LUNG VENTILATION FUNCTION AND PULMONARY GAS EXCHANGE IN ELDERLY PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE DURING COMBINED APPLICATION OF HYPOXIC TRAINING AND RESPIRATORY TRAINING WITH POSITIVE END-EXPIRATORY PRESSURE

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Summary

Introduction. Treatment of chronic obstructive pulmonary disease (COPD) in elderly patients is often limited, leading to inadequate disease control. To enhance treatment effectiveness in elderly individuals with COPD, attention has been drawn to non-pharmacological methods, including hypoxic training and respiratory training with positive end-expiratory pressure (PEEP).

Aim. To assess the duration and effectiveness of combined application of hypoxic training and respiratory training with PEEP on lung ventilation function and pulmonary gas exchange in elderly patients with COPD.

Materials and methods. Forty-six elderly patients with COPD were examined: a group (15 individuals) with the application of respiratory training with PEEP, a group (15 individuals) with the application of hypoxic training, and a group (16 individuals) with the application of respiratory training with PEEP and hypoxic training. Before training, immediately after the training course, one month, and three months after the course of hypoxic and/or respiratory training with PEEP, lung ventilation function, bronchial patency, and blood saturation were determined.

Results. The application of hypoxic training and/or respiratory training with PEEP in elderly patients with COPD led to increased speed parameters reflecting bronchial patency. Also, after the course of hypoxic and/or respiratory training with PEEP, the FVC parameter increased in the examined patients, mainly due to ERV. Hypoxic training, compared to respiratory training with PEEP, had slight advantages in its effect on lung ventilation function in elderly patients with COPD. Application of INGT and/or breathing training with PEER resulted in an increase in SpO₂. The combined application of hypoxic training and respiratory training with PEEP in elderly patients with COPD led to increased effectiveness and duration of therapeutic effect. The impact on bronchial patency and SpO₂ of respiratory training with PEEP and/or hypoxic training was greater in patients with pronounced disease symptoms.

Conclusions. Separate application of respiratory training with PEEP or hypoxic training contributes to increased ventilation, decreased bronchial obstruction and increasing blood saturation, but the therapeutic effect is short-term and lasts no longer than a month. Meanwhile, the combined application of hypoxic training and respiratory training with PEEP in elderly patients with COPD leads to more significant improvement in ventilation and bronchial patency. At the same time, the duration of the therapeutic effect persists for three months. The effectiveness of respiratory training with PEEP and/or hypoxic training in elderly patients with COPD depends on the clinical symptoms of the disease: the more pronounced the symptoms, the greater the impact.

Keywords: COPD, ventilation, pulmonary gas exchange, hypoxic training, respiratory training with PEEP, elderly age
INTRODUCTION

Recently, the burden of chronic obstructive pulmonary disease (COPD) is increasing worldwide. This burden is not only due to its impact on the healthcare system. Significant socio-economic problems are caused by COPD as one of the leading causes of mortality and disability [1]. The significance of COPD was demonstrated in epidemiological studies conducted in the United States from 1970 to 2002. It showed more than a twofold increase in COPD mortality while mortality from cardiovascular diseases decreased [2].

The increase in the incidence and mortality of COPD is due to the high prevalence of cigarette smoking, environmental pollution, and aging of the population [3]. Indeed, it has been proven that COPD prevalence increases with age. Thus, COPD is 2-3 times more common in elderly individuals [4]. Researchers predict that the aging of the world’s population will lead to a more significant role of age as a risk factor for COPD [4]. Therefore, COPD becomes one of the main problems faced by the elderly. COPD, as an age-associated pathology, is usually characterized by prominent clinical manifestations with the development of respiratory failure and leads to a significant deterioration in the quality of life in elderly individuals. This is associated with the development of age-related morpho-functional changes not only in the respiratory but also in the entire oxygen transport system of the body in the elderly [5, 6]. As a result, COPD in the elderly often takes a severe course, leading to the development of arterial hypoxemia, tissue hypoxia, and complications [3, 6]. Therefore, early detection and treatment of COPD, especially in the elderly, are crucial.

It is important to note that early detection and comprehensive treatment can slow down the progression of the disease and improve the quality of life of elderly patients with COPD [4]. At the same time, the treatment of COPD in elderly patients is quite problematic and requires careful and comprehensive approach. The success of therapeutic measures in elderly patients relies on an individualized approach based on an understanding of age-related pathophysiological mechanisms and the clinical picture of the disease.

