NATIONAL PIROGOV MEMORIAL MEDICAL UNIVERSITY, VINNYTSYA

It is ratified
at the conference of Department of Surgery #1
Medical Faculty #1/ Chief of Department

Professor of HEI V.A. Shaprinskiy
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THE MANNUAL

FOR INDIVIDUAL WORK OF STUDENTS
AT THE TRAINING BEFORE LESSON

Educational discipline	Surgery
Module	2
Topic of the lesson	Spontaneous pneumothorax. Surgical thoracic complications of COVID infection
Year	V
Faculty	Medical #1

1. **Actuality:** Spontaneous pneumothorax (SP) belongs to quite frequent conditions, can occur without apparent reasons or be a complication of a wide range of diseases. Despite, it would seem a typical clinical picture and pathophysiological disorders, in practice it can often lead to diagnostic and tactical errors, sometimes fatal. The most dangerous type SP - tension SP - requires a doctor of any specialty to take immediate and adequate actions in diagnosis and providing emergency care.

In the practice of any doctor who provides a care to a patient with COVID infection, situations related to appearance of gas syndrome (SP, pneumomediastinum, subcutaneous emphysema) and surgical complications due to secondary bacterial infection (pleural empyema, purulent pneumoceles) may occur. Timely diagnosis, adequate treatment, and, sometimes, emergency care in such conditions largely determine the outcomes of treatment and have a direct impact on the mortality rate.

2. Educational purposes of class:

• know the definition, causes, pathogenesis of SP
• learn the clinical and radiological signs of SP
• be able to recognize a tension SP and provide emergency assistance to the patient
• be able to draw up a treatment and diagnostic program for SP, to offer adequate types of operations
• offer rehabilitation to patients who have undergone SP
• know the reasons of occurrence, pathogenesis, features of the course of SP, pneumomediastinum, pneumocele in case of lung damage by COVID infection
• learn the peculiarities of the clinic and diagnosis of SP in the case of lung damage by COVID infection, including in patients under assisted ventilation
• be able to recognize a tension SP due to lung damage by a COVID infection and provide emergency assistance to the patient
• be able to draw up a treatment and diagnostic program for SP, pneumomediastinum due to lung damage by COVID infection, offer an adequate volume and timing of possible operations
• understand the prerequisites of the mechanism of surgical complications appearance at bacterial superinfection in the case of lung injury of COVID.
• understand the peculiarities of the clinical picture and diagnosis of EP, purulent pseudocysts of the lungs against the background of COVID infection
• be able to prescribe antimicrobial and surgical treatment to patients with COVID infection complicated by EP, purulent pseudocysts of the lungs
• offer rehabilitation to patients who have undergone surgical complications of lung damage caused by COVID infection

3. Goals of the specialist's personality development (educational)

• Form a holistic impression of the important role of any doctor in recognizing and providing care for SP, pneumomediastinum, thoracic complications of lung damage caused by COVID infection.
• Communicate with patients
• Interact with medical personnel, to consolidate teamwork skills when drawing up a plan for examination and treatment of a patient
• Cultivate a responsibility for the adequacy of decision-making during the diagnosis and treatment of patients with thoracic pathology. To be aware of ethical and legal responsibility for professional actions

4. Basic knowledge, abilities, skills, that are necessary for a training

Disciplines	To know	To be able
Anatomy, topographic anatomy	The structure and topography of the lungs, trachea, bronchial tree. Anatomy of acinus. Blood supplement of lungs. Segmental structure of lungs. Surgical approaches to the organs of thorax.	To define the location of pathological process in lungs.
Physiology	Biomechanics of the breathing. Pleural and transpulmonary pressure. Gas exchange. Frank-Starling's law for the heart.	Explain the mechanism of SP, pneumomediastinum appearence
Pathological physiology	Types of respiratory insufficiency. Mediators of inflammation, their action on a bronchial and vascular wall. Circulatory disorders at inflammation.	Explain the pathological processes at tension SP, pneumomediastinum. Explain respiratory disorders with COVID-19
Microbiology	The exciters of purulent diseases of lungs (nonclostridial anaerobes, aerobes), their properties, factors of aggression, methods of authentication.	To choose a biological environment and appoint the methods of research that are necessary for microbiological diagnostics
Radiology	The principles of basic radiological methods. Radiological anatomy of the lungs. X-ray signs of pneumothorax, pleurisy, pneumomediastinum, hollow formations in the lungs.	To choose the radiological method. According to X-ray signs, diagnose free air and fluid in the pleural cavity; recognize hollow formations in the lungs.
Internal diseases	Methods of physical examination of the thorax. The additional investigations for patients.	To fulfill the palpation, percussion, auscultation. To read the blood and sputum analyses.
Infectious diseases	Etiology, pathogenesis, clinic, diagnosis, medical treatment of pneumonia caused by COVID-19 infection	Make a diagnosis, give a medication to the patient
Pharmacology	Antibiotics, antiseptics, anti-inflammatory drugs.	To make the medicinal prescriptions for the patient.
General surgery	Aseptic and antiseptic. Antibiotic therapy (system, local) at the surgical infection. Method of punction and closed drainage of purulent cavities. Types of the drainage.	To choose the tube for thoracic drainage. To prepare the valvular underwater system. Replace the bandage around the drainage tube.

