood, and infusion was the highest, accounting for 75% [12]. In addition, in the current study, our results showed that the medication often used for patients with COPD at Vinh Phuc General Hospital included antibiotics, bronchodilators, and corticosteroids. The spending on antibiotics of these medications was the highest with 99.37 USD per course of treatment. Our research result was similar to a previous study at two provincial facilities showing that antibiotic costs accounted for the highest proportion (54.5% of inpatient drug costs) [9]. This could be explained by the most common cause of an exacerbation being an infection in the lungs or airways, and treatment of infection for moderate to severe exacerbations is a top priority along with maintaining the patient's ventilation function.

The cost components differed significantly between phase 1 and phases 2 and 3. This indicates that specific allowances and salaries significantly impact medical expenses. Our study used generalised linear models with a log-link function, validated using the normality test of residuals. While not perfect, this method is acceptable. According to J.L. Moran, et al. (2007) [13], the GLM using the inverse Gaussian distribution may be advantageous for cost data analysis. Our results found that gender, place of residence, department classification, comorbidity, and treatment duration correlated with higher hospitalisation costs, consistent with other studies. For example, a study in Turkey found that the number of co-morbidities and the duration of hospitalisation increased the cost significantly [14]. Results from a 2008 Chinese study found that cost positively correlated to the duration of hospitalisation and the number of hospitalisation co-morbidities [15].

The study's strength lies in the analysis of COPD patients' expenses using real data from a large sample size of 1,629 patients, allowing the results to inform policymaking and lay the foundation for future research on economic evaluation. Our study was conducted on patients at Vinh Phuc General Hospital, a provincial grade 1 general hospital. To our knowledge, no similar study has been published from a provincial hospital in Vietnam, making our research a valuable representation of direct medical treatment costs for COPD in such settings and laying the groundwork for larger-scale studies with broader applicability.

However, this study has certain limitations. Firstly, it only measured direct medical costs and did not assess the burden of indirect costs. Secondly, the retrospective data collection method limited the research team's ability to obtain information on the treatment efficacy of each patient. Consequently, the study could not classify the severity of COPD for each patient according to the GOLD criteria, a crucial factor impacting the direct cost of COPD treatment. Furthermore, potential bias may have arisen due to the inclusion of patients with multiple comorbidities. The ICD code for COPD may not accurately capture all exacerbations of COPD, and certain diseases not yet assigned ICD codes but similar in condition to COPD could be misclassified in the insurance payment software under code J44.

5. Conclusions

This analysis not only provides epidemiological evidence of COPD but also estimates the economic burden of COPD on the patient population at Vinh Phuc General Hospital. This is a critical first step for future pharmacoeconomic studies of COPD treatment regimens. The hospitalisation cost was significantly high among patients with COPD, especially males, those with longer treatment durations, and those with comorbidities. The study suggests that strategies to prevent COPD and mitigate its effects should be widely implemented in the community to reduce the economic impact of COPD and improve the quality of life for affected individuals.

CRediT author statement

Nguyen Viet Phu: Methodology, Investigation; Nguyen Thi Mai Phuong: Writing - Original draft preparation, Reviewing and Editing; Dang Huu Duc: Data curation, Software; Vuong Trong Hieu: Software, Validation; Tran Thi Hang: Data collection and Synthesis; Nguyen Thien Phong: Methodology, Writing discussion; Le Hong Phuc: Methodology consultation; Pham Nu Hanh Van: Conceptualisation, Methodology, Supervision.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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