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Recovery of physical stability in patients with bronchial asthma

key words: *bronchial asthma, ethylmethylhydroxypyridine succinate, physical activity.*

Today, modern medicine faced the issue of improving the physical activity of patients with bronchial asthma (BA), because in 90.0% of the quality of life of a person is determined by it, which, in turn, depends on the functional state of the cardiorespiratory system. The main function of physical activity is mobility and the ability to adapt to the execution, if necessary, of stress extreme physical efforts with the achievement of anaerobic threshold (AP) – the moment of physical activity when the lack of oxygen supply to working muscles triggers anaerobic mechanisms of energy supply with the formation of lactic acid, which leads to an increase in the production of carbon dioxide (CO_2) and non-linear increase in ventilation. For any stress the organism corresponds to the reaction of the voltage regulator systems and the mobilization of adaptation mechanisms, and in response to the same intensity of influence, in some people the voltage regulatory systems is moderate, and in others – sharply expressed. It depends on the body's reserves and level of health. It is proven that the patients with asthma, with reduced function of the external respiration, physical activity is supported by excessive activation of anaerobic metabolism and increasing energy cost of the work performed. It was established that at the maximum physical activity in patients with bronchial asthma, regardless of the phase of the disease, there is no effective functioning of the muscular system due to limiting the supply of oxygen to it, resulting in increased energy expenditure in the muscles, with the accumulation of excess lactic acid and shear homeostasis of the body. Therefore, the issue of application in the treatment of patients with asthma drugs complex action, with many points of influence on the pathogenesis of the disease is relevant. Ethylmethylhydroxypyridine succinate is a modern drug that has anti-inflammatory and bactericidal effects, inhibits proteases, enhances drainage function of the lymphatic system, enhances microcirculation, stimulates reparative-regenerative processes, and also provides immunotropic action. Ethyl methylhydroxypyridine succinate is currently widely used in neurological practice. Today, according to the studies conducted by the authors, it has been shown that the use of ethyl methylhydroxypyridine succinate in the complex therapy of patients with bronchial asthma has a pronounced antioxidant effect, a significant anti-inflammatory effect, short-term improvement in fasting function of external respiration (FDD), increased hemoglobin saturation with oxygen, reduction of duration the presence of patients in the hospital, a decrease in the frequency of exacerbations, and hence the controllability of the course of the disease [1, 2]. However, data on the study of its effect on physical activity in patients with bronchial asthma in the literature is not, which led to the main goal of the work.

The main purpose of the work was to investigate the possibility of restoring physical activity in patients with bronchial asthma by using ethyl methylhydroxypyridine succinate against the background of basal therapy of the remission period.

Materials and methods

The research was conducted on the basis of the Department of Pulmonology at the State Enterprise «State Institution» National Institute of Phthisiology and Pulmonology. F.G. Yanovsky National Academy of Medical Sciences of Ukraine «. To solve the research tasks, subjects of study were patients with bronchial asthma (BA). The study included patients only with their voluntary consent with the purpose and scope of the planned examinations. According to the above criteria, the study included 30 patients with asthma in the remission phase, 21 to 65 years of age, on average (31.5 ± 5.6 years), including 12 men and 18 women. All patients were divided into groups: I group (15 patients) received during 60 days daily preparation containing ethylmethylhydroxypyridine succinate, at 125 mg 2 times a day. All patients received standard basal therapy for the remission period, which included the use of an inhaled corticosteroid and a long-term and short-acting β_2 agonist for asthma symptoms. The second group (15 patients) received inhaled glucocorticosteroids and long-term and

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short-acting β_2 agonists and prolonged theophylline for one month. All these patients were included in a prospective, controlled, randomized trial. When diagnosis of asthma was taken into account anamnesis, clinical symptoms, indicators of the function of external respiration, reversibility of obstruction in the sample with bronchodilator. The selection of patients on the severity of asthma was conducted in accordance with the criteria of № 128 of the Ministry of Health of Ukraine of 19.03.2007 «On Approval of Clinical Protocols for the Provision of Medical Aid in the Specialty» Pulmonology «and Order No. 868 of the Ministry of Health of Ukraine of October 08, 2013» Unified clinical protocol of primary, secondary (specialized) medical aid. Bronchial asthma «[8]. As a control, 15 healthy volunteers who had no serious clinically significant pathology were screened. The study was distributed to the initial visit to the clinic, Visit II – immediately after the treatment and Visit III after 3 months.