5. The content of the topic and its structuring

Spontaneous pneumothorax

Spontaneous pneumothorax (SP) is an accumulation of free air in a pleural cavity that occurs for no apparent reason or because of existing pathology of the lungs, less often - the esophagus, diaphragm. Pneumothorax was first described in 1724 by N. Boerhaave. The term "pneumothorax" was introduced by J. Itard in 1803, and later (1819) R. Laennec described the clinical picture of the disease.

Primary spontaneous pneumothorax occurs in people without lung diseases; it happens infrequently. The air leaks usually from the pulmonary alveoli through a tear at the apex. It mostly occurs in tall, thin men aged 20-40. The influence of anthropometric characteristics of patients with SP is explained by the fact that the small area of the base and the significant height of the pleural cone create prerequisites for the creation of a high rarefaction in the pleural dome, which in turn causes "overstretching" of the tops. For the same reason, under the specified conditions, it is a predictor for the appearance of bullous appearance on the tops of the lungs. Thus, emphysematous changes are most often detected in tall, thin subjects with a mass-growth

index of less than 22.

Secondary spontaneous pneumothorax is mostly a complication of lung diseases, much less often – diaphragmatic defect or esophageal rupture. Among the causes of secondary spontaneous pneumothorax, a bullous lung disease (pathological states of the respiratory system, which are characterized by excessive stretching of the alveoli of the lungs with the destruction of their walls and the formation of air cavities) is most common. Besides, diseases of the respiratory tract (chronic obstructive pulmonary disease, cystic fibrosis, asthma); air cysts, infectious lung diseases (tuberculosis, covid infection, pneumocystis pneumonia, bacterial destruction); interstitial lung diseases (sarcoidosis, idiopathic pneumosclerosis, Wegener's granulomatosis, lymphangioleiomyomatosis, tuberous sclerosis, histiocytosis, etc.); connective tissue diseases (rheumatoid arthritis, ankylosing spondylitis, polymyositis and dermatomyositis, scleroderma, Marfan syndrome); some malignant neoplasms (sarcoma, lung cancer); thoracic endometriosis, esophageal ruptures can lead to SP as well.

The morphological substrate for the appearance of pneumothorax is often subpleurally located hollow cavities in the lung tissue, pleural adhesions, granulomas, areas of fibrosis, etc. Depressurization of the lung occurs, as a rule, with ruptures of hollow formations. Lung tears are also possible in places where lung is fixed by a pathological process (adhesions, tumor). There are data on the presence of micropores with a diameter of up to 10 μm in the wall of the bullas, which can cause SP without its rupture. In addition, penetration of air into the pleural cavity is possible through defect of the esophagus in non-traumatic rupture (in particular, at Boerhaave syndrome), fenestration of the diaphragm at extra genital endometriosis.

Pathogenesis. A negative pressure in the pleural cavity is maintaining along the entire respiratory cycle (from –8 to –10 mm Hg at inhalation and from –3 to –6 mm Hg during exhalation; while the rarefaction increases directing from chest bottom to top due to effect of gravity on the lungs). Intrabronchial pressure during apnea and an open glottis is equal to atmospheric pressure; it has a positive value during exhalation (+1–+5 mm Hg), increases markedly during phonation (up to +10 mm Hg), significantly more during shouting, coughing (up to +70 mm Hg). Thus, transpulmonary pressure (the difference between alveolar and intrapleural pressure) ensures the direction of air movement inside the pleural cavity. Due to the gradual disappearance of intrapleural rarefaction and under the influence of lung elasticity, pulmonary collapse occurs. At the same time, in the absence of an adhesive process between the sheets of the pleura, the lung collapses towards a mediastinum (between a root and diaphragm, according to the location of the transition line of the visceral leaf of the pleura into the parietal one). Otherwise, in the presence of pleural adhesions, the lung remains fixed in these places and collapses partially.

At some conditions, which increase the pressure gradient (bronchial obstruction, cough, phonation, screaming, mechanical ventilation, etc.) and the presence of a one-way valve mechanism for air inflow into the pleural cavity, the intrapleural pressure may exceed the intrabronchial pressure during calm breathing. In such cases, a tension pneumothorax occurs. It is characterized not only by respiratory, but also by hemodynamic disorders. They are caused by displacement of the mediastinum and subsequent compression of the vena cava, which leads to impaired blood flow to the heart, progressive weakening of heart contractions up to asystole.