The current strategy for COPD therapy focuses on treating bronchial obstruction — the key pathogenetic link of the disease [7]. The effectiveness of bronchial obstruction correction determines the prognosis and survival of patients with COPD [7]. Pharmacotherapy remains the main method of COPD treatment, but its use is often accompanied by the development of side effects in elderly patients [8]. The development of adverse events in this category of patients when using pharmacological agents has a multifactorial nature. Firstly, it is associated with frequent comorbid conditions in old age, which can complicate pharmacotherapy and increase the risk of adverse effects [9]. Thus, elderly patients with COPD often have comorbid chronic cardiovascular diseases, carbohydrate metabolism disorders, thyroid dysfunction [10]. Moreover, the general pathogenetic pathways of comorbid conditions and their connection with aging mechanisms (chronic inflammation, cellular aging, telomere shortening) significantly increase the risk of developing cardiovascular and metabolic diseases in patients with COPD in old age [10, 11]. Secondly, metabolism changes with age, which affects the speed and effectiveness of drug metabolism [12]. This can lead to drug accumulation in the body and increase their toxicity. Thirdly, due to age-related changes in the neuroendocrine system and weakening of immunity with aging, the reaction to drugs may be more distinct [13].

Therefore, the use of pharmacotherapy for COPD treatment in the elderly can often be limited, leading to inadequate disease control [4]. Thus, attention is drawn to non-pharmacological methods to improve treatment effectiveness in elderly patients with COPD.

One of such non-pharmacological methods is intermittent normobaric hypoxic training (INHT). The effect of hypoxic training is based on breathing a gas mixture with reduced oxygen content, which allows changing the body’s homeostasis in the desired direction. Under the influence of hypoxic training, oxygen transport and utilization improve, aerobic energy production is optimized, and adaptation to hypoxia occurs. As a result of «cross-adaptation», resistance not only to hypoxia but also to other various stress factors increases, functional reserves expand, and compensatory mechanisms are optimized [14]. In clinical practice, hypoxic training has been found to be effective in the treatment of bronchial asthma, cardiovascular diseases, impaired carbohydrate tolerance, etc. [14, 15]. Hypoxic training also improves the functional capabilities of the respiratory system and increases resistance to hypoxia, improves pulmonary gas exchange, and systemic hemodynamics in elderly patients with COPD [16].

Another promising non-pharmacological method for COPD treatment in elderly patients is respiratory training with positive end-expiratory pressure (PEEP) [17, 18]. Creating additional pressure at the end of expiration prevents early expiratory closure of the airways, promotes the reopening and inclusion of alveoli in gas exchange [17, 18]. The use of respiratory training with PEEP promotes alveolar ventilation, increases the efficiency of blood oxygenation in the lungs, and reduces bronchial resistance. When used in elderly patients with COPD, as our experience has shown, respiratory training with PEEP improves the functioning of the cardiorespiratory system [17, 18]. However, the therapeutic effect of respiratory training was not very pronounced and unstable. At the same time, when choosing the method of therapeutic intervention, especially hypoxic training or respiratory training with PEEP, in elderly patients with COPD, not only the effectiveness of treatment but also the duration of the therapeutic effect becomes crucial.
Considering the mechanisms of action, an increase in the intensity and duration of the therapeutic effect can be expected with the combined use of hypoxic training and respiratory training with PEEP in elderly patients with COPD.

AIM

To assess the duration and effectiveness of the combined use of interval normobaric hypoxic training and respiratory training with PEEP in their influence on lung ventilation function and pulmonary gas exchange in elderly patients with COPD.

MATERIALS AND METHODS

Forty-six elderly patients with COPD under observation at the D. F. Chebotarev Institute of Gerontology of the National Academy of Medical Sciences of Ukraine were examined. Patients were in a stable condition, with a disease duration ranging from 7 to 27 years, classified as GOLD stage I-II, clinical groups A and B. The diagnosis of COPD was established according to the GOLD recommendations and the order of the Ministry of Health of Ukraine No. 555 dated June 27, 2013 [8]. The examination program, patient information, and informed consent form for participation in the study were approved by the ethical committee of the D. F. Chebotarev Institute of Gerontology of the National Academy of Medical Sciences of Ukraine. Each participant voluntarily signed the consent form before participating in the study.

