ORIGINAL ARTICLE

The SAFE (SGRQ score, air-flow limitation and exercise tolerance) Index: a new composite score for the stratification of severity in chronic obstructive pulmonary disease

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Background: This study was proposed to develop a composite of outcome measures using forced expiratory volume percentage of predicted, exercise capacity and quality of life scores for assessment of chronic obstructive pulmonary disease (COPD) severity.
Materials and methods: Eighty-six patients with COPD were enrolled into a prospective, observational study at the respiratory outpatient clinic, National University Hospital Malaysia (Hospital Universiti Kebangsaan Malaysia - HUKM), Kuala Lumpur.
Results: Our study found modest correlation between the forced expiratory volume in 1 s (FEV_1), 6 min walk distance and the SGRQ scores with mean (SD) values of 0.97 (0.56) litres/s, 322 (87) m and 43.7 (23.6)%, respectively. K-Means cluster analysis identified four distinct clusters which reached statistical significance which was refined to develop a new cumulative staging system. The SAFE Index score correlated with the number of exacerbations in 2 years ($r = 0.497$, $p < 0.001$).
Conclusion: We have developed the **S**GRQ, **A**ir-**F**low limitation and **E**xercise tolerance Index (SAFE Index) for the stratification of severity in COPD. This index incorporates the SGRQ score, the FEV_1 % predicted and the 6 min walk distance. The SAFE Index is moderately correlated with the number of disease exacerbations.

The diagnosis of chronic obstructive pulmonary disease (COPD) is confirmed by spirometry when the forced expiratory volume in 1 s to forced vital capacity (FEV_1/FVC) ratio is less than 70%. Both the American Thoracic Society and the European Respiratory Society recommend a simple staging system to assess COPD severity based on post-bronchodilator FEV_1 as percentage of the predicted value (FEV_1%Pred).

The FEV_1 cut-off points used to define different stages of COPD are arbitrary and have not been clinically validated. Although FEV_1 does not accurately measure small airflow obstruction, it is the most objective and reproducible measurement to assess physiologically the degree of airflow limitation. A recent study suggested that prognosis of all-cause mortality was found to be strongly associated with age, smoking, and the best attainable FEV_1%Pred in COPD.[1]

On the contrary, other studies have shown good correlation between disease severity and quality of life (QOL) scores independent of the underlying physiologic markers measured by spirometry.[2–4] Patients with poor QOL scores based on the St George's Respiratory Questionnaire (SGRQ) are at greater risk of hospital readmission whereas the FEV_1%Pred or FVC is not related to readmission.[3]

QOL scores and spirometric values also measure different dimensions of disease severity.[5] Wijnhoven *et al* found that a reduced score on the Health-Related Quality of Life Questionnaire (HRQOL) was strongly associated with greater respiratory complaints whereas no association between pulmonary function level and symptoms was found.[1]

Another aspect of disease severity in COPD is exercise tolerance. Studies in pulmonary rehabilitation have shown that assessment of exercise tolerance correlates well with disease severity.[6–8] Walking distance also corresponds well with QOL scores, independent of the severity as assessed by spirometry.[8] In another study by Wegner *et al*, exercise capacity, dyspnoea scores and airway obstruction independently characterised the pathophysiologic conditions of patients with severe COPD.[9]

Would it be possible then to determine the severity of COPD using other independent parameters in addition to the degree of airway obstruction as measured by FEV_1%Pred? In a landmark study, Celli *et al* introduced and validated a multifactorial grading system that incorporated the body mass index, degree of airflow obstruction, functional dyspnoea and exercise capacity of patients with COPD. The cumulative scores of the BODE index correlated well with mortality.[10] However, no QOL questionnaires were used in the study. The incorporation of a QOL assessment would have provided a more holistic stratification of severity in patients with COPD.

Currently the severity of COPD is determined arbitrarily by a spirometric measure of a lung function, FEV_1. Although the decline of FEV_1 is a good marker of disease progression, it does not accurately assess the global manifestations of COPD. We hypothesised that inclusion of other outcome measures such as exercise capacity and health-related QOL scores, in addition to the spirometric measurement FEV_1%Pred, would provide better overall assessment of COPD severity. In this study we have developed a composite of outcome measures using post-bronchodilator FEV_1%Pred, exercise capacity and QOL scores to assess the severity of COPD. In addition, we validated the new composite score against the patients' exacerbation frequency.

