

ORIGINAL SCIENTIFIC PAPER

Dynamics of Changes in Physical Capacity of Patients with Severe Chronic Obstructive Pulmonary Disease during Physical Therapy

Mykola Maistruk¹, Oleg Bazylchuk¹, Olga Andriichuk², Prymachok Liudmila³ and Yurii Dutchak¹

¹Khmelnytkyi National University, Department of Physical Therapy and Occupational Therapy, Khmelnytskyi, Ukraine, ²Lesya Ukrainka Volyn National University, Department of Physical Therapy and Occupational Therapy, Lutsk, Ukraine, ³Municipal Institution of Higher Education "Rivne Medical Academy", Department of Physical Therapy and Occupational Therapy, Rivne, Ukraine

Abstract

The purpose of the study was the assessment of the proposed physical therapy on physical capacity of patients having severe chronic obstructive pulmonary disease (COPD). One hundred and twenty-four (124) patients having severe COPD were examined. All patients underwent standard clinical, laboratory and functional examination. Physical capacity of patients was assessed by the 6-minutes walking distance (6MWD). Application of physical therapy with patients having COPD resulted in a statistically significant greater dynamics of growth of the distance traveled at 6 MWD with both men - by 104.66-9.24 m (at standard treatment - by 57.07-8.99 m; p < 0.001), and women - by 81.17-8.35 m (at standard treatment - by 44.97-6.67 m; p < 0.001). Compared to standard treatment, patients of the main group increased their physical capacity (both men and women) 1.8 times, and the achieved state of their physical abilities (511.2-9.38 m; 100.9-1, 96% of the appropriate value (AV)) significantly exceeded the one at standard treatment (481.5-10.59 m; 94.57-1.99% of AV; p < 0.01). Physical therapy, which is used with patients having severe COPD, results in an increase in their physical abilities, which significantly improve compared to standard treatment.

Keywords: physical therapy, chronic obstructive pulmonary disease, physical capacity, 6-minutes walking distance

Introduction

Chronic obstructive pulmonary disease (COPD) is an extremely topical medical and economic problem due to its high prevalence, severity, high risk of death and high costs of patients' treatment and rehabilitation (Havrysiuk, Yachnyk, & Berenda, 2004; Mohammed, Da Silva, Van Oosterwijck, & Calders, 2017; Kruis, Boland, & Assendelft, 2014). COPD is one of the leading causes of morbidity and mortality worldwide in medical, social and economic terms. Patients suffer from COPD for years; die prematurely from it or its complications. Prolonged exposure to risk factors, aging of population around the world leads to an accelerated increase in the incidence of COPD. This disease affects 8 to 22% of adults aged 40

years and older (Ali, Bolton, & McKeever, 2017; Kim, Lee, & Park, 2016; Kon, Dilaver, & Mittal, 2014; Rodriguez, Arbillaga, & Barberan-Garcia, 2016). According to unofficial statistics, the incidence of COPD in Ukraine is 7%, i. e. it affects about 3,000,000 people (Gashynova, 2015; Linnik, Nedospasova, & Tarasenko, 2017).

An analysis of scientific and methodological, special and medical references related to treatment and physical therapy of patients having COPD has revealed that there is a need to improve approaches to physical therapy, which has significant theoretical, practical and social significance for patients' health protection and improvement.

The aim of the research was to analyze the efficiency of



Correspondence:

M. Maistruk

Khmelnytkyi National University, Department of Physical Therapy and Occupational Therapy, 11, Instytuts'ka str., Khmelnytskyi, 29016, Ukraine E-mail: nikemaynik777@gmail.com influence of the proposed physical therapy on physical activity in patients with severe chronic obstructive pulmonary disease (COPD).

Methods

The research was carried out on the basis of the department of rehabilitation treatment by traditional and alternative methods, and the pulmonology department of the Rivne Regional Clinical Hospital. As patients were admitted to inpatient treatment, results were accumulated. Within the research, available COPD 3 (severe) of patients was the selection criterion. The doctor determined severity of the disease according to the normative document of the Ministry of Healthcare of Ukraine: patients with values of volume of forced expiratory for the first second (VFE1) from 30 to 50% of the appropriate value (AV) according to spirography were classified as the ones having 3rd-degree severity.

One hundred and twenty-four (124) patients with severe COPD were examined; average age was 59.19 ± 0.74 years, of which men - 64 (51.61%) and women - 60 (48.39%). Patients were randomly (using a table of random numbers) assigned to control (men - 32, women - 30 persons) and treatment (men - 32, women - 30 persons) groups, proportionally, as being admitted. Under supervision of doctors, all patients were examined at the beginning and at the end of the research.

