



The dynamics of the functional state of the cardio-respiratory system of patients hospitalized with pneumonia, exacerbation of COPD, and bronchial asthma

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DOI: <https://doi.org/10.34142/HSR.2020.06.01.06>

Abstract.

The purpose of the study is to analyze changes of the cardiopulmonary system indicators of hospitalized patients with respiratory diseases and underwent physical therapy.

Materials and methods. The study was performed as a prospective case series study design. The study involved patients hospitalized with pneumonia, exacerbation of COPD and asthma, who had no contraindications to undergoing physical therapy. A total number of patients were 273 persons; 140 of them with pneumonia, 96 persons with exacerbation of COPD, 37 persons with asthma. Conducted surveys, anthropometric studies, clinical tests and instrumental studies.

Results. COPD patients with acute exacerbation had a lower level of functional status of the cardio-respiratory system than patients with pneumonia or exacerbation of asthma. We found the lowest rates of excursion of the chest, blood saturation, VC, FEV1, PEF and higher than normal inhale rate. In addition, COPD patients did not experience statistically significant improvement during the assessment period in the majority of the analyzed parameters, except excursion of the chest and inhale rate.

Conclusions. Acute exacerbation of COPD has a significant impact on the health of patients and significantly reduces the functional state of the respiratory system. The hospitalization period is not sufficient for full recovery. The rehabilitation of such patients should continue after discharge from the hospital.

Keywords: chronic obstructive pulmonary disease; physical therapy; pulmonary rehabilitation; breath-holding test; chest excursion; spirometry

Анотація

Тимрук-Скоропад К.А., Павлова І.О., Сидорик Н.Ю., Кулітка Я., Романюк В. Динаміка функціонального стану кардіо-респіраторної системи пацієнтів, госпіталізованих з приводу пневмонії, загострення ХОЗЛ та бронхіальної астми.

Мета дослідження – проаналізувати зміни функціонального стану кардіо-респіраторної системи пацієнтів, які госпіталізовані з приводу захворювань органів дихання та проходили фізичну терапію.

Матеріали і методи. Дослідження виконане як проспективне дослідження серії випадків. До дослідження залучали пацієнтів, госпіталізованих з приводу пневмонії, загострення ХОЗЛ та бронхіальної астми, які не мали протипоказів до проходження фізичної терапії. Усього було охоплено 273 пацієнти, з них – 140 осіб з пневмонією, 96 осіб – загостренням ХОЗЛ, 37 осіб – з бронхіальною астмою. Проводили опитування, антропометричні дослідження, клінічні тести та інструментальні дослідження.

Результати. Пацієнти з ХОЗЛ, які мають загострення захворювання та потребують госпіталізації мали нижчий рівень функціонального стану кардіо-респіраторної системи, ніж пацієнти з пневмонією, або загостренням бронхіальної астми. У них виявлено найнижчі показники ЕГК, сатурації крові, ЖЕЛ, ОФВ₁, ПШВ та вищу, ніж норма частоту дихання. Окрім того, у пацієнтів із ХОЗЛ за період перебування на лікуванні та проходження фізичної терапії у стаціонарному відділенні не відбулося статистично достовірного поліпшення більшості проаналізованих показників, за винятком ЕГК та частоти дихання.

Висновки. Загострення ХОЗЛ має значний вплив на стан здоров'я пацієнтів та значно знижує функціональний стан дихальної системи, а терміну госпіталізації не достатньо для повноцінного відновлення. Зважаючи на це, реабілітація таких пацієнтів повинна відбуватися і після виписування із стаціонару.

Ключові слова: хронічне обструктивне захворювання легень; фізична терапія; легенева реабілітація; тести із затримкою дихання; екскурсія грудної клітки; спірометрія

Аннотация

Тимрук-Скоропад К.А., Павлова И.О., Сидорик Н.Ю., Кулитка Ю., Романюк В. Динамика функционального состояния кардио-респираторной системы пациентов, госпитализированных по поводу пневмонии, обострения ХОБЛ и бронхиальной астмы.

Цель исследования - проанализировать изменения функционального состояния кардио-респираторной системы пациентов, которые были госпитализированы по поводу заболеваний органов дыхания и проходили физическую терапию.

Материалы и методы. Исследование выполнено как проспективное исследование серии случаев. К исследованию привлекали пациентов, госпитализированных по поводу пневмонии, обострения ХОБЛ и бронхиальной астмы, которые не имели противопоказаний к прохождению физической терапии. Всего было охвачено 273 пациентов, из них - 140 человек с пневмонией, 96 человек - обострением ХОБЛ, 37 человек - с бронхиальной астмой. Проводили опрос, антропометрические исследования, клинические тесты и инструментальные исследования.