Spirometric study was conducted for all patients with the definition of the main parameters of the function of external respiration (FDD). To determine physical performance in patients with bronchial asthma, a cardiopulmonary biliary and respiratory load test was used [3, 4, 5]. To perform the dosage exercise, the bike EL/2 and Ergoselect 1000 LP Basic with automatic power dissipation, regardless of the speed of the pedaling, were used. The main parameters of pulmonary ventilation and gas exchange, as well as heart rate and electrocardiogram registrations were automatically processed by the Ergopneumotest OM / 05-C unit and the Oxychon Pro-Version JLAB4.67 Ergospirometer system, which includes a pneumotachograph with an integrator, gas analyzers for oxygen and carbon dioxide and an electrocardiogram. Bicycle ergometric research was conducted in compliance with the general test requirements presented to submaximal physical activity. Before the study abolished drugs that affect the functional state of the cardiorspiratory and nervous systems. Smoking was forbidden for two or more hours before the study. Physical exercise was used not earlier than 1 hour after meals. Absolute and relative contraindications to testing and conditions requiring special attention and caution were taken into account on the basis of recommendations [6, 7].

The determination of physical working capacity was carried out in accordance with the RA-150-I B3-BP2-EC1 protocol. The work lasted until the abandonment or stopped when subjective and objective symptoms appeared, limiting the further increase in the load: severe shortness of breath, the achievement of the submaximal heart rate, the appearance of electrocardiographic signs of coronary insufficiency. Deviations of the pace of pedaling from a predetermined level (below 60 rev / min.) Due to muscle weakness or lack of motivation to perform the limiting load was considered as the refusal of the subject from further testing. Максимальний рівень виконаного навантаження оцінювався як межа функціональних можливостей організму. Оцінювались наступні показники:

– VO_2 / kg, – oxygen consumption in ml per minute per kg of body weight, also determined at the maximum load and at the level of anaerobic threshold (ml / min / kg);

– BR, – ventilation reserve, which was observed at maximum load ° (%);

– HR, – HR, which was at the patient at the height of the load (1 / min);

– HRR, – reserve of heart rate stored in a patient at reaching the maximum load (1 / min);

– VO_2 / HR, – oxygen pulse observed at loading height (ml / min);

– SpO_2, – oxygen saturation, estimated at maximum load (%);

– AT – arterial pressure that was in the patient at the height of the load (mm Hg);

– W – maximum achieved load in (W and%);

– physical capacity was evaluated according to the level of maximum oxygen consumption (MPC) reached by the patient (in l / min and in percentage of proper) and the performed work (Watts);

– Anaerobic threshold (determined by metabolic units of 1 METH (kcal / kg) – 3.5 ml / min / kg and as a percentage of the proper.

Each patient was evaluated for the reason for stopping the test. Estimates were obtained by automatic calculation using the methodology developed by the firm. Statistical: Statistical processing of the material was carried out using the licensed software products included in the Microsoft Office Professional 2000 package, the Russian Academic OPEN NO LEVEL License 17016297 license on the IBM Atlon personal computer in Excel. To verify the normality of data sharing, the method was used by Lapach S.N. and others. (2001) (function NORMSAMP-1, which is embedded in the Excel environment) [9, 10]. The work is done at public expense.

The results

At the beginning of the observation, the volume of forced exhalation for 1 second in patients of the I-th group was 63.5%, the compressed vital capacity of the lungs was 75.2%, peak exhalation rate 81.2%, the ratio of forced exhalation for 1 second to forced life capacity of lungs 83,2%. After a course of treatment in patients with this group of significant changes in spirographic parameters did not occur. Namely, the volume of forced exhalation in 1 second made up 69.5%, the compressed vital capacity of the lungs was 75.7%, the peak expiratory rate was 82.6%, the ratio of forced exhalation for 1 second to the forced lumen of life 88.3%. After three months of observation, the volume of forced exhalation for 1 second in patients of the I group remained unchanged and amounted to 66.3%, the forced vital capacity of the lungs was 78.1%, peak exhalation rate 82.3%, the ratio of forced exhalation volume for 1 second up to a forced vital capacity of lungs 82,5%.

In patients of the second group at the beginning of the observation, the volume of forced exhalation for 1 second was 68.2%, the forced vital capacity of the lungs was 75.6%, the peak exhalation rate was 85.1%, the ratio of forced exhalation for 1 second to the forced vital capacity lungs 83.1%. During the observation period, no significant changes were observed in the estimated rates: during the visit II – the volume of forced exhalation in 1 second was 71.5%, the

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compressed vital capacity of the lungs was 74.8%, the peak exhalation rate was 83.5%, the ratio of volume forced exhalation for 1 second up to a forced vital capacity of the lungs 87.3%, on the third visit – the volume of forced exhalation was 72.3%, the forced lung capacity 72.3%, peak exhalation rate 83.4%, the ratio of forced volume exhale for 1 second to the forced vital capacity of the lungs 87.5%.

