

ANALYSIS OF THE EFFECTIVENESS OF PHYSICAL REHABILITATION ACCORDING SPIROGRAPHIC INDICATORS IN COMMUNITY-ACQUIRED PNEUMONIA DURING CONVALESCENCE

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Annotation. *Purpose:* to make a program of physical rehabilitation for convalescents after community-acquired pneumonia, promotes normalization of respiratory function. The objectives of the study was to evaluate the dynamics spirographic indicators during convalescence community-acquired pneumonia. *Material:* the study involved 28 women aged 19 to 24 years with a diagnosis of community-acquired pneumonia after convalescent. *Results:* the positive influence of physiotherapy based dance aerobics; morning hygienic gymnastics; therapeutic massage and physical therapy on indicators of lung volumes, ventilation and bronchial patency according spirographic research. *Conclusion:* in community-acquired pneumonia during the convalescence period recommended physical rehabilitation, which includes curative gymnastics based on dance aerobics, morning hygienic gymnastics, massage therapy, physiotherapy. It improves the functionality of the cardiorespiratory system, nonspecific immunity and overall physical performance level.

Keywords: physical rehabilitation, community acquired pneumonia, spirographic indicators.

Introduction

Pneumonia is a pluricausal epicenter of lungs' disease with involving of respiratory systems and compulsory presence of internal alveolar inflammation excudation in pathological process [2, 3, 4, 12, 16, 19, 20]. Morbidity for pneumonia among adult population of developed countries is 3-16% a years; with it by estimation of specialists, approximately 60% of cases remain not diagnosed [5, 6, 7]. In connection with existing situation, in 2001 American and Canadian thoracic society as well as Centers of control and prophylaxis of morbidity in USA offered new recommendations on diagnostics and antibiotic therapy of pneumonia [15, 17]. But only with the help of antibiotic therapy it is impossible to quickly liquidate inflammation process in lungs, unfavorable progressing of pneumonia and complications after it. For complete rehabilitation of respiratory organs' morphological structure and functions, activation of cardio-vascular and other organism's systems, adaptation to physical loads it is compulsory to apply means of physical rehabilitation in recovery period. But among great number of scientific works, devoted to physical rehabilitation with pneumonia we could not find commonly accepted methodic of therapeutic gymnastic and therapeutic massage. The existing methodic do not consider functional condition of respiratory and vegetative nervous systems as well as tolerance of patients' cardio-vascular system to physical loads. There are contradictory data concerning application of methodic of control and regulation of physical loads in respect to general status of recovery after pneumonia, i.e. there is no optimal pedagogic control in the process of therapeutic gymnastic [9, 11, 13].

Thus, all above mentioned condition demand in working out and evaluation of physical rehabilitation's program, which would facilitate recreation of functional condition of respiratory system and increasing of physical workability in process of recovery after pneumonia.

The work has been fulfilled as per priority direction, in compliance with Law of Ukraine "On Priority directions of science and engineering's development", number 3.5. "Sciences about life, new technologies of prophylaxis and treatment of most frequent diseases" within topic of priority 3.5.29 "Forming of standards and technologies of healthy life style, technology of increasing of food's quality and safety implementation".

Purpose, tasks of the work, material and methods

The purpose of the research: to produce program of physical rehabilitation for recovering persons after not hospital pneumonia, which would facilitate normalizing of indicators of external breathing.

The tasks of the research were evaluation of dynamic of spirometry's indicators during recovery after not hospital pneumonia.

The methods of the research: we carried out the research from September 2013 up to March 2014 on the base of Kharkiv municipal student's hospital. Clinic-functional examinations of 28 women of age from 19 to 24 years old, who recovered after not hospital pneumonia, were the base of our researches. All participants were divided in two groups: main group 2 14 persons (mean age 2-11 years old) and control group – 14 persons (mean age – 20.15 years old).

Function of external breathing was researched with the help of spirometry's data (we determined breathing volume (BV), vital capacity of lungs (VCL), frequency of breathing (FB), minute volume of breathing (MVB), maximal ventilation of lungs (MVL), forced vital capacity of lungs (forced VCL) and maximal volume speed of breathing at inhale and exhale (V_{inh} , V_{exh})) and with the help of hypoxic tests: Tests of Stange and Genchy [10]. In the researches we used instrumental-programmed complex SPIROCOM (made in National sero-space university "KhAI" and STC of radio-electronic medical devices and technologies "KhAI-MEDICA", Kharkiv).

