

Application of the COPD Assessment Test (CAT) to Patients with Interstitial Lung Disease

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Abstract

The COPD Assessment Test was recently developed to assess health status in patients with COPD. However, little was known about its application to patients with interstitial lung disease, so we examined the relationship between the COPD Assessment Test score and respiratory impairment including the clinical picture in subjects with interstitial lung disease. Data were collected retrospectively from 52 consecutive subjects with interstitial lung disease on admission to our facility. All subjects completed the COPD Assessment Test, in which a higher score represented a worse health status. They were also assessed by pulmonary function test, SpO₂ during 6-min walk test, and arterial blood gases. The COPD Assessment Test score was negatively correlated with the percentage of predicted forced vital capacity, forced expiratory volume in 1 second, total lung capacity, diffusion capacity of the lung for carbon monoxide, and PaO₂ ($p = 0.0005$, 0.005 , 0.0002 , 0.0005 , and 0.002 , respectively). Breathlessness was detected as the high scoring item, while phlegm and sleep were the last affected items. The COPD Assessment Test score was higher in subjects with oxygen desaturation in SpO₂ ($\geq 4\%$) during 6-min walk test ($p = 0.0001$) and in subjects on home oxygen therapy ($p = 0.0007$). More than 75% of subjects with oxygen desaturation during walking were classified into a medium or severer impact level of the COPD Assessment Test score, and subjects on home oxygen therapy were classified into a high or severer impact level. PaCO₂ in room air and SpO₂ at rest did not correlate with the COPD Assessment Test score. The reliability of items in the COPD Assessment Test was 0.87 by Cronbach's α coefficient. Our results suggest that the COPD Assessment Test may be a candidate for evaluating the health status and impact of disease on patients with interstitial lung disease.

Keywords

Interstitial Lung Disease, Quality of Life, Questionnaire, Pulmonary Function, Oxygen Saturation,

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Home Oxygen Therapy

1. Introduction

The health-related quality of life (QOL) in patients with COPD has been assessed using questionnaires such as the Medical Outcomes Study Short-Form 36 [1], St. George's Respiratory Questionnaire [2]-[4], and the Chronic Respiratory Disease Questionnaire [5] [6]. A correlation was previously reported between QOL and pulmonary function, especially forced expiratory volume in 1 second (FEV₁) [2] [7]. St. George's Respiratory Questionnaire score was shown to be improved by pulmonary rehabilitation [3] [8] and medication [4]. Moreover, physical impairments including pulmonary function are correlated with preexisting QOL assessment scores in patients with interstitial lung disease using the same questionnaires for COPD [9], and the effectiveness of interventions has been suggested through QOL evaluation [10].

A novel and simple QOL questionnaire was recently developed for use in routine clinical practice to measure the health status of patients with COPD. The results of the COPD Assessment Test (CAT) [11], which only took 107 sec on average to be completed, were correlated with those obtained using St. George's Respiratory Questionnaire, which took an average of 578 sec to be completed [12]. The CAT consists of eight patient-completed items, with higher scores indicating a worse health status, and the total score ranges from 0 to 40. An increase of approximately 2 points in the score on St. George's Respiratory Questionnaire was shown to correspond to a 1-point increase in the CAT score [13].

The CAT scores were categorized into low, medium, high, and very high impact, and users of the CAT proposed descriptive scenarios, as the clinical picture of COPD and possible management considerations, according to the impact of COPD [14]. A statistically significant relationship between the CAT score and pulmonary function, that is, forced vital capacity (FVC), vital capacity (VC), FEV₁, and PaO₂, is also shown in patients with interstitial lung disease [15]. However, the clinical picture of the impact of interstitial lung disease by the CAT score has not been elucidated.

Considering the differences in clinical symptoms between COPD and interstitial lung disease, we retrospectively investigated symptoms affecting the CAT score in subjects with interstitial lung disease. Then, we aimed to propose some potential management considerations according to the grading impact by CAT scores like COPD.

