Desaturation during Physical Exercise in COPD Patients – a Stable-over-time Phenomenon

Roman I. Kalinov1,4, Blagoi I. Marinov3, Dimitrina I. Stoyanova1,4, Vladimir A. Hodgev1,4, Lyudmila G. Vladimirova-Kitova2,4, Fedya P. Nikolov2,4, Stefan S. Kostianev3

1 Department of Pneumonology and Phthisiatrics, St George University Hospital, Medical University of Plovdiv, Plovdiv, Bulgaria
2 Clinic of Cardiology, Medical University of Plovdiv, Plovdiv, Bulgaria
3 Department of Pathophysiology, Medical University of Plovdiv, Plovdiv, Bulgaria
4 Section of Cardiology, First Department of Internal Diseases, Medical University of Plovdiv, Plovdiv, Bulgaria

Correspondence:
Roman I. Kalinov, Department of Pneumonology and Phthisiatrics, St George University Hospital, 66 Peshtersko shosse Blvd., 4001 Plovdiv, Bulgaria
E-mail: dr_kalinov@yahoo.com
Tel.: +359888433414

Introduction: Exercise-induced desaturation is a common finding in patients with moderate and severe COPD. It is an important marker in the course of disease that has a prognostic value for mortality risk.

Aim: To monitor over time COPD patients with and without desaturation during 6-minute walking test (6MWT) and to assess the stability of that phenomenon.

Materials and methods: A 6MWT was administered to 70 patients with COPD which ranged in severity from stage 2A to stage 4D (GOLD 2011); the patients had a mean age of 64.5±10.1, mean pack-years - 38.8±21, FEV1% = 46.4%±15.7%, FVC% = 73.7%±1.3%, MRC = 2.31±0.84, CAT = 20.8±6.6. Oxygen saturation was monitored during the test; indications for desaturation were a decrease of SpO2 by ≥4% and a fall in SpO2 to ≤88% for at least 3 min. The patients were followed-up for mean 40.9±22.3 months and tests were repeated.

Results: Patients were divided into two groups based on the decrease in SpO2: Group A included patients with desaturation (n=35) and Group B – patients with no desaturation (n=35). In 66 of the patients the desaturation profile was stable over time. Only two patients, who did not desaturated at baseline, experienced desaturation in the follow-up 6MWT and another two patients, who desaturated at baseline, did not have it later in the follow-up.

Conclusion: Desaturation is a phenomenon that is persistent over time. Based on the results, it could be concluded that exercise-induced desaturation is a major marker of a particular COPD phenotype.

INTRODUCTION

There is a significant heterogeneity in clinical features and course of disease among COPD patients. It is well known that apart from pulmonary symptoms, there are plenty of extrapulmonary ones that in some cases may lead to complications permanently worsening the condition and the prognosis. A good understanding of the complexity of that disease on a clinical, cellular and molecular levels and the complicated interaction of different pathophysiological mechanisms combined with a particular genetic predisposition in different patients explains the different course of disease and prognosis in people with the same diagnosis of COPD. At first diagnoses assessing the severity and monitoring the treatment effect were all made on the basis of airflow limitation (FEV1), but as data amassed it became clear that considering only this parameter is not enough for the full assessment of the patient. The inclusion of exacerbations, symptoms and comorbidity evaluation in the latest revisions of GOLD is a step in the right direction and gives us additional tools to establish an individual therapeutic plan for patients from different groups.1,2 The so called “clinical phenotyping” is at the basis of the identification of different subgroups of COPD patients which differ from each other in exacerbations, symptoms severity, course of disease, response to treatment, and mortality.

Testing the physical capacity of COPD patients has a great value in evaluating the severity of the disease in individual patients, the prognosis and in
determining the therapeutic approach in the different groups (phenotypes). Monitoring the saturation via pulse oximetry during exercise tests (6 Minute Walk Test, 6MWT) and cardio-pulmonary exercise test, CPET) allows us to detect easily and reliably the patients who desaturate while exercising. The phenomenon of desaturation is common in the advanced stages of COPD and has complex pathogenesis related to airflow limitation, ventilation/perfusion mismatch, shunting of venous blood in the arterial circulation, decreased diffusion capacity, systemic inflammation and oxidative stress, leading to disbalance between oxygen supply and consumption.

