

**MINISTRY OF HEALTH CARE OF UKRAINE
HSEEU "Ukrainian Medical Stomatological Academy"**

"Approved"
at the meeting of the internal
medicine №1 department
The Head of the Department
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**GUIDELINES
FOR the STUDENTS
INDEPENDENT WORK
FOR THE PRACTICAL CLASSES PREPARING**

<i>Academic discipline</i>	Internal medicine
<i>Module</i>	Basics of Internal Medicine
<i>Content module</i>	Fundamentals of diagnostics, treatment and prevention of respiratory diseases
<i>Study subject</i>	Pneumonia
<i>Course</i>	IV
<i>Faculty</i>	of foreign students training

Poltava 2016.

1. Relevance of the topic: The problem of **pneumonia** is one of the most relevant and poorly studied section of modern infectious diseases and pulmonology. This is a fairly common disease has one of the first places among the causes of morbidity and mortality, and in recent years has become the social significance of the fact that leads to economic losses caused by periods of incapacity.

2. The main goal: To be able to assess the typical clinical picture of pneumonia, to determine the tactics of treatment and prophylaxis.

Specific goals:

- To select the information indicating the presence of pneumonia in a patient from the data history;
- To identify the signs of pneumonia in an physical examination of the patient (inspection, palpation, percussion, auscultation)
- To formulate and justify a preliminary diagnosis according to the classification
- To create a scheme of diagnostic search;
- To analyze and interpret the changes in the results of the laboratory and instrumental methods of investigation;
- To conduct differential diagnostics with the similar clinical picture diseases;
- To develop a strategy of treatment depending to the likely pathogen of disease and the existing complications;
- To provide medical care.
- To assess the patient's prognosis and prevention actions;
- To apply deontological communication skills with patients.

3. Basic knowledge, abilities, skills (interdisciplinary integration)

Discipline	To know	To be able to
Previous		
Anatomy	The structure of the bronchial-pulmonary system, blood supply, innervation	
Histology	The structure of the wall of the trachea, bronchi, alveoli in health and disease	
Microbiology	Properties of pneumonia likely pathogens	
Regional anatomy	Chest organs interposition	
Normal physiology	Indicators of respiratory function, their value	determine the function of external respiration
Pathological anatomy	Changes in the structure of the wall of bronchopulmonary tissue with pneumonia	
Pathological Physiology	Pneumotachometry, spirometry indicators depending on the type of ventilation insufficiency	analyze the performance of external respiration
Radiology	Radiological changes at different stages of pneumonia	Interpret the radiological changes in the different stages of pneumonia
Pharmacology	The mechanism of action, indications and side effects of antibacterial, expectorant and bronchodilators drugs	Prescriptions
Propaedeutic therapy	Symptomatology of pneumonia and its complications	perform a physical examination of the patient, analyze the clinical and

	laboratory data of the patient
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4. Tasks for independent work during preparation for classes.

4.1. The list of key terms, parameters, characteristics:

time	definition
1. Pneumonia	Acute infectious inflammation of pulmonary parenchyma mainly of bacterial etiology with obligatory presence of intraalveolar exudation.
2. Modifying factors	Age older than 65 years, long-term antibiotic therapy and systemic corticosteroids therapy, chronic alcoholism, immunodeficiency diseases, multiple diseases of internal organs, diabetes, congestive heart failure, kidney and liver failure.
3. Empirical antibiotic therapy	Treatment, in the case of uncertain pneumonia etiology

4.2. Theoretical questions to the lesson:

1. Definition.
2. What pathologic and pathophysiologic changes occur in pneumonia?
3. List the clinical and pathophysiological syndromes, underlying pneumonia.
4. What is the typical for pneumonia auscultatory picture?
5. What changes have a blood test, sputum, a biochemical characteristic in pneumonia?
6. Specify the modern classification of pneumonia.
7. What are the characteristic radiological signs of pneumonia?
8. The differential diagnosis of pneumonia, tuberculosis, lung cancer, pulmonary infarction;
9. The criteria for severe course of community-acquired pneumonia
10. Complications.
11. The treatment of the patient depending on the likely pathogen of disease and the existing complications
12. Prevention, forecast performance.

