Ministry of Healthcare of Ukraine

Poltava State Medical University

Approved
at the meeting of Internal Medicine №1
Department "____"_____
Protocol № ____ from _____
The Head of the Department
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Methodical guidelines

for students' self-studying to prepare

for practical (seminar) classes and on the lessons

Academic discipline	Internal medicine
Module №	1
Topic of the lesson	Modern examination methods in pulmonology
Course	IV
Faculty	of foreign students training

1. Relevance of the topic: Correct and timely diagnosis is the key to effective treatment and prevention. Therefore, it is important to know and have modern diagnostic methods.

Respiratory disease is accompanied by dysfunction of external respiration, other laboratory and instrumental changes. Pulmonary diseases occupy a large percentage of the total number of diseases. This is primarily due to the fact that in recent decades the number of non-specific lung diseases has increased significantly, the share of which in the structure of the reasons for seeking medical care is over 60%.

2. Certain aims:

- to improve methods of examination of pulmonological patients, to correctly interpret the data of laboratory and instrumental methods of examination .;
- determine the etiological and pathogenetic factors of major respiratory diseases.
- identify a typical clinical picture of major respiratory diseases.
- substantiate the use of basic invasive and non-invasive diagnostic methods used in pulmonology, determine the indications and contraindications for their implementation, possible complications.

3. Basic knowledge, abilities, skills required to study the topic (interdisciplinary integration).

Names of previous disciplines	Obtained skills
1. Anatomy 2. Biochemistry 3. Anatomy 4. Physiology 5. Pathology 6. Radiology 7. Propaedeutic internal medicine 8. Pharmacology	Features of the anatomical structure of the respiratory system Knowledge of the general physiology of the respiratory system Knowledge of the basic biochemical processes underlying the functioning of the respiratory system in normal and pathological conditions Ability to assess pathological changes in the respiratory system in various

	pathological conditions Ability to assess pathological changes in the respiratory system at the cellular level Knowledge of the history of the scheme Demonstrate the ability to conduct surveys (collection of complaints, medical history and life) Possession of the method of physical examination of patients Knowledge of classification, pharmacokinetics and pharmacodynamics of drugs used in the treatment of patients with pulmonological profile, the ability to prescribe

4. Tasks for self-studying to prepare for the lesson and on the lesson.

4.1. List of main terms, parameters, characteristics that should be learnt by student during preparation for the classes:

Term	Definition
Cough	This is a reflex process of removing the contents of the respiratory tract - mucus, sputum, blood, foreign bodies. Cough occurs due to inflammatory, mechanical, chemical and thermal irritation of cough receptors, which are located in the larynx, trachea, bronchi,

	on the leaves of the pleura.
Dyspnea	is understood as a change in the frequency, depth, rhythm of respiration, violation of the relationship between the phases of inspiration and exhalation, accompanied by a subjective feeling of shortness of breath. Depending on which phase of respiration is changed, there are three types of dyspnea: inspiratory (difficult inspiration) expiratory (difficult exhalation) and mixed (both phases of respiration are difficult).
Respiratory failure syndrome	is a condition in which the lungs' ability to supply arterial blood with sufficient oxygen is limited.
Bronchoobstructive syndrome	occurs due to impaired bronchial patency, with spasm, swelling of the mucous membrane and their closure by secretion or tumor. It is characterized by asthma attacks, shortness of breath, prolongation of the exhalation phase at rest and during forced exhalation, whistling rales, which are heard in the distance, when percussion reveals a box sound.

4.2. Theoretical questions for the lessons:

1. Identify the main symptoms of respiratory diseases (shortness of breath, dyspnea, cough, chest pain, etc.).

2. Outline the importance of collecting medical history in patients with pulmonary pathology (features of medical history and life - the duration of smoking, the connection with SARS, burdened heredity, occupational hazards).

3. Name the changes in the physical examination of patients with pulmonary pathology (interpretation of palpation, percussion, auscultation).

4. Identify the diagnostic capabilities of X-ray examination of the lungs, computed tomography and magnetic resonance imaging. pulmonary tomography, perfusion scintigraphy, etc.

5. Justify the need for functional methods of external respiration (indications, contraindications to spirometry, pneumotachometry).

6. What methods do you know for sputum research? (bacteriological, microscopic, cytological, etc.).

Topic content:

The main clinical manifestations characteristic of respiratory diseases include cough, hemoptysis, pulmonary hemorrhage, chest pain, shortness of breath, asthma, respiratory failure syndrome and pulmonary arterial hypertension.

Cough is one of the most common symptoms of respiratory disease. This is a reflex process of removing the contents of the respiratory tract - mucus, sputum, blood, foreign bodies. Cough occurs due to inflammatory, mechanical, chemical and thermal irritation of cough receptors, which are located in the larynx, trachea, bronchi, on the leaves of the pleura. If the cough is not accompanied by sputum, it is called dry. In the presence of sputum, the cough is called wet. Sputum can be mucous, serous, purulent, hemorrhagic, serous-purulent, and so on. The cough may be constant or intermittent. Persistent cough indicates chronic bronchitis or prolonged blood stasis in the lungs. Periodic cough occurs in people sensitive to cold, early in the morning in smokers and alcoholics, as well as in patients with pulmonary emphysema.

