

V.A. Kapustnyk, I.F. Kostyuk, A.Ya. Melenevych, V.M. Tverezovskiy
Kharkiv National Medical University, Kharkiv

BODE INDEX IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN COMBINATION WITH HYPERTENSIVE HEART DISEASE

e-mail: melenevych@ukr.net

The prognostic potential of the BODE index in assessing future cardiovascular risk in patients with chronic obstructive pulmonary disease in combination with hypertensive heart disease based on left ventricular geometry has been established. Comparing the BODE index results depending on the type of left ventricular remodeling, a significant ($p=0.032$) increase in the index was determined in patients with prognostically unfavorable left ventricular remodeling compared to relatively favorable types – 1.73 ± 0.45 scores vs. 1.45 ± 0.63 scores. Patients with comorbid conditions showed a significant decrease in exercise tolerance and a tendency to desaturation. In order to increase the BODE index sensitivity in predicting the course of chronic obstructive pulmonary disease of the GOLD 2 grade, group B in combination with stage II hypertension, we propose to consider the presence of desaturation. That is, to consider a decrease in the saturation levels during a six-minute walk test from the initial value $\geq 4\%$ as one of the prognostically unfavorable criteria.

Key words: chronic obstructive pulmonary disease, hypertensive heart disease, BODE index, echocardiography, left ventricular geometry.

В.А. Капустник, І.Ф. Костюк, А.Я. Меленевич, В.М. Тверезовський

ІНДЕКС BODE У ХВОРИХ НА ХРОНІЧНЕ ОБСТРУКТИВНЕ ЗАХВОРЮВАННЯ ЛЕГЕНЬ У ПОЄДНАННІ З ГІПЕРТОНІЧНОЮ ХВОРОБОЮ

Встановлено прогностичний потенціал індексу BODE в оцінюванні майбутнього серцево-судинного ризику у пацієнтів з хронічним обструктивним захворюванням легень у поєднанні з гіпертонічною хворобою на підставі аналізу геометрії лівого шлуночка. При зіставленні результатів індексу BODE в залежності від типу ремоделювання міокарду лівого шлуночка визначено достовірне ($p=0.032$) збільшення індексу у пацієнтів з прогностично несприятливими типами ремоделювання лівого шлуночка в порівнянні з відносно сприятливими типами – $1,73\pm 0,45$ балів vs. $1,45\pm 0,63$ балів. Пацієнти з коморбідною патологією продемонстрували достовірне зниження толерантності до фізичних навантажень і схильність до десатурації. З метою збільшення чутливості індексу BODE при прогнозуванні перебігу хронічного обструктивного захворювання легень GOLD 2, групи В у поєднанні з гіпертонічною хворобою II стадії ми пропонуємо враховувати також наявність десатурації, тобто зниження рівня сатурації під час шестихвилинного тесту з ходьбою від початкового значення $\geq 4\%$ як один з прогностично несприятливих критеріїв.

Ключові слова: хронічне обструктивне захворювання легень, гіпертонічна хвороба, індекс BODE, ехокардіографія, геометрія лівого шлуночка.

The work is a fragment of the research project "Improvement of cardiovascular risk assessment in chronic obstructive pulmonary disease", state registration No. 0116U004989.

The BODE index is widely used in clinical practice to assess the condition of patients with bronchopulmonary pathology and predict the further course of the disease. It is a multidimensional scoring system for the patient's condition. The prognostic index was proposed by Celli B.R. and colleagues in 2004. The BODE index includes the body mass index estimation (body mass index – B), the forced expiratory volume in the first second (obstruction – O), the severity of dyspnea (dyspnea – D), and the results of a six-minute walking test (exercise capacity index – E). For each parameter, except for the body mass index (BMI), there are from 0 to 3 scores. A $BMI > 21 \text{ kg/m}^2$ corresponds to 0 scores, and a $BMI \leq 21 \text{ kg/m}^2$ corresponds to 1 score. The risk of adverse events and the severity of the patient's prognosis increase with the index. The maximum possible number of scores is 10, which is associated with the most unfavorable prognosis for the patient [3].

The BODE index validity was confirmed by its authors based on an analysis of the results of a prospective study involving 625 patients with chronic obstructive pulmonary disease (COPD). During the follow-up period, 162 patients died from respiratory and other causes. All study participants were divided into 4 quartiles according to the number of BODE index scores (1st quartile – from 0 to 2 scores, 2nd – from 3 to 4 scores, 3rd – from 5 to 6 scores, 4th – from 7 to 10 scores). Among patients of the 4th quartile, the mortality rate reached 80% in 52 months. In addition, it was found that a BODE index score ≥ 7 is associated with 30% of 2-year mortality, 5-6 is associated with 15% of 2-year mortality, and if the BODE index score < 5 , the 2-year mortality rate is less than 10%. The BODE index may decrease under the influence of rehabilitation and treatment measures, which allows us to use as a criterion for assessing therapy effectiveness [2].

