ORIGINAL ARTICLE

Influence of the COPD Assessment Test respiratory item score on the decision to hospitalize patients with disease exacerbation in a hospital emergency department

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Objectives. The COPD Assessment Test (CAT) measures quality of life in patients with chronic obstructive pulmonary disease (COPD) as well as disease impact on activities of daily living. The questionnaire consists of 8 items related to breathing (cough, phlegm, chest tightness, and breathlessness) and other symptoms (low energy level, sleep disturbances, limitations on daily activities, and confidence when leaving the home). We investigated the relative impact of respiratory versus nonrespiratory scoring on the total CAT score at different moments in the course of COPD exacerbations: baseline (24 hours before an exacerbation), during the exacerbation, 15 days later, and 2 months later. To assess the influence of the respiratory item score on decisions to hospitalize patients treated for exacerbated COPD in our hospital emergency department (ED).

Methods. Prospective cohort study. We recruited patients who came to our ED for symptoms consistent with exacerbated COPD. Sociodemographic and clinical data were recorded. Clinical information, including treatments started in the ED and CAT scores, were also recorded. The event was defined as highly symptomatic if the patient's score was 3 points or higher on at least 3 of the 4 respiratory items at baseline. The outcome measures for the first objective were the total CAT score and item scores at the 4 time points before (baseline), during (ED), and after the exacerbation. The outcome for the second objective was hospital admission.

Results. A total of 587 patients were included. The mean (SD) total CAT score was 13.48 (7.29) at baseline, 24.86 (7.25) in the ED, 14.7 (7.47) at 15 days, and 13.45 (7.36) at 2 months. The respiratory item scores accounted for a mean 53.4% (20.76%) of the total score at baseline and 48.2% (11.47%) of the total score in the ED. Eighty-two patients (14.0%) were classified as being highly symptomatic. A total of 359 (61.2%) were admitted. Predictors of hospital admission were classification as highly symptomatic, odds ratio (OR, 3.045; 95% CI, 1.585–5.852, $P < .001$), dyspnea at rest (OR, 2.906; 95% CI:1.943–4.346, $P < .001$), and start of the following treatments in the ED: oxygen therapy (OR, 4.550; 95% CI, 3.056–6.773; $P < .0001$), diuretic (OR, 1.754; 95% CI, 1.091–2.819; $P = .02$), and intravenous antibiotics (OR, 1.536; 95% CI, 1.034–2.281; $P = .03$). The model achieved an area under the receiver operating characteristic curve of 0.80 (95% CI, 0.763–0.836).

Conclusions. Hospital admission from the ED is highly likely in patients with COPD exacerbation who have high baseline CAT scores, dyspnea at rest in the ED, and require oxygen therapy, diuretics, or intravenous antibiotics in the ED. The total CAT score and scores on respiratory items provide a tool for tailoring pharmacologic and nonpharmacologic treaments and can facilitate follow-up evaluations.

Keywords: Chronic obstructive pulmonary disease. COPD. Exacerbation. Emergency department. Quality of life.

Influencia de los ítems respiratorios del copd Assessment Test (cat) en la decisión de ingreso de las agudizaciones de enfermedad pulmonar obstructiva crónica (epoc) atendidos en urgencias hospitalarias

Objetivos. El CAT (COPD Assessment Test) es un cuestionario de calidad de vida que mide el impacto que la enfermedad pulmonar obstructiva crónica (EPOC) está teniendo en el bienestar y vida diaria de los pacientes. Consta de 8 ítems divididos en 4 respiratorios y 4 no respiratorios. Conocer el impacto de las puntuaciones de los ítems respiratorios y no respiratorios en la puntuación CAT total, en diferentes momentos de la exacerbación de EPOC (24 horas antes de la exacerbación o basal, en la exacerbación, a los 15 días y a los 2 meses). Secundariamente, se valoró la influencia de los ítems respiratorios de la puntuación CAT total, en la decisión de ingreso de los pacientes atendidos por exacerbación de EPOC (EA-EPOC) en un servicio de urgencias hospitalario (SUH).

Método. Estudio de cohortes prospectivo. Se reclutaron pacientes que acudían al SUH con síntomas compatibles con EA-EPOC. La variable "Paciente respiratorio altamente sintomático"(PRAS) se definió como el paciente que tiene 3

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puntos o más en al menos 3 de los 4 ítems respiratorios del CAT basal. Las variables de resultado fueron para el primer objetivo: la puntuación CAT total y desglosada por ítems, en los 4 momentos estudiados. Para el segundo objetivo fue el ingreso hospitalario.