Hemoptysis is the appearance of blood in the sputum. Hemoptysis can occur in pulmonary tuberculosis, bronchiectasis, abscess, lung cancer, pulmonary embolism, pneumonia, bronchitis. When pulmonary hemorrhage during coughing, blood mixed with sputum is released, which has a light red color, foamy, pH-alkaline. At the same time asthma, a squeak behind a sternum can be observed.

If a severe cough lasts a long time, the patient develops varicose veins, cyanosis of the face and neck. There may be a short-term loss of consciousness, a symptom of betolepsy.

With the destruction of the vocal cords (tuberculosis, syphilis of the larynx), the cough becomes silent. Deaf cough is observed in large cavities in the lungs. Mild cough (a number of weak, short coughing fits) occurs in the early stages of tuberculosis, laryngitis or laryngotracheitis.

Pain in the chest can be caused by pathological processes in the chest itself (intercostal neuralgia, inflammation of the intercostal nerves, muscles, periostitis, osteomyelitis, rib fractures, sternum), in the respiratory system (with pleural lesions, because the bronchi and lung tissue do not have sensitive nerves), in the heart and aorta (pericarditis, angina, myocardial infarction). In addition, chest pain may radiate from the spine (osteochondrosis), abdominal organs (acute cholecystitis). It is extremely important to find out the cause of pain (respiratory disease or other phenomena).

Typical pain at the time of formation of pneumothorax (penetration of air into the pleural cavity). The patient experiences intense cutting pain in a limited area of the chest according to the place of rupture of the pleura. At the same time there is a sharp shortness of breath. Prolonged, non-stop, chest pain occurs in cancer of the pleura, lungs. Pain in the left half of the chest, which occurs suddenly, lasts 5 to 15 minutes and passes on its own or after taking nitroglycerin, characteristic of the thoracic frog - angina. Pain radiating to the chest is often caused by inflammation of the spinal cord roots. It is shrouded, intensified by coughing, torso tilting, straining, accompanied by a feeling of ants crawling on the skin.

Exhausting pain in the chest with shingles. It appears a few days before the rash on the skin of typical blisters in the intercostal spaces. Pain in cholecystitis, appendicitis, splenic infarction, uterine diseases, etc. also radiates to the chest.

Pain at muscles, chest bones during palpation may indicate their disease: along the intercostal nerves - indicates its neurological nature; when pressing on the vertebrae can occur in pathological processes in them. Muscle pain is characterized by its appearance or intensification during movements; and when the pleura is affected, pain occurs during breathing.

Dyspnea is understood as a change in the frequency, depth, rhythm of respiration, violation of the relationship between the phases of inspiration and exhalation, accompanied by a subjective feeling of shortness of breath. Depending on which phase of respiration is changed, there are three types of dyspnea: inspiratory (difficult expiratory expiration (difficult exhalation) and mixed (both phases of respiration are difficult). Expiratory dyspnea is observed in bronchial asthma, bronchoobstructive syndrome, when the release of air from the lungs is prevented by spasm of small bronchi, their obstruction is quite common. For example, in pulmonary emphysema, breathing is difficult because the chest is already in a state of maximum inspiration, exhalation is also difficult due to the loss of elasticity of the alveolar walls.

Respiratory failure syndrome is a condition in which the lungs' ability to supply arterial blood with sufficient oxygen is limited. Respiratory failure can be obstructive, restrictive, or mixed (as determined by peak flowmetry and computed spirography). Respiratory failure, depending on the rate of development of the clinical picture has acute and chronic forms.

Bronchoobstructive syndrome occurs due to impaired bronchial patency, with spasm, swelling of the mucous membrane and their closure by secretion or tumor. It is characterized by asthma attacks, shortness of breath, prolongation of the exhalation phase at rest and during forced exhalation, whistling rales, which are heard in the distance, when percussion reveals a box sound.

Objective examination methods.

When examining the chest, pay attention to its shape, increase or decrease one half of the chest compared to the other. In the first case it is necessary to think of accumulation in a pleural cavity of exudate (pleura inflammation), transudate (non-inflammatory effusion) or air (pneumothorax). Decrease in the size of one half of a thorax is observed at shrinkage of pulmonary fabric (in case of a cirrhosis of a lung, tuberculosis, bronchiectasis, syphilis, after the transferred lung abscess), atelectasis (decline) of a lung, after absorption of pleurisy exudate (especially purulent). Static chest examination should be supplemented by dynamic, in which attention is paid to the participation of each half of the chest in the act of breathing. Lag of one half of a thorax in the act of breath is observed at an inflammation of a lung, a pleura, a fracture of ribs, an intercostal neuralgia, a myositis of intercostal muscles.

