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Original Research Article

Correlation between 6-minute walk distance and spirometry parameters in stable chronic obstructive pulmonary disease patients

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ABSTRACT

Background: Six minute walk test (6MWT) is a sub-maximal exercise test, used as a clinical indicator of the functional capacity, in patients with cardiopulmonary diseases. It is simple, objective and reproducible test. The present study was designed to assess correlation of six minute walk test with spirometry parameters, in patients with chronic obstructive pulmonary disease.
Methods: In this cross sectional study, fifty patients diagnosed with chronic obstructive pulmonary disease (GOLD criteria) coming to tertiary center were recruited according to inclusion and exclusion criteria. All patients underwent spirometric measurement. Spirometric indices including FEV1, FVC, FEV1/FVC and MVV were tested using computerized spirometer. 6MWT was performed following American Thoracic Society (ATS) guidelines. Percent (%) predicted 6MWD was calculated. Correlation between spirometry and 6MWT was assessed.
Results: It was found that correlation between 6MWT and spirometry is statistically significant. There is significant strong positive correlation between percent predicted 6MWD and FEV1 ($r=0.850$ and $p= <0.001$), whereas there is significant moderate correlation between percent predicted 6MWD and FVC ($r=0.554$ and $p= <0.001$), FEV1/FVC ($r=0.509$ and $p= <0.001$) and MVV ($r=0.615$ and $p= <0.001$).
Conclusions: In chronic obstructive pulmonary disease, percent predicted 6mwd significantly correlated with the spirometry parameters (FEV1, FVC, FEV1/FVC, and MVV). 6MWD decreases as there is decline in the pulmonary function. 6MWT can be a useful replacement of spirometry in assessment of severity of COPD.

Keywords: 6MWD, COPD, PFT

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a growing worldwide public health problem. COPD is determined as a major cause of morbidity and mortality globally. Numbers of people suffer from this disease for years and death occurs prematurely by its complications. COPD causes 2.7 lac deaths every year in India. Almost all forms of smoking products are significantly associated with COPD. In non-smokers, especially women, an exposure to biomass fuels, smoke is an important factor.[1] COPD is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and excessive mucus production. Exacerbations and comorbidities leads to overall severity and death in individual patients. Several other associated conditions such as increased systemic inflammation in early stages

of COPD, risk for future exacerbations, cardiovascular diseases, weight loss, loss of fat-free mass combined with muscle dysfunction, osteoporosis, hypoxemia and depression add to the morbidity and lead to reduced exercise limitation in these patients.[2,3]

According to GOLD international COPD guidelines, spirometry is the gold standard for accurate and repeatable measurement of lung function. The severity of this disease is graded according to the forced expiratory volume in 1 second (FEV1). In COPD, there is airflow obstruction which causes air trapping and hyperinflation due to which patient is unable to exhale forcefully which causes decline in FEV1 values. Also, respiratory muscle weakness contributes to loss in FEV1. FEV1/FVC ratio is generally used to define the presence or absence of airflow limitation. An impaired exercise tolerance is the main feature in COPD. Because of the hypoxemia there is peripheral muscle weakness which leads to impaired exercise tolerance. This impaired exercise tolerance cannot be confidentially predicted from conventional descriptors of COPD patients such as age, gender, FEV1 and body mass index (BMI). For these reasons, it is essential to measure patient's exercise tolerance.[4]

Six minute walk test (6MWT) is a sub-maximal exercise test, used as a clinical indicator of the functional capacity, in patients with cardiopulmonary diseases. It is an objective method to measure the ability to perform daily physical activities. The purpose of the six minute walk test is to evaluate exercise tolerance, monitor therapy and predict prognosis in patients with chronic respiratory disease like COPD, interstitial lung disease (ILD), pulmonary hypertension (PH) and chronic heart failure.[5-7] Test measures distance walked with maximal intensity, which better reflects patient's functional exercise level for daily physical activity.[8] Overall survival in patients is poor with a low Walking distance i.e. <150m.[9]

The facility of spirometry is not available in many rural areas of India because of lack of infrastructure where 6MWT can be done easily. Therefore, in this study, we aimed to correlate 6minute walk distance (6MWD) with different spirometric indices, and thus to evaluate whether 6MWT can replace spirometry in predicting severity of COPD.