In a more detailed analysis it was also found that in the I group of patients with bronchial asthma, in the remission of the disease there is a decrease in physical activity. When performing the maximum physical activity due to non-rational functioning of the cardiovascular and pulmonary systems, in patients with asthma there is a decrease in the flow of oxygen to the blood when performing the maximum physical activity. This is confirmed by the lowered ergospirometric indices characterizing the respiratory system activity: $V'O_2$/kg to (5.7 ± 1.1) ml/min/kg, $V'O_2$ / kg to (74.8 ± 2.1)%, $V'O_2$ to (83.8 ± 3.1)%, $V'O_2p$ (79.4 ± 3.2)%, $V'O_{2max}$, to (89.1 ± 2.1)%, BR to (73, 9 ± 3,5)%, which is accompanied by an increase in the RER to (1,01 ± 0,1) cu (see table 1).

There was no statistically significant difference compared with the beginning of treatment.

Also, the indicators characterizing the effectiveness of the cardiovascular system were changed: dHR / dO_2 to (76,4 ± 6,2)%, HR / VO_2 to (7,5 ± 3,3) bp/ml/kg, HR to (125.8 ± 6.6) bp /min and (84.1 ± 5.2)%, VO_2/HR (6.8 ± 2.5) bp/ml/kg and (73.5 ± 5.1)%, SpO_2 – (82.8 ± 6.6)%. As a result, the tolerance to physical activity and the level of work performed were reduced: W to (68,4 ± 3,2)% and (0,9 ± 0,1) W/kg, (97,4 ± 5,1) BT, dO_2 / dW to (7,3 ± 1,5) ml/min / W, MET – (4,2 ± 1,2) kcal / kg (healthy – (8.4 ± 1.6) kcal / kg), RW – (0.9 ± 0.10) W / kg (healthy – (1.2 ± 0.1) W / kg, PMA (78.4 ± 2.2)% (healthy – (89.3 ± 6.2)%), BR (73.9 ± 3.5)% (healthy – (92.3 ± 4.2)%). Dyspnoea score on the scale Debt to load (0 ± 0,0) points, after loading – (2,1 ± 0,4) points (healthy – 0–1 points).

