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ORIGINAL ARTICLE

A MULTI DIMENSIONAL GRADING SYSTEM FOR ASSESSMENT AND FOLLOW UP OF COPD

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Background: *Recently, the BODE (body mass index, airflow obstruction, dyspnea and exercise capacity) index, a multidimensional grading system was shown to be better than FEV_1 in predicting the risk of hospitalization and death among patients with COPD.*
Objectives: *Evaluation of BODE (body mass index, air flow obstruction, dyspnea and exercise capacity) index as better predictor of hospitalization in COPD patients than FEV_1 alone.*
Design: *Randomized, double blind, prospective study.*
Methods: *This study was conducted on 50 patients, with wide range of severity of COPD their age range was from age 32 - 81 years, including 49 males and 1 female, with smoking index 897.115 ± 53.75, all patients provided written informed consent. They were from the outpatient clinic and others were admitted as inpatient in Ain Shams University hospital. All patients were subjected to the following: Complete history taking, Careful physical examination, Chest x-ray Routine investigation (CBC, ESR, kidney function, liver function and ECG), Arterial blood gas of admitted patients and O2 saturation for outpatient clinic, Measurement of spirometric lung function tests, The BODE index (body mass index, air flow obstruction, dyspnea and exercise capacity) was calculated for each patient, for calculation of the BODE index, we used suggestive model. Patient was followed up for 6 months after doing the test to know number of hospitalization and mortality during this period.*
Results: *Comparison was done between COPD staging as defined by GOLD and BODE index as a predictor of hospitalization during follow up period. In this study using FEV_1 (as defined by GOLD) alone as a single prediction of hospitalization of COPD patients the results were statistically significant as shown the incidence of hospitalization in stage 1 was 0%, Stage II was 31 %, in stage III was 66% and stage IV was 75%, and by using BODE index as a predictor of risk of hospitalization in COPD patients the results were statistically highly significant as shown the incidence of hospitalization in Quartile BODE index 1 (0-2) was 0 %, in quartile 2 (3-4) was 30%, in quartile 3 (5-6) was 58% and quartile 4 (7-10) was 80%. It is noticed that there were statistically differences between two systems as prediction of hospitalization using BODE index was highly statistically significant.*
Conclusions: *from the present study we conclude that the BODE staging system, which includes in addition to FEV_1 other physiologic and clinical variables, helps to better predict hospitalization in patients with COPD. The BODE index is simple to calculate and requires no special equipment. This makes it a practical tool of potentially widespread applicability.*

INTRODUCTION

COPD Chronic Obstructive Pulmonary Disease (COPD) is preventable and treatable disease with some significant extra pulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases.[1]

Although the progression of COPD is usually gradual, the disease is often associated with exacerbations of respiratory symptoms, such exacerbations of symptoms requiring medical intervention in which important clinical events in COPD, and they place a heavy burden on health care resources, in many countries exacerbations of COPD are a leading cause of hospital admission among men.[2]

COPD is currently the fourth leading cause of death in the world,[3] and is predicted to be the third most frequent cause of death in the world by 2020.[4]

The risk of hospitalization and death in patients with COPD is often graded with the use of a single physiological variable, the forced expiratory volume in one second (FEV_1) however, other risk factors, such as presence of hypoxemia or hypercapnia, a short distance walked in a fixed time, a high degree of functional breathlessness and a low body mass index, are also associated with an increase risk of hospitalization and death in COPD, these studies suggest that factors other than the degree of airflow obstruction may influence the frequency of hospitalization of COPD.[4]

Using a multidimensional grading system that assesses the respiratory and systemic manifestation of COPD would thus categorize and predict this outcome better than a classification of disease severity based on FEV_1 alone. [5]

Recently, the BODE (body mass index, airflow obstruction, dyspnea and exercise capacity) index, a multidimensional grading system was shown to be better than FEV_1 in predicting the risk of hospitalization and death among patients with COPD. [4]

Aim of the work: Evaluation of BODE (body mass index, air flow obstruction, dyspnea and exercise capacity) index as better predictor of hospitalization in COPD patients than FEV_1 alone.

PATIENTS AND METHOD

This study was conducted on 50 patients, with wide range of severity of COPD. Their age range was from age 32 - 81 years, including 49 males and 1 female, with smoking index 897.115 ± 53.75, all patients provided written informed consent.

Diagnostic features include: Long history of smoking, shortness of breath, prolonged productive cough and wheezy chest, the diagnosis was confirmed by spirometry. The presence of a post bronchodilator FEV_1<80% of the predicted value in combination with an FEV_1/ FVC<70% confirms the presence of airflow limitation that is not fully reversible.