Результаты. Пациенты с ХОБЛ, с обострением заболевания имели более низкий уровень функционального состояния кардио-респираторной системы, чем пациенты с пневмонией, или обострением бронхиальной астмы. У них обнаружены низкие показатели ЭГК, сатурации крови, ЖЕЛ, ОФВ₁, ПСВ и выше, чем норма частота дыхания. Кроме того, у пациентов с ХОБЛ за период пребывания на лечении и прохождения физической терапии в стационарном отделении не произошло статистически достоверного улучшения большинства проанализированных показателей, за исключением ЭГК и частоты дыхания.

Выводы. Обострения ХОБЛ имеет значительное влияние на состояние здоровья пациентов и значительно снижает функциональное состояние дыхательной системы, а срока госпитализации недостаточно для полноценного восстановления. Несмотря на это, реабилитация таких пациентов должна происходить и после выписки из стационара.

Ключевые слова: хроническая обструктивная болезнь легких, физическая терапия, легочная реабилитация, тесты с задержкой дыхания, экскурсия грудной клетки, спирометрия.



Introduction

Often, the causes of hospitalization of adults in the department of pulmonology are pneumonia, exacerbation of chronic obstructive pulmonary disease (COPD), and bronchial asthma. Physical therapy for all these conditions is provided by clinical indications and orders at the legislative level in Ukraine [1]. However, the completions of treatment and physical therapy in the in-patient department and the patient's discharge from the hospital do not always imply a sufficient restoration of the functional state of the cardio-respiratory system. To a greater extent, this applies to such chronic diseases as COPD and asthma.

In patients with COPD, each exacerbation negatively affects their lung function, physical performance, quality of life, and increases mortality [2, 3]. Taking this into account together with the chronic course of the disease, it is important to mention that patients with COPD and asthma need additional rehabilitation after hospitalization. It has been confirmed that although symptoms after exacerbation of COPD are normally present from 7 to 10 days, approximately 20% of the patients have not fully recovered in 8 weeks [4]. Pulmonary rehabilitation is a comprehensive approach, which is recommended worldwide for all patients after exacerbation of COPD [5]. Typically, patients are encouraged to start pulmonary rehabilitation program within a month after the exacerbation of COPD [6].

The study has been aimed at evaluating and comparing the efficacy of treatment and physical therapy for the cardio-respiratory system in patients with pneumonia and exacerbation of COPD, and asthma. Knowledge of the functional level of the patient's cardio-respiratory system before hospital discharge will help to understand the need for continued rehabilitation after hospitalization.

Aim: Analyze changes in the functional state of the cardio-respiratory system of patients that have been hospitalized for respiratory diseases and received physical therapy.

Materials and methods

Participants

The study involved patients hospitalized for pneumonia, exacerbation of COPD and bronchial asthma, who had no contraindications to physical therapy [7], and also agreed to work with a physical therapist. A total of 273 patients have been enrolled: 140 of them with pneumonia, 96 of them with

exacerbation of COPD, and 37 were people with asthma.

Procedure

The study has been carried out as prospective case series study design. The study has been conducted on the basis of the in-patient pulmonary department of the clinical hospital in Lviv for the period from December 2017 to December 2019. All the patients who took part in the study were familiar with its goals, objectives, and their rights and signed an informed consent.

Physical therapy

Sessions with a physical therapist have been carried out by an individual method. The physical therapy program has been developed individually for each patient, taking into account the rehabilitation examination. When choosing tools of physical therapy, the patient's commitment to this intervention, the type of the disease, its manifestation, and recommendations for treatment have been considered. Sessions per 35 minutes each have taken place daily from Monday to Friday, during which careful monitoring of the patient's condition have been accomplished in order to avoid its deterioration or fatigue [8].

Depending on certain rehabilitation tasks, the following tools and interventions have been used in individual programs of physical therapy [9, 10]:

- 1) chest physiotherapy (airway cleaning interventions, and interventions for facilitating/improving lung ventilation);
- 2) active breathing exercises.