After the treatment with prolonged theophylls, no positive dynamics in spirometric parameters was established. Namely: the volume of forced exhalation in 1 second made up 68.5%, the forced vital capacity of the lungs slightly decreased and amounted to 71.3%, the peak expulsion rate fell to 75.5%, the ratio of forced exhalation for 1 second to the forced vital the capacity of the lungs decreased to 81.4%. There was no significant change in the rates of bicycle lesions, compared to the start of treatment, and a significant difference was observed in comparison with the group of healthy subjects in the $V'O_2$ / kg (5.7 ± 1.1) ml/ min/ kg to (4.1 ± 1.4) ml/min/kg, $V'O_2$/kg with (74.8 ± 2.1)% to (77.5 ± 2.5)%, $V'O_2$ (83.8 ± 3.1)% to (91.6 ± 2.8)%, V'O2p with (79.4 ± 3.2)% to (78.5 ± 2.2)%, $V'O_{2max}$ with (89.1 ± 2,1)% to (91.5 ± 2.5)%. There were no significant changes in the performance of the cardiovascular system: VO_2 / HR with (73,5 ± 5,1)% to (75,5 ± 4,5)%, HR / VO_2 with (7,5 ± 3, 3) bp/ml/kg to (5,8 ± 2,2) units/ml / kg, SpO_2 with (82,8 ± 6,6)% to (82,9 ± 7,4)%. As a result, the tolerance to physical activity, the level of work done and the physical activity of the patients receiving the drug Teopek were reduced. Namely: the index W changed only from (68,4 ± 3,2)% to (72,5 ± 3,8)%, the duration of the third phase with (6,2 ± 2,1) min. to (8.5 ± 2.5) min, MET with (4.2 ± 1.2) kcal/kg to (5.8 ± 1.6) kcal/kg, RW with (0.9 ± 0.1) W/kg to (1,0 ± 0,2) W/kg, BR to (73,9 ± 3,5)% to (75,3 ± 3,2)%. Assessment of dyspnea on the Borg scale after loading from (2.1 ± 0.4) points to (2.2 ± 0.3) points. Three months after the treatment, spirometric indices remained unchanged. Namely: the volume of forced exhalation for 1 second was 63.5%, the compressed vital capacity of the lungs was 72.8%, the peak expiratory rate 74.5%, the ratio of forced exhalation for 1 second to the forced vital capacity of the lungs 80.7%. Physical activity of patients remained low. The function of the cardiovascular system when performing physical work was not effective: $V'O_2$/kg of (5.7 ± 1.1) ml/min / kg before treatment (3.2 ± 1.5) ml/min/kg 3 months after treatment, $V'O_2$/kg (74,8 ± 2,1)% to (78,5 ± 2,4)%, $V'O_2$ with (83,8 ± 3,1)% to (89, 5 ± 2.0)%, $V'O_2p$ with (79.4 ± 3.2)% to (79.7 ± 2.5)%, $V'O_{2max}$ with (89.1 ± 2.1)% to (92.5 ± 2.4)%, duration of the 3rd phase of the test with (6.2 ± 2.1) min. to (8.3 ± 2.2) min, AT with (49.1 ± 3.2)% to (55.3 ± 3.1)%. The work of the cardiovascular system also remained unchanged: HR / VO_2 with (7,5 ± 3,3) bp/ml/ kg up (5,1 ± 1,8) bp/ml/kg, VO_2/HR with (73,5 ± 5.1)% to (76.8 ± 4.4)%. The level of work performed, exercise tolerance and physical activity remained unchanged 3 months after treatment: W (68,4 ± 3,2)% to (73,2 ± 3,3)%, W from (0, 9 ± 0,1) W/kg to (1,0 ± 0,2) W/kg., MET with (4,2 ± 1,2) kcal/kg up to (6.2 ± 1.8) kcal/kg, RW with (0.9 ± 0.1) W/kg to (1.1 ± 0.1) W/kg, PMA with (78.4 ± 2.2)% to (84.5 ± 2,5)%, dyspnea score on the Borg scale after loading from (2.1 ± 0.4) points to (2.0 ± 0.2) points. In patients of group II at the beginning of the observation, the volume of forced exhalation for 1 second was 65.5%, the compressed vital capacity of the lungs was 71.3%, the peak expiratory rate 78.4%, the ratio of forced exhalation volume for 1 second to the forced vital capacity lungs 79.3%. In the II – nd group of patients with bronchial asthma, the remission of the disease also showed a decrease in physical activity. When performing the maximum physical activity, due to chronic bronchospasm, the flow of oxygen to working muscles is reduced, than in healthy ones. This is confirmed by the lowered ergospirometric parameters that characterize the activity of the respiratory system: $V'O_2$/kg to (70,3 ± 2,1)%, $V'O_2$ to (78,4 ± 2,2)%, $V'O_2p$ to (73, 9 ± 1.8)%, $V'O_{2max}$ to (78.7 ± 5.5)%, was accompanied by an increase in RER to (1.00 ± 0.1)%. Also, changes in the adaptive capacity for physical activity of the cardiovascular system were observed: the amount of oxygen transferred by the heart when performing the maximum physical activity was low due to limiting its flow due to obstructive changes in the respiratory system, and therefore the amount of oxygen consumed for performing the work was lowered: dHR / dO_2 to (77.5 ± 4.5)%, HR/VO_2 to (6.3 ± 1.8) bp/ml/kg, HR to (128.1 ± 5.5) min. and (83.6 ± 5.2)%, VO_2/HR to (73.8 ± 3.3)%. Accordingly, exercise tolerance, the level of exercise and physical activity in patients were reduced: W to (68,9 ± 4,4)% and (0,8 ± 0,2) W / kg (93,8 ± 5,5) Wat, dO_2 / dW to (6.3 ± 1.8) ml/min/W,

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Table 1

Indices of cardio respiratory loading test in patients with BA and group with the course of disease of average severity, (M ± m)