2. Methods

2.1. Subjects and Methods

When examined retrospectively, subject record was anonymized and de-identified prior to analysis. The protocol of the present study was approved by the Human Ethics Committee of the University. Fifty-two consecutive subjects with interstitial lung disease were referred for a closer physical examination at the time of diagnosis or during follow-up when they were admitted to our facility in January 2013 to July 2014 (Table 1). Ten subjects were diagnosed with idiopathic pulmonary fibrosis, 25 with systemic sclerosis, 13 with polymyositis/dermatomyositis, and 4 with rheumatoid arthritis. Five subjects were excluded prior to the selection of subjects because they exhibited severe leg pain or muscle weakness when walking. Interstitial lung disease was confirmed by radiographic and/or histopathological examinations. At the time of inclusion in the study, 12 subjects received home oxygen therapy with a flow rate of up to 3 liters per minute.

Subjects completed the Japanese version of the CAT [13] on the first day of their visit. The eight items in the CAT covered cough, phlegm, chest tightness, breathlessness, activity limitations at home, confidence in leaving the home, sleep, and energy. All subjects could complete a 5-point rating scale of each item by themselves. When the 6-min walk test was performed, SpO₂ was recorded at rest and at the end of the test using pulse oximetry. Subjects on home oxygen therapy completed the 6-min walk test with oxygen supplementation at the same oxygen flow rate at home. If subjects could not complete the 6-min walk test due to dyspnea, the SpO₂ value was recorded when subjects quit the test. Exercise-induced oxygen desaturation was defined as a decrease of $\geq 4\%$ from the resting SpO₂ value at the end of the walking test [16]-[18]. For this reason, it was reported that a decrease of $\geq 4\%$ from the resting SpO₂ value was significantly associated with the dyspnea index and FVC <

Table 1. Characteristics of the patients (n = 52).

Variables	Values
Age, years	61.5 ± 13.7
Gender f/m	30/22
Height, cm	159 ± 10
Weight, kg	57 ± 12
Time since diagnosis, years	8 ± 9
CAT total score	15.5 (7.25 - 22.75)
Cough	2 (0.25 - 3)
Phlegm	1 (0 - 2)
Chest tightness	1.5 (0 - 3)
Breathlessness	3 (2 - 5)
Activity limitation at home	1 (0 - 3)
Confidence in leaving the home	1.5 (0 - 4)
Sleep	0 (0 - 2)
Energy	2 (0.25 - 3)
Pulmonary function	
FVC, % predicted	84.1 ± 26.4
FEV ₁ , % predicted	91.2 ± 22.9
TLC, % predicted	76.6 ± 21.0
DLCO, % predicted	51.4 ± 23.9
SpO ₂ at rest, %	97 ± 2
Oxygen desaturation after walking, n	29
PaO ₂ in room air, mmHg	80.1 ± 17.2
PaCO ₂ in room air, mmHg	39.4 ± 5.5
Home oxygen therapy, n	12

Values are expressed as mean ±SD, median (interquartile range), or number. CAT, COPD Assessment Test; FVC, forced vital capacity; FEV₁, forced expiratory volume in 1 second; TLC, total lung capacity; D_{LCO}, diffusion capacity of the lung for carbon monoxide. D_{LCO} could not be measured for 8 subjects due to severely impaired pulmonary function.

80% predicted [18], and implied a risk of mortality [16] in patients with interstitial lung disease.

Clinical information during a closer examination was retrospectively collected from all subjects by reviewing their medical records, in terms of gender, age, morphological measurements, duration of disease at their admission to our facility after diagnosis with interstitial lung disease, percentage of predicted FVC, FEV₁, total lung capacity (TLC), single-breath diffusing capacity of the lung for carbon monoxide (D_{LCO}) (Chestac-9800, Chest Medical Instruments, Tokyo, Japan), and PaO₂ and PaCO₂ in room air. D_{LCO} was adjusted by the measured hemoglobin concentration [19]; however, D_{LCO} could not be measured for eight subjects due to severely impaired pulmonary function.