Palpation of the chest. A certain diagnostic value has a symptom of vocal fremitus, which may be enhanced (compaction of lung tissue in lobar pneumonia, cavities, pulmonary atelectasis), and weakened (thickening of the chest wall, exudative pleurisy, hydrothorax, pneumothorax) pulmonary emphysema, bronchial obstruction by a foreign body).

Comparative and topographic percussion of the lungs.

At comparative percussion at the healthy person the clear pulmonary sound is defined. In ptological processes, the change in percussion sound may be due to a decrease in air in the lung tissue (pneumosclerosis, pneumonia, pulmonary tuberculosis, significant pulmonary edema, etc.), in these cases, percussion sound instead of clear lung becomes shorter, quieter and higher, ie blunted. Complete absence of air in the lungs, filling of the pleural cavity with fluid (transudate, exudate) - will lead to a dull sound, similar to the sound of percussion of airless organs and tissues (liver, muscles). When the contents of the air are released in the lungs (emphysema) or in the pleural cavity (pneumothorax), the percussion sound becomes loud and acquires a tympanic hue, it resembles the sound that occurs when hitting a box, so it is also called box.

Auscultation of the lungs. Basic respiratory noises

Vesicular respiration is an independent noise. which is formed in the pulmonary parenchyma as a result of air penetration into the pulmonary alveoli and is caused by their tension. Listened to the inhale and the first third of the exhale.

Bronchial respiration is a respiratory noise that is formed in the larynx when air passes through the glottis.

Bronchial respiration is best heard over the larynx. At pathology bronchial breath can be listened over lungs if: 1) sites of consolidation of sufficient size, 2) bronchial patency remains.

Bronchial respiration associated with the formation of cavities often acquires a special character or timbre (amphora or metallic bronchial respiration).

Special forms of vesicular respiration. These include the so-called puerile and saccaded respiration. Puerile is a pronounced vesicular respiration with a pronounced exhalation in children. Saccadic or intermittent is vesicular respiration, which does not occur continuously, as usual, but in the form of a series of individual short breaths, interrupted by the same short pauses. The reason for such breathing is the uneven contraction of the respiratory muscles (muscle tremor, fatigue, muscle disease).

Auscultation of side respiratory noises

Side respiratory noises are ***wheezing, crepitation, pleural friction noise***. To listen to side breathing noises, the patient should breathe deeply, preferably through the mouth, coughing periodically. *Wheezing* is dry and moist, which is formed in the bronchi and is heard on inhalation and exhalation.

Dry rales are divided into buzzing (buzzing) and whistling. The main diagnostic value of dry wheezing is that they are a characteristic feature of bronchitis, bronchial asthma and other diseases associated with the accumulation of mucus or narrowing of the airway. *Wet rales* are divided into small-bubble, medium- and large-bubble. Fine-bubble wet rales, depending on the nature of the pathological process in the lungs can be sonorous (consonant) and inaudible (non-consonant). Loud, moist rales are heard in the presence of liquid secretion in the bronchi, surrounded by compacted lung tissue, which occurs in pneumonia.

Crepitation is heard in the form of a light monotonous crack on the breath and does not change when coughing. This is the noise generated by the separation or sticking of more than usual moistened walls of the alveoli.

The appearance of crepitation is observed in croupous pneumonia, pulmonary tuberculosis, pulmonary infarction, atelectasis, congestion in the lungs. Crepitation is often heard in older people in the morning after sleep.

The noise of the pleura friction occurs when the leaves of the pleura due to various pathological processes become uneven, rough or dry.

The noise of the pleura friction in the immediate vicinity of the heart when involved in the process of the pericardium is called pleuropericardial noise. It is listened not only depending on phases of breath, but also cardiac activity.

Bronchophonia is a method of listening to the voice on the chest. This is equivalent to the method of determining voice tremor, because it changes in parallel with it and has the same meaning. The patient whispers words containing the letter "N", such as "ninety-nine".

Methods of examination of patients with pulmonary pathology.

I. Laboratory methods of examination.

1. *Microscopic examination of sputum* makes it possible to detect elastic fibers (a sign of decay of lung tissue in patients with tuberculosis, cancer, abscess), Charcot-Leyden crystals, which are formed from substances of eosinophilic granulocytes (a sign of allergic lung disease), Ehrlich tetrad - crystal calcareous elastic fibers, cholesterol crystals and MBT (characteristic of exacerbation of tuberculosis).

2. *Bacteriological examination of sputum* - obtaining pure cultures of bacteria by sowing material on artificial nutrient media with their subsequent identification.

3. *Bacterioscopic examination* - a method of detecting microorganisms in the material isolated from the body using a microscope and special color of the drug.

Research of biological materials:

Sputum. For examination, patients collect a morning portion of sputum on an empty stomach in a volume of 3-5 ml in sterile vials with a tightly screw cap. It is

desirable to brush your teeth in advance and rinse your mouth with boiled water or sodium bicarbonate solution (1 teaspoon per glass of water). If the patient secretes sputum poorly, or coughs it sporadically and in small amounts, then the evening and early morning on the day of sputum collection he should be given expectorant. If tuberculosis, pneumocystis and legionellosis pneumonia are suspected, irritating aerosol inhalations should be used by inhalation for 10–15 minutes. 30–60 ml of a solution heated to 42–45 ° C, prepared in sterile water, containing 150 g / l of sodium chloride and 10 g / l of sodium bicarbonate. The resulting induced sputum is identical in quality to expectorant sputum.