The risk factors for the SP are: smoking, passive smoking, polluted air, rapid growth in adolescents, viral infections of the respiratory tract, pneumofibrosis due to transferred nonspecific and specific inflammatory processes, genetically determined weakness of connective tissue, congenital deficiency of elastase-α1-antitrypsin inhibitor (occurs enzymatic destruction of lung tissue), attacks of pertussis cough, sneezing, straining and other situations accompanied by a sharp increase in intra-bronchial pressure.

Clinics. The main clinical symptoms of SP are chest pain or discomfort and shortness of breath. The localization and radiation of pain can be quite diverse (behind the sternum, in the back, radiating to the upper arm, neck, hypochondrium, epigastrium), which sometimes creates difficulties for differentiation. Typical physical signs are weak voice tremor, faint breath sounds

or their absence, a box-like percussion sound over the lung field on the side of the lesion. The clinical picture depends on the size of pleural connection with the air-containing structure and the pressure gradient. In case of a violent course of SP, the onset is acute, is accompanied by chest pain, increasing shortness of breath, difficulty speaking, cyanosis, orthopnea, tachypnea. The latent variant of SP is characterized by a gradual, often several-day increase in symptoms and long-term preservation of the patient's generally satisfactory condition. Many patients with non-tension SP get adaptation at rest: pain and dyspnea decrease, although load tolerance reduces.

In case of a tension SP, in addition to the mentioned symptoms, a swelling of the neck veins and a decrease in blood pressure and tachycardia (as manifestations of a block of venous inflow to the heart and, accordingly, a decrease in cardiac output) are determined. Such symptoms as progressive subcutaneous emphysema, asymmetry of the chest with an increase in the affected half, bulging of the subclavian and supraclavicular areas, trachea shift towards healthy side and significant heart dislocation testify to intra-pleural compression as well.

Diagnostics. Chest X-ray at SP reveals homogeneous transparency with contouring of the collapsed lung edge (fig.1). Intense displacement of the mediastinal shadow to the healthy side, widening of the intercostal spaces and a diaphragm depression indicate a tension SP (fig.2).

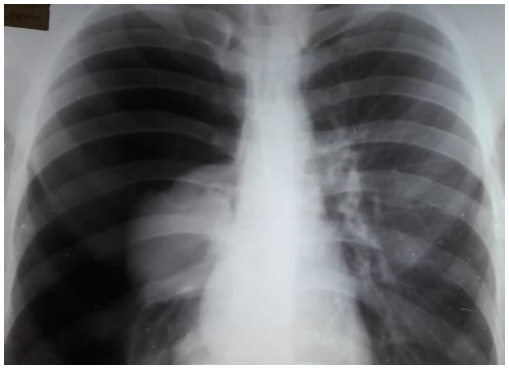


Fig.1

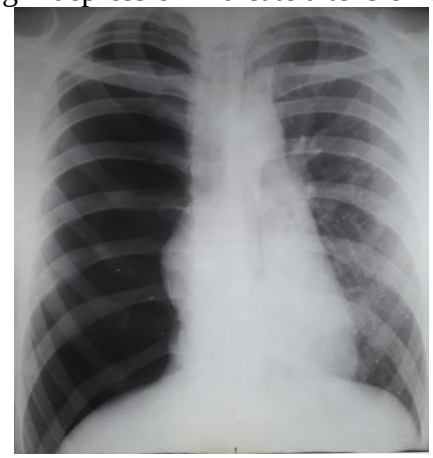


Fig.2

Computed tomography (CT) is a basic method of diagnosis, which allows not only to visualize the accumulation of air in the pleural cavity, but also to establish the severity and localization of bullous changes in the lungs or to detect other diseases that causes pneumothorax. In order to establish the causative lung disease, it is advisable to carry out (CT) already after the drainage of the pleural cavity, optimally - when the lung is expanded, then the value of examination increases.

Video thoracoscopy (VAT) is an important method in the diagnosis and treatment of SP. For the first time, A. Sattler used thoracoscopy due to spontaneous pneumothorax in 1937; he also described the thoracoscopic pattern of bullous lung. The technique allows not only to observe a lung surface, identify the source of air leakage, biopsy if necessary, but also to perform almost the entire range of intra-thoracic operations.

The diagnosis can also be confirmed by the chest ultrasound. A thoracentesis (pleural puncture) is used for diagnostics in an urgent situation if there is some diagnostic doubt.

It is important that the tension SP should diagnosed by clinical data, as it requires immediate care.

Complications of SP: intra-pleural bleeding due to rupture of lung tissue or chest vessels by pleural adhesions (hemopneumothorax); exudative pleurisy (pneumopleurisy). Tension SP causes progressive respiratory failure, mediastinal or (and) subcutaneous emphysema, hypotension, asystole.

Treatment tactics.

Emergency care for tension SP is a needle decompression (i.e. converting a valvular

pneumothorax to an open one). The decompression needle is inserted optimally in the 2nd intercostal space along the mid-clavicular line and remains there until the pleural drainage.