2.2. Statistics

JMP 8 software (SAS Institute Inc., Cary, NC) was used for statistical analysis. The reliability of the eight items in the CAT was examined using Cronbach's α coefficient. Spearman's correlation coefficient was used to examine the correlations between the CAT score and FVC, FEV₁, TLC, DLCO, SpO₂ at rest, PaO₂, and PaCO₂. Using the Mann-Whitney test, we examined the effects of exercise-induced oxygen desaturation ($\geq 4\%$ vs. $< 4\%$) and home oxygen therapy (on vs. off) on the CAT scores. Kruskal-Wallis test was used to assess the differences of symptoms in the CAT among the four impact levels of the CAT score. $p < 0.05$ was considered significant.

3. Results

The CAT score was negatively correlated with the percentage of predicted FVC, FEV₁, TLC, D_{LCO}, and PaO₂ ($p = 0.0005, 0.005, 0.0002, 0.0005, \text{ and } 0.002$, respectively) (Table 2). SpO₂ at rest was as high as $97\% \pm 2\%$ (Table 1) because of oxygen supplementation to subjects on home oxygen therapy; the lowest value of SpO₂ was 92%. PaCO₂ was almost normal, and a review of the medical records revealed that no subjects exhibited CO₂ narcosis. Consequently, the CAT score did not correlate with SpO₂ at rest or PaCO₂ (Table 2).

The reliability of the eight items in the CAT was 0.87 by Cronbach's α coefficient, which was markedly higher than 0.70, a value that was considered to be indicative of internal consistency [13]. The scores of all items in the CAT were significantly different among the four impact levels (Table 3). As items were each scored from 0 to 5, a score of 3 or higher was associated with a likelihood of presenting noticeable symptoms. No median score of items showed a higher score at low impact. A median score of 3 was found for the item of breathlessness, that is, breathlessness when walking up a hill or one flight of stairs, at medium impact. The last items showing a higher median score were phlegm and sleep at very high impact.

The CAT score was significantly higher in subjects with exercise-induced oxygen desaturation than in those without it ($p = 0.0001$) (Figure 1). The 25th percentile score was 13 in subjects with oxygen desaturation. Twelve subjects on home oxygen therapy were included in the group of subjects with exercise-induced oxygen desaturation regardless of oxygen supplementation while walking. These 12 subjects showed significantly higher CAT scores than subjects off home oxygen therapy ($p = 0.0007$), with the 25th percentile score being 21.25 (Figure 2).

Table 2. Spearman's correlation coefficient of the CAT score with parameters of respiratory status (n = 52).

Variables	R	P
FVC, % predicted	-0.47	0.0005
FEV ₁ , % predicted	-0.38	0.005
TLC, % predicted	-0.51	0.0002
D _{LCO} , % predicted	-0.50	0.0005
SpO ₂ at rest, %	-0.06	0.67
PaO ₂ in room air, mmHg	-0.48	0.002
PaCO ₂ in room air, mmHg	-0.16	0.31

CAT, COPD Assessment Test; FVC, forced vital capacity; FEV₁, forced expiratory volume in 1 second; TLC, total lung capacity; D_{LCO}, diffusion capacity of the lung for carbon monoxide. D_{LCO} could not be measured for 8 subjects due to severely impaired pulmonary function.

Table 3. The score of each item in the CAT and impact level.

