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CHARACTERISTICS OF REHABILITATION MEASURES IN CHILDREN WITH COMMUNITY ACQUIRED PNEUMONIA IN OUTPATIENT AMBULATORY POLYCLINIC SETTINGS

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Abstract

A comprehensive approach to the treatment of pneumonia can yield better outcomes if all the capabilities of therapeutic physical training and physiotherapy, whose effectiveness has been proven over many years, are fully utilized. The use of physical rehabilitation methods in pneumonia, particularly respiratory rehabilitation, increases tolerance to physical exertion and allows improvement in oxygen consumption and endurance in patients compared with baseline levels. In addition, it reduces the frequency and duration of hospitalization and significantly enhances the effectiveness of pharmacological therapy.At the first and second stages of care for patients with pneumonia of various etiologies, therapeutic physical exercises that improve the drainage function of the bronchi and stimulate secretion clearance are recommended. The use of physiotherapeutic treatment methods with bactericidal, anti-inflammatory, anti-edematous, and resorptive effects significantly increases the effectiveness of comprehensive therapeutic interventions.

Keywords

pneumonia, physical rehabilitation, therapeutic physical training, physiotherapy.

At present, community-acquired pneumonia is becoming increasingly relevant in our country. Preventing the development of prolonged pneumonia remains a challenging task for every pediatrician. After hospital discharge, rehabilitation measures for children are implemented at primary healthcare institutions. Pneumonia is an acute infectious disease characterized by focal or disseminated involvement of the respiratory sections of the lungs and the presence of exudation within the alveoli. From a clinical perspective, the most important principle is the classification of pneumonia into community-acquired and nosocomial (hospital-acquired) types. Community-acquired pneumonia refers to pneumonia that develops outside a hospital setting or is first diagnosed within the first 48 hours after hospitalization. Respiratory rehabilitation is aimed at the treatment of acute and chronic diseases of the respiratory system and serves to improve the restoration of its function following an acute illness. The possibilities of medical rehabilitation are assessed individually in each case, and interventions are applied based on the patient's clinical and instrumental findings. Physical rehabilitation methods are recommended for patients at high risk of developing complications [4,5], for example, those with comorbid conditions characterized by mucus hypersecretion or ineffective cough, such as neuromuscular disorders, chronic respiratory diseases, cystic fibrosis, and others.
Taking into account national experience in the treatment of pneumonias of various etiologies, the inclusion of therapeutic physical training and physiotherapy in comprehensive patient rehabilitation is considered highly relevant [1,2]. The objectives of therapeutic physical training (TPT) in pneumonia include: improving ventilation of healthy lung tissue and actively involving it in external respiration; enhancing the drainage function of the bronchi; improving blood and lymph circulation in the affected lung segments; accelerating resorption processes in inflammatory lesions of lung tissue; and preventing the development of atelectasis and fibrotic changes [3]. Therapeutic gymnastics procedures should begin with exercises that facilitate

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bronchial drainage [2,3]. Clinical and instrumental diagnostics (radiographic examination, CT, MRI) allow determination of the localization of lung damage and the extent of the pathological process. After identifying the site of involvement, the patient is positioned appropriately. From the optimal starting position, the patient is prescribed specific physical exercises during which the affected part of the lung is positioned above the draining bronchus or bronchi. As a result, sputum moves under the influence of gravity into the main bronchus and reaches the tracheal bifurcation. Since the cough reflex threshold is lowest at this site, an involuntary, forceful cough occurs, usually accompanied by sputum expectoration [1]. The total duration of postural drainage, depending on the severity of the patient’s condition, is at least 10–20–30 minutes.

To drain the lower lung segments, the patient is placed in the prone or supine position on an inclined surface (bed, special couch, or table). The surface is positioned at an angle of 30–45° relative to the floor, with the foot end elevated above the head end. Alternatively, the patient may lie on the bed with the body and head hanging downward at approximately the same angle. If an adequate response to body positioning is observed, the angle may be increased. Changes in the patient’s body position relative to the horizontal plane should be carried out in accordance with clinical recommendations for verticalization, taking into account arterial blood pressure, heart rate, respiratory rate, and oxygen saturation. The functional state of the respiratory system is characterized by respiratory rate, breath-holding time, and vital lung capacity; these indicators are also age-dependent [5,8]. When “STOP” signals appear, trunk inclination is discontinued and the patient is returned to the initial position [4]. The effectiveness of drainage exercises performed with coughing is assessed by the volume of expectorated sputum. According to our experience (Tsikunov M.B. et al.), this effectiveness can be increased by applying symmetric or asymmetric pressure to areas corresponding to the localization of the inflammatory process.