All patients underwent standard clinical, laboratory and functional examination.

Physical capacity was assessed via a 6-minutes walking distance (6MWD). 6MWD was administered 30 minutes before or 2 hours after having a meal. During the test, the distance traveled by the patient in 6 minutes at a moderate pace was measured. The obtained distance was compared with the appropriate value, which was calculated by the formula: 6 MWD (men) = (7.57 x height, cm) - (5.02 x age) - (1.76 x weight, kg) - 309; 6 MWD (women) = (2.11 x height, cm) - (5.78 x age) - (2.29 x weight, kg) + 667. The final test result was presented as percentage of the appropriate value (AV). Additionally, respiratory and circulatory parameters that are directly related to physical capacity of patients were analyzed: respiratory rate (RR), heart rate (HR), blood pressure (BP) - systolic (BPs) and diastolic (BPd).

Patients were treated according to the Ministry of Healthcare of Ukraine. The control group of patients underwent rehabilitation in accordance with the recommendations of the regulatory protocol of the Ministry of Healthcare of Ukraine, and the treatment group - according to the proposed method. Duration of physical therapy averaged 30 days and consisted of inpatient and outpatient stages.

This study complies with the ethics committee of National University of Ukraine on Physical Education and Sport Approval date: 16.12.2020 Approval number: Protocol №2.

All patients were informed about the progress of the study and gave written consent to participate.

Statistical description of selections was carried out by determining the mean (M) and its error (m). The type of parameter distribution in the variation series was determined by the Shapiro-Wilk test. Significance of differences between selections as determined by using non-parametric methods for dependent and independent selections (Wilcoxon T-test, Mann-Whitney U-test). The level of significance with an indication of probability of erroneous assessment (p) was the criterion of authenticity. Estimation of the mean difference was considered significant at p<0.05. Excel XP and STATISTICA 6.0 software (StatSoft, USA) was used for calculations.

Results

The main clinical signs of pathology of patients with severe COPD were complaints on significant shortness of breath, persistent cough and sputum discharge; physical examination revealed impaired breathing, moderate or significant wheezing. Disorders of external respiration, according to spirometry, were significant (in the control group VFE1 was 40.81±1.59% of AV, in the treatment group - 42.06±1.56% of AV).

Drug therapy, which was prescribed in accordance with the regulatory document, according to the severity of the disease, was carried out along with physical therapy. Patients of the control group underwent physical therapy in accordance with the recommendations of the regulatory document of the Ministry of Healthcare of Ukraine (Annex 9), according to which, at severe COPD (reduced motor skills, light motor training), therapeutic gymnastics lasting 35-40 minutes was used in 30-35 exercises at an average pace and terrenkur 1.9-2.7 km long with the speed of 80-110 steps/min.

In the treatment group, physical therapy was based on the same principles and was carried out according to the proposed method. It consisted of patient assessment, patient training, weight correction measures, physical training programs, psychological support. The main aim of physical therapy was to reduce intensity of shortness of breath, improve respiratory function, increase tolerance to physical workload, reduce anxiety and depression associated with COPD, which should reduce the number and duration of hospitalizations, improve quality of life. The elaborated program of physical therapy for each patient envisaged taking into account age peculiarities, clinical picture of the disease and mechanism of its development, existing side-effects and cautions, specific physiological and psychopathological disorders, functional state and level of physical fitness, clear definition of the purpose and mechanism of influence of each exercise on the patient's body. At all stages of rehabilitation, patients were trained to develop realization to follow the recommendations of the doctor and physical therapist. Patient's refusal to smoke, learning proper nutrition, active lifestyle, proper breathing was important. For each patient the program of physical therapy was developed for a long term (Grygus, & Maistruk, 2017; Maistruk, 2017; Grygus, Maistruk, & Zukow, 2017; Maistruk, 2016; Maistruk, 2015).

The examined patients with severe COPD showed reduced output level of physical capacity, as evidenced by the data in Tables 1 and 2. At the beginning of rehabilitation, the examined control group generally traveled the distance of 430.5 ± 11.36 m, which was $83.44\pm2.08\%$ of AV, the treatment group - 421.7 ± 10.28 m ($82.65\pm2.15\%$ of AV). These results indicated that the course of the disease of 3 degrees of severity significantly affected physical abilities of patients, reducing them. Men suffered from this course of the disease more. Their output level of physical abilities in the control group was 79.13 $\pm1.92\%$ of AV, in the treatment group - 75.12 $\pm2.64\%$ of AV, while with women, these indicators were $88.03\pm2.85\%$ of AV (p=0.0432) and $88.92\pm2.48\%$ of AV (p=0.001) respectively.

