

связано с более поздним возрастом возникновения СД 2 типа и длительным латентным не диагностированным течением СД 2 типа, которое поражает периферические нервные волокна еще до момента выявления СД.

4. При СД 1 сенсорная ДПНП наблюдается у 47% больных, моторная у 33%, сенсорно-моторная у 20%.

5. При СД 2 сенсорная ДПНП наблюдается у 27% больных, моторная у 9%, сенсорно-моторная у 64%.

6. При СД 1 у 67% больных выявлен демиелинизирующий тип поражения нервных волокон, у 33%- смешанный.

7. При СД 2 у 64% больных выявлен демиелинизирующий тип поражения нервных волокон, у 36%- смешанный.

УДК 616-053.2.

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HIGH-FREQUENCY CHEST WALL OSCILLATION MODES IN THE TREATMENT OF CHILDREN SUFFERING FROM THE COMMUNITY-ACQUIRED PNEUMONIA

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РЕЖИМИ ВИСОКОЧАСТОТНОЇ ОСЦИЛЯЦІЇ ГРУДНОЇ КЛІТКИ ДЛЯ ДІТЕЙ З ПОЗАЛІКАРНЯНОЮ ПНЕВМОНІЄЮ

Abstract.

New possibilities for improvement of airway clearance are associated with the use of a modern method of drainage of the bronchial tree – high-frequency chest wall oscillation (HFCWO), the mechanism of action of which is based on the parameters of oscillation. These parameters form oscillation modes that play an important role in the implementation of the HFCWO procedures in the integrated complex therapy (CT) of children with community-acquired pneumonia (CAP). There are modes of HFCWO, which differed due to oscillation parameters - vibration frequency, pressure and duration of the procedure. Six HFCWO modes have been developed based on the above criteria, of which modes 1-3 have been developed for asthenic body children and with reduced BMI.

Резюме.

Нові можливості покращення кліренсу дихальних шляхів пов'язані з використанням сучасного методу дренажу бронхіального дерева – високочастотної осциляції грудної клітки (ВЧОГК), механізм дії якої заснований на параметрах осциляції. Дані параметри формують режими осциляції, які відіграють важливу роль в проведенні процедур ВЧОГК в комплексній терапії дітей з позалікарняною пневмонією (ПП). Застосовано режими ВЧОГК, які відрізнялись між собою за рахунок параметрів осциляції – частота вібрації, тиск впливу та тривалість процедури. Шість режимів ВЧОГК розроблені на основі вище зазначених критеріїв, з яких режими 1-3 розроблені для дітей астеничної тілобудови та зі зниженим ІМТ.

Key words: *high-frequency chest wall oscillation, modes, airway clearance, community-acquired pneumonia, children.*

Ключові слова: *високочастотна осциляція грудної клітки, режими, кліренс дихальних шляхів, позаликарняна пневмонія, діти.*

Diseases of the respiratory system occupy one of the leading places in the diseases of children of all age groups [12]. One of the common forms of respiratory tract affection is pneumonia, which is the leading cause of death worldwide. The urgency of coverage of the problem of community-acquired pneumonia (CAP) among the pediatric population is confirmed by the data of the leading organizations, in particular UNICEF and WHO. According to the UN Children's Fund (UNICEF), nearly 3 million children worldwide die of pneumonia annually, which affects the structure of children mortality [15].

Mucociliary clearance (MCC), as a component of mucociliary transport system (MCTS) and cough reflex protect the respiratory system by improving lung clearance and preventing airway obstruction. Many factors complicate the mobilization and evacuation of excretions from the distal lung divisions to the central respiratory tract, in particular the disturbance of the rheological properties of mucus, abnormal ciliary activity and loss of ciliary cells [10, 13].

The emergence of most clinical manifestations in patients with CAP is associated with the cleansing and barrier dysfunction of MCC due to accumulation of pathological secretion in the respiratory tract. To restore the structures of the MCC, it is necessary to adjust the drainage function of the bronchial glands [2, 13, 10].

Basic medication treatment is not always effective in case of disturbance of the protective mechanism - MCC in children with CAP. Important is the search and development of new therapies that potentiate the process of cleaning the bronchial tree from sputum, in turn restoring the main protective mechanisms of the respiratory tract.

One of these directions is airway clearance therapy (ACT). ACT is designed to facilitate secretion mobilization and expulsion, as well as to facilitate complications associated with secretion delay. ACT uses physical or mechanical means to create oscillatory airflow in the respiratory tract, to mobilize pathological excretions, and to facilitate their evacuation by expectorating [11].

The purpose of ACT is to prevent secretion, which helps to maintain airway patency, increase secretion clearance and maximize gas exchange. Among the large spectrum of ACT for use at present, the theoretical foundations and mechanisms of action vary greatly [8].

There are a large number of different ACT such as active breathing cycle, autogenic drainage, PEP (positive expiratory pressure) systems, vibration PEP system, intrapulmonary percussion ventilation, aimed at restoring the drainage function of the bronchial tree, including the hardware facilities, the mechanism of action of which is aimed at restoring airway clearance, disruption of the ventilation function of the lungs and gas exchange [1].