Applying pressure to areas of the chest wall during the expiratory phase facilitates more complete exhalation. In addition, this effect may be combined with low-frequency vibration applied through the therapist’s palm or with targeted mechanical vibration using a vibration massage device. Among breathing exercises, deep diaphragmatic breathing is performed. To increase pressure on the abdominal organs, a sand- or salt-filled bag weighing 0.1–2 kg may be placed on the upper abdomen. The physical therapist may apply rhythmic manual pressure to the lower parts of the chest during expiration, synchronized with the phases of breathing. The pressure may be symmetric or asymmetric, taking into account the localization of pulmonary inflammation. Drainage of the middle lobe of the lung is performed with the patient lying on the left side in a semi-recumbent position, with the head tilted backward, slightly leaning back, and the legs drawn toward the chest. When the patient’s condition is satisfactory, the “sitting” position—especially on a low bench—and the “standing” position are considered effective for draining the upper lung segments. In these positions, the patient performs circular movements with flexed arms. At the initial stage, these movements may be performed passively; the “sitting” or “semi-sitting” position can be ensured using a functional bed [2,3].

Drainage of the upper lung segments is facilitated by positioning the patient in the supine position with the head end elevated, with pillows or bolsters alternately placed under the right and left sides. Other body positions that facilitate sputum expectoration are also used. Each time the position is changed, the patient first performs 4–5 deep, slow breaths: inhaling through the nose and exhaling through pursed lips, followed by a slow deep inhalation and then 3–4 gentle coughs. The procedure is repeated 4–5 times in each position.

For improved clearance of pathological secretions from the upper lobe of the right lung, the patient, from an initial “sitting” or “lying” position, should lean the trunk to the left and simultaneously rotate it 45° in the same direction, with the arm on the affected lung side raised upward. The patient inhales, and after 30–60 seconds, when coughing occurs, bends the trunk forward as much as possible during exhalation. The patient remains in this position for several seconds while coughing, and the therapeutic physical training (TPT/LFK) instructor synchronously applies pressure to the upper chest in time with the cough impulses, mechanically facilitating sputum clearance.

In debilitated patients, after the acute process has resolved and sputum production appears, drainage of cavities located in the upper lobe is performed in the initial "lying" position on the healthy side, with the foot end of the bed elevated by 25–30°. During inhalation, the arm on the affected lung side should be raised. During exhalation, to prevent sputum from flowing into the healthy lung, the patient slowly turns into the prone position and remains there for several seconds while coughing. During coughing, the LFK instructor applies synchronized pressure to the upper chest.

During drainage exercises, as well as while maintaining drainage positions, a mandatory condition for sputum expectoration is prolonged, forceful exhalation, which is necessary to create a strong airflow for bronchial secretion clearance. If dyspnea occurs during the procedure, postural drainage should be discontinued ("STOP" signals in accordance with clinical recommendations for verticalization).

The LFK instructor may also supervise breathing exercises and training sessions remotely via video call or telephone. If remote communication is difficult and the instructor must be physically present, the patient should be positioned near the outlet of room air convection so that exhaled droplets are removed by airflow. The instructor, strictly observing personal protective measures, should stand on the "windward" side and avoid close contact. In this case, the organization of a ventilated convection-based rehabilitation environment should ensure optimal air convection and ventilation [2,7].

When the patient's condition is stable, the instructor may use exercises to train respiratory muscles and techniques to stimulate coughing, sputum expectoration, and sneezing. The patient is positioned facing a fan near a window, with the back toward a fan near the entrance. Under the instructor's supervision, respiratory muscle training is conducted, along with breathing exercises that stimulate coughing, expectoration, and sneezing. The patient also performs stretching exercises on the bed, including the "bicycle" exercise, the "bridge" position, and transitioning from the "lying" to the "sitting" position.