Airway cleaning included chest wall manipulations (percussion, vibration, compression, and chest rotation) and airway cleaning techniques with effective cough methods (autogenic drainage and controlled coughing). Facilitation/ improvement of lung ventilation included the use of breathing techniques (pursed-lip and diaphragmatic breathing), external chest wall manipulations (stretching of the intercostal muscles, and compression), and stretching of the additional respiratory muscles. Active breathing exercises were prescribed with the aim of improving pulmonary ventilation, clearing sputum out of the lungs, and reducing the manifestations of shortness of breath.

Research methods

The study used the following research methods: survey, anthropometry (height, body weight, chest circumference in quiet breathing,



maximum inspiration and maximum expiration), physical research methods (respiration rate, heart rate), tonometry, breath-holding test on inhale and exhale, oximetry, spirometry (indicators of lung capacity, volume of air exhaled in the first second during forced expiration), and peak fluometry (peak expiratory flow rate).

Patients were examined on the 2nd day of hospitalization (first stage) and before hospital discharge (second stage).

Statistical analysis

For statistical data processing, the Origin Pro 8.6 software program has been used. The arithmetical mean (\bar{x}) and standard deviation (S), standard error of mean (m), the smallest value (Xmin), and the

largest value (Xmax) have been defined. Dependent nonparametric samples have been compared using the Wilcoxon criterion Z. For independent samples, the non-parametric Kruskal-Wallis test has been applied. The differences have been considered to be significant when the significance level has not been lower than 95 % ($p < 0.05$).

Results

Age, gender, and anthropometric characteristics of the patients participating in the study are shown in Table 1. The average body mass index (BMI) in all groups has been within normal limits, although BMI has been at the level of deficiency or overweight/ obesity for 39.55 % of people with COPD, and 40.54 % of patients with asthma and 34,29 % of people with pneumonia.

Table 1

Anthropometric and demographic characteristics of patients hospitalized for pneumonia, exacerbation of COPD and asthma

Indicator	COPD (n=96)	Asthma (n=37)	Pneumonia (n=140)
Age (M±SD), years	64.08±10.97	54.64±15.04	41.77±19.75
Height (M±SD), cm	169.56±10.67	167.08±9.12	171.81±16.09
Body weight (M±SD), kg	78.57±11.24	76.46±15.82	74.85±12.68
BMI (M±SD), standard units:	23.29±1.52	22.68±4.07	23.05±16.82
underweight, n (%)	12 (12.5)	4 (10.81)	25 (17.86)
overweight, n (%)	20 (20.8)	9 (24.32)	20 (14.29)
obesity, n (%)	6 (6.25)	2 (5.41)	3 (2.14)
Sex:			
males, n (%)	70 (72.92)	16 (43.24)	97 (69.29)
females, n (%)	26 (27.08)	21 (56.76)	43 (30.72)

Mean values for respiratory chest excursion (CE) in all groups have been below normal, the lower limit of which has been 6 cm (see Table 2). Among the patients with COPD, 14.58 % (14 people) have had CE within normal limits, and 48.96 % (47 people) – ≤ 3 cm. In the group of patients with asthma – 21.62 % (8 people) have had normal CE, and for 40.54 % (15 people) CE has been ≤ 3 cm. CE has been within normal limits in 33.57 % of the patients (47 people) with pneumonia; and for 30 % (42 people) this indicator has been ≤ 3 cm.

Measurement of the resting-state chest circumference (pause) and subsequent comparison with the chest circumference in inhale (CE_{inhale}) and exhale (CE_{exhale}) made it possible to evaluate the contribution of these two indicators to the formation of the total respiratory thoracic excursion. In particular, in patients with COPD, the rate of CE is determined by the CE_{inhale} by 67.81 %, for individuals with asthma this value has been 67.11 %, and for patients with pneumonia – 71,59 %.

After completion of the treatment and physical therapy in hospital, CE, CE_{inhale} and CE_{exhale} have increased compared with those before hospitalization. So, in patients with COPD, an increase in CE has been observed (by 26.7 %, $p=0.01$), in patients with asthma – an increase in CE_{inhale} (by 5.8 %, $p=0.04$) and a decrease in CE_{exhale} (by 12.7 %, $p=0.02$), and in individuals with pneumonia – an increase in CE_{inhale} (by 5.12 %, $p < 0.01$), CE_{exhale} (by 12.16 %, $p < 0.01$), and CE (by 7.52 %, $p < 0.01$).

After hospitalization, the rate of respiratory CE in patients with COPD has remained low, however, the contribution of CE_{inhale} to the respiratory CE increased and amounted 70.81 %. This value has also increased in patients with pneumonia up to 79.9 % and decreased in patients with asthma to 64.5 %.