The obtained data on the output level of physical capacity at a distance of 6 MWD did not coincide with those provided by foreign authors. Thus, (Riario-Sforza et al., 2009). indicated 3 degrees of COPD; the distance traveled by patients during performance of 6 MWD ranged from 327 to 416 m, while (Mariiyn, Danilack, Weston, & Garshick, 2012) - 354 m. We consider this discrepancy is due to different methodological approaches to the implementation of 6 MWD.

Both standard treatment and physical therapy improved physical abilities of all patients, as evidenced by the data in Tables 1 and 2.

Table 1. Value of 6 MWD with patients having severe COPD (males and females) of both gr	oups before and
after rehabilitation (distance covered in meters, $M \pm \tau$)	

Group	Period of examination	Overall in the group	Men	Women
	Before rehabilitation	430.5±11.36	443.6±18.24	416.6±13.01
Control	After rehabilitation	481.5±10.59*	500.6±17.80*	463.0±9.90*
	t values	9.04	6.35	6.76
	p values	0.00	0.00	0.00
Treatment	Before rehabilitation	421.7±10.28	435.4±15.66	421.2±12.21
	After rehabilitation	511.2±9.38*""	540.1±14.14	503.1±13.76*»
	t values	14.7	11.3	9.94
	p values	0.00	0.00	0.00

Legend: *-Statistically significant differences between values before and after rehabilitation (p<0.001); ^w – compared to control group (*-p<0.05, " - p<0.01).

Table 2. Value of 6 MWD with patients having severe COPD (males and females) of both groups before and after rehabilitation (% of appropriate value, $M\pm T$)

Group	Period of examination	Overall in the group	Men	Women
	Before rehabilitation	83.44±2.08	79.13±1.92	88.03±2.85
Control	After rehabilitation	94.57±1.99*	91.52±2.91*	97.82±2.61*
Control	t values	9.2	6.78	6.27
	p values	0.00	0.00	0.00
Treatment	Before rehabilitation	82.65±2.15	75.12±2.64	88.92±2.48
	After rehabilitation	100.9±1.96*	93.12±2.21*	106.3±2.55*»
	t values	9.84	8.12	7.43
	p values	0.00	0.00	0.00

The proposed physical therapy used by us resulted in the formation of better physical abilities of patients compared to standard treatment. Thus, in general, in the treatment group the traveled distance (511.2 ± 9.38 m; $100.9\pm1.96\%$ of AV) was statistically much greater than in the control group (481.5 ± 10.59 m) <0.01); $94.57\pm1.99\%$ of AV). This also applies to women of the treatment group who traveled bigger distance after physical rehabilitation - 503.1 ± 13.76 m ($106.3\pm2.55\%$ of AV) than the ones of the control group - 463.0 ± 9.90 m ($97.82\pm2.61\%$ of AV), which was statistically significant (p<0.05).

The dynamics of 6 MWD given in Table 3 indicates a better effect of the proposed physical therapy on patients' physical abilities. The difference between the values after and before rehabilitation with men of the treatment group was 104.66 ± 9.24 m, which was significantly higher than in the control group - 57.07 ± 8.99 m (p<0.001). The same dynamics of 6 MWD was revealed with women (in the treatment group - 81.17 ± 8.35 m, in the control group - 44.97 ± 6.67 m (p<0.001)). That is, application of physical therapy made it possible to significantly increase physical abilities of patients compared to standard treatment: with men - 1.8 times, with women - 1.8 times, over-

Table 3. Dynamics (difference between values after and before rehabilitation) of 6 MWD of patients having severe COPD (males and females) of both groups by the results of rehabilitation (distance covered in meters, $M\pm\tau$)

Group	Overall in the group	Men	Women
Control	51.31±5.68	57.07±8.99	44.97±6.67
Treatment	89.18±6.32*	104.66±9.24*	81.17±8.35*
t values	6.72	8.24	7.36
p values	0.00	0.00	0.00

all - 1.7 times.

Application of standard treatment along with physical therapy has resulted in the improvement of other indicators of functional state of patients with severe COPD. Patients of both control and treatment groups showed significantly decreased respiration rate and heart rate, decreased blood pressure, as shown in Tables 4 and 5. Differences between the achieved values of these indicators with patients of control and treatment groups have not been revealed.