Resultados. Se incluyeron 587 pacientes. La media de la puntuación CAT total basal fue 13,48 (7,29), en urgencias fue 24,86 (7,25), a los 15 días fue 14,7 (7,47) y a los 2 meses 13,45 fue (7,36). La proporción sobre la puntuación CAT basal total de los ítems respiratorios fue de 53,4% (20,76) y en el momento de llegar a urgencias del 48,2% (11,47). Los PRAS fueron 82 (14,0%). Ingresaron 359 pacientes (61,2%). Los predictores de ingreso hospitalario fueron: PRAS (OR 3,045, IC 95%: 1,585-5,852, p < 0,001), disnea de reposo (OR 2,906, IC 95%: 1,943-4,346, p < 0,001) y algunos tratamientos instaurados en el SUH (oxigenoterapia: OR 4,550, IC 95%: 3,056-6,773, p < 0,001; diurético: OR 1,754, IC 95%: 1,091-2,819, p = 0,02; y antibiótico iv: OR 1,536, IC 95%: 1,034-2,281, p = 0,03). Este modelo logra un área bajo la curva COR de 0,80 (IC 95%: 0,763-0,836).

Conclusiones. En pacientes con EA-EPOC atendidos en urgencias, la alta puntuación de ítems respiratorios en el CAT basal, la disnea de reposo a su llegada al SUH y varios de los tratamientos instaurados en urgencias (oxigenoterapia, diuréticos y antibioterapia intravenosa) demostraron tener buena capacidad de predicción de ingreso hospitalario. La puntuación CAT total así como la puntuación en los ítems respiratorios del mismo son una herramienta que podría ayudar al clínico a individualizar el tratamiento o los controles posteriores.

Palabras clave: Enfermedad pulmonar obstructiva crónica. EPOC. Exacerbación. Departamento de la emergencia. Calidad de vida.

Introduction

Chronic obstructive pulmonary disease (COPD) is a highly prevalent disease worldwide.[1] It is characterized by the presence of persistent respiratory symptoms and airflow limitation due to airway or alveolar abnormalities.[2] During the natural history of the disease, patients suffer exacerbations, some very frequently. These exacerbations play an important role in the clinical course of COPD,[3] the deterioration of lung function,[4] the impairment of their quality of life[5] and even in the short- and long-term mortality from the disease.[6] For some years now the different guidelines for the management of patients with COPD[7,8] have been putting forward the usefulness of quality of life questionnaires for the clinical and evolutionary management of these patients. One of these is the COPD Assessment Test (CAT)[9] which was developed with the aim of improving doctor-patient communication and assessing the most important symptoms in COPD in a simple and reliable manner. This questionnaire, which can be self-administered, consists of 8 items scoring from 0 to 5 points, which focus on respiratory symptoms, such as cough, sputum production, chest tightness and dyspnea or shortness of breath, but also on non-respiratory symptoms, such as lack of energy or sleep disturbances, limitations in performing activities at home or confidence when leaving the house. The overall CAT score ranges from 0 to 40 points, with a higher score denoting a greater impact of the disease. A score of less than 10 implies a low impact of COPD on patients' quality of life; a score between 10 and 20 a medium impact; a score between 21 and 30 a high impact; and a score greater than 30 a very high impact of COPD on the patient's quality of life.

Through experience with cohorts of patients with acute exacerbation of COPD (AE-COPD, the CAT score could provide information on how the patient is doing basally and can even help in monitoring recovery from the exacerbation on the day before the exacerbation.[10,11] The hypothesis of the present study was to demonstrate that in the total CAT score, respiratory items are predictors of exacerbation evolution. Based on this, our objectives were: 1) to determine the impact on the total CAT score of respiratory and non-respiratory items, measured at different times of COPD exacerbation (24 hours before the exacerbation or baseline, at exacerbation, at 15 days and at 2 months); and 2) to assess whether the score obtained in the hospital emergency department (ED) for respiratory items in the baseline CAT is a predictor of hospital admission in patients treated for AE-COPD.

Methods

This was a prospective cohort study with consecutive opportunity sampling. Patients with AE-COPD symptoms who were attented at the EDs of four Spanish hospitals (Txagorritxu in Álava, Galdakao-Usansolo in Bizkaia, Clínico San Carlos in Madrid, Reina Sofía in Murcia) between March 2014 and January 2017 were recruited. All patients included had a previous diagnosis of COPD, confirmed by spirometry at baseline, and consulted the ED for symptoms compatible with AE-COPD. AE-COPD was defined as a change in the patient's baseline dyspnea, cough or expectoration beyond normal day-to-day variations, of acute onset, that could warrant a change in regular medication in a patient with underlying COPD.[7]

All patients with AE-COPD in which the increased dyspnea was due to another cause such as pneumonia, pneumothorax, pulmonary embolism, lung cancer, left heart failure or arrhythmia, or when the patients had a previous diagnosis of asthma, extensive bronchiectasis, sequelae of pulmonary tuberculosis, pleural thickening or restrictive lung disease were excluded. The Ethics Committee of each hospital approved the study, and patients were included once they or a family member of theirs signed the informed consent.