Abbreviations: ANOVA, analysis of variance; COPD, chronic obstructive pulmonary disease; FEV_1, forced expiratory volume in 1 s; FEV_1%Pred, percentage of predicted FEV_1; FVC, forced vital capacity; GOLD, Global Initiative for Chronic Obstructive Lung Disease; HRQOL, Health-Related Quality of Life Questionnaire; QOL, quality of life; SGRQ, St George's Respiratory Questionnaire

PATIENTS AND METHODS

Subjects

Consecutive patients with COPD who attended the Respiratory Outpatient Clinic at the National University Hospital - Hospital Universiti Kebangsaan Malaysia (UKM) were recruited into the study. The study protocol was approved by the medical research and ethics committee of the institution, and written informed consents were obtained from the subjects.

Current or former smokers aged 45–95 years who had COPD according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline were enrolled into the study.[11] The post-bronchodilator FEV_1/FVC ratio must be less than 70% with an increase in FEV_1 of <15% or 200 ml. Patients must be able to complete the 6 min walk test without assistance and they must be able to comprehend instructions and questions in English and Malay.

Patients with multiple comorbidities limiting independent ambulation such as congestive cardiac failure and ischaemic heart disease with angina were excluded from the study. Those patients with terminal diseases and other pulmonary diseases such as localised bronchiectasis, pulmonary fibrosis and asthma were also excluded.

St George's Respiratory Questionnaire

The SGRQ is a self-administered questionnaire designed to measure health impairment in patients with airways disease such as asthma and COPD. The questionnaire consists of 50 items that survey patients' recollection of their symptoms (symptom scores), the disturbance to patients' daily physical activity (activity scores) and psychosocial dysfunction (impact scores). A total score incorporates scores from each component of the SGRQ which ranges from 1 to 100, where 0 indicates best health and 100 indicates worst health.[12] This study used the SGRQ in both the Malay and English languages.[12 13] Patients were required to complete the SGRQ before they performed the simple spirometry and 6 min walk test.

Pulmonary function testing

Simple spirometry was carried out 30 min after the administration of inhaled salbutamol 400 μg using Spiroanalyser ST-95. The post-bronchodilator FEV_1%Pred (using Asian values based on the Fukuda Sangyo Manual) was used to classify the COPD severity according to the GOLD guideline—stage I: mild COPD, FEV_1 >80% predicted; stage II: moderate COPD, 50% <FEV_1 <80% predicted; stage III: severe COPD 30% <FEV_1 <50% predicted; stage IV: very severe COPD, FEV_1 <30% predicted or FEV_1 <50% predicted plus chronic respiratory failure.

Six minute walk test

The 6 min walk test is an index of functional capacity. During the test, patients were required to walk as far as possible in 6 min at their own pace. This was adopted to better reflect the patients' daily activities.[14 15] The test was performed along a continuous hospital corridor adjacent to the respiratory laboratory. Patients underwent two 6 min walk tests at least 30 min apart. This was to eliminate any potential learning effect and the second of the two walk distances was recorded.[15] The distance in metres was then recorded.

Exacerbations

Exacerbations, defined as worsening of COPD symptoms requiring treatment with systemic steroids and/or antibiotics, were recorded by patient self-report and a review of patients' medical records during a 2 year period. This period involves records and self-reports of exacerbations within the preceding 1 year before the initiation of this study and for 1 year following completion of this study. Exacerbation rate was calculated as the number of exacerbations within a 2 year period.

Statistical analysis

Data for continuous, closely symmetrical variables were analysed using standard descriptive methods to estimate means (SD). To compare the relative performance of QOL measures (including all subsets of the SGRQ) in relation to the physiologic measures, we used the two-tailed Pearson product moment correlation coefficient with the level of statistical significance set at $p<0.05$. The Pearson correlation was also used to calculate the correlation between the SAFE Index score and the 2 year exacerbation rate. We used K-Means cluster analysis to ascertain any distinct clustering of the different variables. Several different clusters were tested independently and the relative distances of the clusters were determined along with the analyses of variances to detect the significance. Comparison of means between the different stages of the new SAFE Index score and the individual outcome measures were also tested by utilising the independent samples t test. The statistical software package for the social sciences, SPSS version 11.5, was used to perform the analysis.