All patients were subjected to the following:

A. Complete history taking.

B. Careful physical examination.

C. Chest x-ray.

D. Routine investigation (CBC, ESR, kidney function, liver function and ECG).

E. Arterial blood gas of admitted patients and O2 saturation for outpatient clinic.

F. Measurement of spirometric lung function test was done in the study using flow mate Spirometer (Model 2500).[6]

G. All patients were in a clinical stable condition.

H. The BODE index (body mass index, air flow obstruction, dyspnea and exercise capacity) was calculated for each patient, for calculation of the BODE index, we used suggestive model.[4]

For each threshold value of FEV_1, distance walked

in 6 minutes, and score on modified medical research council (MRC) dyspnea scale the patients received points ranging from 0 (lowest value) to 3 (maximal value). For body mass index the values were 0 or 1. The points for each variable were added, so that the BODE index ranged from 0 to 10 points in each patient.

Table 1. variables and point values used for computation of body mass index, degree of air flow obstruction, dyspnea and exercise capacity (BODE index).[4]

Variables	Point on BODE index			
	0	1	2	3
FEV_1(%of predicted)	≥ 65%	50 – 64	36 – 49	≤ 35
6 minute walk test (m)	≥350	250-349	150 - 249	≤ 149
MMRC dyspnea scale	0 – 1	2	3	4
Body mass index	<21	≥ 21		

The cut off values for assignment of points were shown for each variable, the total possible value ranged from 0 to 10, the FEV_1 categories are based on stages identified dyspnea scale can range from 0 to 4 indicating that the patient is too breathless to leave the house. The values for body mass index were 0 or 1 because of the inflection point in the inverse relation between survival and body mass index at a value of 21.[4]

Then 6 minute walk test was calculated: The test well done in allocation where a rapid, appropriate response to an emergency is possible. Supplies that must be available include oxygen; sublingual nitroglycerine, aspirin, and salbutamol (metered dose inhaler or nebulizer). Reasons for immediately stopping a 6MWT include the following: (1) chest pain, (2) intolerable dyspnea, (3) leg cramps, (4) staggering, (5) diaphoresis, and (6) pale appearance. Patients completed two 6MWD tests per evaluation of more than 30 minutes apart the 6MWT is performed a long, flat, straight, enclosed corridor with a hard surface the longest of the two walk distances was used in analysis .Follow up: Patients were followed up for 6 months after doing the test to know number of hospitalization and mortality during this period.

Exclusion criteria: As judged from history, clinical examination and investigation done, patients with the following criteria were excluded from the study:

A. An illness other than COPD such as bronchial asthma, myocardial infarction, unstable angina, congestive heart failure, renal failure, chronic liver disease.

B. An inability to perform pulmonary function and 6 minute walk test.

Statistical analysis:

1. ***Descriptive statistics:*** Mean, Standard deviation (± SD) Range (maximum–minimum).

2. Analytic statistics: Student T. tests: to measure the difference between two means of quantitative data.Chi2 test: to assess the relation between two or more qualitative variables. The level of the significance is 95%, so: P.value > 0.05 was considered a non significant statistical result. P.value < 0.05 was considered statistically significant result. P. value < 0.01 was considered a highly statistically significant result. These statistical studies were done in SPSS11 (statistical package for social science version 11 for windows xp).

RESULTS

The study was conducted on 50 COPD patients with a mean of age of 57.833 ± 11.8 including 49 males and 1 female, The mean duration of follow-up was 6 months, There were 26 patients (52%) who required at least one hospital admission for COPD during the follow-up period.

Table 2. Baseline characteristics of patients.

Characteristics	Data Mean ± SD
Male / female gender	49/1
Age, year	57.833 ± 11.8
BMI, Kg/m²	29.59 ± 5.955
FEV¹, %predicted	46.17 ± 15.5
Six-minute walk distance, m	281.96 ± 51.4
MMRC dyspnea scale	1.38 ± .56
BODE index score	5.24 ± 1.8

Table 3. Risk of hospitalization as regard COPD staging.