Indices	Healthy	I group of patients		
		before treatment	immediately after treatment	after 3 months treatment
	(n=15)	(n=15)		
Duration of the 3rd phase of the test (min.)	12,92 ± 3,2	6,2 ± 2,1#	8,5 ± 2,5#	8,3 ± 2,2#
$V'O_2$/kg (мл/хв/кг)	7,7 ± 1,1	5,7 ± 1,1#	4,1 ± 1,4#	3,2 ± 1,5#
$V'O_2$/kg (%)	82,3 ± 5,6	74,8 ± 2,1#	77,5 ± 2,5#	78,5 ± 2,4#
$V'O_2$ (%)	102,3 ± 5,6	83,8 ± 3,1#	91,6 ± 2,8#	89,5 ± 2,0#
$V'O_{2p}$ (%)	94,3 ± 8,9	79,4 ± 3,2#	78,5 ± 2,2#	79,7 ± 2,5#
$V'O_{2max}$ (%)	99,3 ± 10,3	89,1 ± 2,1#	91,5 ± 2,5#	92,5 ± 2,4#
RER (в.о)	0,95 ± 0,1	1,01 ± 0,1	1,04 ± 0,1	1,02 ± 0,1
AT (% від $V'O_{2max}$)	65,3 ± 4,3	49,1 ± 3,2	52,3 ± 3,4	55,3 ± 3,1
W (%)	92,9 ±3,5	68,4 ± 3,2#	72,5 ± 3,8#	73,2 ± 3,3#
W (Вт/кг)	2,9 ± 1,1	0,9 ± 0,1#	1,1 ± 0,2#	1,0 ± 0,2#
W (Bt)	185,0 ± 6,3	97,4 ± 5,1#	112,3 ± 6,8#	115,3 ± 8,1#
dO_2/dW (мл/хв/Вт)	11,42 ± 1,3	7,3 ± 1,5#	7,9 ± 1,5#	8,1 ± 1,7#
dHR/dO_2(уд/хв/мл)	78,6 ± 4,5	76,4 ± 6,2	80,5 ± 3,3	79,5 ± 4,5
HR/VO_2(уд/мл/кг)	2,7 ± 1,6	7,5 ± 3,3#	5,8 ± 2,2#	5,1 ± 1,8#
HR (уд/хв)	112,5 ±8,6	125,8 ± 6,6#	120,8 ± 5,5#	117,5 ± 4,7#
HR, (%)	93,5 ± 9,2	84,1 ± 5,2#	87,8 ± 3,5	88,7 ± 2,8
VO_2/HR (уд/мл/кг)	10,2 ± 2,6	6,8 ± 2,5#	7,2 ± 2,9	7,9 ± 2,1
VO_2/HR, (%)	88,6 ± 9,6	73,5 ± 5,1#	75,5 ± 4,5#	76,8 ± 4,4#
SpO_2 (%)	98,6 ± 8,2	82,8 ± 6,6	82,9 ± 7,4	88,9 ± 6,2
MET (ккал/кг)	8,4 ± 1,6	4,2 ± 1,2#	5,8 ± 1,6#	6,2 ± 1,8#
RW (Вт/кг)	1,2 ± 0,1	0,9 ± 0,1	1,0 ± 0,2	1,1 ± 0,1
PMA (%)	89,3 ± 6,2	78,4 ± 2,2#	83,3 ± 2,3	84,5 ± 2,5
BR (%)	92,3± 4,2	73,9± 3,5	75,3 ± 3,2	78,3 ± 4,2
Assessment of shortness of breath on the Borg scale to the load (points)	0	0 ± 0,0	0 ± 0,0	0 ± 0,0
Assessment of shortness of breath on the Borg scale after loading (points)	0–1	2,1 ± 0,4#	2,2 ± 0,3#	2,0 ± 0,2#

Note. # – statistically significant difference with a group of healthy individuals (p <0.05).

BR – (72.7 ± 2.5)%, RW – (0.6 ± 0.1) W/kg, PMA – (74,7 ± 4,4)%, assessment of shortness of breath on the Borg scale to the load – (0 ± 0,0) points, after loading – (3,9 ± 0,2) points (see table 2).

After a course of treatment with ethyl methylhydroxypyridine succinate in patients with this group, there were no significant changes in spirographic parameters. Namely, the volume of forced exhalation in 1 second made up 69.5%, the compressed vital capacity of the lungs was 75.7%, the peak expiratory rate was 82.6%, the ratio of forced exhalation for 1 second to the forced lumen of life 88.3%. Veloergospirometric indices showed a significant improvement compared to the start of treatment. Namely: indicators characterizing the work of the respiratory system: $V'O_2$/kg with (70,3 ± 2,1)% to (93,5 ± 3,2)%, $V'O_2$ with (78,4 ± 2,2)% to (97.3 ± 2.5)%, $V'O_{2p}$ with (73.9 ± 1.8)% to (84.8 ± 2.5)%, $V'O_{2max}$ with (78.7 ± 5.5)% to (93.8 ± 3.8)%.