The highest respiratory rate has been observed in patients with COPD (22.10 ± 0.52 breaths/min); in persons who had pneumonia or exacerbation of asthma, the respiratory rate has been



within normal limits. After hospitalization in patients with COPD, the average respiratory rate has

decreased by 4.75 % ($p=0.04$), however, has not reached the normal level.

Table 2

Changes in indicators in patients who underwent physical therapy after hospitalization for pneumonia, exacerbation of COPD or asthma

Indicator	COPD patients			Patients with asthma			Patients with pneumonia		
	I stage	II stage	p	I stage	II stage	p	I stage	II stage	p
	$\bar{x}\pm S$	$\bar{x}\pm S$		$\bar{x}\pm S$	$\bar{x}\pm S$		$\bar{x}\pm S$	$\bar{x}\pm S$	
CE _{inhale} , cm	2.17±0.15	2.88±0.23	0.07	2.91±0.38	3.08±0.42	0.04	3.32±0.28	3.49±0.37	< 0.01
CE _{exhale} , cm	1.37±0.15	1.34±0.26	0.09	1.20±0.51	1.05±0.23	0.02	1.48±0.23	1.66±0.30	< 0.01
CE, cm	3.6±0.19	4.56±0.60	0.01	4.11±0.80	4.58±0.53	0.2	4.79±0.36	5.15±0.42	< 0.01
RR, breaths·min ⁻¹	22.10±0.52	21.05±0.74	0.04	20.16±0.80	19.21±0.70	0.29	20.00±0.31	18.44±0.40	0.22
HR, beats·min ⁻¹	76.56±1.48	74.56±1.66	0.33	75.62±1.86	78.05±2.55	0.25	80.07±1.31	78.68±1.21	0.07
AP _s , mmHg	129.20±1.89	128.27±2.10	0.24	128.76±2.31	125.00±3.07	0.05	122.99±1.13	118.82±1.88	< 0.01
AP _d , mmHg	80.06±1.39	78.78±1.41	0.2	79.03±2.83	79.24±1.85	0.09	79.38±0.80	76.07±0.88	0.01
Breath-holding test, inhale, s	23.31±1.25	30.18±2.01	0.1	20.83±2.47	23.21±2.80	0.26	34.11±1.27	40.43±1.93	0.16
Breath-holding test, exhale, s	17.84±0.81	19.91±1.17	0.07	15.18±1.45	17.00±2.09	0.28	21.18±0.65	25.46±0.94	0.01
Difference*, s	5.23±0.9	10.26±0.76	0.07	6.83±1.31	6.18±1.34	0.16	12.93±1.69	14.97±2.33	0.07
Ratio**, conventional units	1.33±0.05	1.52±0.07	0.4	1.52±0.09	1.41±0.06	1.0	1.67±0.09	1.63±0.10	0.37
SpO ₂ , %	94.18±0.63	95.00±1.03	0.55	95.33±1.93	96.61±1.01	0.52	96.19±0.56	97.22±0.49	0.69
LC, %	52.17±3.45	55.15±4.44	0.07	67.87±6.65	68.43±9.93	0.86	76.41±3.21	85.01±5.29	0.32
FEV ₁ , %	52.05±4.61	54.76±5.59	0.71	64.10±6.96	67.15±8.54	0.23	81.86±4.05	90.00±8.07	0.16
PEF, min ⁻¹	140.78±14.5	192.70±18.7	0.16	184.78±23.8	214.87±32.4	0.31	272.63±19.1	400.27±27.3	< 0.01
	6	6		8	8		9	5	

Notes: CE – chest excursion; RR – respiratory rate; HR – heart rate; AP_s – systolic arterial pressure; AP_d – diastolic arterial pressure; SpO₂ – oxygen saturation measured by oximeter; LC – lung capacity; FEV₁ – volume of air expelled in the first second of a forced expiration; PEF – peak expiratory flow; * – difference between the values of the inhale breath-holding test and exhale breath-holding test; ** – ratio between the results of breath-holding tests on inhale and exhale

In all the studied groups, the indices of breath-holding test on inhale and exhale have been lower than the value of the norm. This ratio has been evaluated in patients taking into account that normally the exhale breath-holding indicator is 40–50 % (by 2–2.5 times) less than that one in the inhale breath-holding test. This phenomenon has been observed in 7.29 % of people with COPD, 16.21 % of patients with asthma, and 22.14 % of people with pneumonia. Some patients have been observed with the exhale breath-holding score that was equal to or higher than the inhale breath-holding test score. This ratio (≤ 1 s) among patients with COPD has made up 44.79 % (43 people), asthma – 50 % (18 people), and pneumonia – 24.28 % (34 people).