For the diagnosis of acute bacterial infection, one sputum sample is sufficient, in the study of tuberculosis or fungal infection collect morning sputum 3 days in a row, it is not desirable to accumulate its volume for more than 12 hours due to excessive contamination by foreign bacterial flora. The time of delivery of sputum to the laboratory should not exceed 1.5–2 h from the moment of its receipt (refrigeration is allowed, but not more than 6 h), as the delay leads to autolysis of Streptococcus pneumoniae, due to the reproduction of contaminating bacteria changes the true ratio of bronchial microflora secret.

Bronchial lavage fluid.

During inhalation, the patient is injected with a special syringe into the trachea 7-10 ml of sterile isotonic solution, which causes a cough reflex. The patient coughs up the secretion from the deep parts of the bronchial tree, it is collected in a sterile vial and immediately sent to the laboratory. BS, particularly near the site of inflammation, can be done with a bronchoscope. In patients with a pronounced pharyngeal reflex, this procedure is performed after preliminary anesthesia of the epiglottis, larynx and posterior pharyngeal wall. The disadvantage is a significant dilution of the tracheobronchial contents, which reduces the possibility of bacterial excretion, and their concentration drops by about 100 times compared to sputum.

Transtracheal aspirate.

Aspirate from the trachea and draining bronchi, in particular near the site of inflammation of the lung tissue, is obtained using a bronchoscope. It is necessary

to remember that at introduction of a bronchoscope there is a contamination of a secret of the lower parts of a respiratory tract by flora of an oropharynx, it distorts real results. Unlike sputum, TTA can be tested for anaerobes.

Bronchoalveolar lavage.

Bronchoalveolar lavage (ALS), in which the lung segment is flushed with sterile isotonic solution, is most important in the diagnosis of pneumonia caused by mycobacteria, Pneumocystis jiroveci in patients with AIDS (diagnostic efficiency reaches 89-98%), also in patients with cytoma with immunodeficiency or after organ transplantation. Bronchoalveolar lavage can be used for cultural diagnosis of legionellosis, chlamydial and viral infections and for study using molecular methods.

Due to the contamination of the material with the oropharyngeal microflora, the use of bronchoalveolar lavage (BAL) in other clinical situations requires the mandatory use of cytological and quantitative criteria for its evaluation. The presence of less than 1% of epithelial cells indicates the absence of contamination of the oropharyngeal microflora, the quantitative determination of> 104 CFU / ml in a culture study indicates the clinical significance of the isolated microorganism. Additionally, it is possible to prepare stained smears from the sediment after centrifugation of the liquid to detect bacteria, mycobacteria of tuberculosis, legionella and fungi, in patients with immunodeficiency - pneumocystis. The sensitivity and specificity of the method of BAL in the etiological diagnosis of IND vary widely and average, respectively, 69 ± 22 and 88 ± 14%

Brush biopsy. The material is obtained from the bronchi with a special cannula with protected brushes (SHB) using a fiber-optic bronchoscope. The principle of the method is to use a system of retractable channels that protect the material from contamination by the oropharyngeal microflora during the introduction and removal of the bronchoscope from the lower respiratory tract, this allows for research on anaerobes. Brush biopsy is poured into 1 ml of sterile saline or sodium

lactate solution of a complex (Ringer's lactate solution) under aseptic conditions and delivered to the laboratory.

Pleural fluid. Before puncture of the pleural cavity, the skin is treated with 70% ethyl alcohol, then 1-2% iodine solution, which after the procedure is removed with 70% ethyl alcohol to prevent skin burns. After the puncture, the pleural fluid (PR) is collected with a sterile syringe and placed in an anaerobic transport system or sent to a syringe by first removing (or bending) the needle and putting a protective sterile cap on the syringe cannula. The minimum volume of PR required for the isolation of bacteria, 1-5 ml, fungi or mycobacteria - not less than 10 ml.

Transthoracic puncture of infiltrate or lung abscess. Samples are obtained by transthoracic puncture under radiological control. The abscess material includes not only pus but also capsule tissue that separates the abscess. The manure is collected with a syringe, in which it is delivered to the laboratory, or the contents are transferred to anaerobic systems for transportation. The use of tampons to take manure for anaerobic testing is prohibited.

Pulmonary tissue biopsy. Transbronchial and open lung biopsy are the most aggressive invasive methods, the use of which is necessary for the diagnosis of opportunistic infections in patients with immunodeficiency. As a result of the emergence of effective bronchoscopic methods of BAL and thyroid invasive methods have become much less common.

Blood sampling for blood culture.