According to data of medical supervision, clinical con-

Index	Control group				Treatm	Treatment group		
	before	after	τ	ιρ	before	after	τ	р
RR, number in 1 min	19.00±0.52	15.31±0.45**	6.24	0.00	19.53±0.53	14.97±0.46**	8.44	0.00
HR, number in1min	84.44±2.03	76.63±1.31**	6.46	0.00	83.94±2.34	74.91±1.40**	8.76	0.00
BP _s , mm. of mercury	133.3±3.65	125.6±1.82*	7.2	0.00	136.7±3.59	127.4±1.54*	9.26	0.00
BP _d , mm. of mercury	82.03±1.97	80.00±0.98	6.86	0.00	84.22±1.80	79.77±0.91*	7.46	0.00

Table 4. Values of routine cardio-respiratory indices of patients having severe COPD (males and females) before and after rehabilitation ($M\pm\tau$)

Table 5. Values of routine cardio-respiratory indices of patients having severe COPD (males and females) before and after rehabilitation (M±T)

Index	Control group				Treatment group			
	before	after	τ	Р	before	after	τ	р
RR, number in 1 min	17.47±0.32	15.53±0.54**	6.44	0.00	17.89±0.44	14.13±0.35**	9.38	0.00
HR, number in1min	81.87±1.42	74.13±1.23**	7.12	0.00	82.54±1.31	73.34±1.36**	10.58	0.00
BP _s , mm. of mercury	134.5±2.83	126.8±0.94*	6.46	0.00	135.8±2.96	126.1±0.88*	9.82	0.00
BP _d , mm. of mercury	86.33±1.12	81.67±1.60*	7.18	0.00	85.74±1.31	81.05±1.54*	8.68	0.00

dition of the patients improved: decreased cough, improved sputum discharge, decreased shortness of breath; wheezing in the lungs decreased or disappeared. Standard treatment along with physical therapy applied resulted in an increase in functional capabilities of patients, which manifested itself in the increased physical capacity, reduced tension in the cardio-respiratory system at the end of the research, as evidenced by data given by us.

Discussion

Rehabilitation plays the leading role in complex treatment of patients with COPD. Pulmonary rehabilitation implemented in daily treatment of patients allows to reduce illness manifestations, optimize patient's functional status, and lower the cost of treatment via stabilization or reduction of illness manifestations (Cindy, Mackney, Jenkins, & Hill, 2012; Grygus, Maistruk, & Zukow, 2017; Mohammed, Da Silva, Van Oosterwijck, & Calders, 2017; Rodriguez, Arbillaga, & Barberan-Garcia, 2016)

Analysis showed a better dynamics of indices of cardiovascular system's functional state of patients with severe COPD from treatment group, which proves efficiency of the developed technology of physical therapy. Application of physical therapy technologies for patients with COPD results in significant increase of their motor and functional capacity. It is expressed by a statistically significantly greater dynamics of growth of the distance traveled at 6 MWD with both men - by 104.66 \pm 9.24 m (at standard treatment - by 57.07 \pm 8.99 m; p<0.001), and women - by 81.17 \pm 8.35 m (at standard treatment - 44.97 \pm 6.67 m; p<0.001). When using the proposed physical therapy programs, physical abilities of patients, compared with standard treatment, increased with both men and women by 1.8 times, and the achieved state of physical abilities of all patients of the treatment group (511.2 \pm 9.38 m; 100, 9 \pm 1.96% of AV) significantly exceeded the one at standard treatment (481.5 \pm 10.59 m (p <0.01); 94.57 \pm 1.99% of AV).

The research proved therapeutic orientation of physical exercises, proved its necessary inclusion into systematic physical therapy of patients with COPD when composing long-term programs as a basic link of physical therapy.

Implementation of conceptual physical therapy of patients with COPD promoted reduction of COPD clinical symptoms, which allowed to stay active, not be limited at usual physical workload or exercises.

Due to application of the proposed concept of physical therapy of patients with COPD, general level of physical health, physical capacity, life quality could be improved, functional state of cardiorespiratory system could be restored.

Application of physical rehabilitation of patients with COPD allows to obtain positive changes that cannot be obtained with medical therapy only. Due to its application it is possible to control symptoms of the illness, patients' functional state improves, tolerance to physical workload increases, every-day physical activity increases, life quality improves, which is primarily expressed in reduced anxiety and depression related to COPD.