Age, gender, and clinical data on arrival at the ED were collected. At the time of inclusion, a personal interview was carried out in which the patients were asked twice about the CAT questionnaire: once about their situation 24 hours before going to the ED (baseline CAT), and once about their situation at the time of going to the ED (AE-COPD CAT). Subsequently, two telephone interviews were conducted; one at 15 days (CAT 15 days) and another at 2 months after the ED visit (CAT 2 months). The CAT items are scored from 0 to 5 (according to their intensity; 0 is the lowest and 5 is the maximum score). According to recent studies[12] the variable "highly symptomatic COPD patient" is defined as a patient who has 3 or more points in at least 3 of the 4 respiratory items of the baseline CAT.

The severity of the exacerbation was measured by the severity scale for AE-COPD developed by García-Gutiérrez et al.[13] This scale defines four risk categories: mild (0 points), moderate (1-5 points), severe (6-9 points) and very severe (10-18 points).

The outcome variables were, for the first objective, the total CAT score and broken down by items at different times of the exacerbation (24 hours before or at baseline, at exacerbation, at 15 days and at 2 months). For the second objective, the outcome variable was hospital admission.

Data collection was performed by trained personnel under the direct supervision of the principal investigator and clinical collaborators from the ED computer records. These personnel were also responsible for conducting patient interviews.

A longitudinal data analysis was performed to identify differences in the trends regarding the evolution of the CAT score and its component items during the different points in time collected in the study. Differences between all scenarios were analyzed, as well as two-to-two differences between baseline and subsequent scores.

Descriptive statistics were performed, presenting categorical variables as frequency tables and percentages, and continuous variables as means and standard deviations or medians and interquartile ranges. The characteristics of the admitted and non-admitted patients were compared using the chi-square test or Fisher exact test in the case of categorical variables, and by Student t-test or Wilcoxon nonparametric tests in the case of continuous variables.

Univariate logistic regression analysis was performed to identify risk factors associated with patient hospitalization. All variables with $P < .20$ were considered possible independent variables for the multivariable logistic regression model. Variables with $P < .05$ were considered final predictors in the multivariate analysis.

In both the univariate and multivariate analyses, odds ratios (OR) and 95% confidence intervals (CI) were calculated. In the case of the multivariable model, the predictive and explanatory capacity of the model was analyzed with the area under the receiver operating characteristic (COR) curve (AUC)[14] and the model was calibrated with the Hosmer and Lemeshow test.[15]

All statistical analyses were performed using SAS for Windows, version 9.4 (SAS Institute, Carey, USA) and R©, version 4.0.5.

Results

We recruited 736 patients with AE-COPD who attended the EDs of the four participating hospitals; 149 were excluded from the study because they had associated disease, were unreachable at follow-up or were incapacitated. Of the 587 patients included, 559 completed the baseline CAT, 556 the CAT in the ED, 522 at 15 days and 486 at 2 months.

Table 1 shows the means of the total CAT score at baseline 13.48 (7.29), at ED 24.86 (7.25), at 15 days 14.7 (7.47) and at 2 months 13.45 (7.36). The proportion of the total baseline CAT score for respiratory items was 53.4% (20.76) and 48.2% (11.47) at the time of arrival at the emergency department. Statistically significant differences were observed between the total CAT score and their respective respiratory items at baseline, in the emergency department and at 15 days, but not at 2 months, except for the items "oppression" and "energy".

Table 2 shows the baseline and ED care characteristics of the AE-COPD patients according to the decision to admit them to the hospital. A total of 359 patients (61.2%) were admitted. The mean age was 73.5 (10.8), 481 (81.9%) were male, 239 (44.9%) had a baseline FEV (forced expiratory volume) < 50% and 213 (42.3%) had a moderate-severe exacerbation. The highly symptomatic COPD patients were 82 (13.97). Oxygen therapy was administered to 351 patients (60.7%), 561 (96.1%) aerosol therapy, 475 (81.3%) intravenous corticosteroids, 150 (25.8%) diuretics and 299 (51.1%) intravenous antibiotics. Table 3 shows the variables on arrival at the ED that were significantly related to hospital admission: severity of exacerbation, presence of dyspnea at rest and edema, respiratory and heart rate, previous diabetes and initial glycemia, gasometric data (PH, pO_2, pCO_2, O_2 Sat) and the fact of receiving treatment with oxygen, diuretics and antibiotics in the ED. The total baseline CAT score, emergency CAT score and most of its items except for the item "shortness of breath" were significantly related to admission, as well as the fact of being highly symptomatic COPD.

In the multivariate model (Table 4), dyspnea at rest on arrival at the emergency department, being highly symptomatic COPD, and the treatment given in the emergency department with oxygen therapy, diuretics and antibiotics were significantly associated with the decision to admit. Highly symptomatic COPD had a 3.04 times higher risk of admission than patients who were not highly symptomatic. Patients who presented with dyspnea at rest on arrival at the emergency department had a 2.90-fold increased risk of admission.