Blood for blood culture should be examined in the first 3-4 days after the onset of the disease, when it is possible to identify blood cultures in acute bacterial pneumonia in 3-37% of cases. Necessary culture of blood taken at two separate venipunctures with an interval of 30-40 minutes, it reduces the frequency of false-positive results due to skin contaminating bacteria by 70%. If the patient was given antimicrobial therapy in the previous 1-2 weeks, blood is taken 2-3 times a day for 3 days. Blood should not be collected from intravascular catheters unless sepsis of catheter origin is suggested.

The skin over the punctured vein is carefully treated with 70% ethyl alcohol, then 1-2% tincture of iodine for 30 s (treatment of the skin begins from the center of the future puncture towards the periphery). Allow the treated area of skin to dry, then perform a venipuncture, after which the area is again treated with 70% ethyl alcohol to remove excess iodine to avoid skin irritation.

Nasal, pharyngeal and oral cavity swabs. Samples are used to detect many respiratory viruses. Throat swabs are examined for the presence of Chlamydia pneumoniae, Mycoplasma pneumoniae, Legionella spp. by polymerase chain reaction (PCR).

Serum Samples are studied by serological methods in the acute period of infection and in convalescents for the diagnosis of pneumonia caused by Legionella pneumophila, Chamydia pneumoniae, Chlamydia psittaci, Mycoplasma pneumoniae, Streptococcus pneumoniae, viruses.

serological diagnosis: detection of specific blood pressure of different classes (IgM, IgA, IgG) in the blood.

- MP reactions, agglutination, ELISA, indirect immunofluorescence (RNIF), RSC;
- PCR technique - detection of DNA or RNA of pathogenic viruses and bacteria.

II. Instrumental methods of examination.

1. Bronchoscopy - a method of examining the trachea and bronchi by examining them through a bronchoscope. There are rigid bronchoscopy (hollow metal tubes for mechanical ventilation), fibrobronchoscopy (flexible guided bronchoscope with fiber, optics and a channel for biopsy instruments) and combined bronchoscopy (flexible optical telescope from a fibrobronchoscope is performed through a tube).

2. Conventional X-ray tomography is the most common method of layer-by-layer examination; based on synchronous movement in the space of the emitter and X-ray cassette during X-ray imaging. Tomographs are divided into longitudinal (selected layer parallel to the longitudinal axis of the human body), transverse (selected layer perpendicular to the axis of the human body) and panoramic

(selected layer has the shape of a curved surface). Tomographs provide an X-ray image of only the required layer. Longitudinal horizontal linear tomographs based on stationary X-ray machines equipped with a special mechanism for moving the emitter and cassette have become the most widespread. Such tomograph also includes a universal linear tomograph, which allows you to conduct research in vertical and inclined positions. On linear tomograms it is possible to reveal details of anatomic structure of body or pathological process which are not visible on usual roentgenograms which at usual X-ray inspection are hidden owing to superposition (imposition) of shadow formations.

3. Bronchography - a contrast method for diagnosing changes in the bronchi and trachea. There are positional and directional bronchography: transnasal, transoral.

Indications: bronchiectasis, bronchial tumors, airway malformations, chronic bronchitis, bronchopulmonary cysts, bronchial fistulas.

Contraindications: acute inflammatory diseases of the respiratory system, pulmonary hemorrhage, intolerance to iodine drugs, severe signs of pulmonary heart failure.

4. Computed tomography (CT) - a method of irradiating a certain area of the body with a narrow beam of X-rays in multiple directions in one plane. X-rays, which are absorbed by different tissue densities, are recorded by highly sensitive sensors. Computer equipment allows you to record and reproduce up to 10,000 - 200,000 measurements per 1 sec., Which account for the study of one layer of fabric with a thickness of 2-8 mm. This number of measurements is achieved by rotating the X-ray tube and the sensor system around the patient's body at different angles.

5. Magnetic resonance imaging.

Scientists at the University of Sheffield have developed an innovative technique that allows you to illuminate the patient's lungs from the inside with inert gases. This approach allows the detection of early stages of various lung diseases, including emphysema, asthma, cancer and smoking-related pathologies. The new approach involves the patient inhaling a small amount of harmless noble gases

(helium-3 and xenon-129), hyperpolarized by a laser, the power of which is increased by the method of pumping. Magnetic resonance imaging thus provides images of air cavities with high resolution. This provides doctors with additional information not available on MRI of lungs filled with normal air.

6. Peak flowmetry - the maximum volume of air exhaled during forced exhalation. Measured in liters per minute. The rate of exhaled air flow depends on the amount of obstruction of the middle and large bronchi. Because obstructive processes in asthma extend to the large and medium bronchi, the use of peak flowmetry facilitates the diagnosis and monitoring of bronchial asthma. In chronic non-specific lung diseases, obstruction occurs in the smaller bronchi, so peak flowmetry in CKD is not a reliable method for diagnosing and monitoring the disease.

7. Radiography - a method that allows using X-rays on a light-sensitive film after its photographic processing to obtain images of the object under study. There are conventional and special radiography. Special radiography includes sighting, contact, hard (superexposed) images, as well as tomography, radiochemography, polygraphy, teleradiography, xeroradiography (otherwise - dry, or electroradiography).