The common treatment of SP is urgent pleural drainage (e.g. by the modified Bülau technique) under local anesthesia with the installation of a chest tube in the 2nd intercostal space along the mid-clavicular line or the 4th intercostal space along the mid-axillary line. At massive pleural adhesions, the drainage inserts in the place of air accumulation. When the lung does not expand after drainage due to wide fistula, at recurrence of pneumothorax, as well as in order to eliminate the causative lung pathology, VATS or open surgery is necessary. It includes a closure of lung defects (sealing with a mechanical or hardware suture), bullous excision, pulmonary resections (of affected parts of the lung), pleurodesis, as well as intervention on the diaphragm in case of catamenial SP, suture of a defect in the esophagus, etc.

Thoracentesis can be effective at lung collapse up to 20% and only in some cases when the tightness of the lung tissue at the time of manipulation has already been restored, i.e. it is possible to achieve a stable hermetic. Recovery of SP after puncture requires tube drainage with further management of the patient according to the described scheme.

Treatment for spontaneous hemopneumothorax starts from urgent pleural drainage (optimally - in the axillary area). Further tactic depends on intensity of intra-pleural bleeding (discussed in detail at the topic "Chest Injuries").

Surgical complications of lung lesions caused by COVID-19

Lung infections with the COVID-19 virus can cause some surgical complications. They could be divided into three groups: associated with an appearance of gas syndrome (SP, pneumomediastinum, subcutaneous emphysema), due to secondary bacterial infection (pleural empyema, purulent pneumocele, lung abscess) and thromboembolic. The first two groups are considered within the framework of the topic.

The pathogenesis of SP, pneumomediastinum, subcutaneous emphysema is multicomponent. Viral lesion of lung tissue causes diffuse alveolar and interalveolar membranes damage, desquamation of alveolocytes, edema of interstitial tissue, the formation of hyaline membranes, later - the development of fibrosing alveolitis. It leads to rupture of the alveoli and appearance of a pneumatocele. Inducing factor for the emerge, growth and rupture of intrapulmonary cavities is hypertension in the respiratory tract due to pertussis cough, positive pressure respiratory support or mechanical ventilation. Violation of bronchial patency after specific injury to the airways (i.e. edema, desquamation of the epithelium, destruction of muco-ciliary clearance) and loss of elasticity of the lung parenchyma make unfavorable background.

As a matter of fact, ruptures of air cavities can occur in different ways. With subpleural localization, there is a rupture of the visceral pleura with a consequence in SP. On the contrary, when air enters the interstitial space of the lung, there is a stratification of the perivasal and peribronchial spaces, which spreads to the root of the lung and the mediastinum, then pneumomediastinum occurs. A combination of both mechanisms is also possible.

The described complications pose a particular danger for patients who undergo mechanical ventilation. In such cases, due to the forced positive pressure in the respiratory tract, a tension pneumothorax or pneumomediastinum quickly develops, which are fatal if no help is provided.

Purulent surgical complications of COVID-19 pneumonia appear after bacterial superinfection. Thus, intrapulmonary located pneumatocele can become secondarily infected with endogenous or nosocomial flora. Such purulent cysts worsen the course of COVID-19 pneumonia due to the deepening of intoxication and respiratory failure. Pleural empyema in patients with COVID-19 infection also develops as a result of secondary bacterial infection: either at parapneumonic pleurisy (can reach up to 7.3% in critically ill patients with COVID-19 pneumonia), or after persistent SP (in this case, EP with bronchopleural fistula occurs). A general tendency in the course of such EPs is rapid development of the lung rigidity, which requires surgical intervention.

The **clinic and diagnostics** of spontaneous pneumothorax in COVID-19 pneumonia

patients can be difficult due to interpreting a shortness of breath against the background of the underlying disease, as well as difficulties in physical examination that is conducted under special infection control conditions. In any case, a finding of patient's hypoxia resistance to oxygen flow, manifestations of mediastinal compression (swelling of cervical veins, decrease in blood pressure and tachycardia), subcutaneous emphysema progress, asymmetry of the chest with an increase in the affected half, bulging of the subclavian and supraclavicular zones, trachea and heart shift are critically important as revealing tension pneumothorax. The diagnosis is confirmed with chest ultrasound, X-ray, CT. In critical conditions, the use of diagnostic pleural puncture is justified.