In the multivariate model (Table 4), dyspnea at rest on arrival at the emergency department, being highly symptomatic COPD, and the treatment given in the emergency department with oxygen therapy, diuretics

Table 1. Analysis of the CAT score and of each of the items, at the different times of follow-up

	CAT questionnaire				*P* value
	Baseline[a]	Emergencies[b]	15 days[c]	2 months[d]	
Total	559	556	522	486	
Cough*	1.52 (1.27)[b,c]	3.19 (1.43)[a]	1.63 (1.31)[a]	1.48 (1.24)	< .001
Phlegm*	1.41 (1.24)[b,c]	3.01 (1.48)[a]	1.54 (1.3)[a]	1.41 (1.28)	< .001
Oppression*	0.57 (1.04)[b,d]	1.27 (1.6)[a]	0.5 (0.99)	0.44 (0.9)[a]	< .001
Shortness of breath*	3.15 (1.51)[b]	4.32 (1.07)[a]	3.18 (1.43)	3.06 (1.45)	< .001
ADLs limitation*	1.88 (1.78)[b,c]	3.89 (1.45)[a]	2.16 (1.8)[a]	1.84 (1.78)	< .001
feeling safe when leaving home*	1.47 (1.88)[b,c]	3.12 (1.95)[a]	1.82 (1.99)[a]	1.56 (1.87)	< .001
Sleep disorders*	1.46 (1.51)[b]	2.85 (1.74)[a]	1.52 (1.54)	1.53 (1.52)	< .001
Energy*	2.02 (1.38)[b,c,d]	3.19 (1.43)[a]	2.35 (1.32)[a]	2.13 (1.35)[a]	< .001
Total CAT score*	13.48 (7.29)[b,c]	24.86 (7.25)[a]	14.7 (7.47)[a]	13.45 (7.36)	
Total CAT score percentage %					
Respiratory items*	53.42 (20.76)[b,c,d]	48.25 (11.47)[a]	50.19 (20.01)[a]	51.41 (20.52)[a]	< .001
Non-respiratory items*	46.58 (20.76)[b,c,d]	51.75 (11.47)[a]	49.81 (20.01)[a]	48.59 (20.52)[a]	< .001

*Results shown as mean (standard deviation).
[a]Statistically significant differences with respect to the baseline score. [b]Statistically significant differences with respect to the ED score. [c]Statistically significant differences with respect to the score at 15 days. [d]Statistically significant differences with respect to the score at 2 months.
ADLs: Activities of daily living; CAT: COPD Assessment Test.

Table 2. Characteristics of the sample and differences between admitted and non-admitted patients

	Total N = 187 n (%)	Hospital admission		*P*	Lost (%)
		Yes N = 359 n (%)	No N = 228 n (%)		
Age [mean (SD)]	73.5 (10.8)	73.6 (10.8)	73.4 (10.7)	.924	1 (0.2)
Gender (Male)	481 (81.9)	287 (79.9)	194 (85.1)	.114	0 (0.0)
Baseline data					
Baseline CAT [mean (SD)]	13.16 (7.4)	14.24 (7.7)	11.48 (6.6)	< .001	37 (6.3)
CAT baseline, categorized				.001	37 (6.3)
0-10	199 (36.2)	105 (31.2)	94 (43.9)		
10-20	242 (44.0)	149 (44.3)	93 (43.5)		
20-30	99 (18.0)	73 (21.7)	26 (12.1)		
30-40	10 (1.8)	9 (2.7)	1 (0.5)		
Baseline CAT items [mean (SD)]					
1. Coughing	1.49 (1.3)	1.65 (1.3)	1.26 (1.1)	.001	32 (5.4)
2. Phlegm	1.37 (1.2)	1.47 (1.3)	1.21 (1.1)	.046	33 (5.6)
3. Chest tightness	0.56 (1.0)	0.66 (1.1)	0.4 (0.96)	.007	32 (5.4)
4. Shortness of breath	3.11 (1.5)	3.14 (1.5)	3.07 (1.5)	.663	33 (5.6)
5. ADLs limitation	1.83 (1.8)	1.99 (1.8)	1.58 (1.7)	.006	34 (5.8)
6. Feeling safe when leaving home	1.42 (1.9)	1.63 (1.9)	1.08 (1.7)	< .001	34 (5.8)
7. Sleeping disorders	1.43 (1.5)	1.6 (1.5)	1.15 (1.4)	< .001	34 (5.8)
8. Energy	1.97 (1.4)	2.08 (1.4)	1.79 (1.3)	.026	35 (6.0)
Highly symptomatic patient[1] [mean (SD)]	82 (14)	67 (19)	15 (7)	< .001	0 (0)
ED data [mean (SD)]					
CAT ED	24.62 (7.31)	25.71 (7.51)	22.93 (6.66)	< .001	47 (8.0)
CAT ED categorized				< .001	47 (8.0)
0-10	13 (2.4)	8 (2.4)	5 (2.4)		
10-20	119 (22.0)	56 (17.0)	63 (29.9)		
20-30	273 (50.6)	163 (49.5)	110 (52.1)		
30-40	135 (25.0)	102 (31.0)	33 (15.6)		
Emergency CAT items [mean (SD)]					
1.Coughing	3.17 (1.4)	3.28 (1.5)	2.98 (1.4)	.004	36 (6.1)
2. Phlegm	2.97 (1.5)	3.03 (1.5)	2.88 (1.4)	.090	36 (6.1)
3. Chest tightness	1.22 (1.6)	1.39 (1.6)	0.94 (1.4)	.001	37 (6.3)
4. Shortness of breath	4.29 (1.1)	4.36 (1.0)	4.21 (1.2)	.190	42 (7.2)
5. ADLs limitation	3.85 (1.5)	4.01 (1.5)	3.59 (1.4)	< .001	38 (6.5)
6. Feeling safe when leaving home	3.07 (2.0)	3.1 (2.0)	3.02 (1.9)	.488	40 (6.8)
7. Sleeping disorders	2.82 (1.7)	3.07 (1.7)	2.43 (1.7)	< .001	39 (6.6)
8. Energy	3.18 (1.4)	3.37 (1.4)	2.88 (1.4)	< .001	39 (6.6)

