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Original Research Article

Body mass index, obstruction of the airflow, dyspnea, and exercise capacity index as predictor of the severity of exacerbations and systemic involvement in patients with chronic obstructive pulmonary disease

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ABSTRACT

Background: Allocation of the limited resources to the needed patients and decision making regarding timely interventions demand development of a reliable, cost effective, simple assessment tool. Several studies propose body-mass index, airflow obstruction, dyspnea, and exercise (BODE) index for this purpose in patients with Chronic obstructive pulmonary disease (COPD). The objective of this study was to assess the utility of BODE index to predict the severity of exacerbations and systemic involvement in COPD.
Methods: A Present hospital based cross sectional study was carried out among 100 COPD patients. BODE index was used to assess the patients and its association was studied with various variables. The data was analyzed using one-way analysis of variance (ANOVA) test.
Results: As the body index class of severity increases, the number of hospitalizations required in the past also increases and this association is statistically significant. As the severity of the disease increased as indicated by the class the mean number of exacerbations in the past increased and this association was found out to be statistically significant. As the severity of the disease increased as indicated by the class level, the mean number of days of hospitalization increased. But this increase was of small difference and hence on one-way ANOVA test was not found out to be statistically significant. As the pack years increases, the BODE index increases significantly (p value <0.001). As the severity of the disease increased, the mean body mass index decreased. Haemoglobin level was found to decrease with increase in BODE index class of severity. This association was statistically significant.
Conclusions: The BODE index has been found to be a very good tool to assess the prognosis of COPD as well as severity of acute exacerbations.

Keywords: Airflow obstruction, Body-mass index, Chronic obstructive pulmonary disease, Dyspnoea and exercise (BODE) index, Exacerbations, Predict

INTRODUCTION

In patients with chronic obstructive pulmonary disease (COPD) there is over a period of time, reduction in the functional capacity of the lungs. The regular clinical features associated with COPD are cough, there is production of the sputum, there is difficulty in the breathing, and these features occur on and off in the patients. Because of this, the COPD patient has to visit the physician more often than any other type of the patient and thus it puts a lot of burden on his pocket. He frequently remains absent from his work thus reducing the productivity. It has been predicted that COPD will acquire the third place as leading cause of death by 2020.[1]

Half a million people die every year due to COPD in India, which is over 4 times the number of people who die due to COPD in USA and Europe.[2]

COPD is a very common disease in the populations, but it has been said that it can be prevented as well as it can be treated. The symptoms of the respiratory system are persistent. There is limitation to the flow of the air in the lungs. There is also the presence of the abnormalities of the alveolar structures.[3]

Recently it has been more and more considered that COPD is not limited to the lungs. It has been considered in the recent days as it is a part of the chronic systemic inflammatory syndrome. It has been viewed and has been clubbed with the metabolic syndrome. It is the need of the hour to come out of the traditional view about the COPD and see it in a broader perspective as a number of co-morbidities are associated with it.[4]

During the assessment for the COPD, it is important that the assessment should be done in all round fashion. Health status of the patient, future health risk assessment, degree of severity of the limitation of the airflow etc. all should be evaluated for proper treatment and good outcome.

The patient should be evaluated for the abnormality of the spirometry readings, he should be assessed for the symptom's duration and severity, he should be assessed for the future health risk assessment, and also for the presence of other co-morbidities.[3] BODE index in one such index which considers four aspects related to the all-round assessment of the patient with COPD.

Here B means body mass index, O stands for obstruction of the airflow, D is nothing but dyspnea, and E stands for capacity of the exercise based on the six min walk test.[5] Allocation of the limited resources to the needed patients and decision making regarding timely interventions demand development of a reliable, cost effective, simple assessment tool.

Several studies propose BODE index for this purpose in patients with COPD. Hence this study has been undertaken to assess the utility of BODE index to predict the severity of exacerbations and systemic involvement in COPD.

METHODS

The cases for the study are the patients admitted in Department of General Medicine, KIMS Hubli with a diagnosis of COPD during the study period from April 2016 to August 2017. The patients were interviewed according to the proforma.