Pneumomediastinum is manifested by the appearance of symmetrical subcutaneous emphysema on the neck, which spreads to the face, chest, abdomen and limbs. Tension pneumomediastinum is characterized by rapid progression of emphysema, increasing hypoxia (due to compression of small vessels of a small circle in the interstitium) and the development of mediastinal compression syndrome similar to tension SP. CT and X-ray confirms a collection of air within soft tissues (fig.3)

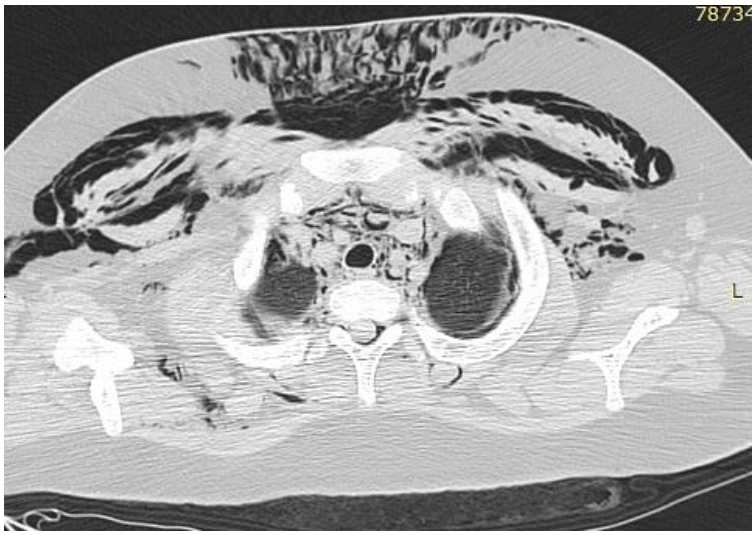


Fig.3

Suspicion to pneumatocele suppuration arises when signs of purulent inflammation appear in patients who previously showed some improvement against the background of regression of the viral lesion: the body temperature raises again, intoxication increases. The cough begins to be accompanied by the release of purulent sputum, the bacterioscopic and bacteriological studies of which reveal pathogens. Laboratory tests become typical for bacterial inflammation like neutrophilic leukocytosis with a shift to immature cells, an increase in the procalcitonin level. CT is the most informative among diagnostic procedures.

Diagnosis of EP in patients with COVID-19 infection has certain features depending on the origin of pleural suppuration. Thus, in the case of bacterial infection of parapneumonic pleurisy, the possibilities of clinical, X-ray, and ultrasound studies in differentiating serous and purulent exudate are limited. Blood markers of bacterial superinfection make importance; although a pleural puncture and establishing the obtained fluid characteristics by cytological and microbiological studies are decisive. In situations when EP develops on the background of a long-standing SP, bacterial invasion is indicated by the appearance of fibrin and purulent secretions into pleural drainage. In view of the need to establish the extent and localization of pus collections, the state of the lung parenchyma, possible pathological changes in the contralateral lung, such patients should undergo a CT scan.

Treatment tactics.

In patients with COVID-19 lung damage, both spontaneous pneumothorax and pneumomediastinum often cause mediastinal compression. This is facilitated by a pertussive cough, hypertension in the respiratory tract when performing respiratory support with positive

pressure or mechanical ventilation, impaired patency of both main and small air ways due to desquamation of the epithelium, swelling of the walls, etc.

In the case of a tension pneumothorax, it is vital to diagnose it early by clinical signs (see above) and provide immediate care by needle decompression. The actual treatment of SP consists in drainage the pleural cavity. Further tactics correspond to those described for secondary pneumothorax (i.e. CT, surgical intervention if necessary).

Tension mediastinal emphysema requires urgent opening and drainage of the anterior mediastinum. The intervention is performed under local anesthesia through a transverse approach above the sternum. It is mostly sufficient to conduct a dissection of the skin, fascia and tissue of the neck to the anterior surface of the trachea.

Purulent false cysts usually require surgical removal (cystectomy), optimally – after acute inflammation subside in the surrounding parenchyma. With EP, adequate drainage of pleural purulent cavity is necessary. In cases of EP with a bronchopleural fistula, it is rational to carry out multi drainage with installing a separate upper tube for air evacuation. In the absence of the lung expansion, its decortication and fistula surgical closure should be performed.

Antimicrobial therapy is prescribed in accordance with the Protocol "Provision of medical assistance for the treatment of coronavirus disease (COVID-19)", approved by the order of the Ministry of Health of Ukraine dated April 2, 2020 No. 762 (as amended). Antibiotic therapy is not indicated for SP and pneumomediastinum without bacterial superinfection. In case of bacterial complications, cephalosporins of the III generation (ceftriaxone, cefotaxime, ceftazidime, cefoxime, cefoperazone, cefpodoxime) are prescribed in combination with macrolides (azithromycin or clarithromycin); alternative: respiratory fluoroquinolones (levofloxacin or moxifloxacin) as monotherapy or in combination with third-generation cephalosporins. In the presence of polyresistant microflora, it is necessary to use 2 or even 3 antibacterial drugs, carbapenems (meropenem) or tigecycline. Vancomycin or linezolid should be prescribed if Gram-positive polyresistant cocci (e.g. MRSA) is prevalent. When prescribing drugs empirically, it is necessary to take into account the results of bacterioscopy of sputum and pleural secretions (Gram+ or Gram- flora), the epidemic situation in the hospital where the patient stays. Afterwards, the correction is performed according to the data of bacteriological studies.