(Continues)

Table 2. Characteristics of the sample and differences between admitted and non-admitted patients (Continuation)

	Total N = 187 n (%)	Hospital admission		*P*	Lost (%)
		Yes N = 359 n (%)	No N = 228 n (%)		
Emergency variables					
Severity of exacerbation				.012	83 (14.1)
Mild	291 (57.7)	176 (53.7)	115 (65.3)		
Moderate	150 (29.7)	103 (31.4)	47 (26.7)		
Severe	40 (7.9)	28 (8.5)	12 (6.8)		
Very severe	23 (4.6)	21 (6.4)	2 (1.1)		
Baseline COPD severity				.415	55 (9.4)
Mild	99 (18.6)	55 (16.9)	44 (21.4)		
Moderate	194 (36.5)	120 (36.8)	74 (35.9)		
Severe-very severe	239 (44.9)	151 (46.3)	88 (42.7)		
Dyspnea on arrival (Yes)	273 (46.7)	212 (59.2)	61 (27.0)	< .001	3 (0.5)
Edemas (Yes)	108 (18.5)	86 (24.1)	22 (9.7)	< .001	4 (0.7)
Diabetes (Yes)	188 (32.2)	131 (36.7)	57 (25.2)	.004	4 (0.7)
History of heart disease (Yes)	271 (46.4)	160 (44.9)	111 (48.7)	.377	3 (0.5)
Accessory musculature (Yes)	48 (8.2)	38 (10.6)	10 (4.4)	.007	1 (0.2)
Paradoxical breathing (Yes)	4 (0.7)	4 (1.1)	0 (0)	.160	2 (0.3)
Cardio-respiratory arrest (Yes)	0 (0)	0 (0)	0 (0)	N/C	1 (0.2)
Hemodynamic instability (Yes)	23 (3.9)	15 (4.2)	8 (3.5)	.674	2 (0.3)
Level of consciousness (< 15 points)	10 (1.7)	4 (1.1)	6 (2.7)	.195	5 (0.8)
Active smoker (Yes)	126 (21.6)	79 (22.2)	47 (20.7)	.671	4 (0.7)
Active smoker [mean (SD)]	20.78 (5.0)	21.55 (5.2)	19.59 (4.5)	< .001	50 (8.5)
SBP [mean (SD)]	141.44 (24.0)	140.07 (24.4)	143.59 (23.1)	.059	9 (1.5)
DBP [mean (SD)]	75.53 (13.8)	74.61 (14.0)	76.98 (13.4)	.052	8 (1.4)
Heart rate [mean (SD)]	88.63 (18.1)	90.48 (18.8)	85.72 (16.5)	.003	7 (1.2)
Temperature [mean (SD)]	36.63 (0.7)	36.65 (0.8)	36.59 (0.6)	.712	15 (2.6)
Glycemia [mean (SD)]	143.28 (60.9)	147.66 (61.9)	136.31 (58.6)	.002	3 (0.5)
Creatinine [mean (SD)]	1.18 (4.0)	1.31 (5.1)	0.99 (0.4)	.889	3 (0.5)
Urea [mean (SD)]	45.96 (21.6)	47.35 (23.2)	43.67 (18.5)	.149	95 (16.2)
PCR [mean (SD)	38.46 (57.0)	43.72 (64.5)	29.43 (39.5)	.399	104 (17.7)
pH [mean (SD)	7.41 (0.01)	7.4 (0.1)	7.42 (0.0)	.003	81 (13.8)
PO_2 [mean (SD)	61.22 (20.3)	58.2 (19.4)	66.81 (20.7)	< .001	85 (14.5)
PCO_2 [mean (SD)	44.32 (12.3)	45.67 (13.6)	41.78 (9.0)	< .001	82 (14.0)
Sat O_2 [mean (SD)	89.86 (8.7)	88.2 (9.4)	92.75 (6.4)	< .001	35 (6.0)
Treatment in the ED					
Oxygen therapy (Yes)	351 (60.7)	273 (77.8)	78 (34.4)	< .001	9 (1.5)
IMV (Yes)	11 (1.9)	11 (3.1)	0 (0)	.009	2 (0.3)
NIV (Yes)	42 (7.2)	37 (10.4)	5 (2.2)	.002	3 (0.5)
Aerosol therapy (Yes)	561 (96.1)	346 (96.9)	215 (94.7)	.182	3 (0.5)
IV corticosteroid (Yes)	475 (81.3)	310 (86.8)	165 (72.7)	< .001	3 (0.5)
Inhaled corticosteroid (Yes)	115 (19.9)	67 (19.0)	48 (21.2)	.506	8 (1.4)
Diuretics (Yes)	150 (25.8)	111 (31.3)	39 (17.2)	.002	5 (0.8)
Antiarrhythmics (Yes)	53 (9.1)	38 (10.7)	15 (6.6)	.094	5 (0.8)
Antipyretics (Yes)	146 (25.0)	101 (28.3)	45 (19.8)	.021	3 (0.5)
IV Antibiotherapy (Yes)	299 (51.1)	209 (58.4)	90 (39.6)	< .001	2 (0.3)
Antidepressant/Anxiolytics (Yes)	56 (9.6)	43 (12.1)	13 (5.7)	.011	6 (1.0)