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There was a significant improvement in the following indicators characterizing the work of the cardiovascular system: HR/VO_2 with (6.3 ± 1.8) bs/ml/kg to (3.9 ± 1.2) bs/ml/ kg, VO_2/HR with (73.8 ± 3.3)% to (89.3 ± 3.2)%. Also, there was an improvement in the indicators of exercise tolerance: W from (68,9 ± 4,4)% to (93,8 ± 3,3)%, from (0,8 ± 0,2) W/kg to (1,4 ± 0,1) w/kg, with (93,8 ± 5,5) watts up to (140,6 ± 5,8) watts, dO_2/dW with (6,3 ± 1,8) ml/min/W to (9.9 ± 1.8) ml/min/wt, BR with (72.7 ± 2.5)% to (78.4 ± 2.2)%, RW with (0.6 ± 0,1) W/kg to (1,2 ± 0,2) W/kg, PMA with (74,7 ± 4,4)% to (89,7 ± 5,6)%, score of dyspnea on the scale Borg to loading – (0 ± 0,0) points, after loading – (3,9 ± 0,2) points, after treatment to the load – (0 ± 0,0) points, after loading – (2,5 ± 0,2) points. Three months after the application of ethylmethylhydroxypyridine succinate against the background of the baseline therapy of the remission period, the spirometric parameters were

Table 2

Indices of cardio respiratory loading test in patients with BA II group with the course of disease of average severity, (M ± m)

Indexes	Healthy	II group of patients		
		before treatment	immediately after treatment	after 3 months treatment
	(n=15)	(n=15)		
Duration of the 3rd phase of the test (min.)	12,92 ± 3,2	6,1 ± 2,1#	9,3 ± 2,2*	9,1 ± 2,4*
V'O_2/kg(мл/хв/кг)	7,7 ± 1,1	5,3 ± 1,3#	8,4± 1,5*	8,3 ± 1,6*
V'O_2/kg (%),	82,3 ± 5,6	70,3 ± 2,1#	93,5 ± 3,2*	94,5 ± 2,5*
V'O_2 (%)	102,3 ± 5,6	78,4 ± 2,2#	97,3 ± 2,5*	92,8 ± 2,5*
V'O_{2p} (%)	94,3 ± 8,9	73,9 ± 1,8#	84,8 ± 2,5*	88,7 ± 2,2*
V'O_{2max} (%)	99,3 ± 10,3	78,7 ± 5,5#	93,8 ± 3,8*	92,9 ± 3,3*
RER (%)	0,95 ± 0,1	1,00 ± 0,1	1,02 ± 0,1	1,03 ± 0,1
AT (% від V'O_{2max})	65,3 ± 4,3	43,5 ± 1,8	47,9 ± 1,6	47,8 ± 1,9
W (%)	92,9 ±3,5	68,9 ± 4,4#	93,8 ± 3,3*	91,9 ± 2,5*
W (Вт/кг)	2,9 ± 1,1	0,8 ± 0,2#	1,4 ± 0,1#*	1,6 ± 0,1#*
W (Bt)	185,0 ± 6,3	93,8 ± 5,5#	140,6 ± 5,8*	149,3 ± 5,4*
dO_2/dW (мл/хв/Вт)	11,42 ± 1,3	6,3 ± 1,8#	9,9 ± 1,8*	10,8 ± 2,1*
HR/VO_2 (уд/мл/кг)	2,7 ± 1,6	6,3 ± 1,8#	3,9 ± 1,2#*	4,5 ± 1,2#*
VO_2/HR (%)	88,6 ± 9,6	73,8 ± 3,3#	89,3 ± 3,2*	83,2 ± 2,9*
dHR/dO_2(уд/хв/мл)	78,6 ± 4,5	77,5 ± 4,5	73,5 ± 3,2	77,6 ± 3,2
HR (уд/хв)	112,5 ±8,6	128,1 ± 5,5#	120,8 ± 5,5#	120,3 ± 3,2#
HR, (%)	93,5 ± 9,2	83,6 ± 5,2#	83,9 ± 2,5	85,3 ± 3,2
BR (%)	92,3± 4,2	72,7± 2,5#	78,4 ± 2,2#	81,3 ± 3,2*
SpO_2 (%)	98,6 ± 8,2	91,3 ± 5,5	92,9 ± 3,9	97,2 ± 3,8
MET (ккал/кг)	8,4 ± 1,6	4,1 ± 1,7#	7,9 ± 1,5*	8,5 ± 1,5*
RW (Вт/кг)	1,2 ± 0,1	0,6 ± 0,1	1,2 ± 0,2	1,2 ± 0,1
PMA (%)	89,3 ± 6,2	74,7 ± 4,4#	89,7 ± 5,6*	89,7 ± 6,4
Assessment of shortness of breath on the Borg scale to the load (points)	0	0 ± 0,0	0 ± 0,0	0 ± 0,0
Assessment of shortness of breath on the Borg scale after loading (points)	0–1	3,9 ± 0,2#	2,5 ± 0,2#	1,5 ± 0,3*

Notes:
1. # – is a statistically significant difference with a group of healthy individuals (p <0.05);
2. * – a statistically significant difference compared with the beginning of treatment (p <0,05).