The examined individuals were divided into three groups: a group (15 individuals) receiving respiratory training with PEEP, a group (15 individuals) receiving hypoxic training, and a group (16 individuals) receiving combined respiratory training with PEEP and hypoxic training. Group allocation was performed using simple randomization with a random number table.

All examined patients received background basic treatment (long-acting β2-agonists and/or long-acting anticholinergics). Short-acting β2-agonists such as salbutamol were allowed for COPD symptom relief during the study.

The inclusion criteria for the study participants were as follows:
1. Signed and dated written informed consent form before study participation.
2. Patients aged 60–74 years.
3. Diagnosis of COPD stage I-II.
4. Maintenance therapy for COPD for at least 2 months before study entry (short-acting β-receptor agonists or short-acting anticholinergics, long-acting β-receptor agonists or long-acting anticholinergics, or their combination).

Patients were excluded from the study if they had:
1. Active asthma diagnosis.
2. Other lung diseases with an active course.
3. Immunosuppression or other pneumonia risk factors.
4. Pneumonia and/or moderate to severe COPD exacerbations lasting less than 14 days before study entry.
5. Respiratory tract infections.
6. History or current signs of clinically significant other diseases.
7. Pathological and clinically significant ECG parameters.
8. Malignant neoplasms not in complete remission for at least 5 years.

Lung ventilation function abnormalities were assessed using spirometry indicators and the forced expiratory flow–volume curve on a «Spirobank» apparatus (Mir, Italy). The following parameters were calculated: tidal volume (VT), frequency (f), inspired reserve volume (IRV), expired reserve volume (ERV), minute ventilation (VE), maximum voluntary ventilation (MVV), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), the ratio FEV1/FVC, PEF (peak expiratory flow), mean expiratory flow rates at 25%, 50% and 75% of vital capacity (MEF25, MEF50, and MEF75).

Blood oxygen saturation (SpO2) was monitored using a «YUM-300» pulse oximeter (UTAS, Ukraine).

To enhance the effectiveness of the cardiopulmonary system in elderly patients with COPD, respiratory training with PEEP and INHT were applied.

The respiratory training with PEEP course consisted of 10 daily sessions, each session comprising 15 minutes of breathing with PEEP of 5 cm H2O. PEEP respiratory training were conducted using the «Threshold PEP» respiratory trainer (Germany). The level of expiratory resistance during respiratory training with PEEP was set at 5 cm H2O. Based on the results of our previous studies, it was determined that this level of expiratory resistance is optimal for elderly individuals with accelerated aging of the respiratory system [18].

The hypoxic training course comprised 10 daily sessions, each session consisting of three five-minute cycles of breathing hypoxic mixture (12% O2, 88% N2) alternating with five-minute periods of normoxia. Hypoxic training was performed using the automated software and hardware complex «Hypotron-M» (the National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute,» Ukraine) [19].

Prospective studies were conducted. All examinations were conducted before the training, immediately after the training course, one month, and three months after the training course.

The obtained data were processed using variation statistics methods with the «Statistica 6.0 for Windows» computer program. All studied parameters had a distribution close to normal. Therefore, parametrical statistical procedures were used. The mean values of the parameters (M) and their errors (m) were calculated. Differences in mean parameter values between the studied groups were evaluated using the Student’s t-test. Statistically significant differences (changes
RESULTS

The analysis of the study data revealed a significant decrease in lung ventilation function and bronchial patency indicators in COPD patients before the start of the training sessions (table 1).