METHODS

this cross sectional study was conducted at tertiary center. 50 patients diagnosed with chronic obstructive pulmonary disease (GOLD criteria) were included. Patients with any other pulmonary diseases or cardiac condition, acute exacerbation of COPD, elevated systolic blood pressure (SBP) more than 180mmHg and resting heart rate (HR) more than 120, peripheral vascular diseases and any musculoskeletal or neurological condition were excluded. Patients with definite respiratory diagnosis were undergone a pulmonary function test, using RMS Helios 401, version-1.3 instrument, using standard protocol. Spirometric indices including FEV1, FVC, FEV1/FVC and MVV were tested using computerized spirometer. Reproducibility was ensured by doing at least three measurements for each lung function. 6MWT was performed according to the ATS guidelines.[10] At the time of test, the patient's HR, BP, RR and RPE was measured. Subjects were asked to walk at their own pace, along a 30m long and straight hallway. Each patient was instructed to walk as much distance as possible in 6 minutes. No encouragement was offered, but the patient were told standardized phrase to indicate the time remaining. The patient were allowed to stop if symptoms of significant distress occurred, like severe dyspnea, chest pain, dizziness, diaphoresis, or leg cramps. However, the patients were asked to resume walking as soon as he can. At the end of six minutes, the patients were asked to stop and measurement of blood pressure, heart rate, respiratory rate will be taken and the distance walked for 6minutes was recorded. The confounding factors like age, weight and height was checked for calculating percent predicted 6MWD using Indian reference equation. Reference equations for 6-min walk test in healthy Indian subjects (25-80 years).[11]

The gender specific reference equations for healthy Indian individuals:

- Males: 561.022 - (2.507 × age [years]) + (1.505 × weight [kg]) - (0.055 × height [cm]).
- Indian females: 30.325 - (0.809 × age [years]) - (2.074 × weight [kg]) + (4.235× height [cm]).
- Percent predicted 6 MWD = actual 6MWD/predicted 6MWD x100.

Statistical test was done using the software SPSS (Statistical Package for Social Sciences) Version 16. Correlation between percent predicted 6minute walk distance and spirometry parameters (FEV 1, FVC, FEV1/FVC, and maximal voluntary ventilation) was done by the Pearson's correlation coefficients.

RESULTS

A total of 50 patients consisting of 35 males and 15 females, were included in the study on the basis of inclusion and exclusion criteria. The patients included in the study were in the age group of 50-75 years (mean age for males= 58.19±8.01, for females = 60.46±9.47). Out of these 50 COPD patients included in the study, 28 patients were smokers and 22 were non-smokers. The mean BMI of study patients were 24.973±3.29 with highest BMI of 32.51 and lowest BMI of 20.08. Majority of patients (30%) in this study were of normal BMI of 18.5 to 22.9. Only (4%) of patients in this study were Obese (>30 BMI).

The mean actual 6MWD was 359.43 meters with standard deviation (SD) of 36.65. The mean percent predicted 6MWD as per Indian reference equation by Ramanathan et al, formula calculated was 71±13.74%.

The mean values for FEV1, FVC, FEV1/FVC and MVV were 49±11.29, 71±15.13, 61±9.39 and 61±14.50 respectively.

Correlation analysis: The correlation coefficients between percent predicted 6MWD with the spirometric parameters were shown in Table 1. 6MWD had significant strong positive correlation with FEV1 (r=0.850; p<0.001). Whereas, 6MWD had significant moderate positive correlation with FVC, FEV1/FVC and MVV (r=0.554, 0.509, 0.615 respectively; p<0.001). It shows that decrease in spirometry parameters was associated with decrease in 6MW.

Table 1: Correlation between percent predicted 6 MWD and spirometry parameters.