Impact level	Low	Medium	High	Very High	P
CAT score	0 - 10	11 - 20	21 - 30	31 - 40	
N	19	16	15	2	
Cough	1 (0 - 2)	2 (1 - 3)	3 (0 - 4)	3.5 (3 - 4)	0.032
Phlegm	0 (0 - 1)	2 (1 - 2.75)	2 (1 - 4)	4 (3 - 5)	0.003
Chest tightness	0 (0 - 1)	1.5 (0.25 - 3)	3 (2 - 4)	4 (4 - 4)	<0.0001
Breathlessness	1 (0 - 3)	3 (2 - 4)	5 (4 - 5)	5 (5 - 5)	<0.0001
Activity limitations at home	0 (0 - 0)	1.5 (0.25 - 2.75)	4 (3 - 5)	3.5 (3 - 4)	<0.0001
Confidence in leaving the home	0 (0 - 0)	2 (0 - 3)	4 (3 - 5)	4 (4 - 4)	<0.0001
Sleep	0 (0 - 0)	1.5 (0 - 2)	2 (0 - 4)	3 (3 - 3)	0.0002
Energy	0 (0 - 2)	2.5 (2 - 3)	3 (3 - 4)	4.5 (4 - 5)	<0.0001

Values are expressed as median (interquartile range). CAT, COPD Assessment Test. Kruskal-Wallis test was used to assess the differences among the four impact levels.

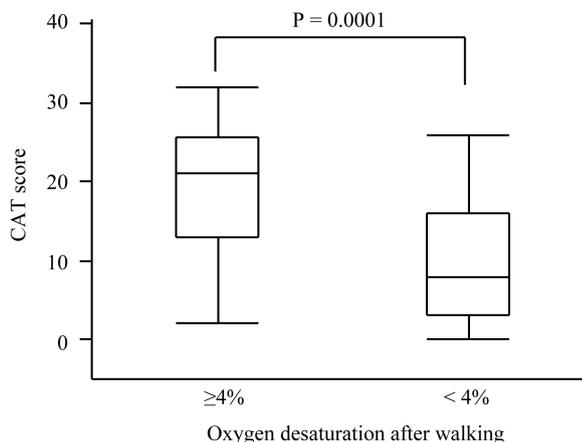


Figure 1. The COPD Assessment Test (CAT) scores classified according to oxygen desaturation. Boxes represent medians and interquartile ranges, whiskers represent the Tukey boxplots (the lowest datum still within the 1.5 interquartile range of the lower quartile, and the highest datum still within the 1.5 interquartile range of the upper quartile). The 25th percentile score was 13 in subjects with oxygen desaturation.

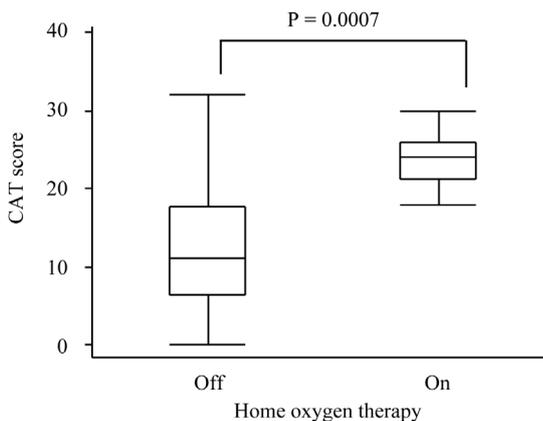


Figure 2. The COPD Assessment Test (CAT) scores classified according to home oxygen therapy. Boxes represent medians and interquartile ranges, whiskers represent the Tukey boxplots (the lowest datum still within the 1.5 interquartile range of the lower quartile, and the highest datum still within the 1.5 interquartile range of the upper quartile). The 25th percentile score was 21.25 in subjects on home oxygen therapy.