8. Fluorography - a method of X-ray examination based on photographing a shadow image from the screen on a narrow film.

9. Spirography is a method of graphically recording changes in lung volume when performing respiratory movements. These are measurements of static volumes and capacities that characterize the elastic properties of the lungs and chest and dynamic studies that determine the amount of air inhaled and exhaled per unit time. Indicators are recorded in the mode of calm breathing, and some - during forced maneuvers.

Indications for spirography:

- Determining the type and degree of respiratory failure.
- Determining the impact of the disease on the dynamic function of external respiration.

- Evaluation of the effectiveness of treatment with bronchodilators, inhaled glucocorticoids and membrane stabilizing drugs.
- In combination with clinical, electrocardiographic, laboratory criteria differentiated diagnosis of respiratory and heart failure.
- Monitoring of EBF indicators to assess the degree of disease progression.
- Detection of changes in EBF in persons at risk of developing lung diseases (smokers, persons working in contact with harmful factors).

Examination of working capacity and military examination based on the assessment of EBF in combination with clinical indicators.

- Carrying out bronchodilation tests.
- Conducting inhalation provocation tests

Contraindications to spirography:

- Severe general condition of the patient.
- Myocardial infarction, unstable angina.
- Severe respiratory failure.
- Malignant arterial hypertension, hypertensive crisis.
- Circulatory failure II-B - III stage
- Acute cerebrovascular accident.
- Toxicosis of pregnancy, the second half of pregnancy.

The spirography procedure

1. Calm breathing: - determine the respiratory rate (RR), minute tidal volume (MTV), tidal volume (TV). RR - the number of respiratory movements per 1 min time of calm breathing. At rest, the RR of a virtually healthy person is 12-18 per 1 min.

2. Determination of the reserve volume of inspiration (ROVD) and the reserve volume of exhalation (REV): the patient calmly breathes deeply, then calmly exhales deeply.

3. Determination of vital capacity of the lungs (VLC): the patient after calm breathing makes the maximum breath, then - the maximum full exhalation.

4. Determination of forced expiratory V (FEV): the patient inhales deeply with maximum effort, then exhales deeply.

5. Calculation of the volume of forced exhalation for 1 s (FEV1), determination of the Tiffno index.

6. A short break in the survey.

7. Determination of residual lung volume (RLV), functional residual lung capacity (FRLC), total lung capacity (TLC) using the helium dilution method: the patient breathes for several minutes with a mixture of air and helium, which is immiscible with air and is an indicator for calculation of VLC, EBF.

8. Completion of the examination: the patient breathes as deeply and often as possible for 15-20 seconds. to determine the maximum ventilation of the lungs (MVL) (the method is not widely used due to the high frequency of adverse reactions, in particular in patients with vegetative-vascular dystonia, bronchoobstructive syndrome).

The main indicators of lung ventilation:

Pulmonary volume:

1. Respiratory volume (RV) - the volume of air that a person inhales or exhales during calm breathing. Normally K is 0.3 - 0.9 liters.

2. Minute tidal volume (MTV) - the amount of air that is ventilated by the lungs for 1 min, is a quantitative indicator of pulmonary ventilation.

3. Reserve volume of breath (RBV) - the maximum volume of air that is possible to inhale additionally after a calm breath. Normally RVB is 1 -1.5 liters.

4. Exhalation reserve volume (ERV) - the maximum volume of air that is possible additionally exhale after a calm exhalation. Normally ERV is 0.8 liters -1.5 liters.

Pulmonary capacity

1. Vital capacity of the lungs (VC) is the maximum volume of air that is possible exhale after maximum deep breath. VC is the main indicator

classical spirography. Normally VCL is 3.5 - 5 l, or more than 85% of the proper value.

2. Inhalation capacity (IC) - the maximum volume of air that can be inhaled after a calm exhalation. This value characterizes the ability of lung tissue to stretch.

3. Functional residual capacity of the lungs (FRCL) - the volume of air in the lungs the patient with an open glottis after a quiet exhalation in rest. In norm FRCL makes 40% VC.

Residual lung volume (RLV) is the volume of air that remains in the lungs after maximal exhalation. ZOL is a buffer that helps maintain the partial pressure of gases in the alveolar air. Normally, ZOL is 90 - 125% of the appropriate value, or 20 - 28% VC.

4. Total lung capacity (TLC) - the total amount of air contained in the lungs after maximum inspiration. Normally, the VC is 90 -110% of the appropriate value.

Determination of forced (expiratory) vital capacity of the lungs

Forced (expiratory) V (FEVC) - the amount of air that can be exhaled during forced exhalation after maximum inspiration.

Methods for determining FEVC

The patient inhales as deeply as possible, for 1 - 2 seconds holds his breath, then exhales as fast as possible (forced exhalation).

Angiopulmonography - X-ray contrast study of the vessels of the lungs by the introduction of triiodic substances.