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Table 3

Indices of cardio respiratory loading test in patients with asthma I and II with a course of disease of moderate severity, (M ± m)

Indexes	Healthy	I group – patients with asthma after treatment	II group – patients with asthma immediately after treatment
	(n=15)	(n=15)	(n=15)
Duration of the 3rd phase of the test (min.)	12,92 ± 3,2	8,5 ± 2,5#	9,3 ± 2,2#
V'O_2/kg, (мл/хв/кг)	7,7 ± 1,1	4,1 ± 1,4	8,4± 1,5*#
V'O_2/kg, (мл/хв./кг),%	82,3 ± 5,6	77,5 ± 2,5#	93,5 ± 3,2*#
V'O_2, (%)	102,3 ± 5,6	91,6 ± 2,8#	97,3 ± 2,5#
V'O_{2p}, (%)	94,3 ± 8,9	79,4 ± 3,2#	84,8 ± 2,5#
V'O_{2max}, (%)	99,3 ± 10,3	89,1 ± 2,1#	93,8 ± 3,8#
RER (%)	0,95 ± 0,1	1,01 ± 0,1	1,02 ± 0,1
AT (% від V'O_{2max})	65,3 ± 4,3	49,1 ± 3,2#	47,9 ± 1,6
W (%)	92,9 ±3,5	68,4 ± 3,2#	93,8 ± 3,3*#
W (Вт/кг)	2,9 ± 1,1	0,9 ± 0,1#	1,4 ± 0,1#*
W (Bt)	185,0 ± 6,3	97,4 ± 5,1#	140,6 ± 5,8*#
dO_2/dW (мл/хв/Вт)	11,42 ± 1,3	7,3 ± 1,5#	9,9 ± 1,8*#
dHR/dO_2 (уд/хв/мл)	78,6 ± 4,5	76,4 ± 6,2	73,5 ± 3,2
HR/VO_2 (bps/мл/кг)	2,7 ± 1,6	7,5 ± 3,3#	3,9 ± 1,2#*
VO_2/HR (%)	88,6 ± 9,6	84,1 ± 5,2	89,3 ± 3,2
HR/Vkg (уд/мл/кг)	9,2 ± 3,8	6,8 ± 2,5	3,9 ± 1,2#*
SpO_2, (%)	98,6 ± 8,2	82,8 ± 6,6	92,9 ± 3,9
BR (%)	92,3± 4,2	75,3 ± 3,2	78,4 ± 2,2
MET (ккал/кг)	8,4 ± 1,6	4,2 ± 1,2#	7,9 ± 1,5*
RW (Вт/кг)	1,2 ± 0,1	0,9 ± 0,1	1,2 ± 0,2
PMA (%)	89,3 ± 6,2	78,4 ± 2,2	89,7 ± 5,6*
Assessment of shortness of breath on the Borg scale to the load (points)	0 ± 0,0	0 ± 0,0	0 ± 0,0
Assessment of shortness of breath on the Borg scale after loading (points)	0–1	2,2 ± 0,3	2,5 ± 0,2

Notes:
1. * – a statistically significant difference between the groups immediately after the treatment (p <0,05); 2. # – statistically significant difference with the group of healthy (p <0,05).

not significantly changed: the volume of forced exhalation in 1 second was 72.5%, the compressed vital capacity of the lungs was 76.7%, the peak expiration rate was 83.2%, the ratio of the volume of forced exhalation for 1 second to the forced vital capacity of the lungs is 87.5%. In cycling-respirometer characteristics, a significant difference was observed compared with the start of treatment, in the following indices: Duration of the 3– rd phase of the test with (6.1 ± 2.1) min. to (9.1 ± 2.4) min, V'O_2/kg with (70.3 ± 2.1)% to (94.5 ± 2.5)%, V'O_2 with (78.4 ± 2,2)% to (92,8 ± 2,5)%, V'O_{2p} with (73,9 ± 1,8)% to (88,7 ± 2,2)%, V'O_{2max} with (78, 7 ± 5.5)% to (92.9 ± 3.3)%. There was a significant difference compared with the beginning of treatment and in the indicators characterizing the cardiovascular system: HR/VO_2 with (6,3 ± 1,8) bs/ml/ kg up (4,5 ± 1,2) bs/ml /kg, VO_2/HR with (73,8 ± 3,3)% to (83,2 ± 2,9)%, MET with (4,1 ± 1,7) kcal / kg to (8,5 ± 1,5) kcal/kg. Also, a significant difference was observed in comparison with the beginning of treatment and in the indicators of the performed work: W from (68,9 ± 4,4)% to (91,9 ± 2,5)%, dO_2/dW from (6,3 ± 1, 8) ml/min / W to (10.8 ± 2.1) ml/min/W. In the remaining indicators of cardio respiratory testing, the positive tendency