The bronchial tree drainage method with using high-frequency chest wall oscillation (HFCWO) became widespread [17]. Among the high-tech and modern devices of mechanical influence by the method of high-frequency vibration on the chest "The Vest Airway Clearance System", Hill-Rom Inc. (USA) should be noted (Fig.1).



Fig. 1. The Vest Airway Clearance System, model 105

According to the literature, there was established improvement of airway clearance in the group of patients with cystic fibrosis (CF) [9]. In foreign studies, there was shown the feasibility and efficacy of the use of HFCWO in chronic obstructive pulmonary disease (COPD), bronchiectasis, neurological diseases (cerebral palsy), diseases accompanied by the motor neuronal affection, muscular dystrophy [3, 4, 13, 18].

Oscillation parameters, i.e. frequency of vibration, pressure and duration form the modes of HFCWO, which, in turn, play a major role in the implementation of procedures for HFCWO in the treatment of children with CAP.

Therefore, we consider the selection of the above the indicated values of the parameters of oscillation to be effective, on the basis of which the modes of HFCWO are formed.

It is important to take into account the criteria, in particular the state of the patient, the type of constitution, the body mass index (BMI), the nature and extent of the broncho-pulmonary process affection, and the existing complications for the formation of oscillation modes based on the parameters of HFCWO.

The division of children into groups according to the age was based on the use of the childhood periodization scheme, developed by S.M. Grombach, based on the classification of childhood periods, proposed by the professor M.P. Gundobin following the anatomical, histological and physiological features of the child's body, which make up the key to understanding the originality of diseases in childhood [16].

The course of any disease, its prognosis and treatment depend not only on the nature and strength of the pathogenic agent, but also on the individual characteristics of the organism [7]. The type of constitution and BMI affects children's health, its adaptive capability, predisposition to various diseases, in particular respiratory tract diseases [14].

The purpose of the study: to determine the modes of HFCWO for each age group of children with CAP, depending on the type of constitution.

Material and methods. The study included children aged 6 to 17 years with a confirmed diagnosis of CAP. All children were divided into groups depending on the modes of the HFCWO. These modes were formed on the basis of the following criteria: age, type

of constitution, body mass index. The average number of procedures for HFCWO was 10.

In total, there were 8 modes of HFCWO, which differed from each other by the oscillation parameters - vibration frequency (Hz), pressure (Bar) and duration of the procedure (min). Modes 7 and 8 are described depending on the age of the children and the underlying disease [1] (Tab. 1).

Table 1.

Modes HFCWO

Age groups of children	Modes	Frequency, Hz	Pressure, Bar	Duration, min
4 to 7 years	7	6-9	1-2	10-12
8 to 17 years	8	6-12	2	10-15

*Note. Parameters of oscillations depending on the age of children and the underlying disease.

Six modes of HFCWO were developed on the basis of the above criteria, from which modes 1,3 and 5 were developed for children of the asthenic body structure and with reduced BMI (Tab. 2).

Table 2.

Modes HFCWO

Parameters of oscillation for children of the asthenic type of constitution and with reduced BMI					
Age of the children	Modes	Procedures of oscillation	Frequency, Hz	Pressure, Bar	Duration, min
6 to 7 years	1	The 1st procedure	8	1	5
			7	2	5
		The 2nd procedure	8	1	8
			7	2	7
		The 3rd procedure	9	1	5
			8	2	5
		The following procedures	9	1	8
			8	2	7
girls aged 7 to 11 years old boys aged 7 to 12 years old	3	The 1st procedure	9	1	5
			8	2	5
		The 2nd procedure	9	1	8
			8	2	7
		The 3rd procedure	10	1	8
			9	2	7
		The following procedures	10	1	10
			9	2	10
girls aged 12 to 17 years old boys aged 13 to 17 years old	5	The 1st procedure	10	1	5
			9	2	5
		The 2nd procedure	10	1	8
			9	2	7
		The 3rd procedure	11	2	8
			10	3	7
		The following procedures	11	2	10
			10	3	10
Parameters of oscillation for children of the normosthenic type of constitution					
6 to 7 years	2	The 1st procedure	9	1	5
			8	2	5
		The 2nd procedure	9	1	8
			8	2	7
		The 3rd procedure	10	1	5
			9	2	5
		The following procedures	10	1	8
			9	2	7

girls aged 7 to 11 years old boys aged 7 to 12 years old	4	The 1st procedure	10	1	5
			9	2	5
		The 2nd procedure	10	1	8
			9	2	7
		The 3rd procedure	11	2	8
			10	3	7
		The following procedures	11	2	10
			10	3	10
girls aged 12 to 17 years old boys aged 13 to 17 years old	6	The 1st procedure	11	2	5
			10	3	5
		The 2nd procedure	11	2	8
			10	3	7
		The 3rd procedure	12	3	8
			11	4	7
		The following procedures	12	3	10
			11	4	10

Oscillation modes 1-6 have a combined mechanism of action on the respiratory tract. The first part of the procedure, due to the predominance of the parameter-oscillation frequency (Hz), creates high-frequency low-amplitude oscillations that are transmitted to the bronchial wall and contribute to the separation of sputum from smaller-bore caliber and its mobilization in the larger-bore caliber of the bronchial tubes, where it is easily removed by expectorating and facilitates the evacuation process. By increasing the frequency of oscillations (Hz), each procedure of HFCWO improves the rheological properties of sputum, which also facilitates the process of mobilizing and its expectorating [9, 11].