RESULTS

Baseline characteristics

A total of 86 patients with COPD were recruited, of which 88% (76) were male. Sixty-five per cent (56/86) of patients were Chinese, 29% Malay (25/86) and 6% Indian (5/86). Only two patients were excluded due to physical constraints, being predominantly wheelchair bound. The mean (SD) age was 67.7 (8.6) years and the mean post-bronchodilator FEV_1 was 0.97 (0.56) litres/s (table 1).

The majority of the patients who attended the respiratory outpatient clinic have moderate to severe COPD with a mean FEV_1%Pred of 43.1 (21.3)%. The distribution of COPD severity was mild in five patients, moderate in 22 patients, severe in 29 patients, and very severe in 30 patients. The mean 6 min walk distance was 321 (87) m. The SGRQ questionnaire consists of three main domains including symptom, impact and activity. The higher the total scores, the greater is the disability.

Relationships among outcome measures

The relationship between the FEV_1, 6 min walk test and domains of the SGRQ were evaluated using a table of Pearson product moment correlations of pairs of variables (table 2). Although statistically significant, the correlations between the FEV_1, 6 min walk distance and SGRQ component scores tended to be weak or moderate. The highest correlation was between

Table 1 Baseline characteristics

Variables	Min	Max	Mean (SD)
Age	48	94	67.7 (8.5)
6MWD (m)	107	533	322 (87)
FEV_1 (litres)			
Total (n = 86)	0.20	2.50	0.97 (0.55)
Stage I (n = 5)			2.18 (0.29)
Stage II (n = 22)			1.48 (0.42)
Stage III (n = 29)			0.86 (0.23)
Stage IV (n = 30)			0.50 (0.14)
FEV_1%Pred (%)	11.6	97.9	43.1 (21.3)
SGRQ scores			
Symptom	6.3	100.0	50.2 (23.2)
Impact	0.0	86.5	35.2 (23.8)
Activity	5.2	100.0	55.1 (27.9)
Total	4.3	90.8	43.7 (23.6)

FEV_1, forced expiratory volume in 1 s; 6MWD, 6 min walk distance.

Table 2 Pearson product moment correlation coefficient of all variables

	Pearson's correlation, r	p Value
FEV_1 vs symptom score	−0.294	0.006
FEV_1 vs activity score	−0.536	<0.001
FEV_1 vs impact score	−0.417	<0.001
FEV_1 vs total score	−0.464	<0.001
FEV_1 vs 6MWD	0.351	0.001
6MWD vs symptom score	−0.272	0.011
6MWD vs activity score	−0.536	<0.001
6MWD vs impact score	−0.459	<0.001
6MWD vs total score	−0.483	<0.001

FEV1, forced expiratory volume in 1 s; 6MWD, 6 min walk distance.

the activity score and FEV_1 or 6 min walk distance ($r = -0.536$).

Cluster analysis

A K-Means cluster analysis was used to group the patients with COPD according to the physiology, functional capacity and QOL measures. Using the cluster analysis, two to six cluster solutions were explored. Differentiation into four clusters provided the best delineation that achieved statistical significance. Comparisons between cluster variables for the four clusters are shown in table 3. Cluster 1 comprised seven patients with the worst pulmonary function, functional capacity and health status whereas cluster 4, which comprised 13 patients, had the best measures of the three parameters.

The validity and linearity of the four cluster solution was explored by comparing subcluster membership across the three parameters using analysis of variance (ANOVA). The 6 min walk distances had the highest correlation among the clusters, whereas the FEV_1 had the lowest significant correlation. The FEV_1%Pred did not show significant correlation among the clusters (data not shown). This is consistent with findings in other studies.[3 5 6] The ranges of the FEV_1%Pred for each group were lower compared to the values used to stage COPD severity according to the GOLD guideline. The linearity in the correlations of the three parameters offers an alternative staging system to the GOLD staging system using FEV_1%Pred value.

We then proceeded with assigning scores to the different clusters, incorporating the SGRQ total score, the 6 min walk distance and the GOLD COPD grading for severity. The GOLD staging was chosen due to the lack of any significant correlation between the FEV_1%Pred and the other variables in our study. This may be due to the small number of mild COPD patients in our study population.