Inclusion criteria

- Patients with COPD.

Exclusion criteria

- Asthma proved on spirometry with
- Patients with recent myocardial infarction,
- Patients with unstable angina and
- Patients with congestive cardiac failure

COPD was diagnosed in patients if the patient gave history of productive cough lasting for minimum three months for continuous two years along with signs of limitation of the flow of the air with wheeze as well as hyperinflation signs. This in addition to if the FEV1/FVC ratio was less than 0.7 on doing the spirometry. After obtaining informed written consent, basic demographic data were recorded. Presenting symptoms were recorded in detail. Detailed history regarding the illness in the past including number of hospitalizations and duration of hospital stay were noted. Tobacco use was enquired about, and pack years calculated for all smokers. Detailed physical examination including anthropometric measurements and 6 min walking test was done on each patient.

For measuring 6 min walking distance, the patient is asked to walk on flat surface corridor of length 30 meters to and fro. Completing 60 meters is considered as 1 lap. Number of laps in 6 minutes is measured and scoring was done

Each patient was subjected to complete hemogram, liver function tests, renal function tests, chest X-ray, 2D-Echo and spirometry.

BODE index was calculated as follows. The score of BODE was zero if the FEV1% was less than 65 along with six min walk test score more than 350 along with MMRC between 0-1 along with body mass index more than 21. The score of BODE was one if the FEV1% was between 50-64, along with six min walk test score between 250-349 along with MMRC score of two and body mass index less than or equal to 21. The score of BODE was two if the FEV1% was between 36-49 along with six min walk test score between 150-249 along with MMRC score of three. The score of BODE was three if FEV1% was less than or equal to 35 along with six min walk test score of less than or equal to 149 along with MMRC score of four.

Table 1: Bode index class of severity.

Class of severity	BODE index
Class I (mild)	0-2
Class II (moderate)	3-5
Class III (severe)	≥6

Table 1 shows BODE index class of severity. The BODE index ranged from 0-10 in each patient. Based on the BODE index score, severity of illness was classified into mild, moderate and severe. BODE classification of severity was correlated with pack years, number of

hospitalizations and duration of hospital stay. Systemic involvement of COPD in present study is assessed by nutritional status and cardiac involvement. The parameters used for assessment of nutritional status are hemoglobin and albumin level. Cardiac involvement is assessed with ejection fraction in 2D Echo.

Statistical analysis

Statistical analysis was performed using SPSS 23.0 for windows (IBM Corporation). The characteristics were compared by means of one-way ANOVA for categorical variables. P value of 0.05 is considered significant.

RESULTS

Table 2 shows distribution of patients according to BODE index classes of severity. There were 31 patients in the class I of BODE index which indicated mild degree of severity and the score ranged from 0-2. There were 42 patients in class II of BODE index which indicated moderate degree of severity and the score ranged from 3-5. There were 27 patients in class III of BODE index which indicated severe degree of severity and the score ranged from 6-10. Thus, the majority of the patients were having moderate degree of severity of the disease.

Table 2: Distribution of patients according to bode index classes of severity.

BODE index class of severity	Number	%
Class I (0-2) (mild)	31	31
Class II (3-5) (moderate)	42	42
Class III (6-10) (severe)	27	27

Table 3 shows association of BODE index class of severity with number of hospitalizations. As the Bode index class of severity increases, the number of hospitalizations required in the past also increases and this association is statistically significant. The mean number of hospitalizations is strongly associated with BODE index. The mean number of hospitalizations in patients with class I was only 1.6 which increased to 2.7 in patients with class II and it further increased to 3.7 in patients with class III.

Table 3: Association of BODE index class of severity with number of hospitalizations.

Group	No. of patients	Mean number of hospitalizations	Standard deviation
Class I	31	1.6	0.8
Class II	42	2.7	2.1
Class III	27	3.7	0.9

P value <0.001 using one-way ANOVA.

Table 4 shows association of BODE class of severity with number of exacerbations in the past. As the severity of the disease increased as indicated by the class the mean number of exacerbations in the past increased and this association was found out to be statistically significant.

Table 4: Association of BODE class of severity with number of exacerbations in the past.