[1]Highly symptomatic patient defined as a patient who has 3 or more points in at least 3 of the 4 respiratory items of the baseline CAT.
N: frequency; %: percentage; CAT: COPD Assessment Test; COPD: chronic obstructive pulmonary disease; SBP: systolic blood pressure; DBP: diastolic blood pressure; IMV: invasive mechanical ventilation; NIV: noninvasive mechanical ventilation; GCS: Glasgow Coma Scale; CRP: C-reactive protein; N/C: not calculable.

and antibiotics were significantly associated with the decision to admit. Highly symptomatic COPD had a 3.04 times higher risk of admission than patients who were not highly symptomatic. Patients who presented with dyspnea at rest on arrival at the emergency department had a 2.90-fold increased risk of admission.

With respect to the treatment administered in the emergency department, receiving oxygen therapy increases the risk of admission 4.55 times, the administration of diuretics 1.75 times and intravenous antibiotherapy 1.53 times. As shown in Table 4, the model has a Hosmer-Lemeshow contrast p-value of .669 and an AUC (95% CI) of .80 (95% CI: 0.76 to 0.83), which validates the results obtained.

Discussion

This study shows the impact of respiratory and non-respiratory symptoms on the total CAT score at dif-

Table 3. Univariate analysis for income prediction

Variables	OR (CI 95%)	*P*
Age (years)	1.001 (0.986-1.017)	.852
Gender (Male vs Female)	0.703 (0.450-1.099)	.122
Baseline data		
baseline CAT*	1.053 (1.028-1.080)	< .001
baseline CAT, categorized		
10-20 vs 0-10	1.432 (0.979-2.095)	.064
20-30 vs 0-10	2.484 (1.468-4.204)	.001
30-40 vs 0-10	5.671 (0.912-35.247)	.063
Baseline CAT items		
1. Coughing*	1.281 (1.113-1.474)	.006
2. Phlegm*	1.184 (1.028-1.364)	.019
3. Chest tightness*	1.297 (1.081-1.555)	.005
4. Shortness of breath*	1.026 (0.919-1.146)	.647
5. ADLs limitation*	1.141 (1.035-1.259)	.008
6. Feeling safe when leaving home*	1.178 (1.070-1.298)	.001
7. Sleeping disorders*	1.229 (1.091-1.385)	.001
8. Energy*	1.166 (1.030-1.320)	.015
Highly symptomatic patient[1] ***(yes vs no)***	3.179 (1.775-5.693)	.001
Emergency data		
CAT ED*	1.054 (1.029-1.080)	< .001
CAT ED categorized		
10-20 vs 0-10	0.576 (0.179-1.855)	.355
20-30 vs 0-10	0.957 (0.307-2.991)	.940
30-40 vs 0-10	1.980 (0.608-6.442)	.257
Emergency CAT items		
Coughing*	1.154 (1.025-1.299)	.018
2. Phlegm*	1.071 (0.954-1.202)	.244
3. Chest tightness*	1.209 (1.076-1.357)	.001
4. Shortness of breath	1.128 (0.967-1.315)	.127
5. Limitation of domestic actions*	1.208 (1.076-1.357)	.001
6. Safety when leaving home*	1.020 (0.935-1.113)	.654
7. Sleeping problems*	1.236 (1.118-1.367)	< .001
8. Energy*	1.266 (1.122-1.428)	< .001
ED variables		
Severity of exacerbation		
Moderate vs mild	1.426 (0.940-2.164)	.095
Severe vs mild	1.492 (0.731-3.044)	.271
Very severe vs mild	5.634 (1.448-21.926)	.013
Severity of baseline COPD		
Moderate vs mild	1.297 (0.794-2.119)	.299
Severe-very severe vs mild	1.372 (0.853-2.208)	.192
Dyspnea on arrival (yes vs no)	3.903 (2.720-5.601)	< .001
Edemas (yes vs no)	2.896 (1.756-4.775)	< .001
Diabetes (yes vs no)	1.711 (1.183-2.476)	.004
History of heart disease (yes vs no)	0.861 (0.617-1.201)	.378
Accessory musculature (yes vs no)	2.498 (1.228-5.084)	.011
Hemodynamic instability (yes vs no)	1.174 (0.491-2.805)	.718
Level of consciousness (< 15 points in GCS vs None)	2.343 (0.657-8.359)	.189