Each variable represents different outcome measures to be assessed in patients with COPD. The SGRQ represents the health impairment or quality of life, the 6 min walk distance represents exercise capacity, and the FEV_1%Pred represents the physiologic measurement of the airflow limitation. The cumulative grading for this proposed new SAFE Index (**S**GRQ, **A**ir-**F**low limitation and **E**xercise tolerance Index) is illustrated in table 4. We then constructed the new staging system for the SAFE Index based on the quartile cut-off values. The distribution of the patients in this new SAFE staging system is itemised below.

The SAFE Index was internally validated against the independent outcome measures for COPD and an external comparator, the rate of COPD exacerbation. Following reassignment of the study data into the aforementioned stages, we computed the Pearson's product moment correlation to assess the correlation between the SAFE Index score and that of FEV_1, 6 min walk distance, SGRQ scores and the exacerbation rates within the preceding 2 year period. The results are illustrated in table 5 and 6. We found strong correlation between the SAFE Index scores with all variables measured in this study, thereby validating the construct of the SAFE Index. We also found moderate correlation between the SAFE Index scores and the exacerbation rate for COPD, thereby validating its scores against a proven indicator for disease severity in COPD.

DISCUSSION

Many studies have found that although the degree of airflow limitation is closely related to mortality,[1] it is poorly correlated with other measures of disability afforded by the QOL assessment[2–4 16] and exercise tolerance.[6–8] Furthermore, studies into pulmonary rehabilitation have also found that although intervention improves the QOL scores and exercise tolerance, improvement of the FEV_1%Pred is usually minimal or unchanged.[6–8 17] This limits the use of the FEV_1%Pred as the sole indicator of severity in COPD.

More recent studies have tried looking at other, more reliable measures of disease severity.[18–20] The most recent BODE Index proposed by Celli and colleagues stratified severity based on the body mass index (BMI), degree of airflow obstruction, functional dyspnoea and exercise capacity. They found that the cumulative score of the BODE Index correlated well with mortality.[10]

The BODE Index comprises different domains that quantify debility in COPD. They constitute pulmonary impairment (FEV_1%Pred), patient's perception of symptoms (the MMRC dyspnoea scale), and two other independent domains (the 6 min walk distance and the BMI) that express the systemic consequences of COPD.[10] Each domain has been independently found to correlate strongly with survival in COPD.[18 21 22]

Table 3 Analysis of the means and variances on the clusters

Cluster Patients (n)	1 (7)	2 (26)	3 (40)	4 (13)	Linearity (ANOVA)
SGRQ total score (SD)					
Mean	69.6 (22.6)	54.8 (22.8)	36.8 (18.6)	28.9 (20.4)	r = −0.440
Min	32.5	11.9	4.3	7.9	F = 21.7
Max	90.8	84.3	74.1	66.1	p<0.001
6MWD, m (SD)					
Mean	148.5 (28.7)	256.1 (23.5)	351.1 (28.3)	455.8 (27.5)	r = 0.793
Min	107	208	309	430	F = 566.8
Max	192	300	400	533	p<0.001
FEV_1, litres (SD)					
Mean	0.72 (0.45)	0.87 (0.53)	1.01 (0.47)	1.42 (0.74)	r = 0.383
Min	0.20	0.40	0.25	0.60	F = 14.4
Max	1.78	1.95	2.10	2.50	p<0.001

ANOVA, analysis of variance; FEV_1, forced expiratory volume in 1 s; 6MWD, 6 min walk distance.

Table 4 Variables and the point values for the cumulative score of the SAFE index for staging of chronic obstructive pulmonary disease patients

	Points on the new index			
Variables	**0**	**1**	**2**	**3**
FEV_1%Pred*	⩾80	50-79	30-49	<30
6MWD (m)†	⩾400	300-399	200-299	⩽199
SGRQ (total score)†	⩽30	31-49	50-64	⩾65
Staging	**Number of patients (%)**			
Stage I SAFE score 0–2	16 (19)			
Stage II SAFE score 3–4	28 (32)			
Stage III SAFE score 5–6	20 (23)			
Stage IV SAFE score 7–9	22 (26)			

FEV_1%Pred, percentage of predicted forced expiratory volume in 1 s; 6MWD, 6 min walk distance; SGRQ, St George's Respiratory Questionnaire.
*The FEV_1% predicted categories are based on stages defined by the GOLD COPD staging.
†The values are derived from the K-means cluster analysis illustrated in table 3.