4. Theoretical questions for the lesson:

- Definition of SP
- Etiology, pathogenesis of SP;
- Tension SP: definition, pathogenesis of disorders;
- SP clinics depending on course options;
- Clinical recognition of tension SP;
- X-ray signs of SP;
- Emergency care for a tension SP;
- Treatment of SP. Diagnostics and treatment program taking into account the underlying pathology; kinds of surgical interventions;
- Rehabilitation and follow-up of patients after the SP;
- Causes and pathogenesis of SP, pneumomediastinum, pneumocele in case of lung damage by COVID infection;
- Peculiarities of the course and clinical picture of SP when the lungs are affected by COVID infection, including in patients on assisted ventilation;
- Diagnosis of pneumomediastinum in case of lung damage by COVID infection;
- Emergency care and treatment of SP in case of lung damage by COVID infection;
- Treatment of pneumomediastinum when the lungs are affected by COVID infection;

- Prerequisites and pathogenesis of surgical complications with bacterial superinfection (purulent pseudocysts, empyema of the pleura) when the lungs are affected by COVID infection.
- Clinic and diagnosis of EP, purulent pseudocysts of the lungs against the background of COVID infection
- Peculiarities of antimicrobial and surgical treatment of patients with COVID infection complicated by EP, purulent pseudocysts of the lungs
- Rehabilitation of patients who have undergone surgical complications of lung lesions caused by COVID infection

Materials for self-control:
A. Tests:

1 Spontaneous pneumothorax includes:
a) traumatic
b) postoperative
c) medical
d) catamenial
e) iatrogenic

#2 Primary spontaneous pneumothorax occurs more often in:
a) asthenics
b) normosthenics
c) hypersthenics
d) the constitution is irrelevant

3 Catamenial pneumothorax occurs more often in:
a) children of preschool age
b) tall thin men
c) geriatric contingent
d) women

4 The direct cause of spontaneous pneumothorax is most often:
a) complications of tuberculosis
b) polycystic lung disease
c) pulmonary were
d) COPD
e) COVID infection

5 Spontaneous pneumothorax causes:
a) Lung atelectasis
b) Lung dyslectase
c) Lung collapse
d) The indicated phenomena are essentially equivalent

#6 Spontaneous pneumothorax in COPD belongs to:
a) primary
b) secondary
c) iatrogenic
d) depends on the situation

7 Tension pneumothorax more often is:
a) closed

b) valve
c) open
d) answer a) and b)
e) answer a) and c)
f) answer c) and b)
g) answer a) b) and c)

#8 Mortality in tension pneumothorax is caused by:
a) hypoxia
b) cardio-hemodynamic disorders
c) pleuro-pulmonary shock
d) all options are correct

#9 Tension pneumothorax should be diagnosed:
a) according to the clinical picture
b) by X-ray
c) by computer tomography
d) by ultrasound
e) all options are correct

#10 Emergency care for tension pneumothorax is:
a) pleural puncture
b) needle decompression
c) applying an occlusive dressing
d) passive drainage of the pleural cavity
e) active drainage of the pleural cavity
f) all options are correct

#11 Emergency care is necessary at:
a) closed pneumothorax
b) valvular pneumothorax
c) both
d) does not need any
#12 The CT in spontaneous pneumothorax is necessary:
a) when the lungs are not expanded
b) when empyema occurs
c) with COVID infection
d) if tuberculosis is suspected
e) in all cases of SP

13 In a patient with a tension SP and pulmonary failure of the III degree against the background of a COVID infection, first of all, it is necessary:
a) inject 16 mg of dexamethasone intravenously
b) start mechanical ventilation
c) perform needle decompression of the pleural cavity
d) perform a conicotomy
e) all answers are correct

14 Antibiotic therapy for a patient with SP on the background of a COVID infection:
a) is needed if drainage of the pleural cavity is performed
b) is needed in case of proven bacterial superinfection
c) is indicated if steroids are prescribed

h) answers a) b) and c)
d) is always needed
e) not needed at all

15 Pneumomediastinum against the background of COVID infection mostly occurs as a result of:
a) spread of air from the pleural cavity
b) perforations of acute gastrointestinal ulcers
c) the spread of air through the interstitia along the vessels and bronchi
d) diffusion of air through micropores in the membranous part of the trachea

16 A patient with progression of pneumomediastinum against the background of COVID infection needs:
a) injection of 16 mg of dexamethasone intravenously
b) performing an anterior cervicotomy
c) performing a lateral cervicotomy
d) performing a thoracotomy
e) performing a tracheostomy

17 Diagnostics of purulent pseudocysts against the background of COVID infection is optimal by:
a) physical examination
b) polyposition radiography
c) FBS
d) ultrasound
e) CT scan
f) VATS

#18 The most effective way to treat purulent pseudocysts against the background of COVID infection is:
a) Antimicrobial therapy
b) Surgical intervention
c) Antiviral therapy
d) Immunotherapy
e) All methods are equivalent

