

## Influence of Pulmonary Rehabilitation on Clinical Characteristics in Patients with Chronic Heart Failure and Chronic Obstructive Pulmonary Disease

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### Abstract

**Background:** The improvement of treatment strategies in patients with chronic obstructive pulmonary disease (COPD) and especially with comorbid pathology should provide rational conversion of standard schemes of therapy and rehabilitation in accordance with their clinical, pathogenic, functional and economic feasibility.

**Objective:** To assess the influence of pulmonary rehabilitation on clinical characteristics in patients with chronic heart failure (CHF) and concomitant COPD.

**Methods:** The study included 102 patients with CHF and concomitant COPD (males, 62%; mean age,  $68.2 \pm 4.5$  years). All patients were divided into two groups: control group (CG) ( $n = 54$ ), received only standard therapy of CHF and COPD; and intervention group (IG) ( $n = 48$ ) were additionally taught the full yogic breathing as a program of pulmonary rehabilitation. Calculation of points by clinical evaluation scale (CES), assessment of CHF functional class (FC) (NYHA) and 6-minute walk test (6MWT - with the evaluation of dyspnea by the Borg scale) were performed in all patients on admission to the department and at discharge. Significant association was defined by  $p$  value  $< 0.05$ .

**Results:** At baseline, there were no significant differences in clinical characteristics of the patients and studied parameters between the groups. At discharge both groups showed significant reduction of dyspnea by the Borg scale (in CG: from  $7.2 \pm 0.8$  points to  $5.2 \pm 0.3$ ; in IG: from  $7.4 \pm 0.6$  points to  $3.2 \pm 0.4$ ), the number of points by CES (in CG: from  $10.8 \pm 0.3$  points to  $7.2 \pm 0.4$ ; in IG: from  $10.7 \pm 0.6$  points to  $5.9 \pm 0.6$ ). Increase in exercise tolerance (by the distance of 6MWT) was observed in both groups (in CG: from  $215 \pm 24$  m to  $275 \pm 22$  m; in IG: from  $219 \pm 21$  m to  $308 \pm 24$  m). The changes were more significant in IG compared to CG. We observed the prominent decrease in CHF FC and length of hospital stay in IG.

**Conclusions:** Application of full yogic breathing as the program of pulmonary rehabilitation in addition to standard therapy of the patients with CHF and COPD is associated with a significant decrease in CHF FC, an increase in exercise tolerance and a reduced length of hospital stay. (Int J Cardiovasc Sci. 2018;31(5)499-504)

**Keywords:** Cardiac Insufficiency / physiopathology; Pulmonary Disease, Chronic Obstructive / rehabilitation; Exercise Therapy; Oxygen Consumption.

### Introduction

Scientists have extensively been discussing the necessity of pulmonary rehabilitation in patients with chronic obstructive pulmonary disease (COPD), the main objectives of which are to reduce symptoms and improve the quality of life.<sup>1</sup> It was found that the rehabilitation

measures have a positive impact on important aspects of the patient's life. The results of several studies show that pulmonary rehabilitation could increase physical activity, oxygen consumption and patients' endurance, reduce the frequency and duration of hospitalization, and greatly improve the efficiency of therapy.<sup>2-4</sup> It follows that the improvement of treatment strategies in patients with

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COPD should provide rational conversion of standard schemes of therapy and rehabilitation in accordance with their clinical, pathogenic, functional and economic feasibility. Pulmonary rehabilitation is currently viewed as a key strategy in the management of respiratory system diseases.<sup>5</sup> The selection process for the rehabilitation of patients take into account their functional status, severity of dyspnea, motivation level, and smoking status, although the creation of individualized programs for the integrated treatment of patients with COPD remains an unsolved problem of scientific and practical medicine. According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommendations,<sup>6</sup> the minimum length of an effective rehabilitation is 6-12 weeks (at least 12 sessions, 2 times per week, for at least 30 minutes). A complete rehabilitation program should include physical exercise, smoking cessation, nutritional therapy, patient education and psycho-emotional support.<sup>7</sup> However, until now we have no effective program to maintain a therapeutic effect for a long time especially for the patient with comorbid pathology COPD and chronic heart failure (CHF). A perspective area of pulmonary rehabilitation is a full yogic breathing exercise.<sup>8</sup> Therefore, the aim of the present study was to assess the effectiveness of pulmonary rehabilitation in addition to the standard medical care of patients with COPD and CHF.