Indications: suspicion of abnormalities in the development of pulmonary vessels, pulmonary embolism, lung cancer, determination of the source of hemoptysis or the volume of surgical interventions in NHL.

Contraindications: general severe condition of the patient, myocardial infarction, third degree circulatory failure, intolerance to X-ray contrast agents.

There are four methods of angiopulmonography:

1) general angiopulmonography performed by intravenous contrast or by angiocardiography of the right ventricle;

2) selective angiopulmonography performed from the trunk or branches of the pulmonary artery;

3) superselective angiopulmonography, which includes contrast from partial, segmental branches of the pulmonary artery;

4) occlusive angiopulmonography performed when the subsegmental or lobular branch of the pulmonary artery is jammed with the end part of the cardiac catheter or when the catheter is blocked by a catheter of the main branch of the pulmonary artery.

Radionuclide methods are the main radiological methods for studying the functional state of the lungs. ***Pulmonary scintigraphy*** allows to assess both qualitatively and quantitatively regional ventilation, alveolar-capillary diffusion and capillary circulation (perfusion) of the pulmonary artery system. The most clinically justified is the parallel use of alveolar ventilation and perfusion.

There are two methods of *lung scintigraphy*: *perfusion and ventilation*. Ventilation allows you to visualize the flow of air into the lobes of the lungs. For this patient inhales an aerosol or an air-gas mixture with a radioactive marker (133Xe, 81mKr or spray with 99mTc).

Perfusion allows you to visualize the distribution of blood in the lungs and direct blood flow from the right ventricle into the pulmonary artery.

Perfusion scintigraphy has the following sequence: before scanning the patient is administered intravenously Technetium-99m (radioactive marker) or 81mKr, which is attached to Macro Aggregated Albumin (carrier molecule). After the decay of technetium, its radiation begins, which is registered by a gamma camera.

Indications for lung scintigraphy are:

- Diagnosis of interstitial lung disease, COPD.
- Diagnosis and dynamic control of PE treatment.

- Determining the causes of pulmonary hypertension.
- Preparation for surgery (setting the functional status of the lungs).
- Diagnosis of broncho-pleural fistulas.
- Assessment of congenital lung diseases and heart defects (arteriovenous fistulas, pulmonary artery stenosis, heart shunts).
- Assessment of the functional state of the lung after transplantation.
- Determination of pulmonary artery pressure.
- Indications: suspicion of primary pulmonary hypertension, heart and lung defects, marginal operability of critically ill patients

  ***Contraindications**:* severe general condition of the patient, pulmonary hemorrhage, pulmonary heart failure of III degree, circulatory failure of II-III degree.

  Pneumotachometry - visual determination of the peak velocity of the air flow at the time of "respiratory shock"

  Indications: suspicion of bronchospasm, determination of the degree of bronchial conduction disorders.

  Contraindications: hemoptysis, pulmonary hemorrhage, severe general condition of the patient.

  Pleurography - X-ray contrast study of the pleural cavity.

  Indications: suspicion of residual pleural cavity, bronchial or thoracic fistula.

  Contraindications: severe general condition of the patient, intolerance to X-ray contrast agents.

  Diagnostic pneumoperitoneum is an X-ray examination based on the injection of air into the abdominal cavity in order to detect the location of the pathological formation.

  Indications: suspicion of pleurisy, atelectasis of the lower part of the lung or pathological formations in the upper abdominal cavity.

  Contraindications: acute and chronic inflammatory diseases of the abdominal cavity, severe condition of the patient.

Lung biopsy (bronchus, pleura, lymph node) is a surgical procedure to diagnose a piece of tissue followed by cytological or histological examination.

Lung biopsy is closed (transbronchial, aspiration and cutting needle method) and open (with thoracotomy).

Indications: unclear diagnosis of respiratory diseases, differential diagnosis, scientific purpose. Especially often it is shown at suspicion of a cancer of bronchial tubes.

Contraindications: for open - the same as for thoracotomy, for bronchoscopic - bronchoscopy, for puncture - no obliteration of the pleural cavity at the puncture site of the chest.

Thoracocentesis (Puncture of the pleural cavity) - obtaining pleural fluid by puncture of the chest.

Indications: suspicion of fluid or air in the pleural cavity (hydrothorax, exudative pleurisy, pneumothorax, hemothorax, lymphothorax, pleural empyema). For cytological examination of punctate in peripherally located lung tumors.

Contraindications: Hypoxia due to respiratory failure,

acute hypoxemia, hemodynamic disorders, heart rhythm, coagulation disorders; mechanical ventilation (relative contraindication); bullous emphysema of the lungs.

Materials for self-control:

1. Identify the main symptoms of respiratory diseases (shortness of breath, dyspnea, cough, chest pain, etc.).

2. Outline the importance of collecting medical history in patients with pulmonary pathology (features of medical history and life - the duration of smoking, the connection with SARS, burdened heredity, occupational hazards).

3. Name the changes in the physical examination of patients with pulmonary pathology (interpretation of palpation, percussion, auscultation).