#19 A patient with a COVID infection has a multichamber pleural empyema with a bronchopleural fistula. The optimal surgery is:
a) Lobectomy
b) Pulmonectomy
c) Decortication of the lung, sealing of the fistula
d) Fistulectomy
e) The operation is not performed

#20 In a patient with empyema of the pleura against the background of a COVID infection, bacterioscopy revealed Gr- bacilli. Choose an antimicrobial agent:
a) Vancomycin
b) Amikacin
c) Linesolin
d) Sumamed
e) Favipiravir

B. Tasks for self-control:

Task #1. Men, 27, complaints of a pain in the right half of the chest (mainly in the back area, periodically radiating to the upper arm), which intensifies when trying to take a deep breath, cough; notes moderate shortness of breath when walking. Pain in the back on the right arose suddenly in the evening 3 days ago. The next day, he went to the family doctor, after a physical examination, the diagnosis was made: intercostal neuralgia and he was prescribed ibuprofen. As a child, he often suffered from colds and bronchitis. He had an appendectomy a year ago. Back pain has been bothering since adolescence. Patient underwent MRI of the spine 2 years ago, scoliosis with II degree diagnosed. Office worker. Smokes for 4 years about 7-8 cigarettes a day. He does not drink strong alcohol, occasionally beer and energy drinks.

Objectively: Asthenic body structure. Blood pressure 130/80 mm Hg. Pulse 68. RR 20. SpO_2 97%. Auscultation: breath sounds are markedly decreased to the right. Chest percussion reveals a box sound to the right. The left border of the heart is 1.5 cm inward from the mid-clavicular line, where the heartbeat is detected, the right border is not determined due to tympanitis near the right edge of the sternum. The abdomen is unremarkable. Neck veins are not dilated. There are no limb deformations or swellings.

1. Establish a clinical diagnosis.
2. Does the patient need emergency care (justify)?
3. Suggest treatment tactics.

Task #2. Women, 25, complains of pain in the right half of the chest, moderate shortness of breath when walking. Complaints appeared last night while browsing social networks. Pain of a similar location, but of much lower intensity, was noted 4 weeks ago (she celebrated her birthday that day). She did not give birth. Menstruation started yesterday on time. There were no surgeries or trauma. Denies allergies.

Objectively: Asthenic physique. Blood pressure 130/80 mm Hg. Pulse 72. BH 26. SpO_2 96%. Auscultation reveals significant decrease of breath sounds to the right. Percussion gives a box sound to the right. Heart sounds are normal. Abdominal organs without pathology.

1. Establish a clinical diagnosis.
2. What additional examinations are necessary?
3. Suggest treatment tactics.

Task #3. Men, 68, was delivered by the "Ambulance" team in serious condition. Keeps a sitting position and cannot lie down, periodically cough. Inhales oxygen through a mask. Mucous cyanosis presents. RR 42 per minute, Pulse 112, arrhythmic. Blood pressure 76/58 mm Hg. SpO_2 77%. On examination, the chest is barrel-shaped, jugular veins are distended. Percussion gives a box sound on the right. Auscultation reveals absence of breath sounds to the right and prolonged exhalation with whistling wheezes to the left with.

1. Establish a clinical diagnosis.
2. What is a patient management?

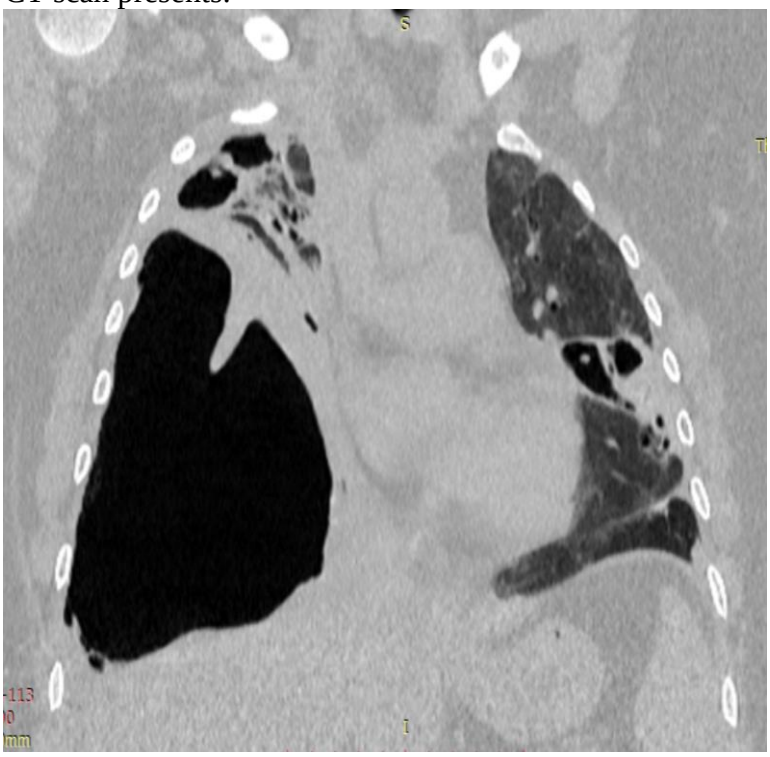
Task #4. A 19-year-old man complains of swelling of the neck and both eyelids, periodic dry cough. He noticed these changes in the morning while shaving.