Results of the research

Primary examination of recovering patients after not hospital pneumonia was carried out during 2-4 days after their discharging from hospital. Primary spirographic examination showed that the passed infiltrated processes in lungs of the examined patients resulted in reducing of some external breathing's indicators. As we can see in table 1 both patients of main and control groups had reduced indicators of lung volumes and lung ventilation (MVL, B, FB, V_{inh} , V_{exh} .)

Increasing of FB in both groups has compensating character in connection with progress of pathological process in lungs and decreasing of functioning lung tissue. Indicators VCL and BV of both groups' women were within normal values, but at lower limit of norm that can result from low physical condition or pathological infiltrating process in lungs. Increasing of MVB up to 6.30 ± 0.16 l/min in main group and up 6.28 ± 0.05 l/min. in control group is connected with mobilization of compensatory mechanisms (hyper-ventilation is physiological defense against hypoxia), resulted from pathological process in lungs.

Table 1

Spirographic indicators of main and control groups' patients received at primary examination ($M \pm m$)

Indicators	Norm	Groups		t	p
		Main group, n=14	Control group, n=14		
Breathing frequency (BF) inh/exh p.min.	6-18	18.64 ± 0.29	18.71 ± 0.22	0.20	>0.05
Vital capacity of lungs (VCL), l	2.50-4.00	2.66 ± 0.05	2.59 ± 0.05	0.93	>0.05
Forced VCL, l	2.20-3.70	2.42 ± 0.07	2.42 ± 0.06	0.02	>0.05
Maximal ventilation of lungs (MVL), l/min	50-70	60.99 ± 1.28	60.43 ± 1.16	0.32	>0.05
Minute volume of breathing (MVB), l/min.	3.50-5.00	6.30 ± 0.16	6.28 ± 0.05	0.11	>0.05
Breathing volume (BV), ml	300-900	336.43 ± 6.08	347.71 ± 3.15	1.65	>0.05
Speed of inhale (V_{inh}), l/sec.	35-5.0	3.01 ± 0.07	2.94 ± 0.02	0.96	>0.05
Speed of exhale (V_{exh}) l/sec.	33-4.2	2.88 ± 0.02	2.84 ± 0.03	1.18	>0.05

Low indicators of volume speed of forced inhale and exhale (3.01 ± 0.07 l/sec in MG and 2.94 ± 0.02 l/sec. in CG)) are after effects of reducing of breathing muscles' potentials of recovering patients after pneumonia. Indicators of forced VCL and MVL in main and control groups was within norm that witness about absence of disorders in nervous regulation of external breathing's function, worsening of bronchial permeability, decreasing of lung tissue's elasticity and reducing of respiratory system's energetic potential.

Researching indicators of hypoxic tests we came to conclusion that they were reduced owing to progressing of recovering patients' asthenic-vegetative syndrome after pneumonia: time of pause after inhale in main group was 16.79 ± 0.22 sec. and 16.50 ± 0.25 sec. in control group ($p > 0.05$). Pause after exhale in main group was 14.37 ± 0.23 sec. and in control – 14.44 ± 0.18 sec. ($p > 0.05$).

For increasing of cardio-respiratory system's functional condition, strengthening of breathing muscles, increasing of chest and diaphragm's excursion, increasing of vital capacity of lungs, normalization of breathing and ventilation of lungs, increasing of non specific immunity, improvement of psycho-emotional status of patient and rising of general physical workability's level, in main group we applied program of physical rehabilitation, which included therapeutic gymnastic on the base of dance aerobic; morning hygienic exercises; therapeutic massage by P.B. Yefimenko's methodic (2013) [8]; sauna therapy for training of temperature regulating, adaptation mechanisms.

Physical load in attenuated, attenuating-training and training motion modes was dozed by complexity of movements, quantity of repetitions, amplitude, speed of fulfillment.

In attenuated motion mode we used general developing exercises for all muscular groups in combination with exercises for strength and flexibility in order to prepare muscular-ligament system and cardio-vascular system for higher physical loads; exercises for vestibular system; for balance; exercises with ball and gymnastic rod with not full and then with full amplitude with moderate speed, from initial positions "standing", "walking", "sitting on floor" on base of aerobic. Quantity of repetitions of every exercise was 10-14 times. Muscles of girdle and torso were accentuated.