## Methods

### Sample

This was a prospective, single-center, non-blinded trial conducted in the Donetsk National Medical University, based on Department of Urgent Cardiology and Rehabilitation of Institute of Emergency and Reconstructive Surgery, enrolling 102 participants between September 2013 and November 2015. Patients were included if they met the GOLD criteria for a diagnosis of COPD:<sup>6</sup> a post-bronchodilator ratio [forced expiratory volume in 1 second (FEV1) to forced vital capacity (FVC)] < 0.70 and a < 15% or 200-mL increase in FEV1 following inhalation of a  $\beta_2$  agonist; age  $\geq$  18 years; stable ischemic heart disease in history and decompensation of CHF with symptoms leading to hospitalization. Chronic heart failure was diagnosed with the presence of history of CHF and at least one symptom (dyspnea, orthopnea, or edema) and one sign (moist rales, peripheral edema, ascites, or pulmonary vascular congestion on chest radiography). Patients with a gastroesophageal reflux

disease, diaphragmatic hernia, cancer, pregnancy, cardiac surgery within 90 days of enrollment, comorbid conditions with an expected survival of less than 6 months, acute myocardial infarction at time of hospitalization, retinal detachment, increased intracranial and intraocular pressure were excluded.

All participants read and signed the informed consent form before the participation in the study. Both informed consent form and the prospective analysis of the data for research purposes were approved by the Ethics Committee (report number 108/7).

### Full yogic breathing

Patients were assigned to either standard CHF and COPD therapy alone (control group, CG) or standard CHF and COPD therapy plus full yogic breathing (intervention group, IG). Patients of IG were additionally taught the full yogic breathing - deep slow breathing, consisting of three consecutive phases: abdominal, thoracic and clavicular. Inhale was made wavelikely, with consistent use of abdominal muscles and diaphragm, intercostal muscles rather than the muscles of the shoulder girdle. Exhale was done in the same sequence. At the beginning, participants of IG practiced full breathing in the supine or sitting position 4 times per day, 8-10 breaths at a time; then during exercise they increased the number of rounds up to 10 per day and performed it also while sitting, standing or walking when they encountered unbearable shortness of breath.

All patients kept diaries while they performed breathing exercises during the observation period. Then investigators estimated their compliance to this method of treatment according to their diaries.

### Assessment of physical fitness components: clinical evaluation scale, 6-minute walk test, pre- and post-bronchodilator spirometry data, SpO<sub>2</sub>

Calculations of points by clinical evaluation scale (CES), assessment of CHF FC and 6-minute walk test (6MWT - with the evaluation of dyspnea by the Borg scale) were performed in all patients on the admission to the department and at discharge. Pre- and post-bronchodilator spirometry assessments were performed with a portable spirometer (BTL-08 Spiro Pro; BTL, United Kingdom), in accordance with the American Thoracic Society criteria.<sup>9</sup> Values of FEV1 were expressed in liters, as percentages of the FVC, and as percentages of the reference values. The peripheral capillary oxygen saturation (SpO<sub>2</sub>) was assessed

with an oximeter (M70; Biolight, China) while the patients were breathing room air.

### Statistical analysis

Processing of the results was performed on a personal computer using statistical analysis package "Statistica 6.0". The D'Agostino & Pearson, Shapiro-Wilk and Kolmogorov-Smirnov tests were used to test the normality of data distribution. The paired and unpaired Student t test was used for comparisons of continuous, normally distributed variables between groups. The Mann-Whitney test was used for analysis of continuous variables without normal distribution, and the chi-square statistics for categorical variables (clinical features). Results are shown as mean and standard error for continuous, normally distributed variables, and as median and interquartile range (25<sup>th</sup>-75<sup>th</sup> percentile) or percentage (as appropriate) for the others. Significant association was defined by p value < 0.05.

### Results

The pre-specified duration of the enrollment period was two years and during that time we interviewed

168 patients. Forty-two did not meet inclusion criteria, 24 declined to participate. A total of 102 patients were enrolled, 54 to CG and 48 to IG.

At baseline, there were no significant ( $p > 0.05$ ) differences between the groups in the patients' clinical characteristics (Table 1). At admission patients received in both groups standard therapy in comparable doses.