Technique for the stretching exercise from the "lying" to the "sitting" position: the patient grasps the sides of the bed with both hands and, using upper limb strength, raises the trunk into a "sitting" position, holds this position for 5 seconds, and then returns to the "lying" position; the exercise is repeated several times.

Technique for the "bridge" exercise: the patient lies supine with knees flexed and feet flat on the bed; the pelvis is raised 10–15 cm above the bed and lowered repeatedly.
Technique for the "bicycle" exercise: the patient lies supine with knees flexed; the upper body remains still while the lower legs alternately perform movements resembling pedaling a bicycle (to full extension, i.e., to the farthest point of foot movement). Depending on the severity of the

patient’s condition, exercises are performed while breathing room air, supplemental oxygen, noninvasive ventilation, or mechanical ventilation via tracheostomy.

In mild and moderate cases, beginning from days 3–5 of illness (bed rest), the patient assumes a “lying” and/or “sitting” position on the bed with legs lowered and performs dynamic exercises under the supervision of an LFK instructor. Exercises are prescribed for small and medium muscle groups, along with breathing exercises—both static and dynamic. The ratio of general strengthening to breathing exercises is 1:3, 1:2, or 1:1. Exercises are performed at a slow to moderate pace, with each exercise repeated 4–8 times at maximal range of motion. The increase in heart rate should not exceed 5–10 beats per minute. Session duration is 10–15 minutes; independent sessions are possible up to three times daily for 10 minutes each.

Beginning from days 5–7 of illness (ward or semi-bed regimen), the patient continues exercises under the supervision of an LFK instructor in the “sitting” position on a chair and/or in the “standing” position. The workload is increased under monitoring of heart rate, respiratory rate, blood pressure, and oxygen saturation; each exercise is performed at a moderate pace and repeated on average 8–10 times. Exercises with objects for large muscle groups are added. The ratio of breathing to general strengthening exercises is 1:2 or 1:1. Heart rate should not exceed 90–100 beats per minute. Session duration is 15–30 minutes; walking is added when the condition is satisfactory. Total daily training time may reach 1.0–1.5 hours; independent sessions are possible three times daily for 15–20 minutes.

Beginning from days 7–10 of illness (general regimen), therapeutic gymnastics procedures are similar to those used in the ward regimen but are performed with a higher workload under LFK instructor supervision, allowing heart rate to increase up to 110 beats per minute. The duration of one session is 30–40 minutes. Independent exercise, including walking, training on exercise equipment, and games, totals up to 2.0–2.5 hours per day. Therapeutic gymnastics sessions consist of three parts: introductory, main, and concluding. Sessions are conducted by an LFK methodologist, and after mastering the complex, patients perform the exercises independently.
Mechanotherapy with biological feedback is performed on the upper and lower limbs in passive and/or active-assisted modes depending on the patient’s condition, under monitoring of standard parameters in accordance with clinical recommendations for verticalization, including blood pressure (BP), heart rate (HR), respiratory rate (RR), and oxygen saturation.

Disinfection using antiseptics and ultraviolet irradiation is carried out once daily in the morning and evening.

In cases of prolonged pneumonia, vacuum massage may be prescribed. Its therapeutic effect is achieved through mechanical stimulation, the development of congestive hyperemia, occasionally accompanied by local hemorrhages, and the formation of active products of tissue breakdown. Rubber, glass, or porcelain cups with a volume of 50–200 ml, or a portable massage device with a set of nozzles of 25–60 ml, are used. The procedure is performed taking into account the patient’s individual tolerance and skin response.

A comprehensive rehabilitation program increases tolerance to physical activity, improves oxygen consumption and endurance compared with baseline levels, reduces the frequency and duration of hospitalization, and significantly enhances the effectiveness of pharmacological therapy [2].

In local clinical practice, physiotherapeutic treatment methods are included in comprehensive patient management [9].

The objectives of physiotherapy in pneumonia include:

anti-inflammatory (bacteriostatic, bactericidal) effects;

anti-edematous effects;

resorptive effects;

improvement of external respiratory function, particularly bronchial patency;

enhancement of lymphatic and blood circulation in the bronchopulmonary system;

correction of impaired immune status;

hyposensitizing effects;

prevention of atelectasis and adhesive processes;

training of thermoadaptive mechanisms.