Table 1

<table>
<thead>
<tr>
<th>Indexes</th>
<th>The initial condition</th>
<th>Condition immediately after training</th>
<th>Condition a month after training</th>
<th>Condition three months after training</th>
</tr>
</thead>
<tbody>
<tr>
<td>VT, L</td>
<td>0.46 ± 0.01</td>
<td>0.54 ± 0.01*</td>
<td>0.53 ± 0.02*</td>
<td>0.47 ± 0.01</td>
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<td>f, min⁻¹</td>
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<td>1.57 ± 0.05</td>
<td>1.54 ± 0.03</td>
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<td>ERV, L</td>
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<td>0.91 ± 0.03</td>
<td>0.75 ± 0.04</td>
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<td>VE, L/min</td>
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<td>8.69 ± 0.30</td>
<td>8.24 ± 0.33</td>
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<td>MVV, L/min</td>
<td>81.08 ± 4.35</td>
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<td>98.65 ± 4.25*</td>
<td>84.23 ± 4.21</td>
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<tr>
<td>FVC, L</td>
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<td>FEV₁, L/s</td>
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<td>0.61 ± 0.02</td>
<td>0.62 ± 0.03</td>
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<td>MEF₅₀, L/s</td>
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<td>1.45 ± 0.11</td>
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<td>1.27 ± 0.11</td>
<td>1.20 ± 0.12</td>
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<td>SpO₂, %</td>
<td>94.73 ± 0.17</td>
<td>95.85 ± 0.03*</td>
<td>95.74 ± 0.11*</td>
<td>94.82 ± 0.13</td>
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<td>0.54 ± 0.02*</td>
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<td>0.45 ± 0.02</td>
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<tr>
<td>f, min⁻¹</td>
<td>17.63 ± 0.31</td>
<td>16.44 ± 0.25*</td>
<td>16.75 ± 0.26*</td>
<td>17.56 ± 0.25</td>
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<tr>
<td>IRV, L</td>
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<td>ERV, L</td>
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<td>VE, L/min</td>
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<td>8.95 ± 0.38</td>
<td>8.90 ± 0.34</td>
<td>8.57 ± 0.30</td>
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<tr>
<td>MVV, L/min</td>
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<td>90.53 ± 4.11*</td>
<td>79.09 ± 4.64</td>
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<tr>
<td>FVC, L</td>
<td>2.73 ± 0.07</td>
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<td>0.61 ± 0.02</td>
<td>0.60 ± 0.01</td>
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<tr>
<td>PEF, L/s</td>
<td>3.53 ± 0.15</td>
<td>4.04 ± 0.15*</td>
<td>3.91 ± 0.16</td>
<td>3.60 ± 0.15</td>
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<td>MEF₂₅, L/s</td>
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<td>MEF₅₀, L/s</td>
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<td>MEF₇₅, L/s</td>
<td>1.16 ± 0.10</td>
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<td>1.18 ± 0.10</td>
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<tr>
<td>SpO₂, %</td>
<td>94.94 ± 0.32</td>
<td>96.06 ± 0.24*</td>
<td>95.75 ± 0.20*</td>
<td>95.00 ± 0.29</td>
</tr>
</tbody>
</table>

INHT + respiratory training with PEEP, n = 16

<table>
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<td>f, min⁻¹</td>
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<td>0.96 ± 0.05*</td>
<td>0.88 ± 0.04</td>
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<td>VE, L/min</td>
<td>7.79 ± 0.27</td>
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<td>8.46 ± 0.28</td>
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<td>MVV, L/min</td>
<td>71.12 ± 5.08</td>
<td>106.15 ± 4.06*</td>
<td>99.35 ± 5.24</td>
<td>94.21 ± 4.70</td>
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<td>FVC, L</td>
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<td>FEV₁, L/s</td>
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<td>1.95 ± 0.06*</td>
<td>1.90 ± 0.04*</td>
<td>1.66 ± 0.05</td>
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<tr>
<td>FEV₁/FVC</td>
<td>0.59 ± 0.02</td>
<td>0.62 ± 0.03</td>
<td>0.62 ± 0.02</td>
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<td>PEF, L/s</td>
<td>3.65 ± 0.17</td>
<td>4.43 ± 0.14*</td>
<td>4.36 ± 0.14*</td>
<td>3.78 ± 0.17</td>
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<td>MEF₂₅, L/s</td>
<td>1.72 ± 0.11</td>
<td>2.45 ± 0.11*</td>
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<td>1.76 ± 0.10*</td>
<td>1.77 ± 0.09*</td>
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<td>MEF₇₅, L/s</td>
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<td>1.49 ± 0.09*</td>
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<tr>
<td>SpO₂, %</td>
<td>94.81 ± 0.25</td>
<td>96.18 ± 0.23*</td>
<td>95.86 ± 0.22*</td>
<td>95.17 ± 0.26</td>
</tr>
</tbody>
</table>

Notes:* – p < 0.05 compared to baseline;** – p < 0.05 compared to INHT;# – p < 0.05 compared to respiratory training with PEEP.
The management of modern COPD therapy is aimed at the critical mechanism of this pathology – bronchial obstruction [7]. Therefore, the state of bronchial patency and lung ventilation function in elderly patients with COPD was evaluated immediately after INHT application and/or respiratory training with PEEP, as well as dynamically after one month and three months of observation.