Group	No. of patients	No. of exacerbations in the past (mean)	Standard deviation
Class I	31	4.1	3.4
Class II	42	9.8	10.7
Class III	27	12	8.5

P value < 0.001 using one-way ANOVA.

The mean number of exacerbations in the past in patients belonging to class I was 4.1. The mean number of exacerbations in the past in patients belonging to class II was 9.8. The mean number of exacerbations in the past in patients belonging to class III was 12.

Table 5: Association of bode class of severity with mean number of days of hospitalization.

Group	No. of patients	No of days of hospitalisation (mean)	Standard deviation
Class I	31	11.3	7.6
Class II	42	12.6	7.9
Class III	27	13.9	6.7

P value = 0.44 using one-way ANOVA.

Table 5 shows association of BODE class of severity with mean number of days of hospitalization. As the severity of the disease increased as indicated by the class level, the mean number of days of hospitalization increased. But this increase was of small difference and hence on one-way ANOVA test was not found out to be statistically significant. The mean number of days of hospitalization in the past in patients belonging to class I was 11.3. The mean number of days of hospitalization in the past in patients belonging to class II was 12.6. The mean number of days of hospitalization in the past in patients belonging to class III was 13.9.

Table 6: Association of BODE index class of severity with pack years among smokers.

Group	No. of patients	Pack years (mean)	Standard deviation
Class I	31	26.7	25
Class II	42	45.8	29
Class III	27	105.8	68

P value <0.001 using one-way ANOVA.

Table 6 shows association of BODE index class of severity with pack years among smokers. As the pack years increases, the BODE index increases significantly (p value <0.001). This indicates the strong association of

smoking and the severity of COPD. The mean pack years in the past in patients belonging to class I was 26.7 years. The mean pack years in the past in patients belonging to class II was 45.8 years. The mean pack years in the past in patients belonging to class III was 105.8 years.

Table 7: Association of BODE index class of severity with BMI.

Group	No. of patients	BMI (Mean)	Standard deviation
Class I	31	23.6	5.9
Class II	42	21.2	4.6
Class III	27	20.5	5.4

P value = 0.04 using one -way ANOVA

Table 7 shows association of BODE index class of severity with BMI. As the severity of the disease increased, the mean body mass index decreased. Or the other way authors can say that as the body mass increased, the severity of the disease decreased. This trend was found out to be statistically significant. The mean BMI in patients belonging to class I was 23.6 years. The mean BMI in patients belonging to class II was 21.2 years. The mean BMI in patients belonging to class III was 21.2.

Table 8: Association of BODE index class of severity with haemoglobin levels.

Group	No. of patients	Haemoglobin (mg/dl) (Mean)	Standard deviation
Class I	31	11.6	1.5
Class II	42	11	1.5
Class III	27	10	2

P value = 0.003 using one -way ANOVA

Table 8 shows association of BODE index class of severity with hemoglobin levels. Hemoglobin level was found to decrease with increase in BODE index class of severity. This association was statistically significant. The mean Hemoglobin (mg/dl) in patients belonging to class I was 11.6 mg/dl. The mean Hemoglobin (mg/dl) in patients belonging to class II was 11 mg/dl. The mean Hemoglobin (mg/dl) in patients belonging to class III was 10 mg/dl.

Table 9: Correlation of BODE index with BMI, S albumin and haemoglobin.

Features	Direction	Pearson correlation coefficient	P value
BMI	Negative	0.28	0.005
Serum albumin	Negative	0.70	<0.001
Haemoglobin	Negative	0.56	<0.001

Table 9 shows correlation of BODE index with BMI, S Albumin and Hemoglobin. BODE index is negatively correlated significantly with BMI, S. albumin and hemoglobin (Pearson correlation analysis). The Pearson correlation coefficient for body mass index was 0.28 and it was statistically significant. The Pearson correlation coefficient for serum albumin was 0.70 and it was statistically significant. The Pearson correlation coefficient for hemoglobin was 0.56 and it was statistically significant.

Table 10: Association between BODE index class of severity and ejection fraction.