The main contraindications to physiotherapeutic procedures include instability of somatic and neurological status; severe intoxication; hyperthermic syndrome (body temperature above 37.5–38°C); stage III cardiopulmonary insufficiency; chronic kidney disease stage III or higher; hepatic failure; severe rhythm and conduction disturbances (frequent grouped and polytopic ventricular extrasystoles, complete AV block, tachysystolic atrial fibrillation); seizure syndrome; hemorrhagic syndrome; pulmonary hemorrhage or hemoptysis; pneumothorax; suspected tumor in the treatment area; and the presence of a pacemaker or metallic foreign bodies (for electrotherapy and electromagnetic exposure).

For the treatment of focal pneumonia, the following are recommended:

UHF therapy (ultrahigh-frequency electric field) is prescribed from days 4–5 of disease onset in patients with mild to moderate severity, in the presence of exudate and absence of contraindications [9,10]. UHF electric fields (40.68 MHz and 27.12 MHz) can affect deep-seated tissues inaccessible to other energy modalities. UHF therapy has anti-inflammatory, bacteriostatic, and anti-edematous effects (reducing exudation and inflammatory edema), suppresses microbial activity, enhances local phagocytosis, and limits the inflammatory focus from surrounding healthy tissues, allowing its use during the exudative–proliferative phase. Capacitor plates with a diameter of 11.3 cm are positioned so that the inflammatory focus lies between them at a distance of 2–3 cm (not exceeding 6 cm). In the acute phase, athermic doses (power 30–40 W) are used; procedure duration is 8–10–12 minutes, daily, with a course of 5–6

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sessions to reduce edema. Increasing the number of procedures is not recommended due to the risk of pulmonary fibrosis [9,10].

In some cases, in debilitated and/or elderly patients, including those with cardiovascular comorbidities, UHF therapy is applied in pulsed mode, which has less effect on circulation and stimulates metabolic and trophic processes. Exposure is delivered using the “Impulse-3” device with flexible capacitor plates (16×11 cm) or rigid plates (15 cm diameter); pulse duration is 2 µs, average output power 4.5–6 W, exposure time 10–15 minutes, with a course of 5–6 procedures.

Microwave electromagnetic field therapy (SMF/EMF) is prescribed from days 10–12 of disease onset in patients with mild to moderate severity, in the absence of contraindications and complications [9,10]. Power is 30–40 W, procedure duration 10–12 minutes daily, with a treatment course of 8–10 sessions. Therapy may be applied in the decimeter (DMW) and centimeter (CMW) ranges.

Decimeter wave therapy (DMW therapy) at a frequency of 460 MHz penetrates tissues up to 11–13 cm and is recommended for deep inflammatory processes. The “Volna-2” device is used; a rectangular emitter (35×16 cm) is positioned 5 cm from the patient’s body, output power 35–40 W, procedure duration 10–15 minutes, daily, with a course of 7–8 sessions. In bilateral processes, exposure is applied to the lung root areas using a cylindrical emitter placed between the scapulae or over the sternum at a distance of 5 cm; power 30–40 W, duration 8–10 minutes daily, course 8–10 sessions [3,7].

Centimeter wave therapy (CMW therapy) is recommended for superficially located pathological foci, as waves at 2375 MHz penetrate tissues up to 5 cm. In the exudative phase, power of 20–30 W is recommended; in prolonged cases, 50–60 W. A rectangular emitter with a diameter of 14 cm is positioned 5–7 cm above the pathological focus; exposure duration is 6–8 minutes per field, daily, with a course of 10–12 sessions [10].

Aerosol therapy using nebulizers to generate fine-dispersed aerosols of medications is widely used in pulmonology. It is prescribed from days 4–5 after normalization of body temperature, with adherence to antiseptic handling rules. Nebulizer inhalers do not damage the structure of administered medications and allow inhalation not only of bronchodilators and corticosteroids, but also mucolytics, immunomodulators, and surfactant emulsions in cases of respiratory distress syndrome.