		FEV1	FVC	FEV1/FVC	MVV
Percent predicted 6MWD	Pearson correlation coefficient (r value)	0.850	0.554	0.509	0.615
	P value	0.000	0.000	0.000	0.000
	N	50	50	50	50

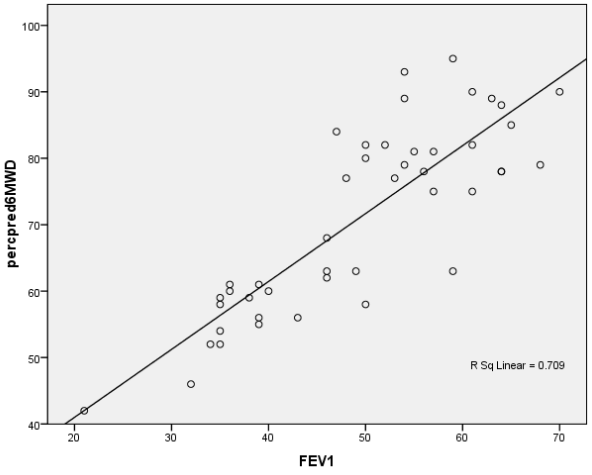

Figure 1: Correlation between percent predicted 6 MWD and FEV1.

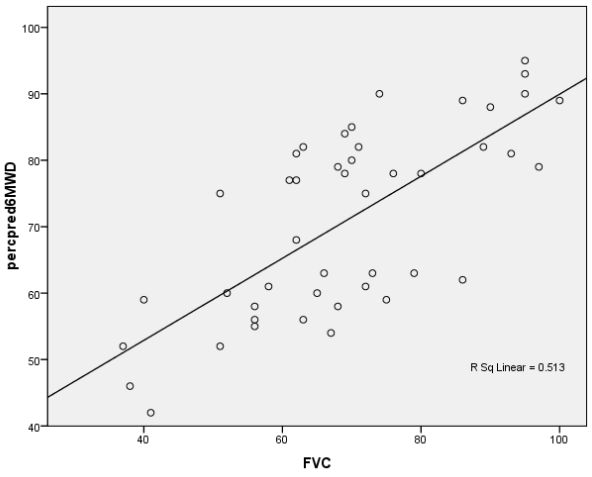

Figure 2: Correlation between percent predicted 6 MWD and FVC.

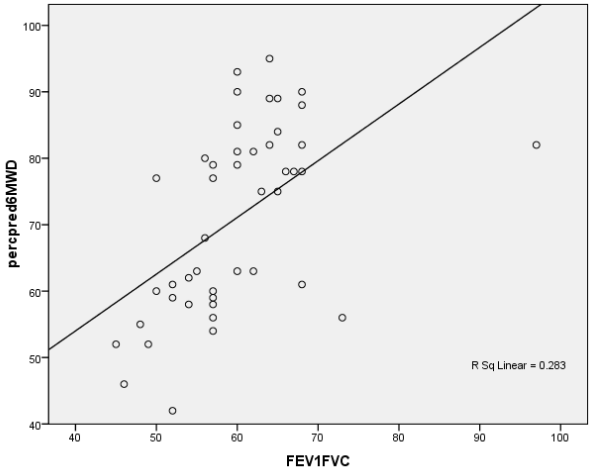

Figure 3: Correlation between percent predicted 6 MWD and FEV1/FVC.

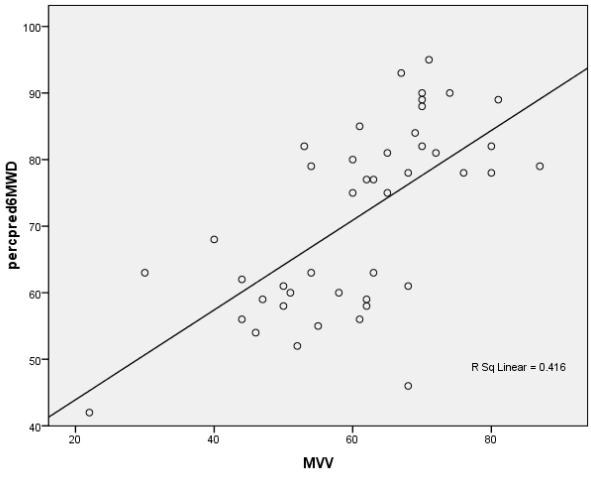

Figure 4: Correlation between percent predicted 6 MWD and MVV.