In order to improve the prognostic capacity, scientists offer various modifications of the BODE index. The most famous of these are: the BODEx index, proposed in 2009 by Soler - Cataluna J.J. and colleagues, in which the six-minute walking test (6-MWT) was replaced with an exacerbation [6]; the m-BODE index (Cardoso F. et al., 2007), where the decrease in exercise tolerance is assessed on the basis of analysis of oxygen consumption (VO_2), and not on the result of 6-MWT [1]; the i-BODE index (Williams J.E. et al., 2012) – to assess exercise tolerance, it is proposed to use not 6-MWT, but another cardiopulmonary exercise test: a shuttle test with an increasing pace of walking [7]; the BODEm index (Martinez F.J. et al., 2006) – to assess the level of shortness of breath the questionnaire on respiratory disorders recommended by the University of California, San Diego [2] is used instead of the MRC (Medical Research Council) scale. These tests demonstrated a predictive ability for overall patient mortality, but due to the small number of study participants, the classic BODE index, which was tested in multi-scale prospective studies, is currently the most commonly used one.

It is important to determine the BODE index in comparison with comorbid conditions, especially with the risk of adverse cardiovascular events in patients with COPD with concomitant hypertensive heart disease (HHD), due to the widespread prevalence of this comorbid pathology.

The purpose of our study was to analyze the results of the BODE index depending on the presence of hypertensive heart disease and the features of left ventricular (LV) remodeling in patients with chronic obstructive pulmonary disease.

Materials and methods. The study involved 100 patients with COPD of occupational etiology of GOLD 2 grade, group B (according to the recommendations of GOLD 2016), who were treated at the clinic of the Institute of Occupational Health and Occupational Diseases of Kharkiv National Medical University. The mean age of patients was 54.42 ± 6.23 years. Of them, there were 79% men and 21% women. The main group included 69 patients with COPD in combination with stage II HHD, the comparison group – 31 patients with COPD. The examination was performed in remission, which was characterized by stable clinical symptoms and indicators of external respiration function. All patients underwent general clinical and laboratory examination, pulse oximetry, external pulmonary function test, electrocardiography, echocardiography (EchoCG) and chest radiography. The BODE index, the results of a six-minute walking test (6-MWT), the saturation level (SpO_2) and the degree of breath shortness on the G. Borg scale before and after 6-MWT were also evaluated.

Based on the study of echocardiographic parameters, the types of LV geometry were determined according to the A. Ganau classification according to the ratio of myocardial mass index (MMI) and the index of LV relative wall thickness (RWT): 1) normal geometry of the left ventricle: $MMI < N$, $RWT < 0.42$; 2) concentric LV remodeling: $MMI < N$, $RWT > 0.42$; 3) concentric LV hypertrophy: $MMI > N$, $RWT > 0.42$; 4) eccentric LV hypertrophy: $LV > N$, $RWT < 0.42$. RWT was calculated using the formula: $RWT = (IVSd + PWd) / LVEDD$, where: LVEDD – LV end-diastolic dimension (mm), IVSd – Interventricular septal thickness at end-diastole (mm), PWd – Posterior wall thickness at end-diastole (mm). MMI values above 115 g/m^2 in men and more than 95 g/m^2 in women were considered a criterion for subclinical heart disease and high cardiovascular risk in accordance with the European guidelines for the management of patients with arterial hypertension in 2013 [5].

In accordance with the recommendations of the Ethics Committees For Biomedical Research, Ukrainian Health Legislation and the Declaration of Helsinki of 2000, European Community Directive 86/609 On Human Participation In Biomedical Research we received written consent to conduct the study from every patient.

Statistical processing of the obtained data was performed using the STATISTICA 8.0 package using non-parametric statistical methods. Descriptive statistics are presented as the arithmetic mean and standard deviation ($M \pm SD$). Qualitative indicators are presented in the form of absolute values and percentages. The probability of differences in independent groups was assessed using the Mann-Whitney U-test. Correlation analysis was performed using Spearman Rank-Order Correlation. All statistical tests were bilateral, the differences were considered significant at $p < 0.05$.