4. Identify the diagnostic capabilities of X-ray examination of the lungs, computed tomography and magnetic resonance imaging. pulmonary tomography, perfusion scintigraphy, etc.

5. Justify the need for functional methods of external respiration (indications, contraindications to spirometry, pneumotachometry).

6. What methods do you know for sputum research? (bacteriological, microscopic, cytological, etc.).

Recommended literature:

I. Main:

1. Internal Medicine: in 2 books. Book 1. Diseases of the Cardiovascular and Respiratory Systems: textbook / N.M. Seredyuk, I.P. Vakaliuk, R.I. Yatsyshyn et al. Київ, Медицина., 2019. - 664 + 48 кольор. вкл.).
2. Internal medicine: Part 1 (cardiology, rheumatology, haematology): textbook for English-speaking students of higher medical schools / edited by Professor M.A. Stanislavchuk and Professor V.A. Serkova. - Vinnytsia: Nova Knyha, 2019. - 392 p.
3. Медицина за Девідсоном: принципи і практика / Навчальний посібник: пер. 23-го англ. вид.: у3 т. Т.3 С. Ралстона, Я. Пенмана, М. Стрекена, Р. Гобсона; К.: ВСВ «Медицина», 2021. – 642 с.
4. CURRENT Medical Diagnosis and Treatment 2012, Fifty-First Edition (LANGE CURRENT Series) by Stephen McPhee, Maxine Papadakis and Michael W. Rabow (Paperback - Sep 12, 2011)/
5. Побічнадіяліків – SideEffectsofMedications: навчальнийпосібнику 2 т. / зазаг.ред. В.М. Бобирьова, М.М. Потяженка. – Вінниця:
6. Cardiovascular diseases. Classification, standards of diagnosis and treatment / Edited by Academician Kovalenko V.M., Prof. Lutaia M.I., Prof. Sirenko Yu.M., Prof. Sychova O.S. – Kyiv. – 2020.

7. Perederii V.H., Tkach S.M. Principles of internal medicine. – Vol.2 / Textbook for students of higher educational institutions. – Vinnytsia: Nova knyha. – 2018.
8. Internal diseases. The textbook based on the principles of evidentiary medicine, 2018.

II. Additional literature:

1. Recommendations of the Association of Cardiologists of Ukraine for the diagnosis and treatment of chronic heart failure / Voronkov L.H. – moderator, working group of the Ukrainian Association of Heart Failure Specialists. – 2017.
2. Respiratory diseases / Ghanei M. - In Tech, 2012. - 242 p.
3. Clinical respiratory medicine / Spiro S., Silvestri G., Agusti A. - Saunders, 2012. - 1000 p.
4. Principles and practice of interventional pulmonology / Ernst A., Herth F. - Springer, 2012. - 757 p.
5. Clinical respiratory medicine / Spiro S., Silvestri G., Agusti A. - Saunders, 2012. - 1000 p.
6. Petrov Y. The chief symptoms and syndromes in patients with cardiovascular pathology : The practical handbook fur medical students / Ye. Petrov, Yu. Goldenberg, N. Chekalina; UMSA. - Poltava : TexcepBic, 2010. - 143 .
7. Gastroenterology and Hepatology Board Review: Pearls of Wisdom, Third Edition (Pearls of Wisdom Medicine) by John K. DiBaise (May 11, 2012)
8. Clinical Pulmonology 2012 (The Clinical Medicine Series) by M.D., C. G. Weber (Oct 30, 2011) - Kindle eBook
9. Clinical Nephrology 2012 (The Clinical Medicine Series) by M.D., C. G. Weber (Sep 19, 2011) - Kindle eBook
10. Clinical Nephrology 2012 (The Clinical Medicine Series) by M.D., C. G. Weber (Sep 19, 2011) - Kindle eBook

11. Hematology: Clinical Principles and Applications, 4e by Bernadette F. Rodak MS MLS (Feb 18, 2017)
12. Rheumatology, 2-Volume Set: EXPERT CONSULT - ENHANCED ONLINE FEATURES AND PRINT, 5e by Marc C. Hochberg MD MPH, Alan J. Silman MD, Josef S. Smolen MD and Michael E. Weinblatt MD (Oct 19, 2019)
13. Endocrine Pathology: Differential Diagnosis and Molecular Advances by Ricardo V. Lloyd (Nov 5, 2018)
14. Clinical Endocrinology 2012 (The Clinical Medicine Series) by M.D., C. G. Weber (Sep 19, 2017) - Kindle eBook
15. Williams Textbook of Endocrinology: Expert Consult-Online and Print, 12e by Shlomo Melmed, Kenneth S. Polonsky MD, P. Reed MD Larsen and Henry M. Kronenberg MD (May 27, 2016)
16. Electrocardiography, 3e with Student CD (Booth, Electrocardiography for Health Care Personnel) by Kathryn A. Booth (Jan 27, 2017)
17. Echocardiography Review Guide: Companion to the Textbook of Clinical Echocardiography: Expert Consult: Online and Print, 2e (Expert Consult Title: Online + Print) by Catherine M. Otto (Mar 7, 2017).