Figure 1 shows that there is significant strong positive correlation between percent predicted 6MWD and FEV1 (r= 0.850, P= <0.001). Figure 2 shows that significant moderate correlation between percent predicted 6MWD and FVC (r= 0.554, P= <0.001). Figure 3 shows that there is significant moderate correlation between percent predicted 6MWD and FEV1/FVC (r= 0.509, P=<0.001). Figure 4 shows that there is significant moderate correlation between percent predicted 6MWD and MVV (r= 0.615, P= <0.001).

DISCUSSION

The study was aimed to correlate 6 MWD and Spirometry parameters in patients with COPD. 50 (35 males and 15 female) subjects were selected on the basis of inclusion and exclusion criteria. The patients included in the study were in the age group of 50-75 years (mean age for males= 58.19±8.01, for females = 60.46±9.47). Out of these 50 COPD patients included in the study, 28 patients were smokers and 22 were non-smokers. The objective of the study was to correlate the 6minute walk distance with the spirometry parameters by calculating Pearson's correlation coefficient. The statistical analysis ran by SPSS showed that there is significant strong positive correlation (Pearson's correlation coefficient r =0.850, P= <0.001) between 6 MWD and FEV1. Whereas, FVC, FEV1/FVC, MVV are having significant moderate positive correlation with 6MWD (Pearson's correlation coefficient r =0.554, r = 0.509, r =0.615, P =<0.001) respectively. It meant that decrease in spirometry parameters was associated with decrease in 6MWD. Agrawal M et al, studied correlation between six minute walk test and spirometry in chronic pulmonary disease also found that FEV1 and FVC had very significant positive correlation with absolute as well as percent predicted 6MWD whereas there was no correlation between FEV1/FVC and MVV with 6MWD.[12] Studies done by Hatem FS AL Ameri and Mehta etal showed positive correlation between 6MWT and FEV1 and FVC.[13] In these studies correlation of 6MVD with FEV1/FVC and MVV were not studied.

The chronic airflow limitation is characteristic of COPD which is caused by a mixture of small airway disease (obstructive bronchiolitis) and also parenchymal destruction (emphysema). Except chronic airflow limitation and a multiple pathological changes in lungs, COPD also causes various significant extrapulmonary changes which cause reduction in physical activity in patients with COPD. Study done by Watz H, Waschki B et al in 2007 found that higher values of systemic inflammation and left cardiac dysfunction are related with reduced physical activity in patients with COPD, which does not depend upon the stages of COPD according to GOLD or the multidimensional BODE index.[14]

In our study we found that there is significant positive correlation between percent predicted 6MWD and spirometry parameters. There is decrease in percent predicted 6MWD with decrease in the pulmonary function test because of the peripheral muscle weakness leading to impaired exercise tolerance in COPD patients.

In advanced disease, there is loss of fat-free mass, muscle atrophy, and deconditioning of muscle mass leading to peripheral muscle weakness which finally results in reduction in exercise tolerance in patients with COPD.[15,16]

Weight loss, depression and anaemia are found frequently in COPD patients and have significant effect on the severity and mortality in COPD.[17]

As described earlier, skeletal muscle dysfunction is an important extrapulmonary sequel of COPD. It affects quadriceps muscle the most, this result in decreased muscle strength with reduced endurance capacity. There are number of factors that lead to dysfunction of skeletal muscle in COPD. Amongst which chronic hypoxemia significantly contribute to this process. Probable mechanism for that is hypoxia leads to low-grade chronic systemic inflammation that characterizes COPD. TNFα can provoke muscle cell apoptosis and protein degradation via the proteasome system.[18] Levels of TNFα, and of other circulating inflammatory cytokines, such as interleukin-8, can cause skeletal muscle dysfunction in COPD.