After 0.5 month, with sufficient increasing of general physical workability, patients started to train in *attenuating-training mode*.

In attenuating-training mode we used exercises for upper limbs and girdle, neck, torso with elements of aerobic, with full amplitude, at moderate speed and quantity of repetitions – 8-16 times; exercises for coordination and for improvement of vestibular system; dozed breathing exercises in walking, considering activity of vegetative nervous system; pauses for rest and relaxation exercises; run, jumps and hops.

In training mode we used exercises for upper limbs and girdle's muscles, for neck and torsi with element of aerobic and with full amplitude at moderate and quick speed, with quantity of repetitions 12-16-30 times; exercises for coordination and vestibular system; dozed breathing exercises in walking, considering activity of vegetative nervous system; pauses for rest and relaxation exercises. All physical exercises were fulfilled from initial positions "sitting on floor" and "standing". When composing complexes of TPC we accentuated combining of different, earlier mastered exercises in choreographic compositions; change of temp, rhythm, direction and amplitude of movements.

With aerobic training in attenuated and attenuating-training modes we used rhythmic music of "foxtrot", "Charleston", "tango", Latin-American rhythms ("cha-cha-cha", "samba", "rumba"); in training mode we applied quicker music in "disco", "rock-n-roll", "brake-dance" style [14].

In control group patients practiced therapeutic physical culture by methodic of S.M. Popov (2005, 2008) [9, 13], they passed turpentine bath therapy; mineral wax applications on inter blade area and therapeutic massage by methodic of A.A. Biriukov (2004) [1].

Repeated examination of recovering patients was carried out after application of physical rehabilitation programs during two months. Testing of external breathing's function showed improvement of spiographic indicators in main and control groups, which resulted from application of physical rehabilitation means (see table 2). For example in main group FB reduced from 18.64 ± 0.29 to 9.86 ± 0.29 inh/exh/p.min., in control group from 18.71 ± 0.22 to 12.43 ± 0.34 inh/exh/p.min., that witness about reducing of asthenic-vegetative syndrome and about improvement of respiratory system's condition ($p < 0.001$). Application of complex physical rehabilitation program resulted in statistically significant increasing of VCL in main group by 24.4% (in control – by 17.8%) and increasing of BV from 336.43 ± 6.08 to 480.29 ± 11.28 ml in MG (in CG - from 347.71 ± 3.15 to 437.57 ± 8.17 ml) that is after effect of increasing of lung tissue's elasticity and reducing of chest's rigidity.

Table 2

Spiographic indicators of main and control groups' patients received at repeated examination ($M \pm m$)

Indicators	Norm	Primary examination	Repeated examination	t	p
1	2	3	4	5	6
Main group, n=14					
Frequency of breathing (FB), inh/exh/p.min	6-18	18.64 ± 0.29	9.86 ± 0.29	21.31	<0.001
Vital capacity of lungs (VCL) l	2.50-4.00	2.66 ± 0.05	3.31 ± 0.04	10.1	<0.001
Forced VCL, l	2.20-3.70	2.42 ± 0.07	3.14 ± 0.07	7.03	<0.001
Maximal ventilation of lungs (MVL), l/min	50-70	60.99 ± 1.28	64.83 ± 0.86	2.50	<0.05
Minute volume of breathing (MVB), l/min.	3.50-5.00	6.30 ± 0.16	4.40 ± 0.10	10.33	<0.001
Breathing volume (BV), ml	300-900	336.43 ± 6.08	480.29 ± 11.28	11.23	<0.001
Speed of inhale (Vinh.), l/sec.	3.5-5.0	3.01 ± 0.07	4.34 ± 0.08	12.61	<0.001
Speed of exhale (Vexh.) l/sec.	3.3-4.2	2.88 ± 0.02	3.72 ± 0.06	12.49	<0.001
Control group, n=14					
Frequency of breathing (FB), inh/exh/p.min	6-18	18.71 ± 0.22	12.43 ± 0.34	15.41	<0.001
Vital capacity of lungs (VCL) l	2.50-4.00	2.59 ± 0.05	3.05 ± 0.06	5.59	<0.05
Forced VCL, l	2.20-3.70	2.42 ± 0.06	2.88 ± 0.06	5.92	<0.05
Maximal ventilation of lungs (MVL), l/min	50-70	60.43 ± 1.16	61.31 ± 1.11	0.55	>0.05
Minute volume of breathing (MVB), l/min.	3.50-5.00	6.28 ± 0.05	5.08 ± 0.09	12.12	<0.001
Breathing volume (BV), ml	300-900	347.71 ± 3.15	437.57 ± 8.17	10.26	<0.001
Speed of inhale (Vinh.), l/sec.	3.5-5.0	2.94 ± 0.02	3.50 ± 0.04	12.23	<0.001
Speed of exhale (Vexh.) l/sec.	3.3-4.2	2.84 ± 0.03	3.41 ± 0.04	12.92	<0.001