Group	No. of patients	Ejection fraction (Mean)	Standard deviation
Class I	31	50.6	9.1
Class II	42	51.1	8.2
Class III	27	48.1	88

P value = 0.35 using one- way ANOVA.

Table 10 shows association between BODE index class of severity and ejection fraction. Mean ejection fraction of BODE class I patients was 50.6%, class II was 51.1% and class III was 48.1%. There was no statistically significant association found between ejection fraction and increasing class of severity based on BODE index.

DISCUSSION

In present study, it is found that as the pack year's increases BODE index also increases. There is a significant positive association between BODE index and smoking status. Similar results were given by Shivakumar BG et al, and Ong KC et al.[6,7]

According to present study, as the BODE index class of severity increases, number of exacerbations also increases. Similar studies done by Ong KC et al, and McKellar A et al, also proved the same.[7,8]

Faganello MM et al, in a follow-up study done on patients with COPD found significant variation of BODE index scores in exacerbators and non-exacerbators (P value <0.001).[9]

Authors found a positive association between number of times the patients were hospitalized and the BODE index. This was found to be statistically significant. McKellar A et al, concluded that the BODE index is a good predictor of the number of times the patients were hospitalized which is in accordance with the findings of the present study.[8]

Alcazar B et al, through his study showed that higher BODE index is one of the factors associated with need for hospitalization in acute exacerbation of COPD (P value <0.001).[10]

Authors did not find any association between the BODE index and the number of days the patient stayed in the hospital. But Shivakumar BG et al, observed in their

study that there was a significant association between the BODE index and the number of days the patient stayed in the hospital.[6]

As the severity of the disease increased, the mean body mass index decreased. Or the other way authors can say that as the body mass increased, the severity of the disease decreased. This trend was found out to be statistically significant. Similar study done by Yamauchi Y et al, proved that overweight and obese patients had a lower mortality than low–normal weight patients, which supports the obesity paradox. The obesity paradox, which is based on a protective effect of adipose tissue against mortality, has been observed in various chronic diseases, including cardiovascular disease, chronic heart failure, stroke, chronic kidney disease, type 2 diabetes mellitus, and pulmonary hypertension.[11]

This study proved negative association between BODE index and albumin levels with significance. Similar study done by Shivakumar BG et al, also showed that as BODE index class of severity increases, albumin levels decreases (P value = 0.0408).[6]

Ardestani ME et al, in a similar study observed that no significant association exists between serum albumin levels and the classes of severity which is not in accordance with present study.[12]

Increased level of inflammatory cytokines may lead to shortened survival of red blood cells, reduced erythropoietin response to hypoxemia, impede iron utilization and impaired bone marrow response to erythropoietin.[13] Jeswani G et al, and Silverberg DS et al, through their studies proved high prevalence of microcytic anemia in COPD patients.[13,14] However these hypotheses need to be backed by more evidences.

Present study has shown negative correlation between BODE index and hemoglobin level which is significant. This can be attributed to the fact that COPD is a chronic systemic inflammatory condition.

Present study proves that BODE index is a marker of nutritional status of the patient in terms of S. albumin and hemoglobin levels.

Kalaycioglu E et al, also proven in his study that higher BODE index was associated with impaired LV mechanics in patients with COPD (P value <0.001).[15]

This study suggests BODE index as a reliable, easy, cost effective, inexpensive tool to assess the severity and systemic involvement in COPD. BODE index comprises parameters from all aspects of illness including symptomatology (dyspnea scale), systemic involvement (BMI and 6 min walking test) and degree of pulmonary impairment (FEV1%). The only tool needed for deriving BODE index is spirometry which is inexpensive.

BODE index can be reliably used as an assessment tool to decide regarding need for hospitalization and referral in patients with COPD. Thus, effective allocation of resources can be implemented for management of COPD especially in developing countries like India where incidence of COPD also is in rising trend.

CONCLUSION

The BODE index has been found to be a very good predictor for likely hospitalization and severity of acute exacerbations. It also indicated the degree of severity of systemic involvement. It is simple to use and hence can be used at primary level of health care to assess the COPD patients easily and accurately.

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