Another mechanism that can lead to skeletal muscle dysfunction is generation of oxidative stress. In normal aerobic metabolism, reactive oxygen species are produced and within physiological levels it participates in cell signalling and host-Defense against infection. Higher levels of reactive oxygen can mediate damage to lipids, proteins, and DNA, and drive inflammatory cascades. Imbalance between the generation of reactive oxygen species and antioxidant capacity leads to oxidative stress which impairs skeletal muscle contractility.[19,20]

Chronic hypoxemia can cause development of adverse sequel of COPD, which includes pulmonary hypertension, secondary polycythemia, systemic inflammation, and skeletal muscle dysfunction. All of these factors lead to impaired quality of life, reduced exercise tolerance, increased risk of cardiovascular morbidity, and greater risk of death.[21]

Apart from peripheral muscle weakness exercise-limiting factors in patients with COPD can be imbalance between ventilatory capacity and demand, which is manifested by diminished maximum and sustainable voluntary capacity at rest and eventually by the inability to sufficiently increase minute ventilation during exercise, and the increased ventilatory requirements lead to sensation of dyspnea. Reduced ventilatory capacity: Increased airway resistance due to combined effect of excessive mucus production and thickening of wall of bronchial lumen either by inflammation or reduced elastic lung recoil causes expiratory flow limitation which leads to air

trapping. The lung hyperinflation at rest hampers patient ability to increase ventilation in demanding situation like exercise.[22]

Increased ventilatory Demand: COPD patients adopts pattern of rapid and shallow breathing at rest and during exercise compared to normal. This reduces exhalation time causing further air trapping and dynamic lung hyperinflation and reduces lung compliance. Eventually, reduced lung compliance leads to progressively increased demand of power output. Leading to increase in breathing rate, this aggravates dyspnea and limits exercise performance.[23]

Also due to imbalance between oxygen supply to respiratory and peripheral muscles can lead to exercise limitation. COPD patients produces a considerably greater work of breathing than in healthy individuals leading to the greater ventilation per se and also the higher oxygen cost per liter of ventilation.[24] 6MWT evaluates the integrated responses of all including the respiratory system, cardiovascular systems, blood, neuromusculoskeletal system, and muscle metabolism.

As seen earlier, COPD is associated with loss of muscle mass and peripheral muscle dysfunction which finally results in the digression of the exercise tolerance. Exercise tolerance reflects patient's quality of life and predicts the prognosis. The 6MWT is easy to administer, economic, better tolerated, and more reflective of activities of daily life. It may be widely used to evaluate the exercise tolerance in patients with heart or lung disease.[25]

Pulmonary function test is the gold standard for the diagnosis of COPD at present.[26] FEV1 has traditionally been used to grade severity of COPD. However, the PFT is difficult to perform for some patients, especially for patients with seriously impaired pulmonary function and extreme dyspnea and it can be insensitive tool for assessing the functional status in these patients. Moreover, many hospitals could not provide the specialized equipment for the PFT. In these circumstances, the 6MWT can play a very important role in measuring the functional status of these patients. Hence, the correlation of 6MWT and pulmonary function test, in patients with chronic pulmonary diseases, makes this test easy and a simple tool for assessing the disease status and can be safely performed in patients with advanced respiratory disease. Therefore, 6MWT can be used as an additional tool in combination with other physiological parameters in assessing the lung function in COPD patients.

This study has several limitations as follows:

- No healthy person was taken as control and we could not compare 6MWD of study population with healthy control, post-bronchodilator 6MWT was not done in our study.
- Correlation of age, BMI with 6MWD and spirometry parameters was not evaluated.

CONCLUSION

In chronic obstructive pulmonary disease, percent predicted 6mwd significantly correlated with the spirometry parameters (FEV1, FVC, FEV1/FVC, and MVV). 6MWD decreases as there is decline in the pulmonary function. The 6MWT may be used to monitor changes of pulmonary function in COPD.