The inclusion of INHT or respiratory training with PEEP in basic therapy led to some reduction in bronchial obstruction in elderly patients with COPD. This was evidenced by an increase in their speed indicators, reflecting bronchial patency (see table 1). The improvement in bronchial patency immediately after the course of INHT application or respiratory training with PEEP naturally led to an improvement in lung ventilation function in the examined patients. The increase in lung ventilation efficiency was reflected in an increase in their FVC (see table 1). Moreover, the increase in FVC mainly occurred due to ERV (see table 1).

Analysis of the VE structure revealed changes in breathing pattern in elderly patients with COPD after the INHT course and respiratory training with PEEP. This manifested as an increase in VT with some decrease in f (see table 1).

The use of INGT, compared to respiratory training with PEEP, had slight advantages in influencing lung ventilation function in elderly patients with COPD (see table 1). However, the combined use of INGT and respiratory training with PEEP in elderly patients with COPD led to an increase in therapeutic effect (see table 1).

Lung ventilation in examined patients with COPD slightly decreased after one month of observation following the separate use of both INHT and respiratory training with PEEP: lung capacity decreased, lung reserve decreased, but they were still higher than baseline. Positive changes in breathing pattern and minute ventilation were preserved (see table 1). However, the positive effect of respiratory training with PEEP on bronchial patency was not maintained even after one month (see table 1). In contrast to respiratory training with PEEP, the duration of the effect not only on lung ventilation function but also on bronchial patency was maintained for one month after separate INHT use (see table 1). Unfortunately, the separate use of both respiratory training with PEEP and INHT did not maintain the therapeutic effect for three months (see table 1). Meanwhile, with the combined use of respiratory training with PEEP and INHT, the positive effect on lung ventilation function and bronchial patency was maintained for one month and, for some indicators, even for three months (see table 1).

As a result of the improvement in ventilation and bronchial patency in examined patients with COPD following the use of INHT and/or respiratory training with PEEP, a decrease in the level of arterial hypoxemia was observed, reflected in increased \( \text{SpO}_2 \) (see table 1). Moreover, the increase in lung gas exchange efficiency was maintained for one month both with separate and combined use of respiratory training with PEEP and INHT (see table 1). This statement is supported by the analysis of \( \text{SpO}_2 \) dynamics in examined elderly patients with COPD (see table 1).

As it is known, the effectiveness of a particular therapeutic method largely depends on the clinical manifestations of the disease. Therefore, it was interesting to evaluate the effect of INHT or respiratory training with PEEP, or their combination on bronchial patency and \( \text{SpO}_2 \) depending on the severity of clinical manifestations in elderly patients with COPD.

For this purpose, a one-way analysis of variance of the influence of the disease symptomatology factor («many» or «few» symptoms – clinical groups A or B) on FEV\(_1\) shifts and \( \text{SpO}_2 \) shifts immediately after the course of exercises in the examined patients was conducted.

The results obtained allowed us to establish that the effectiveness of the influence of respiratory training with PEEP or INHT, or their combination on bronchial patency and \( \text{SpO}_2 \) depends on the clinical group of the examined patients (see table 2). That is, the effectiveness of the influence of respiratory training with PEEP and/or INHT on bronchial patency and \( \text{SpO}_2 \) is higher in patients with pronounced disease symptoms (clinical group B).

<table>
<thead>
<tr>
<th>Indicators, landslides</th>
<th>F- criterion</th>
<th>p</th>
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<tr>
<td>FEV(_1)</td>
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<tr>
<td>( \text{SpO}_2 )</td>
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<tr>
<td>( \text{SpO}_2 )</td>
<td>4,49</td>
<td>0,039</td>
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</table>

Table 2

The significance of the influence of the clinical group factor (A or B) on indicators of bronchial patency and blood saturation in elderly patients with COPD during the application of respiratory training with PEEP and/or INHT, \( n = 46 \)
In this context, the beneficial effect of respiratory training with PEEP or INHT, or their combination on bronchial patency in patients with pronounced symptoms of the disease, was more significant. These differences remained statistically significant over the course of one month of observation (see table 2).