Identifying and monitoring the “desaturators” in the COPD population is part of searching the combinations of disease signs which describe the difference between COPD individuals and which relate them to important clinical results for the single patient.

**AIM**

To monitor continuously COPD patients with and without desaturation during 6MWT and to find out if this phenomenon is stable over time.

**MATERIALS AND METHODS**

The study was carried out in the Departments of Pulmonology, Cardiology and Pathophysiology in the Medical University of Plovdiv, Bulgaria, between 2009 and 2017.

Seventy male patients with COPD in different stages were included in the study. According to the GOLD 2011 criteria, they were as follows: 2A – 1 patient; 2B – 20 patients; 3D – 33 patients; 4D – 16 patients (Table 1).

**STUDY INCLUSION CRITERIA**

 Patients in COPD stages from 2A to 4D (GOLD) in a stable condition – not in exacerbation of COPD or any of the concomitant diseases.

**EXCLUSION CRITERIA**

- Left heart failure [ejection fraction (EF) ≤ 50%, brain natriuretic peptide (BNP) ≥ 150 pg/mL], uncontrolled rhythm disorders, unstable coronary artery disease (CAD), recent myocardial infarction (MI) and post-pulmonary thromboembolism (PTE) conditions. In all patients a baseline echocardiography and ECG were performed to exclude left ventricular dysfunction of myocardial or valvular type.

| Parameters | mean±SD |
|------------|---------|
| Age (years)| 64.5±10.1|
| Smoking (pack / years)| 38.8 ± 21.0|
| FEV1 (% pred.)| 46.4±15.7|
| KCO (% pred.)| 75.1±26.3|
| PaO2 (mm Hg)| 64.3±9.8|
| PaCO2 (mm Hg)| 41.9±5.8|
| SpO2bas (%)| 93.1±3.5|
| 6 MWT (m)| 493±89|
| mMRC| 2.3±0.8|
| SGRQ| 59.1±15.1|
| CAT| 20.8±6.6|
| Number of exacerbations*| 1.9±1.4|
| BODE index| 3.4±1.9|
| DOREMIBOX| 4.7±1.5|
| EF (% pred.)| 59.0 ± 4.5|
| BNP (pg/mL)| 57.0 ±62.6|
| mPAP (mm Hg)| 39.1±5.6|
| CCI| 0.73±1.0|

FEV1: forced expiratory volume for 1 second; KCO: diffusion capacity, corrected for alveolar volume; PaO2: partial pressure of O2; PaCO2: partial pressure of CO2; SpO2bas.: baseline saturation; 6MWT: the distance in meters covered during the test; mMRC: modified Medical Research Council dyspnea score; SGRQ: St George’s Respiratory Questionnaire; CAT: COPD Assessment Test; BODE index: Body mass index, airflow Obstruction, Dyspnea and Exercise capacity; DOREMIBOX: the first index in which exacerbations are included as an important criterion for disease severity and progression; EF: ejection fraction; BNP: natriuretic peptide type B; mPAP: mean pressure in the pulmonary artery; CCI: Charlson Comorbidity Index Number of exacerbations*: Moderate and Severe according to GOLD definitions. Moderate – the symptoms require the use of corticosteroids and/or antibiotics. Severe – the symptoms require admission to an emergency room or hospitalization
Complete medical history regarding current, previous and concomitant diseases, tobacco smoking and pack/years, number of exacerbations in the last year, was obtained from each patient. We subjected the patients to the following tests: spirometry with a bronchodilator test (BDT); bodyplethysmography and measurement of the diffusion capacity (Master Screen Diffusion/Body, E. Jaeger, Germany); blood-gas analysis of arterialized capillary blood (ABL 830 FLEX, Radiometer, Denmark); 6 minute walk test (6MWT).