Active smoking (yes vs no)	1.089 (0.725-1.635)	.682
Respiratory frequency*	1.090 (1.048-1.134)	< .001
PAS	0.994 (0.987-1.001)	.088
PAD*	0.988 (0.976-1.000)	.046
Heart rate*	1.015 (1.005-1.025)	.002
Temperature*)	1.128 (0.895-1.422)	.307
Glycemia*	1.003 (1.000-1.006)	.034
Creatinine*	1.009 (0.960-1.061)	.720
Urea*	1.008 (0.999-1.017)	.074
CPR*	1.005 (1.001-1.009)	.011
pH*	0.006 (0.001-0.202)	.004
PO_2*	0.978 (0.968-0.989)	< .001
PCO_2*	1.032 (1.013-1.052)	.001
O_2 sat*	0.879 (0.844-0.916)	< .001
Treatment in the emergency department		
Oxygen therapy (yes vs no)	6.635 (4.576-9.622)	< .001
IMV (yes vs no)	4.735 (1.884-11.902)	< .001
Aerosol therapy (yes vs no)	1.748 (0.758-4.031)	.190
IV corticosteroid (yes vs no)	2.469 (1.616-3.770)	< .001
Inhaled corticosteroid (yes vs no)	0.867 (0.573-1.313)	.501
Diuretics (yes vs no)	2.176 (1.443-3.281)	.002
Antiarrhythmics (yes vs no)	1.663 (0.895-3.091)	.108
Antipyretics (yes vs no)	1.587 (1.065-2.366)	.023
IV antibiotherapy (yes vs no)	2.129 (1.517-2.988)	< .001
Antidepressants/anxiolytics (yes vs no)	2.202 (1.161-4.176)	.016

(Continues)

*Estimation per unit of increase.
[1]Highly symptomatic patient defined as a patient who has 3 points or more in at least 3 of the 4 respiratory items of the baseline CAT.
OR: odds ratio; CI: confidence interval; CAT: COPD Assessment Test; COPD: chronic obstructive pulmonary disease; SBP: systolic blood pressure; DBP: diastolic blood pressure; GCS: Glasgow Coma Scale; CRP: C-reactive protein; IMV: invasive mechanical ventilation; SD: systolic blood pressure.

ferent time points: baseline, at exacerbation and at recovery of AE-COPD patients. Although most patients had a CAT ≥ 10 points (64%), thus classified as high impact of COPD on quality of life, less than one-sixth of the total patients were categorized as highty symptomatic COPD.

The health status assessed by the CAT total score recovered at 2 months, as well as its items except for "chest tightness" which improved and "energy" which slightly worsened. The latter may be related to an already known decrease in physical activity during and after the exacerbation.

Regarding the role of respiratory items in the decision to admit patients with AE-COPD, we observed that highly symptomatic COPD together with dyspnea at rest and the use of different treatments in the emergency department (oxygen therapy, diuretics and antibiotherapy) have a higher probability of admission for AE-COPD.

Our results regarding the total CAT score show significant differences related to the stable situation and the time of exacerbation, in line with different studies and meta-analyses,[10,11,16-19] as well as the almost complete recovery of the baseline score 2 months after the exacerbation.[11,20]

This paper shows how CAT items contribute differently to the total CAT score at the different times studied; the item "shortness of breath" scored the highest at all times studied, while "chest tightness" scored the lowest. It is interesting to note that both items correspond to respiratory items. These results are consistent with those observed in several previous studies, one of which was carried out in patients attending rehabilitation[12] who were given a questionnaire on admission to the service and another after pulmonary rehabilitation, where it was also found that the item with the highest score both pre- and post-rehabilitation was "shortness of breath".