4. Discussion

In the present study, the CAT score was correlated with percentage of predicted FVC, FEV₁, TLC, D_{LCO}, and PaO₂. Previously, in patients with interstitial lung disease, components in the Short-Form 36 were correlated with FVC, FEV₁, and D_{LCO}, but not with TLC [9] [20]. The Chronic Respiratory Questionnaire score correlated with D_{LCO}, but not with FVC, FEV₁, or TLC [9]. St. George’s Respiratory Questionnaire score correlated with FVC, FEV₁, D_{LCO}, and TLC [9]. It was also shown that the CAT score correlated with FVC, VC, FEV₁, and PaO₂, as mentioned in the introduction [15]. These findings clearly support a significant relationship between QOL evaluation including the CAT score and pulmonary function in patients with interstitial lung disease. In patients with COPD, percentage of predicted FEV₁ is an important correlate of QOL among the representatives of pulmonary function [2] [7], and the parameter in patients with interstitial lung disease might also be a good candidate for a primary correlate of QOL. It has been reported that St. George’s Respiratory Questionnaire scores were worse for patients with interstitial lung disease than for patients with COPD with similar degrees of FEV₁ impairment [21]. The same kind of study would be required for the CAT considering the clinical management of interstitial lung disease.

As SpO₂ at rest was elevated up to 97% on average, no correlation was observed with the CAT score. However, exercise-induced oxygen desaturation significantly affected the CAT score even in subjects with supplemental oxygen. The 25th percentile score were 13 in patients with exercise-induced oxygen desaturation in the present study, which suggested impairment of oxygen saturation might be of concern at medium and severer impact in interstitial lung disease. Additionally, patients on home oxygen therapy might be at the high and severer impact levels. Previously, prescription of long-term oxygen therapy by an oxygen concentrator was shown not to affect the QOL of patients with severe COPD, although they showed lower QOL than patients with less severe COPD [22]. For this reason, it was explained that COPD patients used oxygen as they expected some benefit in terms of survival. In the present study, the high CAT score in subjects on home oxygen therapy might have been due to the severity of disease and exercise-induced oxygen desaturation.

In the present study, the reliability of items in the CAT as shown by Cronbach's α coefficient was 0.87. This value was reported as 0.88 in the original CAT [11] and as 0.89 in the Japanese version of the CAT [13], which is the approved translation of the CAT questionnaire for COPD. These results suggest that all items were consistent and measured almost the same underlying construct statistically, even in patients with interstitial lung disease.

Breathlessness was the main symptom for subjects at the medium impact level, scored as 3. In patients with COPD, breathlessness was part of the clinical picture as well as cough and activity limitations at home at the medium impact level, and these subjects were known to suffer from cough and phlegm [14]. However, cough and activity limitations at home were not noticeable symptoms at the medium impact level (scored as 2 and 1.5, respectively), and phlegm was the last item with a higher score (≥ 3) in subjects in this study. The difference in the clinical picture between interstitial lung disease and COPD was suggested to be shown even by the CAT.

Optimized management should be proposed for patients with a higher CAT score in the future. Pulmonary rehabilitation was suggested to improve QOL in interstitial lung disease [10], so possible management should be considered according to the impact level. For example, pulmonary rehabilitation seemed to improve 6-min walking distance effectively in patients with poor functional status with interstitial lung disease [23]. Therefore, the impact level of the CAT score for beneficial management as pulmonary rehabilitation should be clarified to propose an intervention for patients with interstitial lung disease.

The Japanese version of the CAT was developed in 2012 [13]; therefore, the number of subjects who have taken this test is limited to those who have visited our facility. Even though the number of subjects was small in this study, a significant relationship between the CAT score and pulmonary function was shown. A prospective study is needed to demonstrate the more precise impact of interstitial lung disease, accumulating a broader range of information on the clinical picture and possible management considerations.

5. Conclusion

The CAT score in subjects with interstitial lung disease was correlated with pulmonary function and was higher in subjects with exercise-induced oxygen desaturation and on home oxygen therapy than that in those without these factors. The reliability of the eight items in the CAT was as high as that in patients with COPD. Moreover, the clinical symptom found to be the high scoring item was breathlessness. Cough and phlegm, typical symptoms in COPD, were not noticeable at the lower impact level in this study. The CAT might be available to evaluate health-related QOL in patients with interstitial lung disease.

Disclosures

None.

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