High-frequency oscillation therapy generates fluctuations in the air flow, sufficient to create a cough reflex, which reduces the discharge viscosity [6]. These effects help patients mobilize pathological excretions from the peripheral to the central respiratory tract, where they can be easily removed by expectoration or coughing [8]. Repetitive coughing movements after the influence of HFCWO induce a more significant increase in clearance of mucus than one cough motion.

The second part of the procedure of HFCWO due to the prevalence of the influence parameter – pressure (Bar), has a compressive effect under the influence of positive pressure on the chest, improves the mobility of the chest and the elastic properties of the lungs, its elongation of the respiratory area [5]. Improvement of these indices positively affects the functional and volumetric parameters of the lungs, which in turn leads to improved ventilation function of the lungs.

The vibration compression therapy for the chest was performed using the "The Vest Airway Clearance System", Model 105 (Hill-Rom Services, Inc., USA). The system of high-frequency oscillation of the chest consists of a special, pneumatic vest, which tightly covers the entire chest, connected by two tubes with a remote impulse generator of air pressure. The air pressure generator quickly puts the flow of impulses into the vest with the help of air, inflates and blows it down, compressing the chest with a fixed frequency and given

pressure. The resulting impulses cause the pressure inside the vest to oscillate, creating the effect of high-frequency oscillations of the chest. The device has three working settings: pulse frequency (in the range of 1 to 20 Hz), pulse pressure (in the range of 1 to 10 Bar) and the procedure time (1 to 60 minutes) [3, 4, 13, 18].

The procedures were carried out in a sitting position, with a straight back, the area of influence - the chest, in the first half of the day, 30 minutes after eating once a day for 8-10 days, depending on the length of in-hospital stay of the patient. Relaxed breathing was recommended, after completing the procedure, children were asked to cough to remove sputum residues.

At the beginning of the course of treatment, an introductory lesson was given, in which an informative conversation with the child and his parents was conducted to prevent negative emotions regarding the therapy of HFCWO, to explain the principle of its action, desired effects, possible subjective feelings. In the opening session, in order to select a safe and efficient oscillation mode, a test procedure on the Vest was performed for 10 minutes on a "step-by-step" basis, starting with for example a vibration frequency of 9 Hz and a pressure of 1 bar and ending with a vibration frequency of 8 Hz and a pressure 2 Bar for children aged 6 to 7 (mode 2) with an increase of the above parameters of high-frequency oscillation in the following procedures (Tab. 2).

Contraindications to conducting HFCWO are: fever over 38°C, severe intoxication, complicated course of the underlying disease, expressed eczema and purulent-inflammatory skin diseases.

Results and discussion. In the course of the study, the optimal modes of HFCWO were determined based on the oscillation parameters, taking into account the criteria of choice, namely age, type of the constitution, body mass index. For the category of children of the asthenic type of the constitution and the lowered BMI, separate modes of 1, 3 and 5 HFCWO are given. These modes form the procedures of HFCWO, which are an integral part of the comprehensive therapy of community-acquired pneumonia in children.

The "drainage" position for example "sitting on a chair bending the body to the side", "sitting on a chair bending the body forward", "standing bending the body to the side" of the body played an important role in the procedure of HFCWO. Oscillation with a constant change in drainage positions significantly increased the mobilization and facilitated the discharge of sputum in children.

In the process of conducting the procedures using The Vest we have noted that a positive psychological impact on the child is played by the previous presence and communication with friends during the procedures of HFCWO before the first procedure. All this contributed significantly to the overall positive result of therapy and allowed the child to adapt quickly to a new treatment.

Conclusions. To improve the ACT, which involves HFCWO, it is necessary to select the individual mode of oscillation procedures that play a key role in the complex treatment of CAP.

The Vest Airway Clearance System is a modern and easily made method for drainage of the bronchial tree, which enhances airway clearance, improving the functioning of the respiratory system.

The HFCWO using the The Vest device should be included in the daily complex therapy of CAP, taking into account the simplicity and safety of the method, the absence of oral contact with the parts of the device, the relatively passive participation of children in procedures and the lack of a labor-intensive phase of training.

Abbreviations. ACT: Airway Clearance Therapy; HFCWO: High frequency chest wall oscillation; CAP: Community-acquired pneumonia; BMI: Body Mass Index; MCTS: Mucociliary transport system; CT: Complex therapy; WHO: World Health Organization; UN: United nations organization, United nations; MCC: Mucociliary clearance; USA: The United States of America; CF: Cystic fibrosis; PEP: Positive Expiratory Pressure; CCT: conventional chest physiotherapy; COPD: chronic obstructive pulmonary disease; PF: pulmonary function.

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