- 6MWT was performed in a closed 35-meter-long corridor; the tested subjects were asked to walk for 6 minutes and cover as much distance as possible. The patients were instructed to walk from one end of the corridor to the other as fast as they can for 6 minutes. They were allowed to stop for a rest. During walking the subjects were encouraged with standard phrases.4 The covered distance was measured in meters. At baseline and at the end of the test, dyspnea was assessed by the modified Borg scale (1-10). Each patient performed the test minimum 2 times in 2 days. In the follow-up visit spirometry, 6MWT and filling-up the quality of life questionnaires [modified Medical Research Council (mMRC), COPD-assessment test (CAT)] were performed in a single day.

- Oxygen saturation was monitored during the 6MWT by a pulse oximeter PalmSat 2500+ (Nonin Medical, Plymouth, MN, USA) and a decrease of SpO2 by ≥ 4% and oxygen saturation ≤ 88% were considered a desaturation event.

- Every patient underwent echocardiography (HP, Sonos 2500 System, USA). Left ventricular ejection fraction was evaluated via Simpson’s method. The mean pressure in the pulmonary artery (mPAP) was calculated automatically by the system’s software.

- BNP is a diagnostic marker of heart failure (HF). Biological material: venous blood with EDTA as an anticoagulant. The separated plasma was contained in -70°C until its processing. The device used was Sirio S microplate reader, SEAC, Italy and the method: competitive inhibition enzymatic immunoassay.

- The standardized test mMRC, Saint George Respiratory Questionnaire (SGRQ) and CAT were used to evaluate quality of life, dyspnea perception and the related with it limitation of physical activity.9-14

- Monitoring of the patients was performed for 40.9±22.3 (mean±SD) months with repetition of the 6MWT, mMRC and CAT.

The study design was reported at a local Ethics Committee at the Medical University of Plovdiv and all its stages and components were approved. All patients who matched the inclusion/exclusion criteria were thoroughly informed about the study and signed informed consents prior to taking any actions related to the study.

Statistical analysis
Data were analysed using SPSS v. 22.0 for Windows (SPSS, Chicago, USA). The results were presented as mean value ± standard deviation (mean±SD), except where otherwise stated. Sometimes we reported the minimal and maximal values in order to give an idea about the range. Kolmogorov-Smirnov test was used to check for normal distribution. Comparing two means was done with Student’s t-test, respectively for independent variables – independent samples T-test and for related variables – paired samples T-test. When analyzing the dependencies between normally distributed quantitative variables, we used Pearson’s coefficient of correlation. To assess the reproducibility of the 6MWT in regards of manifesting desaturation on exertion the coefficient of agreement kappa was used. It is used to compare two separate measurements, especially when a gold standard is missing. The coefficient of agreement kappa is a measurement of test reproducibility; κ > 0.7 is considered a good test, while a malfunctioning test is with κ < 0.3. To establish determinants of the percentage desaturation we used stepwise regression analysis. The significance level for the null hypothesis was p < 0.05.

RESULTS
Of 70 tested patients, 35 (50%) desaturated during the 6MWT. In the follow-up for 40.9±22.3 months on average the desaturation profile remained unchanged in 66 (94%) of them (Fig. 1).

To assess the reproducibility of the 6MWT in terms of inducing desaturation on exertion, we used the statistical method Kappa. As we performed two series of tests in a different time interval, we created a two-dimensional array to represent all data variations. After processing, the result for κ = 0.886 which demonstrates the high degree of reproducibility and gives reason to consider desaturation as a phenomenon describing initial pathophysiological mechanisms, forming the disease and it is stable over time in that patient population.

On the basis of the decrease in SpO2 during the test, the patients were divided into two groups –
Desaturation During 6MWT in COPD Patients – a Stable Phenomenon

The two groups differ significantly in terms of FEV1%; FVC%; IC%; diffusion capacity corrected for alveolar volume (KCO%); PaO2; PaCO2; baseline SpO2, mMRC, mPAP and 6 MWT (p < 0.05), but not in terms of CAT, SGRQ, Charlson Comorbidity Index (CCI), EF% pred., and number of exacerbations in the last year (Table 2).