After treatment and physical therapy, most indicators of hypoxic tests in patients of the three groups have not changed ($p>0.05$). Only patients with pneumonia experienced an improvement in

exhale breath-holding (by 20.87 %, $p=0.01$). In patients with COPD or asthma, the breath-holding test on inhale and exhale remained below normal, and in patients with pneumonia they reached the lower limit of normal. The difference between the values of the inhale breath-holding test and exhale breath-holding test increased in patients with COPD by 1.9 times ($p=0.07$), in patients with pneumonia – by 1.2 times ($p=0.07$), the ratio between these indicators in patients with COPD have increased by 1.14 times ($p=0.4$), and for patients with pneumonia decreased by 1.02 times ($p=0.37$).

The blood saturation rate at the beginning of hospitalization in patients with COPD was in the range “below normal” (94.18±0.63 %), and also lower ($p<0.05$) than in patients with asthma (95.33±1.93 %), or pneumonia (96.19±0.56 %). After treatment and physical therapy in patients of all groups, blood saturation indices were within normal



limits, and tended to increase compared with the data before hospitalization, but the data were statistically unreliable.

After treatment and physical therapy, changes in blood pressure were observed in two groups, in particular, patients with asthma were characterized by a decrease in systolic blood pressure (2.34 %, $p=0.05$), and patients with pneumonia showed a decrease in systolic blood pressure (by 3.39 %, $p<0.01$) and diastolic blood pressure (by 4.17 %, $p=0.01$).

Patients with COPD were characterized by low levels of LC, FEV₁ and PEF compared to people with asthma or pneumonia ($p<0.05$). At the beginning of hospitalization these indicators were below normal in patients of all groups; only the FEV₁ indicator in patients with pneumonia was within normal limits (81.86±4.05 %). After hospitalization LC, FEV₁, and PEF did not grow significantly in patients with COPD and asthma. In patients with pneumonia these indicators grew and became within normal limits; statistically significant changes were observed in relation to the PEF indicator (by 46.82 %, $p<0.01$).

Discussion

Patients with COPD who have exacerbations of the disease and need hospitalization have had a lower level of the functional state of the cardio-respiratory system than patients with pneumonia or exacerbation of asthma. They have shown low levels of CE, blood saturation, LC, FEV₁, PEF and higher than normal respiratory rate.

The largest number of people (48.96 %) with critically low EC (≤ 3 cm) have been identified in the group of patients with COPD, while among patients with asthma and pneumonia there have been 40.54 % and 30.00 % of such persons, correspondingly. Patients of all groups have had cases when the chest circumference on exhalation occurred to the level of EC_{pause} or was greater than that, although patients with COPD have shown the greatest number of such cases. This is due to hyperinflation of lungs and difficulties in performing a deep breath out after a deep breath in.

The contribution of CE_{inhale} to the total respiratory CE in patients with COPD (67.81 %) and asthma (67.11 %) was less than in patients with pneumonia (71.59 %). This can be explained by pulmonary hyperinflation, increased volumes of the chest (emphysematous chest), which leads to more unfavorable working conditions of the respiratory muscles from a biomechanical point of view [11]. In addition, such position of the chest leads to a decrease in the strength of the respiratory muscles,

alongside with their weakening [12, 13]. After treatment and physical therapy, the contribution of CE_{inhale} to total respiratory CE in all patients increased. In particular, at the second stage of the examination, this indicator constituted 70.81 % for patients with COPD and 79.9 % for people with pneumonia, that we regard as a positive effect.

The breath-holding test rates on inhale and exhale in patients with COPD and asthma have been lower than in patients with pneumonia. In addition, in patients with obstructive diseases, there is a decrease in the difference and the ratio between these indicators. If we take into account that the exhale breath-holding test should normally be 40–50 % of the value of the inhale breath-holding test, then the ratio between these indicators should be 2–2.5 conventional units. No such values have been found for either of the groups. This ratio was low in patients with COPD (1.33±0.05 conventional units), and the highest – in patients with pneumonia (1.67±0.09 conventional units). In addition, in some patients the exhale breath-holding test was equal to or greater than the inhale breath-holding test. This trend was typical for individuals with asthma (50 % of the patients) and COPD (44.79 % of the patients); only in 24.28 % of the patients with pneumonia, the exhale breath-holding test index was equal to or greater than index of the inhale breath-holding test. It can be assumed that hyperinflation of lungs and the worsening of conditions for oxygen diffusion at deep breathing during holding of breath are the causes of the change in the ratio of the inhale and exhale breath-holding tests. However, in order to confirm and explain this phenomenon, it is advisable to conduct an additional research.