**DISCUSSION**

The effectiveness of pulmonary gas exchange, determined by ventilation and bronchial patency, is crucial for the quality of life in COPD patients [4, 7]. The condition of ventilation and pulmonary gas exchange is determined not only by the effectiveness of therapeutic measures but also by the severity of pathological changes in the respiratory system against which the treatment is carried out.

A clear consequence of bronchial obstruction and ventilation impairment is the reduction in the efficiency of pulmonary gas exchange in elderly COPD patients. This manifested as a decrease in SpO₂ in the examined elderly COPD patients (see table 1).

Changes in breathing patterns in examined COPD patients under the influence of respiratory training with PEEP and INHT can be considered favorable as they are energetically advantageous. Moreover, the use of both INHT and respiratory training with PEEP contributed to increased respiratory reserves in elderly COPD patients. This is confirmed by the increase in MVV in elderly COPD patients immediately after the course of respiratory training with PEEP (see table 1).

The detected changes in lung ventilation function and bronchial patency in COPD patients are a consequence of the adaptive effect of INHT and respiratory training with PEEP. On the one hand, the positive pressure in the lungs during respiratory training with PEEP leads to an increase in the number of involved «unstable» alveoli in gas exchange [17, 18]. Also, due to the positive pressure in these alveoli, the initial volume, residual capacity, and perfusion are restored [17, 18]. The increase in residual capacity leads to a decrease in compliance and a decrease in intrapulmonary shunting [17]. These effects contribute to a reduction in alveolar dead space and an increase in effective alveolar ventilation, leading to increased PaO₂ and decreased PaCO₂. On the other hand, intermittent hypoxic exposure results in training of the respiratory center and increased strength of respiratory muscle contractions [14]. Furthermore, increased bronchial patency may also be due to sympathetic effects on the bronchi due to stress hypoxic exposure [14, 15].

**Blood saturation** is an integral indicator of pulmonary gas exchange. The effectiveness of gas exchange in the lungs is determined, on the one hand, by lung ventilation and bronchial patency, and on the other hand, by diffusion capacity and lung perfusion. Previously, in a number of studies, we demonstrated the positive effect of INHT and respiratory training with PEEP on diffusion capacity and lung perfusion [16, 17]. Therefore, it can be stated that the increase in SpO₂ in elderly COPD patients is due to the improvement in ventilation-perfusion ratio resulting from increased bronchial patency, improved ventilation, and increased lung perfusion due to the effect of INHT and respiratory training with PEEP.

How can the relationship between the effectiveness of training (INHT and/or respiratory training with PEEP) and the clinical symptoms of COPD in examined patients be explained? On the one hand, the clinical manifestations of COPD (shortness of breath, cough, sputum production) lead to a reduction in the patient’s quality of life and cause distress to the patient. The relationship between the clinical symptoms of the disease and bronchial obstruction is rather conditional. Often, significant airflow limitation occurs with modest symptoms. That is, the symptoms are not significant yet there is already bronchial obstruction. This is especially typical for elderly patients due to the age-related decrease in cough reflex sensitivity [5]. At the same time, cough and productive sputum are signs of COPD that may appear much earlier than bronchial obstruction. The onset of shortness of breath is usually an indication of significant bronchial obstruction. There is a well-known high correlation between lung hyperinflation, bronchial obstruction, and shortness of breath [20]. Therefore, increased bronchial patency contributes to a reduction in shortness of breath and improvement in clinical symptoms.

**CONCLUSIONS**

Adding respiratory training with PEEP and/or INHT to basic therapy contributes to increased ventilation efficiency, reduced bronchial obstruction and increasing blood saturation in elderly COPD patients. The therapeutic effect with separate use of respiratory training with PEEP or INHT is short-lived and lasts no longer than one month. Meanwhile, the combined use of INHT and respiratory training with PEEP in elderly COPD patients leads to a more significant improvement in ventilation and bronchial patency. At the same time, the duration of the therapeutic effect is maintained for three months. The effectiveness of using respiratory training with PEEP and/or INHT in elderly COPD patients depends on the clinical symptoms of the disease: the more pronounced the symptoms, the greater the effect of the intervention.