The percentage desaturation in the whole group ΔSpO2 6.3±5.0% correlates with the basic spirometric and blood-gas parameters FEV1% (r = -0.40; p = 0.001), FVC% (r = -0.28; p = 0.019), KCO% (r = -0.45; p = 0.001), baseline SpO2 (r = -0.55; p = 0.001), PaO2 (r = -0.55; p = 0.001), 6MWT (r = -0.33; p = 0.005), mMRC (r = 0.30; p = 0.011), mPAP (r = 0.32; p = 0.009), but not with CAT, SGRQ, comorbidity and the number of exacerbations for the last year.

The stepwise regression analysis was performed including parameters from spirometry, blood-gas analysis, diffusion, scales for dyspnea and symptoms assessment, 6MWT, basal SpO2, mean pressure in the pulmonary artery (mPAP), comorbidity, smoking in pack/years, BMI, age (years) and the number of exacerbations for the last year. The results show that only PaO2, KCO and baseline SpO2 are significant determinants of the percentage desaturation ΔSpO2 in the following equation:

\[
\Delta \text{SpO2} \% = 60.1 – 0.2 \times \text{PaO2} – 4.6 \times \text{KCO} – 0.3 \times \text{baseline SpO2}
\]

(SSE: Standard error of the estimate)

DISCUSSION AND CONCLUSIONS

We found 35 patients (50%) in the present study that desaturated during the 6MWT and the desaturation profile remained unchanged over time in 66 of all the tested subjects (94%).

Jenkins S et al.\textsuperscript{23} reported a study of a large group of people with chronic pulmonary diseases (741 patients) of which 572 with COPD and 47% (n=345) desaturated during 6MWT. Van Gestel et al.\textsuperscript{24} also found a considerable prevalence of desaturation among COPD patients using the same test (61.7% out of the total 154 included in their study). Other authors have reported a frequency of desaturation among COPD patients between 29% and 55% and despite the different criteria and different studied populations it is safe to assume that this is a quite common finding in the late stages.
Table 2. Comparison of the functional and clinical parameters in patients with and without desaturation

| Parameters                      | Without desaturation | With desaturation | p      |
|---------------------------------|----------------------|-------------------|--------|
| Age years                       | n = 35               | 63.8±9.3          | 65.3±10.9 | 0.542 |
| Smoking pack/years              |                      | 41.5±20.1         | 36.0±21.7 | 0.288 |
| BMI kg/m²                       |                      | 26.5±5.5          | 24.6±5.4 | 0.154 |
| Diagnosis COPD years            |                      | 9.1±7.1           | 9.1±7.1 | 0.974 |
| FEV1 % pred.                    |                      | 52.9±14.2         | 39.9±14.6 | 0.001 |
| FVC % pred.                     |                      | 77.6±15.6         | 68.4±21.1 | 0.043 |
| IC % pred.                      |                      | 82.5±17.6         | 66.7±19.6 | 0.002 |
| KCO % pred.                     |                      | 85.6±22.6         | 65.0±25.9 | 0.001 |
| PaO₂ mm Hg                      |                      | 69.6±8.0          | 59.0±8.6 | 0.001 |
| PaCO₂ mm Hg                     |                      | 39.4±3.4          | 44.5±6.6 | 0.001 |
| SpO₂ bas. %                    |                      | 94.7±1.1          | 91.6±4.4 | 0.001 |
| SpO₂ min. %                    |                      | 92.2±1.4          | 80.9±7.8 | 0.001 |
| 6MWT m                         |                      | 518±75            | 469±97 | 0.021 |
| Borg scale                      |                      | 2.8±1.4           | 3.3±1.5 | 0.709 |
| mMRC                           |                      | 2.0±0.8           | 2.6±0.8 | 0.001 |
| SGRQ                            |                      | 57.8±16.0         | 60.3±14.2 | 0.491 |
| CAT                             |                      | 20.2±6.9          | 21.4±6.4 | 0.454 |
| Number of exacerbations* n      |                      | 1.9±1.2           | 2.2±1.6 | 0.675 |
| CCI % pred.                     |                      | 0.63±0.91         | 0.83±1.1 | 0.410 |
| EF % pred.                      |                      | 58.9±4.1          | 59.2±4.6 | 0.807 |
| mPAP mmHg                       |                      | 37.1±4.7          | 40.3±6.3 | 0.023 |
| BODE index                      |                      | 2.6±1.8           | 4.2±1.6 | 0.001 |