Table 4. Multivariate analysis for prediction of admissions

Variables	β (e.e.)	OR (CI 95%)	*P*
Intercept	–1.37 (0.19)		< .001
Highly symptomatic patient[1] (yes vs no)	1.11 (0.33)	3.045 (1.585-5.852)	.001
Dyspnea on arrival at the ED (yes vs no)	1.07 (0.21)	2.906 (1.943-4.346)	< .001
Oxygen therapy (yes vs no)	1.52 (0.20)	4.550 (3.056-6.773)	< .001
Diuretics (yes vs no)	0.56 (0.24)	1.754 (1.091-2.819)	.020
IV antibiotherapy (yes vs no)	0.43 (0.20)	1.536 (1.034-2.281)	.033
AUC (CI 95%)/p-Hosmer Lemeshow		0.800 (0.763-0.836)/ 0.6695	

β (s.e.): estimate (standard error). [1]Highly symptomatic patient defined as a patient who has 3 or more points in at least 3 of the 4 respiratory items of the baseline CAT.
OR: odds ratio; CI: confidence interval; AUC: area under the ROC curve.

Another study in newly diagnosed COPD patients[21] found the CAT item "shortness of breath" as a predominant symptom and concluded that the predictive value of the total CAT score was overloaded by the dyspnea component, which is consistent with what was observed in our work. Jones et al.[9] also analyzed all CAT items and their weight on the total score and concluded that the item "shortness of breath" had the highest discriminatory power for the mildest patients, whereas "safety to leave home" discriminated best in the most severe patients.

It should be noted that in our study, at the time of exacerbation, 6 of the 8 items that make up the CAT had a score of more than 3 points, which shows a high impact, both respiratory and nonrespiratory. This fact could be explained by the fact that patients with exacerbation worsen respiratory symptoms (cough, secretions, dyspnea), but this respiratory worsening, which would define the exacerbation, has a direct impact on their general quality of life (limitation of domestic activities, safety when leaving the house, and energy).

The results of this study indicate that the decision to admit patients presenting to the ED for AE-COPD is related to three groups of variables. The first, and most novel, is the high impact of respiratory symptoms on the quality of daily life of COPD patients as measured by the baseline CAT and expressed by the term highly symptomatic COPD. This could be explained by the fact that these patients, having intense respiratory symptoms at baseline, the slightest worsening requires more intense and specialized treatment, and can be considered as the "exacerbating phenotype".[8]

The second variable related to admission is the presence of dyspnea at rest on initial ED evaluation, which supports the idea that dyspnea is a key symptom in exacerbation.[7] Finally, the three types of ED treatment for exacerbation play an important role in the admission decision: first, oxygen therapy related to the existence of respiratory failure at the time of exacerbation and, therefore, to the severity of the exacerbation.

Second, the use of diuretics, due to their probable relationship with a preexisting decompensated cardiac comorbidity that may require therapeutic intensification and stricter control at hospital level. And third, the use of intravenous antibiotherapy. We consider that the relationship of this variable with the need for admission is due more to the route of administration than to the antibiotic itself, as it is likely to be patients with problems for oral administration, infections with resistant germs that require intravenous antibiotics or poor general condition of the patient at the time of exacerbation. However, it should be considered that in our study we do not know whether the route of administration was justified or whether it was due to therapeutic inertia. In this sense, we should consider whether using the antibiotic orally could reduce the number of admissions and therefore contribute to cost containment.

In a systematic review,[22] in another study performed in a cohort of outpatients[23] and other subsequent studies[24-31] on risk factors for hospitalization in AE-COPD patients, reference is made to the influence of various variables on the decision to admit patients to hospital (home oxygen therapy, low baseline quality of life, low daily physical activity, age, FEV_1, mucus hypersecretion, comorbidities, patient frailty, baseline oxygen saturation, and previous visits to the emergency department, among others). Most of them are related to the patient's baseline situation and very few to the patient's situation in the exacerbation itself and to the therapeutic measures used in the patient with AE-COPD.[29,31]

The limitations of the study are those inherent to longitudinal studies, including missing data. On the other hand, this is an ED study, and therefore we lack information on mild and moderate exacerbations seen in primary care. The baseline CAT score was estimated by the patient himself when asked about his situation 24 hours before the exacerbation, assuming this score as the baseline. Although this information could already be affected by its proximity to the time of the exacerbation consultation, we found that the CAT score 2 months after the exacerbation is similar to that of 24 hours before the exacerbation, supporting the assumption that the CAT 24 hours before the exacerbation is equal to the actual baseline CAT. We do not have data related to drug doses at baseline or in the emergency department. It should also be noted that the results can only be extrapolated to patients with COPD without any of the exclusion criteria mentioned in the methods section, including patients with exacerbation and pneumonia.

In conclusion, in patients with AE-COPD seen in the ED, the high score of respiratory items in the baseline CAT, dyspnea at rest on arrival to the ED and several of the treatments initiated in the ED (oxygen therapy, diuretics and intravenous antibiotic therapy) proved to have a good predictive capacity for patients with comorbidities could help to reduce the need for hospital admission. Thus, our results indicate that the total CAT score and its respiratory items could be a tool to help the clinician to give an individualized approach to pharmacological and non-pharmacological treatments, as well as to subsequent controls. Practically speaking, closer outpatient monitoring of the highly symptomatic COPD and patients with comorbidities could help to decrease the need for admission.

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