Results of the study and their discussion. Patients with COPD in combination with HHD had probable differences with patients with isolated COPD on the following indices: the distance according to the result of 6-MWT – $383.41 \pm 14.85 \text{ m}$ vs. $395.68 \pm 18.99 \text{ m}$, $p = 0.006$; SpO_2 after 6-MWT – $93.71 \pm 1.65\%$ vs. $94.52 \pm 1.59\%$, $p = 0.037$; desaturation – $4.14 \pm 1.44\%$ vs. $3.39 \pm 1.31\%$, $p = 0.017$; BODE index – 1.84 ± 0.41 scores vs. 1.10 ± 0.47 scores, $p < 0.001$. Thus, patients with combined pathology showed signs of decreased exercise tolerance and a tendency to desaturation compared with patients with isolated COPD. A BMI value below than 21 kg/m^2 is associated with an increased risk of future adverse events. In our study, only 3 patients

had a BMI < 21 kg/m² and received 1 score in the BODE index. The result of the BODE index of the vast majority of examined patients was not affected by BMI. Regarding forced expiratory volume₁ (FEV₁), due to the fact that all patients according to the spirometric classification had a moderate degree of bronchial obstruction (GOLD 2) – 50% ≤ FEV₁ < 80% of the required ones, the vast majority of patients received 1 score for this indicator. The MRC scale of breath shortness in most patients was 2 scores, because respiratory disorders force patients to walk slower than people of the appropriate age, and there is a need to stop when walking at their own pace on level ground. The contribution of dyspnea level assessment to the BODE index of most patients was 1 score. The result of 6-MWT of all participants in our study was more than 350 m, which, according to the Bode index Assessment Scale, is a threshold value for the future unfavorable course. Therefore, the result of 6-MWT did not affect the total score of the BODE index.

In general, the prognostic value of the BODE index in our case was favorable, but the BODE index was probably higher in patients of the main group. This result can be explained by the moderate severity of the disease and the remission phase of the examined patients with COPD. The prognostic potential of the BODE index increases with COPD severity increasing.

There was a significant decrease in SpO₂ during 6-MWT from the initial value in COPD in combination with HHD compared to isolated COPD. Desaturation is considered to be a decrease in SpO₂ during 6-MWT from the initial value by more than 4%. Desaturation is associated with an accelerated decrease in pulmonary function and a 2-fold increase in the risk of the future adverse events [4].

According to the LV geometry, the predominance of prognostically unfavorable types of LV remodeling was established. Namely, eccentric LV hypertrophy was found in 16 patients out of 69 (23%) and concentric LV hypertrophy in 35 patients out of 69 (51%) among patients with COPD in combination with HHD. In contrast, among patients with isolated COPD, more prognostically favorable types of remodeling predominated: concentric remodeling in 15 patients out of 31 (48%) and normal LV geometry in 11 patients out of 31 (35%). Based on these data, patients were divided into 2 groups according to the type of remodeling – prognostically relatively favorable (n=44) and unfavorable (n=56). Comparing the BODE index result depending on the remodeling type, a probable (p=0.032) index increase was determined in patients with a prognostically unfavorable type of LV remodeling compared to a relatively favorable type – 1.73±0.45 scores vs. 1.45±0.63 scores.

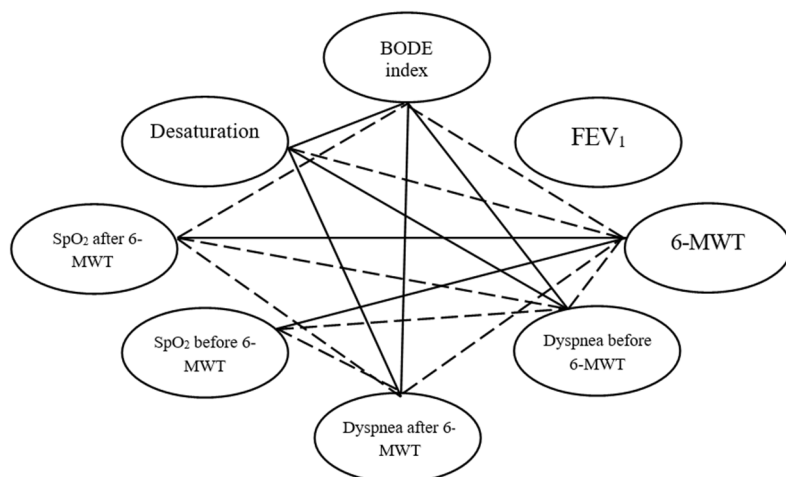


Fig. 1. Probable correlations of the studied parameters in patients with COPD in combination with HHD

Notes: — direct correlation
- - - - - inverse correlation

Based on the correlation analysis in patients with COPD in combination with HHD, significant relationships were found between the following parameters (Fig. 1): BODE index and distance passed by patients during 6-MWT ($r = -0.447$; $p < 0.001$), dyspnea degree on G. Borg scale before 6-MWT ($r = 0.591$; $p < 0.001$), dyspnea degree on G. Borg scale after 6-MWT ($r = 0.435$; $p < 0.001$), SpO₂ after 6-MWT ($r = -0.346$; $p < 0.001$), desaturation ($r = 0.354$; $p < 0.001$); the distance passed by patients in 6-MWT and dyspnea degree on G. Borg scale before 6-MWT ($r = 0.614$; $p < 0.001$), dyspnea degree on G. Borg scale after 6-MWT ($r = 0.614$; $p < 0.001$), dyspnea degree on G. Borg scale after 6-MWT