*Prospects for further research* consists in elucidating the impact of the combined use of hypoxic training and respiratory training with PEEP on the cardiovascular system in elderly patients with COPD.

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COMPLIANCE WITH ETHICAL REQUIREMENTS

The study was conducted in accordance with the principles of the Helsinki Declaration of the World Medical Association «Ethical principles of medical research involving a person as an object of research.» All study participants provided informed consent in writing to participate in the study.

LITERATURE


REFERENCES


ВЕНИТІЛЯЦІЙНА ФУНКЦІЯ ЛЕГЕНЬ ТА ЛЕГЕНЕВИЙ ГАЗООБМІН У ХВОРИХ ПОХИЛОГО ВІКУ З ХРОНІЧНИМ ОБСТРУКТИВНИМ ЗАХВОРЮВАННЯМ ЛЕГЕНЬ ПРИ КОМБІНОВАНОМУ ЗАСТОСУВАНІ ІНГТ ТА ДИХАЛЬНИХ ТРЕНУВАНЬ З ПОЗИТИВНИМ ТИСКОМ НАПРИКІНЦІ ВИДИХУ

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Вступ. Лікування ХОЗАЛ у пацієнтів старшого віку часто обмежено, що призводить до недостатнього контролю захворювання. Для підвищення ефективності лікування у людей старшого віку з ХОЗАЛ приймають увагу безмедикаментозні методи, зокрема гіпоксичні тренування та дихальні тренування з позитивним тиском наприкінці видиху.

Мета. Оцінити тривалість та ефективність комбінованого застосування гіпоксичних тренувань та дихальних тренувань з позитивним тиском наприкінці видиху при їх впливі на вентиляційну функцію легень та легеневий газообмін у хворих похилого віку з ХОЗАЛ.

Матеріали та методи. Обстежено 46 людей похилого віку з ХОЗАЛ: група (15 осіб) з дихальними тренуваннями з PEEP; група (15 осіб) з гіпоксичними тренуваннями; група (16 осіб) з комбінованим застосуванням дихальних та гіпоксичних тренувань. До тренувань, відразу після курсу тренувань, через місяць та через три місяці після курсу гіпоксичних та/або дихальних тренувань з позитивним тиском наприкінці видиху визначали вентиляційну функцію легень, бронхіальну прохідність та сатурацію крові.

Результати. Застосування ІНГТ та/або дихальних тренувань з PEEP у хворих похилого віку з ХОЗАЛ призводить до збільшення швидкісних показників, що відображають прохідність бронхів. Також після курсу ІНГТ та/або дихальних тренувань з PEEP у обстежених хворих підвищився показник FVC, переважно, за рахунок ERV. Застосування ІНГТ, у порівнянні з дихальними тренуваннями з PEEP, мало невеликі переваги щодо впливу на вентиляційну функцію легень у хворих похилого віку з ХОЗАЛ. Комбіноване застосування ІНГТ та дихальних тренувань з PEEP у хворих похилого віку з ХОЗАЛ призводило до зростання ефективності та тривалості лікувального ефекту. Вплив на бронхіальну прохідність та SpO2 дихальних тренувань з PEEP та/або ІНГТ був більшою у хворих з вираженою симптоматикою хвороби.

Висновки. Окреме застосування дихальних тренувань з PEEP або ІНГТ сприяє підвищенню вентиляції та зниженню бронхіальної обструкції, але лікувальний ефект при цьому нерівномірний та зберігається не більше місяця. Водночас комбіноване застосування ІНГТ та дихальних тренувань з PEEP у хворих похилого віку з ХОЗАЛ призводить до більш значного покращення вентиляції та бронхіальної прохідності. При цьому тривалість терапевтичного ефекту збільшується протягом трьох місяців. Ефективність застосування дихальних тренувань з PEEP та/або ІНГТ у хворих похилого віку з ХОЗАЛ залежить від клінічної симптоматики хвороби: чим більше виражена симптоматика, тим більший ефект впливу.

Ключові слова: ХОЗАЛ, вентиляція, легеневий газообмін, гіпоксичні тренування, дихальні тренування з PEEP, похилий вік