BMI: body mass index; FEV₁: forced expiratory volume in 1 second; FVC: forced vital capacity; IC: inspiratory capacity; KCO: diffusion capacity corrected for alveolar volume; PaO₂: partial pressure of O₂; PaCO₂: partial pressure of CO₂; SpO₂ bas.: baseline saturation; SpO₂ min: minimal saturation during exercise; 6MWT: the distance in meters covered during the test; Borg scale: for assessing dyspnea and fatigue during exercise; mMRC: modified Medical Research Council dyspnea score; SGRQ: St George’s Respiratory Questionnaire; CAT: COPD Assessment Test; CCI: Charlson Comorbidity Index; EF: ejection fraction; mPAP: mean pressure in the pulmonary artery; BODE index: Body mass index, airflow Obstruction, Dyspnea and Exercise capacity of COPD.²¹,²⁸,³⁰

To date there has been no widely accepted definition of desaturation and unified criteria for its detection in different types of physical exercise. There are different criteria to evaluate the absolute and relative decreases of PaO₂ and SpO₂ for detection of hypoxemia in physical exercise.¹⁵ The borderline values for SpO₂ are usually ≤88-90%, as the extent of decrease from baseline ranges from 2% to 5%. The duration in which the SpO₂ values are below the appointed threshold is also rarely defined, varying in the different sources between 0.5 and 5 minutes.¹⁵ The exercise tests used to objectivize presence or absence of desaturation are also a wide variety: from everyday physical activity, 6MWT, shuttle tests and stair climb
tests, to CPET with incremental or constant load performed on a treadmill or an ergometer.\textsuperscript{15} Those substantial variations lead to considerable confusion and misinterpretation of study results. After taking into account a lot of considerations and previously published experience we defined our own criteria for desaturation. We aimed to prove unequivocally the drop in SpO\textsubscript{2} via recorded continuous pulse oximetry for the time of the whole 6MWT, as the requirement for the value being ≤88% for a minimum of 3 minutes eliminates the possibility for technical mistakes. In all the tested subjects we performed at baseline echocardiography and BNP measurement to exclude the presence of heart failure which would have altered the results and would have led to misinterpretation. In 66 of the patients, we observed no changes in the desaturation profile. Two of the patients with baseline desaturation did not experience such in the subsequent tests and in another two it appeared for the first time on measurement to exclude the presence of heart failure which would have altered the results and would have led to misinterpretation. After taking into account a lot of considerations and previously published experience we defined our own criteria for desaturation. We aimed to prove unequivocally the drop in SpO\textsubscript{2} via recorded continuous pulse oximetry for the time of the whole 6MWT, as the requirement for the value being ≤88% for a minimum of 3 minutes eliminates the possibility for technical mistakes. In all the tested subjects we performed at baseline echocardiography and BNP measurement to exclude the presence of heart failure which would have altered the results and would have led to misinterpretation. In 66 of the patients, we observed no changes in the desaturation profile. Two of the patients with baseline desaturation did not experience such in the subsequent tests and in another two it appeared for the first time on the later tests. We presume that desaturation is a phenomenon determined by the interaction between the pathophysiological mechanisms forming the disease, it persists over time in the majority of COPD patients where it leads to faster progression and more severe disease course.\textsuperscript{34} Desaturation on exertion is probably a characteristic feature of a specific COPD “phenotype” rather than an event, occurring in the normal disease course.

Monitoring saturation continuously for the whole time of the 6MWT makes it possible to detect desaturation. This is a safe and secure test which does not require expensive technical equipment and highly trained personnel, yet it is comparable to the “gold standard” CPET.\textsuperscript{1,16} The 6MWT is well studied in terms of reproducibility of the distance covered and sensitivity for therapeutic interventions\textsuperscript{4,17}, but not so well in terms of reproducibility of desaturation.