After treatment and physical therapy, the state of the cardio-respiratory system of all the patient groups improved. More statistically significant changes have been observed in relation to patients with pneumonia. In particular, an increase in CE ($p<0.01$) and PEF ($p<0.01$), a decrease in blood pressure ($p<0.05$), and other indicators tended to normalize, however, statistically significant changes compared to the initial level have not been observed. This picture is understandable due to the non-chronic course of the disease, the young age of the patients and a small number of concomitant diseases in the group.

Another dynamics of the indicators has been found in patients with COPD and bronchial asthma. Although all of the studied parameters improved slightly ($p>0.05$), they remained at a level significantly lower than normal. In patients with asthma, CE_{inhale} ($p=0.04$), CE_{exhale} ($p=0.02$), AP_s ($p=0.05$) improved; in patients with COPD there was



an improvement of CE ($p=0.01$) and respiratory rate ($p=0.04$).

Evaluation of the results of the examination of patients at the beginning and after hospitalization revealed that patients with exacerbation of COPD had worse indicators of the cardio-respiratory system than patients with asthma or pneumonia. In addition, there was no statistically significant improvement in most of the parameters analyzed, with the exception of CE and respiratory rate among patients with COPD for the period of treatment and physical therapy in the in-patient department. It can be explained by the following reasons:

- a significant effect of exacerbation of a chronic disease on health status, a significant worsening of symptoms and test parameters, slow processes of their normalization and recovery;
- a short stay of the patient in the in-patient treatment program, during which the rehabilitation goals cannot be achieved;
- the impossibility during physical exacerbation and hospital stay to use such physical therapy that is most effective for patients with COPD (aerobic and strength training exercises).

Limitation of the study

The study has several limitations. In particular, such important criteria for treatment and rehabilitation as the quality of life, the manifestation of the disease symptoms (to a large extent this relates to COPD and asthma) and physical performance have not been evaluated. Also, the group of patients with asthma was significantly smaller compared with other groups of patients.

Nowadays, in international practice of rehabilitation, there are guidelines and recommendations for the use of physical therapy for patients with COPD [7, 14, 15], asthma [16], and pneumonia [17]; these interventions should have proven effectiveness. The interventions (including breathing exercises, techniques for cleaning the airways, as well as drainage positions) that have been used in this study are actively used in Ukraine [18]. However, they have a low level of evidence in terms of effectiveness, and recommendations for their use in the routine physical therapy of patients with pneumonia, exacerbation of COPD [3] and asthma require further study. A review of approaches to

physical therapy, their approximation to the modern clinical guidelines and adaptation to the national healthcare environment will optimize and increase the efficiency of patient rehabilitation during hospitalization.

Prospects for further studies are the development and testing of pulmonary rehabilitation programs that are tailored in accordance with the best international experience and are effective for patients with chronic diseases of the respiratory system, in particular COPD.

Conclusions

1. Before hospitalization, patients with COPD had the worst indicator rates (chest excursion, respiratory rate and spirometry) compared to patients with asthma and pneumonia.

2. For the period of treatment and physical therapy in the in-patient department, patients with COPD, pneumonia, and asthma showed a tendency, or had statistically confirmed improvement in most indicators of the cardio-respiratory system. Only in individuals with pneumonia indicators were closer to the normal level; there were practically no changes in the parameters of patients with COPD. The patterns of changes in the indices of chest excursion and breath-holding test on inhale and exhale in the studied groups of patients have been revealed.

3. Exacerbations of COPD have a significant impact on patient's health status and significantly reduce the functional state of the respiratory system, and the hospital stay is not enough for a full recovery. Despite this, the rehabilitation of such patients should be carried out after discharge from the hospital. World practice of pulmonary rehabilitation of patients with COPD provides this opportunity to all patients with COPD, who have had exacerbations. Accordingly, the approximation and implementation of modern pulmonary rehabilitation programs for patients with COPD in the Ukrainian system of rehabilitative care remains relevant.

Conflict of interest

The authors report that there is no conflict of interest.



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Received: 01.03.2020

Принята в редакцію 01.03.2020