As part of the variable selection process, Celli stipulated that, ''Each variable should correlate independently with the prognosis of COPD, should be easily measurable, and should serve as a surrogate for other potentially important variables''.[10] The ease of measurability is doubly important in the setting of general practice or resource-poor health systems, within which the majority of COPD patients lie.

There is, however, a need for a more comprehensive staging system for better categorisation of patients with COPD.[19] The incorporation of a QOL assessment would provide a more holistic stratification of severity in patients with COPD. Any meaningful classification and/or stratification of severity in COPD should incorporate a standardised QOL assessment vis à vis the usual physiologic assessment of airflow limitation and exercise capacity.[23] Other factors that have been shown to be related to survival include age, dyspnoea, symptoms of chronic bronchitis, airways obstruction and diffusion capacity.[18]

The SGRQ was included for several reasons. Firstly, although it is slightly more laborious to administer compared to the MMRC and the body mass index (BMI), it is self-administered by the patients and will take no longer than the time usually spent waiting before being seen at the doctor's practice.[24] Furthermore the wealth of information afforded by the more comprehensive respiratory questionnaire far outweighs the time disadvantage in administering it and it is certainly more informative than the BMI and MMRC combined.[25]

Secondly, the SGRQ is available and has been validated in a multitude of languages,[12 13] a significant advantage in a multicultural and more importantly multilingual society like Malaysia. Finally, many studies have affirmed the ability of the SGRQ in detecting change following both pharmacological and physical intervention. This is essential in assessing the efficacy of intervention, hence making it indispensable to a composite score stratifying severity in COPD.[1–3 7 8 12 13 17 24]

Table 5 Pearson's correlation between the new index score with other variables

Variables	Pearson's correlation, r	p Value
SAFE Index vs FEV_1	−0.807	<0.001
SAFE Index vs FEV_1%Pred	−0.710	<0.001
SAFE Index vs 6MWD	−0.621	<0.001
SGRQ indices		
SAFE Index vs symptom score	0.604	<0.001
SAFE Index vs activity score	0.816	<0.001
SAFE Index vs impact score	0.763	<0.001
SAFE Index vs total score	0.801	<0.001
SAFE Index vs 2 year exacerbation rate	0.497	<0.001

FEV_1%Pred, percentage of predicted forced expiratory volume in 1 s; 6MWD, 6 min walk distance; SGRQ, St George's Respiratory Questionnaire.

The 6 min walk distance is incorporated for its value in interventional studies. Many studies have proven the correlation between the 6 min walk distance and other aspects of severity in COPD. It has also been shown to improve following intervention in COPD, especially in studies associated with pulmonary rehabilitation.[6–8 14 15]

The physiologic measurement FEV_1%Pred was included for several reasons. Firstly, any attempt at classifying COPD should incorporate measures of airflow limitation as it is the earliest and most tested index of disease severity.[19 23] The only drawback to the FEV_1%Pred is it is usually little or unchanged in interventional studies, hence the need for other indicators of disease severity.[6–8 17] Secondly, incorporating the absolute FEV_1 would have made our study less comparable to studies incorporating more conventional measures of airflow limitation. Even the BODE Index by Celli incorporated the FEV_1%Pred albeit by utilising the American Thoracic Society criteria compared to our GOLD criteria.

Thirdly, and on a more fundamental level, although absolute FEV_1 correlated better with the other indices compared to the FEV_1%Pred, absolute FEV_1 is not the real indicator of an individual's airflow restriction as it is dependent on the gender, age and height of each individual. For example, the FEV_1 of 1.5 litres/s in a 75-year-old lady who is only 5 feet 4 inches (162 cm) is certainly not equivalent to the same FEV_1 in a 40-year-old manual labourer who is 6 feet 2 inches (188 cm) tall.

Our study found modest correlations among the FEV_1, 6 min walk distance and the SGRQ scores. This concurred with the results of other studies which reported the same conclusions, most notably the National Emphysema Treatment Trial.[16 17] We also observed that, of the different subsets of the SGRQ questionnaire, the activity score correlated better with both the FEV_1 and the 6 min walk distance.