Poullain et al. compare 6MWT and CPET on an ergometer in 80 patients with COPD and concludes that the 6MWT is more sensitive for desaturation detection during exercise. The used criterion was a decrease in the SpO\textsubscript{2} by ≥4% for a minimum of the least 3 minutes of the test. The results were reproducible regardless of the protocol and this allows us to use them when prescribing O\textsubscript{2} therapy at home.\textsuperscript{18}

Hernandes et al. check the reproducibility of 6MWT in a retrospective observational study including 1544 COPD patients who performed two tests on two consecutive days. Criteria for desaturation were either a difference between baseline and final SpO\textsubscript{2} ≥ 4% and/or final SpO\textsubscript{2} < 88% and desaturation reproducibility also was assessed. The average change in oxygen saturation during the first and second 6MWT was -5.7% (95% CI -15-0%) and -5.5% (95% CI -16-0%), respectively. The authors conclude that the change in SpO\textsubscript{2} during 6MWT is reproducible (ICC - 0.81, p < 0.001). Besides, the sensitivity and specificity for predicting desaturation during the second 6MWT based on the results from the first were 80% and 77%, respectively.\textsuperscript{19}

Contrary to those results, Chatterjee et al.\textsuperscript{20} studied 88 COPD patients and found only moderate reproducibility κ = 0.62 in 3 6MWT performed in an average period of 21 days, but the desaturation criteria in their study included minimal duration of only 5 seconds which significantly differs from our criterion of minimum 3 minutes.

Stolz et al. studied 574 COPD patients and a follow-up of 2 years, as a control 6MWT was performed each year. Criterion for desaturation was a decrease of SpO\textsubscript{2} to <88% with no specified duration. On the basis of their data, the authors calculate that the probability after one year for those who were not desaturators at baseline to experience desaturation is 21.6%, for the desaturators there was 37.3% probability to remain such and 48.5% probability to not suffer from desaturation on a subsequent test after one year. The authors conclude that this phenomenon has a low reproducibility and is rather intermittent in COPD patients but they clearly declare that their results should not be extrapolated to other definitions of desaturation.\textsuperscript{21}

Garcia-Talavera et al. studied 83 COPD patients for 5 years -- all of them desaturating during 6MWT as at baseline they conducted two 6MWTs at a 30-minute interval and the patients were divided into early desaturators – in the first minute and late desaturators – after the first minute. Every 6 months they performed another 6MWT with constant pulse oximetry. The authors conclude that over a 5-year period, 65% of the so-called early desaturators develop severe hypoxemia and require long-term O\textsubscript{2} therapy, while such development was seen in only 11% of the late desaturators. The authors do not report any patients who have changed their desaturation profile in the course of the study although such assessment was not among the objectives of the study.\textsuperscript{22}

We found that the desaturators with COPD differ significantly from the non-desaturators dur-
The phenomenon of desaturation during 6MWT is stable and reproducible over time. Patients with desaturation present with lower spirometric and blood-gas parameters, symptom scores and more limited physical capacity. In that subpopulation of COPD patients the disease course is less favourable and prognosis is worse. Based on that data we consider the desaturation on exertion to be a main marker of a separate COPD phenotype.

REFERENCES
1. Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2017.
2. Donaldson G, Seemungal T, Bhowmik A, et al. Relationship between exacerbation frequency and lung function decline in chronic obstructive pulmonary
3. Palange P, Ward SA, Carlsen K-H, et al. Recommendations on the use of exercise testing in clinical practice. Eur Respir J 2007; 29: 185-209.

4. American Thoracic Society Statement. Guidelines for the six-minute walk test. Am J Respir Crit Care Med 2002; 166: 111-7.

5. Rabinovich RA, Vilaró J, Roca J [Evaluation exercise tolerance in COPD patients: The 6-minute walking test]. Arch Bronconeumol 2004; 40(2): 80-5 [Article in Spanish].