After application of physical rehabilitation means forced VCL of recovering after pneumonia patients increased in MG from 2.42 ± 0.07 to 3.14 ± 0.07 l ($p < 0.001$) and in CG – from 2.42 ± 0.06 to 2.88 ± 0.06 l ($p < 0.05$) as a result of air resistance decreasing in thin bronchi. Increasing of MVL up to 64.83 ± 0.86 l/min in main group and up to

61.31±1.11 l/min. in control groups ($p<0.05$) witnesses about improvement of external breathing's functional and energetic potentials, its nervous regulation and lungs tissues' elasticity.

MVB statistically significantly reduced in main group from 6.30±0.16 to 4.40±0.10 l/min, in control group from 6.28±0.05 to 5.08±0.09 l/min. Owing to reduction of hyperventilation, which is a physiological defense against hypoxia with pneumonia.

In both groups we registered statistically significant increasing of volume speed of forced inhale and exhale as a result of respiratory tracts permeability's improvement and increasing of breathing muscles' potential.

When comparing repeated indicators of external breathing's function in MG and CG we determined statistically significant improvement in main group that witness about effectiveness of complex physical rehabilitation in its influencing on respiratory system's functional condition (see table 3).

Table 3

Spirographic indicators of main and control groups' patients, received at repeated examination (M±m)

Indicators	Norm	Groups		t	p
		MG, n=14	CG, n=14		
Frequency of breathing (FB), inh/exh/p.min	6-18	9.86±0.29	12.43±0.34	5.69	<0.05
Vital capacity of lungs (VCL) l	2.50-4.00	3.31±0.04	3.05±0.06	3.55	<0.05
Forced VCL, l	2.20-3.70	3.14±0.07	2.88±0.06	2.70	<0.05
Maximal ventilation of lungs (MVL), l/min	50-70	64.83±0.86	61.31±1.11	2.51	<0.05
Minute volume of breathing (MVB), l/min.	3.50-5.00	4.40±0.10	5.08±0.09	5.20	<0.05
Breathing volume (BV), ml	300-900	480.29±11.28	437.57±8.17	3.07	<0.05
Speed of inhale (Vinh.), l/sec.	3.5-5.0	4.34±0.08	3.50±0.04	9.72	<0.001
Speed of exhale (Vexh.) l/sec.	3.3-4.2	3.72±0.06	3.41±0.04	4.24	<0.05

Repeated hypoxic tests resulted in determination of statistically significant increasing of pause period after inhale/exhale in main group. In control group dynamic of these indicators was insignificant. Besides, in main group results of Shtage's test were "satisfactory" and results of Genchy's test – "good". Comparing indicators of hypoxic tests of MG and CG after repeated examination we came to conclusion that in main group inhale/exhale pause was longer than in control group ($p<0.001$).

Conclusions:

For improvement of cardio-vascular system's potentials, strengthening of breathing muscles, increasing of chest and diaphragm's excursion, normalization of breathing process and lungs' ventilation, increasing of non specific immunity, improvement of psycho-emotional status and general physical workability in recovery period after not hospital pneumonia it is recommended to apply physical rehabilitation program, which included therapeutic gymnastic on base of dance aerobic; morning hygienic exercises; therapeutic massage by P.B. Yefimenko's methodic (2013); sauna therapy.

The prospects of further researches imply analysis of dynamic of cardio-vascular system's response to physical load in process of physical rehabilitation of recovering patients after not hospital pneumonia.

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