By the end of the observation period, a significant reduction in office heart rate (HR), respiratory rate (RR) at rest, severity of dyspnea by the Borg scale, the number of points by CES, and increased 6MWT distance were observed in both groups. Moreover, all these changes were more considerable in the IG as compared with the CG (Table 2).

Oxygen saturation increased in both groups (in CG: from 93 (84; 95)% to 94 (83; 97)%,  $p = 0.01$ ; in IG: from 93 (84; 95)% to 98 (95; 98)%,  $p < 0.001$ ), more pronounced in IG ( $p = 0.03$ ).

A reduction of CHF FC (NYHA) was observed in 82% of the IG patients and only in 61% of the CG patients ( $\chi^2 = 4.55$ ,  $p = 0.03$ ).

Average duration of hospitalization was shorter in the IG ( $16.7 \pm 3.1$  days versus  $19.9 \pm 3.8$  days in CG,  $p < 0.05$ ).

**Table 1 - Clinical characteristics of the groups of patients**

Parameter	CG (n = 54)	IG (n = 48)	p values
Age, years	67.2 ± 6.1	69.3 ± 5.6	$p = 0.67$
Gender (male: female)	32 : 22	26 : 22	$\chi^2 = 0.1$ , $p = 0.75$
BMI (kg/m <sup>2</sup> )	26.6 ± 0.9	24.8 ± 0.5	$p = 0.07$
Smoker (actual)	n = 31 (57%)	n = 31 (64%)	$\chi^2 = 0.04$ , $p = 0.83$
Duration of smoking, years	32.5 ± 5.8	27.7 ± 3.5	$p = 0.5$
FC II (NYHA)	n = 9 (17%)	n = 10 (22%)	$\chi^2 = 0.04$ , $p = 0.84$
FC III (NYHA)	n = 35 (65%)	n = 30 (62%)	$\chi^2 = 0.01$ , $p = 0.96$
FC IV (NYHA)	n = 10 (18%)	n = 8 (16%)	$\chi^2 = 0.01$ , $p = 0.96$
FEV1/FVC	0.62 [0.55 - 0.66]	0.60 [0.57 - 0.62]	$p = 0.34$
Diabetes mellitus, type 2	n = 12 (22%)	n = 9 (19%)	$\chi^2 = 0.01$ , $p = 0.91$
Arterial hypertension	n = 45 (83%)	n = 35 (73%)	$\chi^2 = 1.07$ , $p = 0.3$
Hypercholesterolemia	n = 28 (52%)	n = 27 (56%)	$\chi^2 = 0.06$ , $p = 0.8$
History of myocardial infarction	n = 35 (65%)	n = 35 (73%)	$\chi^2 = 0.05$ , $p = 0.82$

CG: control group; IG: intervention group; BMI: body mass index; FC: functional class; NYHA: New York Heart Association; FEV1: forced expiratory volume for 1 second; FVC: forced vital capacity.

**Table 2 - Dynamics of clinical parameters in both groups**

Parameter	Patients			
	CG (n = 54)		IG (n = 48)	
	At baseline	At discharge	At baseline	At discharge
RR at rest, per min	24.3 ± 2.2	20.2 ± 1.6*	24.2 ± 2.1	18.1 ± 1.7*
Office HR, beats/min	71.8 ± 3.9	66.7 ± 2.5*	72.1 ± 3.8	62.4 ± 2.4*
6MWT, m	215.2 ± 24.8	275.7 ± 22.1*	219.1 ± 25.1	308.3 ± 24.1*
Number of points by CES	10.8 ± 0.3	7.2 ± 0.4*	10.7 ± 0.6	5.9 ± 0.6*
Severity of dyspnea by the Borg scale, points	7.2 ± 0.8	5.2 ± 0.3*	7.4 ± 0.6	3.2 ± 0.4*
SpO <sub>2</sub> , %	93 (84; 95)	94 (83; 97)*	93 (84; 95)	98 (95; 98)*

CG: control group; IG: intervention group; BMI: body mass index; FC: functional class; NYHA: New York Heart Association; FEV1: forced expiratory volume for 1 second; FVC: forced vital capacity.

Thus, our findings showed that the application of pulmonary rehabilitation in addition to standard therapy in patients with CHF and COPD is associated with a significant increase of exercise tolerance and decrease in length of hospital stay.