6. European Respiratory Society Taskforce Document. Clinical exercise testing with reference to lung diseases: indications, standardization and interpretation strategies. Eur Respir J 1997; 10: 2662-89.

7. Friedlander AL, Lynch D, Dyar LA, et al. Phenotypes of chronic obstructive pulmonary disease. COPD. 2007; 4(4): 355-84.

8. Han MK, Agusti A, Calverley PM, et al. Chronic obstructive pulmonary disease phenotypes: The future of COPD. Am J Respir Crit Care Med 2010; 182(5): 598-604.

9. Fletcher CM, Elmes PC, Fairbairn AS, et al. The significance of respiratory symptoms and the diagnosis of chronic bronchitis in a working population. Br Med J 1959; 2(5147): 257-66.

10. Bestall C, Paul EA, Garrod R, et al. Usefulness of the Medical Research Council (MRC) dyspnoea scale as a measure of disability in patients with chronic obstructive pulmonary disease. Thorax 1999; 54: 581-6.

11. Jones PW, Harding G, Berry P, et al. Development and first validation of the COPD assessment test. Eur Respir J 2009, 34: 648-54.

12. Jones PW, Jenkins C, Bauerle O. Health Care Professional user guide. Expert guidance on frequently asked questions. 2009.

13. Jones PW, Quirk FH, Baveystock CM. The St George’s Respiratory Questionnaire. Respir Med 1991; 85(Suppl B): 25-31.

14. Jones PW, Quirk FH, Baveystock CM, et al. A self-complete measure for chronic airflow limitation - the St George’s Respiratory Questionnaire. Am Rev Respir Dis 1992; 145:1321-7.

15. Panos RJ, Eschenbacher W. Exertional desaturation in patients with chronic obstructive pulmonary disease. COPD 2009; 6(6): 478-87.

16. Wasserman K, Hansen JE, Sue DY, et al. Principles of Exercise. Testing and Interpretation, 2nd Edition. Malvern, PA: Lea and Febiger, 1994: 132 144.

17. Sciurba F, Criner GJ, Lee SM, et al. Six-minute walk distance in chronic obstructive pulmonary disease: reproducibility and effect of walking course layout and length. Am J Respir Crit Care Med 2003; 167: 1522-7.

18. Poulain M, Durand F, Palomba B, et al. 6-minute walk testing is more sensitive than maximal incremental cycle testing for detecting oxygen desaturation in patients with COPD. CHEST Journal 2003; 123(5): 1401-7.

19. Hernandes NA, Wouters EF, Meijer K, et al. Reproducibility of 6-minute walking test in patients with COPD. Eur Respir J 2011; 38(2): 261-7.

20. Chatterjee AB, Rissmiller RW, Meade K, et al. Reproducibility of the 6-minute walk test for ambulatory oxygen prescription. Respiration 2010; 79(2): 121-7.

21. Stolz D, Boersma W, Blasi F, et al. Exertional hypoxemia in stable COPD is common and predicted by circulating proadrenomedullin. Chest 2014; 146(2): 328-38.

22. Garcia-Talavera I, Tauroni A, Trujillo JL, et al. Time to desaturation less than one minute predicts the need for long-term home oxygen therapy. Respiratory care 2011; 56(11): 1812-7.

23. Jenkins S, Cecins N. Six-minute walk test: observed adverse events and oxygen desaturation in a large cohort of patients with chronic lung disease. Intern Med J 2011; 41(5): 416-22.

24. Van Gestel AJ, Clarenbach CF, Stöwhas AC, et al. Prevalence and prediction of exercise-induced oxygen desaturation in patients with chronic obstructive pulmonary disease. Respiration 2012; 84(5): 353-9.

25. Martinez FJ, Foster G, Curtis JL, et al. NETT Research Group. Predictors of mortality in patients with emphysema and severe airflow obstruction. Am J Respir Crit Care Med 2006; 173: 1326-34.

26. Takigawa N, Tada A, Soda R, et al. Distance and oxygen desaturation in 6-min walk test predict prognosis in COPD patients. Respir Med 2007; 101: 561-7.