Physical rehabilitation should be recommended to patients with COPD in order to help control the symptoms, improve life quality, and increase physical activity.

Perspectives of further research lie in the analysis of efficiency of influence of the proposed method of physical therapy on the function of external respiration of patients with COPD.

Acknowledgements

There are no acknowledgements.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Received: 20 November 2020 | Accepted: 11 January 2021 | Published: 01 September 2021

References

- Ali, H., Bolton, C. E., & McKeever, T. M. (2017). The effect of pulmonary rehabilitation on mortality, balance, and risk of fall in stable patients with chronic obstructive pulmonary disease: A systematic review. *Chronic Respiratory Disease*, 14(1), 54–62.
- Cindy, Ng. L. W., Mackney, J., Jenkins, S., & Hill, K. (2012). Does exercise training change physical activity in people with COPD? A systematic review and meta-analysis. *Chron Respir Dis.*, 9(1), 17-26.
- Gashynova K. (2015). COPD exacerbation: Influence of severity and type of systemic inflammation on the hospitalizations rate. *Eur. Respir.*, *46*(Suppl. 59), 683.
- Grygus, I., & Maistruk, M. (2017). Changes in functional state of patients having chronic obstructive pulmonary disease in the process of physical rehabilitation. *Academic journal of Prykarpattya u University. Series: Physical culture, 25-26*, 83-91.
- Grygus, I., Maistruk, M., & Zukow, W. (2017). Effect of Physical Therapy on Respiratory Function in Patients with Chronic Obstructive Pulmonary Disease. *Collegium Antropologicum*, 41(3), 255–261.
- Havrysiuk, V. K., Yachnyk, A. Y., & Berenda E. A. (2004). Perspectives analysis of functional walking tests application for patients having chronic pulmonary diseases. *Pulmonology journal of Ukraine*, 3, 46-50.
- Kim, J. K., Lee, C. M., & Park J. Y. (2016). Active case finding strategy for chronic obstructive pulmonary disease with handheld spirometry. *Medicine*, 95(50), 5683.
- Kon, S. S., Dilaver, D., & Mittal, M. (2014). The Clinical COPD Questionnaire: response to pulmonary rehabilitation and minimal clinically important

difference. Thorax., 69(9), 793–798.

- Kruis, A. L., Boland, M. R. S., & Assendelft, W. J. J. (2014). Effectiveness of integrated disease management for primary care chronic obstructive pulmonary disease patients: results of cluster randomized trial. *BMJ*, 349, 5392
- Linnik, M. I., Nedospasova, O. P., & Tarasenko, O. R. (2017). Comparative data on distribution of respiratory organs diseases and medical care for patients having pulmonological and allergy diseases in Ukraine for the period of 2010-2016. Kyiv. Lira Publishers.
- Maistruk M. (2017). Efficiency of physical rehabilitation of patients having chronic obstructive pulmonary disease. *Academic journal of Prykarpattya University. Series: Physical culture, 27-28,* 83-91.
- Maistruk, M. (2016) Educational Work with the III with Chronic Obstructive Pulmonary Disease. Youth Academic Journal of Lesya Ukrainka Eastern European National University. Physical education and sport, 23, 72-77.
- Maistruk, M. (2015) Methodological Aspects of Physical Rehabilitation Conducting of the ill With Chronic Obstructive Pulmonary Disease. Physical education, sport, and health culture in modern society: Youth Academic Journal of Lesya Ukrainka Eastern European National University, 3(31), 216-220.
- Mariiyn, L. M., Danilack, A. V., Weston, A. N., & Garshick, E. (2012). Daily step counts in a US cohort with COPD. *Respir Med.*, 106(7), 962–969.
- Mohammed, J., Da Silva, H., Van Oosterwijck, J., & Calders, P. (2017). Effect of respiratory rehabilitation techniques on the autonomic function in patients with chronic obstructive pulmonary disease: A systematic review. Chronic Respiratory Disease, 14(3), 217–230.
- Riario-Sforza, G. G., Incorvaia, C., Paterniti, F., Pessina, L., Caligiuri, R., Pravettoni, C., Di Marco, F., & Centanni, S. (2009). Effects of pulmonary rehabilitation on exercise capacity in patients with COPD: A number needed to treat study. *International Journal of COPD*, 4, 315–319.
- Rodriguez, D. A., Arbillaga, A, & Barberan-Garcia, A. (2016). Effects of interval and continuous exercise training on autonomic cardiac function in COPD patients. *Clin Respir. J.*, *10*(1), 83–89.