Objectively: normal condition. Blood pressure 120/80 mm Hg. st.. Pulse 72, rhythmic. RR 18, SpO_2 98%. Breath sounds are clear and symmetric on both sides. Heart auscultation reveals crunching, rasping sound, synchronous with the heartbeat. Abdominal examination is unremarkable. Locally: slight symmetrical swelling of the neck, spreading to supraclavicular areas and face presents. When palpating tissues, crepitation is determined.

1. Establish a clinical diagnosis.
2. What additional examination is necessary?
3. Suggest patient management.

Task #5. A 62-year-old woman is being treated for pneumonia caused by the COVID virus in the box of the infectious department. The position in bed is sitting. Her continuing shortness of breath practically makes verbal contact impossible. She presses the oxygen mask to the face. RR 48 per minute. SpO_2 68%. The skin is covered with sweat. Nail beds are cyanotic.

CT scan presents.



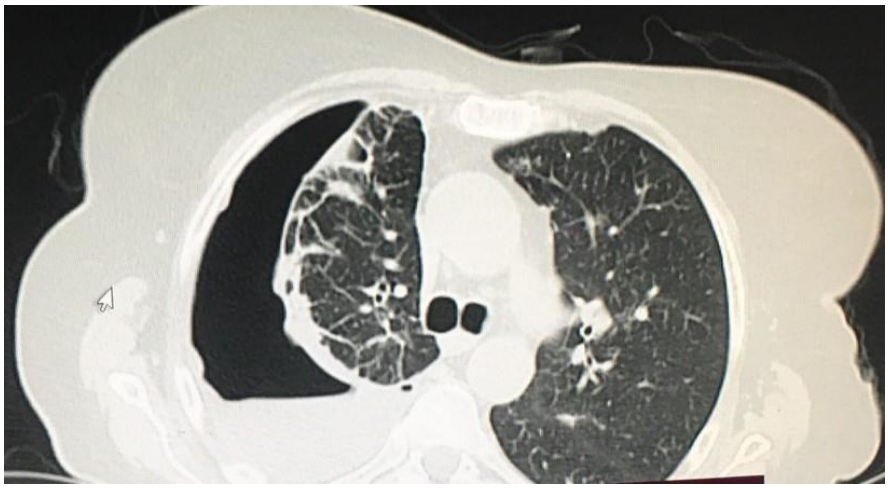
1. What is the complication?
2. Give some corrections to the treatment.

Task #6. A 52-year-old woman who is being treated for pneumonia caused by the COVID virus is in the intensive care unit of the infectious disease hospital. Due to decompensated respiratory failure, the patient undergoes non-invasive artificial lung ventilation through a hermetic mask in CPAP mode (constant positive airway pressure). After receiving a signal from the patients monitor about parameters deviations, the doctor on duty conducts an examination. Objectively: the patient is under sedation. BP 75/50 mm Hg. Heart rate 124. SpO_2 73%. The chest is asymmetrical due to an increase in the right half. Dilated veins are contoured on the neck. On percussion over the right half of the chest, there is a box sound. Breath sounds are absent to the right. There are no abnormalities in the operation of equipment.

1. What is the complication?
2. Which is a doctor on duty action?

Task #7. A 69-year-old woman has been treated for one and a half month for pneumonia caused by a COVID infection, which 4 weeks ago was complicated by a spontaneous pneumothorax (A Bülau thoracic drain was urgently installed). During the last two weeks, a cloudy liquid with white patches (150-200 ml per day) discharges through the chest tube. The last control PCR test is negative. Currently, she complains of a cough with purulent sputum, weakness, shortness of breath when walking, fever in the evening. Receives ceftriaxone, azithromycin. Objectively: RR 32 per min., HR 96 per 1 min., BP 130/70 mm Hg, SpO2 87% without oxygen. Lips are cyanotic. Chest: percussion on the right is of a box sound above and blunt one beneath; breath sound are weak on the right. Abdomen is without features. Locally: waterseal thoracic drainage is emplaced in 3rd intercostal space in the right middle axillary line, the tube is connected to reservoir, in which a white cloudy liquid with sediment presents. When

coughing and talking, air bubbles through the tube. According CBC: hemoglobin 96 g/l, Lk 12.6 G/l (young 3%, rod nuclear 12%, segmentonuclear 74%, lymphocytes 9%, monocytes 2%). CT scan is added.



1. What is the complication?
2. Make corrections to the treatment.

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Author: Volodymyr Kryvetsky.
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