The advantages of compressor nebulizer aerosol therapy compared with other aerosol methods include:

rapid and direct delivery of medications to the bronchial and alveolar mucosa, targeting the lungs as the organ of action;

regulation of aerosol delivery during the respiratory phase;

combined administration of medications, particularly bronchodilators and mucolytics;

applicability at any age and across varying severity levels, without the need for forced deep inhalation or synchronization with hand movements;

simultaneous oxygen delivery;

concurrent use of respiratory trainers;

integration of the nebulizer into assisted or mechanical ventilation circuits. Depending on clinical manifestations, antiviral agents, antibiotics (based on microbial sensitivity), bronchodilators, and ultrasonic inhalations of heparin are recommended. Solution temperature is 36°C; procedures are performed 2–3 times daily; bronchodilator inhalations are administered as needed (during episodes of dyspnea), with a treatment course of 6–8 days. Ozone therapy has a virucidal effect due to peroxidation of phospholipids and viral capsid lipoproteins, leading to disruption of viral integrity [16]. Oxidation of viruses impairs their binding to specific cellular receptors, resulting in inactivation of a portion of free viral particles in the bloodstream. In acute pneumonia, ozone therapy is recommended even in children aged 3 months to 3 years using the following protocol: ozonated saline at a concentration of 3 mg/L is administered at 10 ml/kg body weight once daily for 4–5 days. The addition of ozone therapy and sodium hypochlorite to комплекс treatment may be considered an effective detoxifying and antibacterial approach in acute pneumonia [6,11].

In prolonged pneumonia, ozone therapy significantly enhances the effectiveness of antibacterial treatment, accelerates resorption of radiographically detected infiltrative changes, allows sputum sanitation against mycoplasma and chlamydia 2–3 weeks earlier, and improves patients' general condition. Its effectiveness has also been demonstrated in the treatment of acute abscess-forming pneumonia. Magnetotherapy has anti-inflammatory, anti-edematous, and reparative–regenerative effects; it improves microcirculation and accelerates resorption of infiltrative changes. Inductors are placed paravertebrally and/or over the pathological focus; frequency 50 Hz, intensity 20–30 mT, procedure duration 10–20 minutes, daily for 8–10 days. Pulsed magnetic fields are generated at 0.17–33 pulses/s with magnetic induction not exceeding 30 mT. Procedures last 15–30 minutes daily for 15–20 days. Infrared irradiation is prescribed from days 7–9 of disease onset in patients with mild to moderate severity, in the absence of contraindications and complications. Infrared laser irradiation has anti-inflammatory, bactericidal, reparative–regenerative, and immunomodulatory effects; it penetrates tissues up to 5–6 cm, improves microcirculation, reduces vascular permeability, and suppresses pathogenic microflora. The laser emitter is placed over the projection of the pathological focus; pulse frequency 80 Hz. Infrared laser (0.89–1.2 μm) is applied at a constant power of 40–60 mW and pulsed power of 3–5 W, 1–2 minutes per zone, total procedure duration 12–15 minutes daily, with a course of 8–10 sessions. Exposure zones include the mid-chest, Krenig zones, interscapular paravertebral areas, and the projection of inflammation. Ultrasound therapy is prescribed from days 18–21 of disease onset; it has anti-inflammatory, desensitizing, antispasmodic, and defibrosing effects, influences bronchial smooth muscles, and facilitates sputum clearance. The transducer area is 4 cm^2; exposure is applied paravertebrally and over the pathological focus at a power density of 0.05–0.2 W/cm^2, with 3–5 minutes per field, total duration 12 minutes, course of 8–10 procedures.

Conclusion

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Physical rehabilitation methods are recommended at all stages of care for patients with pneumonia of various etiologies. Respiratory rehabilitation increases tolerance to physical activity, improves oxygen consumption and endurance, shortens hospitalization duration, and enhances the effectiveness of pharmacological therapy. From the first stage of rehabilitation, therapeutic exercises and special positioning are recommended to improve bronchial drainage function and facilitate secretion clearance. Many years of physiotherapy practice demonstrate the effectiveness of physical factors, including antiviral, bactericidal, anti-inflammatory, anti-edematous, and resorptive effects. Given the high contagiousness of coronavirus infection, physical factors should also be used for antiviral purposes in wards and procedure rooms where patient manipulation is performed. An individualized and comprehensive approach yields the best outcomes in the treatment of pneumonia when all therapeutic exercise and physiotherapy options are fully utilized, as their effectiveness has been confirmed over many years.

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