		Total	Non Hospitalization	Hospitalization	P. Value	Significance
COPD-STG 1	N of pt	2	2	0		
	%of pt	4%	4%	0%		
	%of pt to N of pt in stg		100%	0%		
COPD-STG 2	Nof pt	19	13	6		
	%of pt	38%	26%	12%		
	%of pt to N of pt in stg		68.42%	31.58%		
COPD-STG 3	N of pt	21	7	14	.0314	Significant
	%of pt	42%	14%	28%		
	%of pt to N of pt in stg		33.33%	66.67%	< 0.05	
COPD-STG 4	N of pt	8	2	6		
	%of pt	16%	4%	12%		
	%of pt to N of pt in stg		25%	75%		
Total		50 100%	24 48%	26 52.%		

N (number), pt (patient), H (hospitalization), NH (non hospitalization), stg (stage of COPD).
So number of hospitalized patients increase with increase COPD staging.

Table 4. Number of patients and hospitalization according to BODE index.

		Significance	P. value	Q-4 BODE index (7– 10)	Q- 3 BODE index (5 – 6)	Q-2 BODE index (3–4)	Q-1 BODE index (0– 2)	Total
Without hospitalization	N of pt	24	5	9	7	3		
	%of pt	48%	10%	18%	14%	6%		
	%of NH pt		100%	69%	41.18%	20%		
With hospitalization	N of pt	26	0	4	10	12	<0.01	HIGHLY SIGNIFICANT
	%of pt	52%	0%	8%	20%	24%		
	%of H pt		0%	31%	58.82%	80%		
TOTAL		50 100%	5 10%	13 26%	17 34%	15 30%		

Q mean (Quartile), PT (patient), N (number), NH (non hospitalized), H (hospitalized).

As this table shows number of patients in Quartile1 (Q1) was (5) 10% of total patient numbers 100% are none hospitalized. In Q2 number of patients (13) 26% of total patient number, 31% of them were hospitalized. In Q3 number of patient (17) 34% of total patient number, the hospitalized number was (10) 58.8%. In Q4 number of patient (15) 30% of total patient number, 80% were hospitalized.

P. value = 5.106E-03 so $p < 0.01$ so the result was highly significant.

Patients with higher BODE scores had higher rates of hospitalization When categorizing the BODE scores into four quartiles (quartile 1, score of 0 to 2; quartile 2, score of 3 to 4; quartile 3, score of 5 to 6; and quartile 4, a score of 7 to 10), we found that the BODE index is a better predictor of hospital admissions than the staging system of COPD as defined by GOLD.

Table 4 showed that risk of hospitalization is parallel to BODE index.

Table 5. Number of patients and hospitalization according to Body Mass Index.

		Total	BMI 0	BMI 1	P. Value	Significance
without Hospitalization	N of pt	24	3	21		
	%of pt	48%	6%	42%		
	%of NH pt		100%	45%		
					.0630	Non Significant
With Hospitalization	N of pt	26	0	26	>0.05	
	%of pt	52%	0%	52%		
	%of H pt		0%	55%		
Total			3 6%	47 94%		

BMI (body mass index), **PT** (patient), **N** (number), **NH** (non hospitalized), **H** (hospitalized).
55% of hospitalized patients with **BMI ≥** 21.

Table 6. Number of patients and hospitalization according to air flow obstruction.

Air Flow obstruction	Number of Patients	Hospitalization in 6m	% of Hospitalization
0 = $FEV_1 \geq 65\%$	7	0	0%
1 = FEV_1 50 – 64	14	6	42%
2 = FEV^1 36 – 49	14	9	64%
3 = $FEV_1 \leq 35$	15	11	73%

FEV_1 categories are based on stages identified by American thoracic society.

Table 7. Dyspnea scale as single parameter for predicting risk of hospitalization in COPD patients.

		TOTAL	Dys-s 0	1	2	3	P. Value	Significance
Without Hospitalization	N of pt	24	2	16	6	0		
	%of pt	48%	4%	32%	12%	0%		
	%of NH pt		100%	59%	28%	0%		
With Hospitalization	N of pt	26	0	11	15	0	.034 <0.05	Significant
	%of pt	52%	0%	22%	30%	0%		
	%of H pt		0%	40%	71%	0%		
TOTAL			2	27	21	0		
			4%	54%	42%	0%		

Dys (dyspnea), s (scale), PT (patient), N (number), NH (non hospitalized), H (hospitalized).
In this table the hospitalized patients in dyspnea scale (1) were40%while hospitalized patient in scale (2) was 71%.
P. value = .0348 < 0.05 so the result was significant.

Table 8. Exercise capacity as single parameter for predicting risk of hospitalization in COPD patients.