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REFERENCES

1. Barnes PJ. Chronic obstructive pulmonary disease: A growing But Neglected Global epidemic. Plos Med. 2007;4(5):e112.
2. Watz H, Magnussen H. Comorbidities of COPD. Internist (Berl). 2006;47(9):895-6.
3. The Official statement of the American thoracic society, approved by the American thoracic society board of directors 2002. Am J Respir Crit Care Med. 2002;166:111-7.
4. Di Marco F, Terraneo S, Roggi MA, Repossi AC, Pellegrino GM, Veronelli A, et al. Physical activity impairment in depressed COPD subjects. Res Care. 2014 May 1;59(5):726-34.
5. Miyamoto S, Nagaya N, Satoh T, Kyotani S, Sakamaki F, Fujita M, et al. Clinical correlates and prognostic significance of six-minute walk test in patients with primary pulmonary hypertension: comparison with cardiopulmonary exercise testing. Am J Res Crit Care Med. 2000 Feb 1;161(2):487-92.
6. Chetta A, Aiello M, Foresi A, Marangio E, D'Ippolito R, Castagnaro A, et al. Relationship between outcome measures of six-minute walk test and baseline lung function in patients with interstitial lung disease. Sarcoidosis, vasculitis, and diffuse lung diseases: J WASOG. 2001 Jun;18(2):170-5.
7. Eaton T, Young P, Milne D, Wells AU. Six-minute walk, maximal exercise tests: reproducibility in fibrotic interstitial pneumonia. Am J Respir Crit Care Med. 2005;171(10):1150-57.
8. Andrzejczak-Karbowska M, Kapusta J, Inman M, Kowalski J, Irzmański R. Evaluation of the effectiveness of exercise-based controlled physical effort in women with heart failure in the elderly. Polski merkuriusz lekarski: organ Polskiego Towarzystwa Lekarskiego. 2015 Jan;38(223):11-5.
9. Dajczman E, Wardini R, Kasymjanova G, Préfontaine D, Baltzan MA, Wolkove N. Six minute walk distance is a predictor of survival in patients with chronic obstructive pulmonary disease

undergoing pulmonary rehabilitation. Canadian respiratory journal. 2015;22(4):225-9.
10. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166:111-7.
11. Ramanathan RP, Chandrasekaran B. Reference equations for 6-min walk test in healthy Indian subjects (25-80 years). Lung India: official organ of Indian Chest Society. 2014 Jan;31(1):35.
12. Agrawal MB, Awad NT. Correlation between Six minute walk test and spirometry in chronic pulmonary disease. JCDR. 2015 Aug;9(8):OC01.
13. Al Ameri H. Six minute walk test in respiratory diseases: A university hospital experience. Annals of Thoracic Medicine. 2006 Jan 1;1(1).
14. Watz H, Waschki B, Boehme C, Claussen M, Meyer T, Magnussen H. Extrapulmonary effects of chronic obstructive pulmonary disease on physical activity: a cross-sectional study. Am J Res Crit Care Med. 2008 Apr 1;177(7):743-51.
15. Ernard S, Leblanc P, Whittom F, Carrier G, Jobin J, Belleau R, Maltais F. Peripheral muscle weakness in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 1998;158:629-634.
16. Gosker HR, Engelen MP, van Mameren H, van Dijk PJ, van der Vusse GJ, Wouters EF, et al. Muscle fiber type IIX atrophy is involved in the loss of fat-free mass in chronic obstructive pulmonary disease. Am J Clin Nutri. 2002;76:113-9.
17. Similowski T, Agustí A, MacNee W, Schönhofer B. The potential impact of anaemia of chronic disease in COPD. Euro Respir. J 2006;27:390-6.
18. Kim HC, Mofarrahi M, Hussain SN. Skeletal muscle dysfunction in patients with chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis. 2008;3:637-58.
19. Davidson AC, Leach R, George RJ, Geddes DM. Supplemental oxygen and exercise ability in chronic obstructive airways disease. Thorax. 1988;43:965-71.
20. Kent BD, Mitchell PD, McNicholas WT. Hypoxemia in patients with COPD: cause, effects, and disease progression. Inter J Chron Obst Pul Dis. 2011;6:199-208.
21. O'Donnell DE, Webb KA. The major limitation to exercise performance in COPD is dynamic hyperinflation. J Appl Physiol. 2008;105:753-5.
22. Tantucci C. Expiratory flow limitation definition, mechanisms, methods, and significance. Pul Med. 2013;2013:749860.
23. O'Donnell DEOD, Laveneziana P. Patterns of cardiopulmonary response to exercise in lung diseases; 2007.
24. Panagiotou M, Vogiatzis I, Kastanakis E. Exercise Limitation in COPD. Pneumon. 2013;26(3):245-56.
25. Solway S, Brooks D, Lacasse Y, Thomas S. A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. Chest 2001;119:256-70.
26. Rabe KF, Hurd S, Anzueto A, Barnes PJ, Buist SA, Calverley P, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med. 2007;176:532-55.

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