This suggests that the patients' reporting of their physical ability mirrored that of their actual exercise capacity.[16] These findings are similar to other studies which showed discriminate correlation in certain subsets of the SGRQ questionnaire with FEV_1 and 6 min walk distance.[16 19 26] Boueri and colleagues also found significant difference in scores pertaining to physical function but not to social function.[16]

The cluster analysis identified four distinct clusters that reached statistical significance. The only variable that did not reach significance was the FEV_1%Pred which was not surprising given its poor correlation with the other values before the cluster analysis. Further analysis of the means on the clusters

Table 6 The mean values of each independent outcome measure within each stage of the new SAFE Index

	SAFE Index			
	Stage I	**Stage II**	**Stage III**	**Stage IV**
Mean FEV_1%Pred	66.85 (5.34)	45.01 (2.94)	35.45 (3.51)	30.09 (3.76)
Mean 6MWD	405.0 (18.7)	341.5 (8.6)	324.5 (16.2)	232.7 (15.8)
Mean SGRQ total score	19.4 (2.5)	30.6 (2.3)	51.4 (3.3)	71.9 (2.9)
Mean 2 year exacerbation	0.25 (0.11)	0.65 (0.15)	1.52 (0.26)	2.36 (0.49)

FEV_1%Pred, percentage of predicted forced expiratory volume in 1 s; 6MWD, 6 min walk distance; SGRQ, St George's Respiratory Questionnaire.

coupled with the ANOVA to determine any linearity and its significance then followed. Within these clusters, the 6 min walk distance not only correlated the best with both FEV_1 and the SGRQ scores but it also showed the highest linearity (ANOVA, $r = 0.793$ and $p<0.001$). Moreover, the minimal and maximal values were uniformly distributed and may be taken to represent the primordial form of a new staging system incorporating the 6 min walk distance.

We then formulated the SAFE Index as an alternative holistic instrument for the staging of severity in COPD. It incorporated relevant domains which independently characterised severity in COPD. The SAFE Index scores were found to be highly correlated with the other independent outcome measures tested thereby validating the construct of the SAFE Index. Further correlation with COPD exacerbation showed a statistically significant modest correlation, thereby indicating the validity of the SAFE Index in assessing severity of COPD.

This study shows that a composite score incorporating measures of airflow limitation, exercise capacity and health-related QOL scores can reliably predict the rate of exacerbation in COPD. What is not known is whether the SAFE Index will be able to detect changes in individuals in contrast to population studies. Both the 6 min walk distance and the SGRQ have been shown to have minimally clinically important difference levels which signify individual changes over time.[27] Whether this will be carried forward into the SAFE Index remains to be seen as the presence of the FEV_1%Pred may dilute any changes that may be observed.

In conclusion, this study showed modest correlation between the 6 min walk distance and the SGRQ scores, particularly the activity component of the SGRQ, and independent of the FEV_1%Pred. It also showed four distinct clusters which represented aggregates of values that were refined to constitute a new staging index. We propose that the new SAFE Index be adopted as an alternative staging tool as it showed a statistically significant moderate correlation with symptomatic exacerbation which is an independent outcome measure for disease severity in COPD. We do, however, realise the weakness in the disproportionate representation among the different genders, race and severity of airflow limitation in our sample. Future direction should therefore include the subsequent validation of this new staging system against all-cause and disease-related mortality. It should also eliminate potential sampling biases such as ethno-geographical preponderances in the sampling pool.