## Discussion

One important extrapulmonary manifestation of COPD is skeletal and respiratory muscle dysfunction.<sup>10</sup> With the increasing severity of the disease, COPD patients lose exercise endurance and often complain of fatigue and dyspnea. These symptoms curtail patients' ability to exercise and compromise cardiac fitness, which further limits their exercise tolerance, creating a vicious downward spiral that can eventually lead to generalized debility and immobility.<sup>11</sup> Encouragingly, early interventions with exercise programs may restore some of the lost health status related to muscle dysfunction and increase patients' exercise tolerance and stamina.<sup>12-14</sup> On this basis, a perspective direction of physical rehabilitation among patients with COPD and CHF is training of respiratory muscles. By increasing the strength and endurance of the respiratory muscles, as well as improving the efficiency of gas exchange, application of the full yogic breathing leads to an improvement of spirometry indices and arterial oxygen saturation. In our research we obtained data of increased arterial oxygen saturation after practicing the full yogic breathing.

The positive impact of the yogic breathing exercises in the rehabilitation among patients with CHF and COPD has been described by many researchers. Thus, Soni et al.<sup>15</sup> have noted a positive effect of yoga training on diffusion capacity in COPD patients. The results of another study<sup>16</sup> have shown that 1 month of yoga practice, including breathing exercises, led to a significant reduction of dyspnea according to the visual analogue scales. A prospective, randomized, controlled study<sup>17</sup> involving 24 patients with COPD, who performed pranayama in addition to standard therapy, has also shown the improvement of lung function parameters and quality of life. Similar results have been described by Bernardi et al.,<sup>18</sup> who have noted an increase in exercise tolerance and a decrease in dyspnea severity after one month of performing the full yogic breathing by patients with CHF. In addition, Gomes-Neto et al.<sup>19</sup> have shown that yoga practice, including breathing exercises, led to an increase in exercise tolerance in patients with CHF.

Mechanisms of influence of the full yogic breathing on the status of patients with CHF and COPD are not entirely clear. It is known that CHF is characterized by impaired autonomic regulation - decreased parasympathetic tone and, consequently, increased sympathetic activity.<sup>20</sup> There is evidence of autonomic balance optimization and increasing sensitivity of arterial baroreflex on the background of yoga.<sup>21</sup> By acting on lung tissue baroreceptors, as well as stretch receptors located in the smooth muscle layer of the large airways, slow deep yogic

breathing activates the parasympathetic nervous system. The influence of yogic breathing on the respiratory and vasomotor centers of the medulla oblongata cannot be ruled out. This phenomenon may be based on some general respiratory and cardiac neuronal network.

In addition to active participation in the development of the respiratory muscles and autonomic balance optimization, deep yogic breathing reduces body weight, the effects on lipid peroxidation, normalizes blood pressure and HR, which is very important in the context of frequent comorbidity of respiratory and cardiovascular disease.

The study by Guleria et al. "Yoga is as effective as standard pulmonary rehabilitation in improving dyspnea, inflammatory markers, and quality of life in patients with COPD" has evoked a wide response, comparing the efficacy of yoga with standard pulmonary rehabilitation in patients with COPD.<sup>22</sup> Scientists have found an equivalent reduction in C-reactive protein and interleukin-6 levels after performing pranayama as well as at the end of a standard pulmonary rehabilitation. These results allowed concluding that yoga is a cost-effective form of rehabilitation that is just as effective as standard rehabilitation.

## Conclusions

Application of full yogic breathing in addition to standard therapy of patients with CHF and COPD is associated with a significant decrease in CHF FC and dyspnea severity, and an increase in exercise tolerance and arterial oxygen saturation.

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## Author contributions

Conception and design of the research: Smyrnova GS. Acquisition of data: Taradin GG. Analysis and interpretation of the data: Taradin GG. Statistical analysis: Vatutin MT. Writing of the manuscript: Smyrnova GS. Critical revision of the manuscript for intellectual content: Vatutin MT. Supervision / as the major investigator: Babkina TM.

## Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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## Study Association

This study is not associated with any thesis or dissertation work.

## Ethics approval and consent to participate

This study was approved by the Ethics Committee of the DNMU under the protocol number 108/7. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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