		TOTAL	6mWT 0	1	2	3	P. Value	Significance
With Hospitalization	N of pt	24	3	17	4	0		
	%of pt	48%	6%	34%	8%	0%		
	%of NH pt		60%	54%	28%	0%		
Without Hospitalization	N of pt	26	2	14	10	0	0.22 >0.05	Non Significant
	%of pt	52%	4%	28%	20%	0%		
	%of H pt		40%	45%	71%	0%		
TOTAL		50	5	31	14	0		
		100%	10%	62%	28%	0%		

This table shows that risk of hospitalization as regard exercise capacity was non significant, yet hospitalization in 6MWT 0 was 40%, in 6MWT 1 was 45% and 6MWT 2 was 71%.

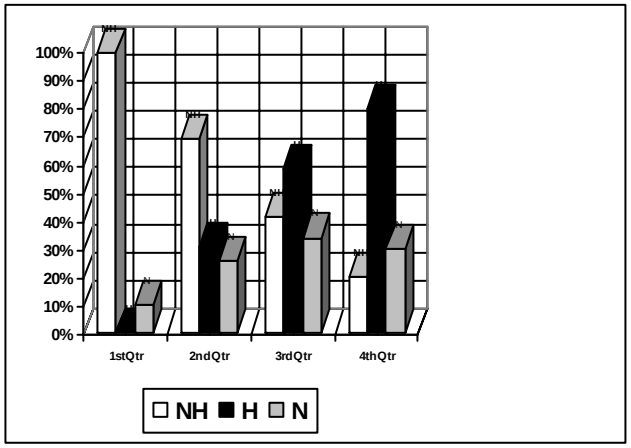

Fig 1. Risk of hospitalization as regard Quartile BODE index.

This figure illustrate that hospitalization as regard BODE index increasing by increasing BODE score.

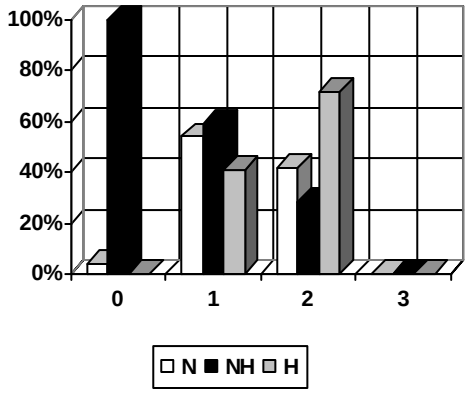

Fig 2. Dyspnea scale as single parameter for predicting risk of hospitalization in COPD patients.

This figure shown that number of hospitalized is directly correlated with dyspnea scale.

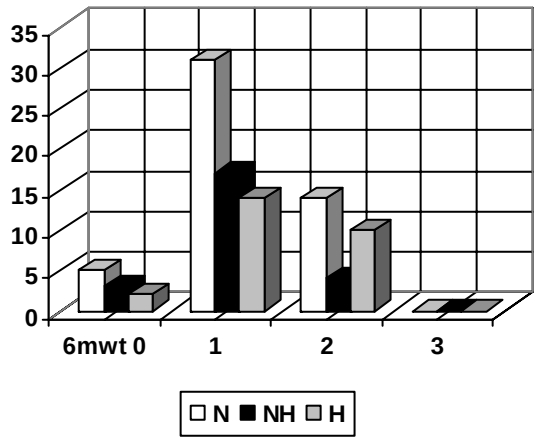

Fig 3. Exercise capacity as single parameter for predicting risk of hospitalization in COPD patients.

This figure illustrates that risk of hospitalization increase with low exercise capacity.

DISCUSSION

The multistage scoring system used in this study (BODE index) incorporates variables that can be easily evaluated in any office setting, and the BODE index has potential widespread applicability, just like the FEV_1. Important to the acceptance for use of this new classification system is the evidence to support that it provides more useful prognostic information than FEV_1 alone.

The multidimensional staging system of the BODE index has already been shown to be a superior predictor of the risk of death in COPD patients compared to the FEV_1-based staging system by the ATS.[4]

Furthermore, a staging system utilizing the BODE index was found to have superior predictive power for this outcome compared to the GOLD classification of disease severity.[1]

A comparison was done between COPD staging as defined by GOLD and BODE index as a predictor of risk of hospitalization during follow up period, and also each variable of BODE index was used as a single parameter for prediction of hospitalization of COPD patients.

In this study using FEV_1 (as defined by GOLD) alone as a single prediction of hospitalization of COPD patients the results were statistically significant as show the incidence of hospitalization in stage 1 was 0%. Stage II was 31 % in stage III was 66% and stage IV was 75%.

P value was < 0.05 this indicates that risk of hospitalization increase by increasing COPD staging.