27. Hussein K, Alkarn AF, Hamdi S, et al. Factors predicting exercise-induced oxygen desaturation in stable COPD. European Respiratory Journal 2012; 40(Suppl 56): P839.

28. Dogra AC, Gupta U, Sarkar M, et al. Exercise-induced desaturation in patients with chronic obstructive pulmonary disease on six-minute walk test. Lung India 2015; 32: 320-5.

29. Crisafulli E, Iattoni A, Venturelli E, et al. Predicting walking induced oxygen desaturations in COPD patients: A statistical model. Respir Care 2013; 58: 1495-503.

30. Andrianopoulos V, Franssen FM, Peeters JP, et al. Exercise-induced oxygen desaturation in COPD patients without resting hypoxemia. Respir Physiol Neurobiol 2014; 190: 40-6.
Десатурация при физической нагрузке у больных ХОБЛ - устойчивое явление во времени

Роман И. Калинов1,4, Благой И. Маринов3, Димитрина И. Стоянова1,4, Владимир А. Ходжев1,4, Людмила Г. Владимирова-Китова2,4, Федя П. Николов2,4, Стефан С. Костянев3

1 Кафедра пневмологии и фтизиатрии, УМБАЛ „Св. Георги”, Медицинский университет - Пловдив, Пловдив, Болгария
2 Клиника кардиологии, Медицинский университет - Пловдив, Пловдив, Болгария
3 Кафедра патофизиологии, Медицинский университет - Пловдив, Пловдив, Болгария
4 Секция кардиологии, Первая кафедра внутренних болезней, Медицинский университет - Пловдив, Пловдив, Болгария

Адрес для корреспонденции:
Роман И. Калинов, Кафедра пневмологии и фтизиатрии, УМБАЛ „Св. Георги”, Медицинский университет - Пловдив, бул. „Пещерско шосе” № 66, 4001 Пловдив, Болгария
E-mail: dr_kalinov@yahoo.com
Tel: +359888433414

Дата получения: 30 августа 2018
Дата приемки: 12 декабря 2018
Дата онлайн публикации: 19 января 2019
Дата публикации: 30 июня 2019

Ключевые слова: ХОБЛ, десатурация, вызванная физической нагрузкой, 6MWT

Введение: Десатурация, вызванная физической нагрузкой - обычное явление среди пациентов с умеренной и тяжёлой формой ХОБЛ. Это важный маркер в ходе заболевания, который имеет прогностическую ценность в определении риска смерти.

Цель: Мониторинг пациентов с ХОБЛ с десатурацией или без неё во время 6-минутного теста на ходьбу (6MWT) и оценка устойчивости явления.

Материалы и методы: Тест 6MWT выполнили 70 пациентов с ХОБЛ в диапазоне от 2A до 4D (GOLD 2011); средний возраст пациентов составлял 64,5 ± 10,1, средняя продолжительность курения - 38,8 ± 21, FEV1% = 46,4% ± 15,7%, FVC% = 73,7% ± 1,3%, МRC = 2,31 ± 0,84, CAT = 20,8 ± 6,6. Кислородная сатурация наблюдалось во время теста, признаки десатурации были следующими: SpO2 уменьшился на ≥4%, а SpO2 до ≤88% снизился в течение не менее 3 мин. Наблюдение за пациентами проходило в среднем в течение 40,9 ± 22,3 месяца, а тесты повторялись.

Результаты: Пациенты были разделены на 2 группы в зависимости от снижения SpO2: в группу А входили пациенты с десатурацией (n = 35), а в группу В - без десатурации (n = 35). У 66 пациентов профиль десатурации был стабильным во времени. Только два пациента, которые не «десатурировались» на исходном уровне, получили десатурацию в последующем 6MWT, а два других пациента, которые «десатурировались» на исходном уровне, не проявили её в последующих тестах.

Выводы: Десатурация - это устойчивое явление во времени. На основании результатов можно сделать вывод, что десатурация, вызванная физической нагрузкой, является основным маркером для конкретного фенотипа ХОБЛ.