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Table 4

Indices of cardio respiratory loading test in patients with asthma and group II with the course of disease of average severity, (M ± m)

Indexes	Healthy	I group – patients with asthma after treatment	II group – patients with asthma immediately after treatment
	(n=15)	(n=15)	(n=15)
Duration of the 3rd phase of the test (min.)	12,92 ± 3,2	8,3 ± 2,2#	9,1 ± 2,4#
$V'O_2$/kg (мл/хв/кг)	7,7 ± 1,1	3,2 ± 1,5#	8,3 ± 1,6*
$V'O_2$/kg (мл/хв/кг),%	82,3 ± 5,6	78,5 ± 2,4#	94,5 ± 2,5*
$V'O_2$ (%)	102,3 ± 5,6	89,5 ± 2,0#	92,8 ± 2,5*
$V'O_{2p}$ (%)	94,3 ± 8,9	79,7 ± 2,5#	88,7 ± 2,2*
$V'O_{2max}$, (%)	99,3 ± 10,3	92,5 ± 2,4#	92,9 ± 3,3
RER	0,95 ± 0,1	1,02 ± 0,1	1,03 ± 0,1
AT (%)	49,65 ± 4,3	55,3 ± 3,1#	47,8 ± 1,9
W (%)	92,9 ±3,5	73,2 ± 3,3#	91,9 ± 2,5*
W (Вт/кг)	2,9 ± 1,1	1,0 ± 0,2#	1,6 ± 0,1#*
W (Bt)	185,0 ± 6,3	115,3 ± 8,1#	149,3 ± 5,4*#
dO_2/dW (мл/хв./Вт)	11,42 ± 1,3	8,1 ± 1,7#	10,8 ± 2,1
dHR/dO_2 (уд/хв./мл)	78,6 ± 4,5	79,5 ± 4,5	77,6 ± 3,2
HR/VO_2 (уд/мл/кг)	2,7 ± 1,6	5,1 ± 1,8#	4,5 ± 1,2#*
VO_2/HR (%)	88,6 ± 9,6	76,8 ± 4,4#	83,2 ± 2,9
BR (%)	92,3± 4,2	78,3 ± 4,2#	81,3 ± 3,2*
MET (ккал/кг)	8,4 ± 1,6	6,2 ± 1,8#	8,5 ± 1,5
RW (Вт/кг)	1,2 ± 0,1	1,1 ± 0,1#	1,2 ± 0,1
PMA (%)	89,3 ± 6,2	84,5 ± 2,5	89,7 ± 6,4
Assessment of shortness of breath on the Borg scale to the load (points)	0 ± 0,0	0 ± 0,0	0 ± 0,0
Assessment of shortness of breath on the Borg scale after loading (points)	0–1	2,0 ± 0,2	1,5 ± 0,3

Notes:
1. * – a statistically significant difference between the groups immediately after the treatment (p <0,05); 2. # – statistically significant difference with the group of healthy (p <0,05).

toward normalization, as compared with the beginning of treatment, was maintained.

When comparing the indices of both groups, after the application of different treatment regimens, a significant difference was found in the evaluated metrics. Namely: there was a significant difference in the performance indicators of the pulmonary system: $V'O_2$/kg, $V'O_2$, W, dO_2/dW, HR/VO_2, MET, PMA (see table 3).

After 3 months of observation, the reliability in the evaluated metrics between the groups was virtually unchanged. Namely: the volume of forced exhalation for 1 second was 71.5%, the compressed vital capacity of the lungs was 79.7%, peak exhalation rate 82.2%, the ratio of forced exhalation for 1 second to forced vital capacity of the lungs 84.6%.

In bicycle-gospomerometric indices, a significant difference was observed in the performance of the pulmonary system: $V'O_2$ / kg, $V'O_2$, $V'O_{2p}$, W, dO_2 / dW, HR / VO_2, – (see table 4).

Thus, the use of ethyl methylhydroxypyridine succinate against background therapy of the remission period in patients with bronchial asthma in order to restore physical activity allows: to increase cardiorespiratory endurance and metabolic cost of the work performed, improve the level of performed load, the efficiency of oxygen consumption due to the growth of oxygen pulse, increase the oxygen value of the performed work, to reduce hyperventilation, which gives grounds to recommend ethylmethylhydroxypyridine succinate for complex therapy rick with this pathology.

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