By using BODE index as a predictor of risk of hospitalization in COPD patients, the results were statistically highly significant, the incidence of hospitalization in Quartile BODE index 1 (0-2) was 0 %, in quartile 2 (3-4) was 30%, in quartile 3 (5-6) was 58% and quartile 4 (7-10) was 80%. P value was < 0.01, this indicates that risk of hospitalization increase by increasing BODE score. This was fully fit with Ong et al, 2005[7] study they used BODE index as predictor of hospitalization in COPD patients and compared it with FEV_1 classification of GOLD and found that BODE index was a better predictor of hospitalization than using FEV_1 alone. As Patients with higher BODE scores had higher rates of hospitalization. The geometric mean number of hospitalizations per month for patients with BODE scores ranging from 0 to 5 was 0.32, and the corresponding number for patients with BODE scores ranging from 6 to 10 was 0.42 ($p < 0.001$), a significant effect of BODE score on the number of hospital admissions was found. In comparison, there was also a significant but smaller effect of the FEV_1 percentage of predicted on the number of hospital admissions.

The BODE index was also reported to be a much better predictor of the severity in COPD acute exacerbations than FEV_1 as said by Marin et al, 2003.[8]

Celli et al 2004[4] found that the BODE index is a better predictor of the risk of death from any cause and from respiratory causes than is the FEV_1 alone, each quartile increase in the BODE score was associated with increased mortality ($P<0.001$). Thus, the highest quartile (a BODE score of 7 to 10) was associated with a mortality rate of 80 percent at 52 months, the ability of the BODE index to predict the risk of death was 0.74, as compared with a value of 0.65 with the use of FEV_1 alone.

In this study each variable of BODE index was used as a single parameter of prediction of risk of hospitalization in COPD patients.

Using body mass index as a predictor of risk of hospitalization in COPD patients we found that 55% of hospitalized patients were in BMI>21 and this mean that risk of hospitalization increasing with higher BMI but results was statistically non significant this indicate it cannot be used as a single parameter of predicting hospitalization in COPD patients, This was not fully fit with Celli et al 2004[4] who found BMI below 21 associated with an increased risk of death. An observation similar to that reported by Landbo et al, 1999,[9] in a large population study (this may be due to the smaller number of patients with BMI < 21 and this may be due to higher incidence of obesity in COPD patients in Egypt.

As regard exercise capacity (6m walk test) as a predictor of hospitalization we found that 6m walk test score 0 (> 350m) risk of hospitalization was 40%, Score 1 (250-349) risk of hospitalization was 45%, score 2 (150-249) was 71% but there was no patients in score 3 (≤ 149) as patients in this score was too ill and too much breathlessness. Results were statistically non significant, P value was (0.2246 >0.05). This may be due to that no patients were in score 3 and may be due to the small number of patients in the study to detect significance however we noticed that risk of hospitalization increased with decreasing exercise capacity. This was fully fit with Ong et al, 2005[7] who found hospitalization and mortality in COPD patients higher with low 6m walk test.

Also Celli et al, 2004[4] found that risk of death in COPD patients was more with low 6m walk test.

Pinto et al, 2004[10] found that 6MWD was a significant predictor of survival in COPD patients with a risk ratio of death of 0.82 per 50 m decrease in 6MWD and the 6MWD is a better predictor of mortality than $FEV_1$and BMI in this subset of

patients and it showed that in patients with severe disease, the decline in 6MWD occurred independently of the change in FEV_1.

In using dyspnea score (MMRC dyspnea score) in this study as a single predictor of risk of hospitalization in COPD patients we found that in score 0 risk of hospitalization was 0%, in score 1 was 52%, in score 2 was 71% there was no patients in score 3 as they are too breathlessness to perform 6MWD and not complied for follow up. We noticed that hospitalization increased with increasing dyspnea score and P value was 0.0348 <0.05 so the results were statistically significant. This was accepted by Ong et al, 2005[7] who found risk of hospitalization increase with increasing dyspnea score, also Celli et al, 2004[4] found the score on the MMRC dyspnea scale as a better predictor of the risk of death than was the FEV_1.

Conclusion: The main finding of this study was that the BODE staging system, which includes in addition to FEV_1 other physiologic and clinical variables, helps to better predict hospitalization in patients with COPD.

The BODE index is simple to calculate and requires no special equipment. This makes it a practical tool of potentially widespread applicability.

Further studies with more number of patients with variable parameters should be done to confirm the finding.

COPD staging should be revised so as to give a multidimensional grading system a role in the classification of severity of the disease.

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