6 - MWT ($r = -0.739$; $p < 0.001$), SpO₂ before 6-MWT ($r = 0.344$; $p < 0.001$), SpO₂ after 6-MWT ($r = 0.788$; $p < 0.001$), desaturation ($r = -0.779$; $p < 0.001$); dyspnea degree on G. Borg scale before 6-MWT and SpO₂ before 6-MWT ($r = -0.230$; $p = 0.022$), SpO₂ after 6-MWT ($r = -0.537$; $p < 0.001$), desaturation ($r = 0.539$; $p < 0.001$); dyspnea degree on G. Borg scale after 6-MWT and SpO₂ before 6-MWT ($r = -0.260$; $p = 0.009$), SpO₂ after 6-MWT ($r = -0.725$; $p < 0.001$), desaturation ($r = 0.732$; $p < 0.001$).

Thus, in patients with COPD on the background of HHD, the BODE index had moderate direct correlations with the dyspnea degree on G. Borg scale before and after 6-MWT and desaturation; moderate

inverse – with distance passed by patients in 6-MWT and SpO₂ levels after 6-MWT. A strong correlation was observed between the distance passed by patients in 6-MWT and the SpO₂ level after 6-MWT and desaturation.

In general, our results of the study of desaturation coincide with the results of scientists Enright PL [4], agreeing with them. Correlation analysis in patients with COPD in combination with HHD revealed correlations found in the studies of Anzueto A, Mancia G, Soler-Cataluña JJ [2, 5, 6].

Conclusions

1. The prognostic potential of the BODE index in assessing the future cardiovascular risk in patients with COPD in combination with HHD based on the analysis of LV geometry. Patients with prognostically unfavorable LV geometry types had significantly higher BODE index values compared to patients whose LV geometry types were relatively favorable for possible cardiovascular complications.

2. Patients with COPD in combination with HHD in 6-MWT passed a significantly shorter distance and showed a tendency to desaturation relative to patients with isolated COPD. In addition, a strong inverse correlation was found between the distance traveled by patients in 6-MWT and the desaturation level.

3. In order to increase the BODE index sensitivity to predict the future course of GOLD 2 COPD, group B in combination with HHD stage II, we propose to take into account the presence of desaturation, i.e., SpO₂ decrease during 6-MWT from the initial value $\geq 4\%$ as one of the prognostically unfavorable criteria.

The prospect of further research is to analyze the prognostic potential of the BODE index taking into account desaturation in assessing future risks in patients with COPD of varying severity with concomitant cardiovascular pathology in multi-scale prospective studies.

References

1. Abdel-Aaty HE-S, Zamzam MA, Azab NY, El Wahsh RAER, El Beltagy SA. Comparison of GOLD classification and modified BODE index as staging systems of COPD. Egyptian Journal of Chest Diseases and Tuberculosis. 2014; 63:821-28. DOI: 10.1016/j.ejcdt.2014.06.008.
2. Anzueto A, Heijdra Y, Hurst JR, editors. Controversies in COPD: ERS Monograph. Plymouth, UK: published by European Respiratory Society; 2015. 333 p. doi: 10.1183/2312508X.10008315.
3. Celli BR. Predictors of mortality in COPD. Respir Med. 2010 Jun; 104(6):773-9. PMID: 20417082, DOI: 10.1016/j.rmed.2009.12.017.
4. Enright PL. Oxygen desaturation during a 6-min walk identifies a COPD phenotype with an increased risk of morbidity and mortality. Eur Respir J. 2016 Jul; 48(1):1-2. PMID: 27365500, DOI: 10.1183/13993003.00884-2016.
5. Mancia G, Fagard R, Narkiewicz K, Redón J, Zanchetti A, Böhm M, et al. 2013 ESH/ESC Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). J Hypertens. 2013; 31(7):1281-357. PMID: 23817082, DOI: 10.1097/01.hjh.0000431740.32696.cc.
6. Soler-Cataluña JJ, Marzo M, Catalán P, Miralles C, Alcazar B, Miravittles M. Validation of clinical control in COPD as a new tool for optimizing treatment. Int J Chron Obstruct Pulmon Dis. 2018 Nov 14; 13:3719-3731. PMID: 30532528, DOI: 10.2147/COPD.S178149.
7. Williams JE, Green RH, Warrington V, Steiner MC, Morgan MD, Singh SJ. Development of the i-BODE: validation of the incremental shuttle walking test within the BODE index. Respir Med. 2012 Mar; 106(3):390-6. PMID: 21978938, DOI: 10.1016/j.rmed.2011.09.005.

Стаття надійшла 19.11.2019 р.