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REFERENCES

1 **Wijnhoven HA**, Kriegsman DM, Hesselink AE, *et al*. Determinants of different dimensions of disease severity in asthma and COPD: pulmonary function and health-related quality of life. *Chest* 2001;**119**:1034–42.
2 **Fan VS**, Curtis RJ, Tu SP, *et al*. Using quality of life to predict hospitalization and mortality in patients with obstructive lung diseases. *Chest* 2002;**122**:429–36.
3 **Osman IM**, Godden DJ, Friend JA, *et al*. Quality of life and hospital readmission in patients with chronic obstructive pulmonary disease. *Thorax* 1997;**52**:67–71.
4 **Seemungal TA**, Donaldson GC, Paul EA, *et al*. Effect of exacerbation on quality of life in patients with chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 1998;**157**:1418–22.
5 **Franssen FME**, Wouters EFM, Baarends EM, *et al*. Arm mechanical efficiency and arm exercise capacity are relatively preserved in chronic obstructive pulmonary disease. *Med Sci Sports Exerc* 2002;**34**:1570–6.
6 **Edwards DG**, Dunagan DP, Walschlager SA, *et al*. Changes in pulmonary function after symptom limited graded exercise testing in COPD patients 1199. *Med Sci Sports Exerc* 1997;**29**:210.
7 **Fuchs-Climent D**, Le Gallaise D, Varray A, *et al*. Quality of life and exercise tolerance in chronic obstructive pulmonary disease: effects of a short and intensive inpatient program 1. *Am J Phys Med Rehabil* 1999;**78**:330–5.
8 **Fuchs-Climent D**, Le Gallaise D, Varray A, *et al*. Factor analysis of quality of life, dyspnea, and physiologic variables in patients with chronic obstructive pulmonary disease before and after rehabilitation. *Am J Phys Med Rehabil* 2001;**80**:113–20.
9 **Wegner RE**, Jörres RA, Kirsten DK, *et al*. Factor analysis of exercise capacity, dyspnoea ratings and lung function in patients with severe COPD. *Eur Respir J* 1994;**7**:725–9.
10 **Celli BR**, Cote CG, Marin JM, *et al*. The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *N Eng J Med* 2004;**10**:1005–12.
11 **National Institutes of Health, National Heart, Lung, and Blood Institute**. *Global initiative for chronic obstructive lung disease, Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease updated*. Bethesda, Maryland: NIH, NHLBI, 2004:1–95.
12 **Jones PW**, Quirk FH, Baveystock CM. The St George's respiratory questionnaire. *Respir Med* 1991;**85**:25–31.
13 **Jones PW**, Spencer S, Adie S. The St. George's respiratory questionnaire manual. *St George's Hospital Medical School*, 2003;*ver* 2.1.
14 **McGavin CR**, Gupta SP, McHardy GJR. Twelve minute walking test for assessing disability in chronic bronchitis. *BMJ* 1976;**i**:822–3.
15 **Butland RJA**, Pang J, Gross ER, *et al*. Two, six and twelve minute walking tests in respiratory disease. *BMJ* 1982;**284**:1607–8.
16 **Boueri FMV**, Bucher-Bartelson BL, Glenn KA, *et al*. Quality of life measured with a generic instrument (short form-36) improves following pulmonary rehabilitation in patients with COPD. *Chest* 2001;**119**:77–84.
17 **Kaplan RM**, Ries AL, Reilly J, *et al*. Measurement of health-related quality of life in the national emphysema treatment trial. *Chest* 2004;**126**:781–9.
18 **Nishimura K**, Izumi T, Tsukino M, *et al*. Dyspnea is a better predictor of 5-year survival than airway obstruction in patients with COPD. *Chest* 2002;**121**:1434–40.
19 **Celli BR**. The importance of spirometry in COPD and asthma: effect on approach to management. *Chest* 2000;**117**:S15–19.
20 **Van Schayck CP**. Is lung function really a good parameter in evaluating the long-term effects of inhaled corticosteroids in COPD? *Eur Respir J* 2000;**15**:238–9.

21 **Domingo-Salvany A**, Lamarca R, Ferrer M, *et al*. Health-related quality of life and mortality in male patients with chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 2002;**166**:680–5.
22 **Schols AM**, Slangen J, Volovics L, *et al*. Weight loss is a reversible factor in the prognosis of chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 1998;**157**:1791–7.
23 **Efremidis G**, Manolis A, Spiropoulos K. Global initiative for chronic obstructive pulmonary disease statement and health-related quality of life. *Clin Pulm Med* 2005;**12**:333–6.
24 **Ståhl E**, Jansson SA, Jonsson AC, *et al*. Health-related quality of life, utility, and productivity outcomes instruments: ease of completion by subjects with COPD. *Bio Med Central* 2003;**1**:1–7.
25 **Spencer S**, Calverley PMA, Burge PS, *et al*. Impact of preventing exacerbations on deterioration of health status in COPD. *Eur Respir J* 2004;**23**:698–702.
26 **Dourado VZ**, Antunes LCO, Tanni SE, *et al*. Relationship of upper-limb and thoracic muscle strength to 6-min walk distance in COPD patients. *Chest* 2006;**129**:551–7.
27 **Gross NJ**. Chronic obstructive pulmonary disease outcome measurements: What's important? What's useful? *Proc Am Thorac Soc* 2005;**2**:267–71.