4.3. Practical tasks that are performed in class:

Test questions:

1. The main criteria for severe pneumonia does not apply:
 - 1) respiratory rate
 - 2) body temperature
 - 3) intoxication
 - 4) the severity of the cough
2. Patients with a moderate course that do not require hospitalization, the presence of comorbidities and "modifying factors" refers to:
 - 1) 1 group of community-acquired pneumonia
 - 2) 2 group of community-acquired pneumonia
 - 3) 3 group of community-acquired pneumonia
 - 4) 4 group of community-acquired pneumonia
3. The criteria for the diagnosis of community-acquired pneumonia is not:
 - 1) The body temperature below 38°C
 - 2) cough with sputum
 - 3) the typical physical signs
 - 4) radiologically confirmed focal lung infiltration
4. Does not apply to extra-pulmonary pneumonia complications:

- 1) acute pulmonary heart
 - 2) amyloidosis
 - 3) nonspecific endocarditis
 - 4) myocarditis
5. The informative method of nosocomial pneumonia etiology is everything except:
- 1) microbiological examination of sputum
 - 2) sputum cytology
 - 3) the culture of bronchial secretions
 - 4) the culture of pleural fluid
6. As an antibacterial therapy for the patients of group 1 with community-acquired pneumonia is not indicated:
- 1) macrolide
 - 2) an aminoglycoside
 - 3) amoxicillin
 - 4) fluoroquinolone
7. The criteria for severe pneumonia are:
- 1) rapid progression of focal-infiltrative changes in the lungs
 - 2) septic shock
 - 3) acute renal failure
 - 4) all of the above

Topics Content

Definition. Pneumonia is an acute infection inflammation of pulmonary parenchyma with obligatory intraalveolar exudation development.

Etiology. Potential etiologic agents in pneumonia are bacteria, fungi, viruses, protozoa.

Metapneumoviruses, coronaviruses which responsible for SARS (severe acute respiratory syndrome), community-acquired strains of methicillin-resistant *Staphylococcus aureus* (MRSA) are new identified pathogens.

Bacterial Pneumonia. Bacterial pneumonia can affect anyone at any age. It can develop on its own or after a serious cold or flu. The most common cause of bacterial pneumonia is *Streptococcus pneumoniae*. Bacterial pneumonia can also be caused by *Chlamydomphila pneumonia* or *legionella pneumophila*. *Pneumocystis jiroveci* pneumonia is sometimes seen in those who have weak immune systems, due to illnesses like AIDS or cancer.

Viral Pneumonia. In most cases, respiratory viruses can cause pneumonia, especially in young children and the elderly. Pneumonia is usually not serious and lasts a short time. However, the flu virus can cause viral pneumonia to be severe or fatal. It's especially harmful to pregnant women or individuals with heart or lung issues. Invading bacteria can cause complications with viral pneumonia.

Mycoplasma Pneumonia. Mycoplasmas are not viruses or bacteria, but they have traits common to both. They are the smallest agents of disease that affect humans. Mycoplasmas generally cause mild cases of pneumonia, most often in teenagers and young adults.

Other Types of Pneumonia. Many additional types of pneumonia affect immune-compromised individuals. Tuberculosis and *pneumocystis carinii* pneumonia (PCP) generally affect persons with AIDS. In fact, PCP can be one of the first signs of illness in people with AIDS.

Less common types of pneumonia can also be serious. Pneumonia can be caused by inhaling food, dust, liquid, gas, and by various fungi.

No one is immune to pneumonia, but there are certain factors that can raise the risks: previous stroke or problems swallowing: people who have had a stroke, have problems swallowing, or are bedridden can easily develop pneumonia. Age: infants from birth to age of two are at risk for pneumonia, as are individuals in age of 65 and elderly. Weakened immune system: this includes people who take medications (steroid drugs and cytostatic drugs in oncology) that weaken the immune system and people with HIV, AIDS, or cancer. Drug abuse: this includes excessive alcohol consumption and smoking.

Certain medical conditions: asthma, cystic fibrosis, diabetes mellitus, and heart failure raise the risks for pneumonia.

Pathogenesis. Proliferation of microbial pathogens at the alveoli and the patient's response to those pathogens commonly results pneumonia. Aspiration from the oropharynx is the most common way for microorganisms to gain access to lower respiratory tract; some pathogens may be inhaled as contaminated droplets; sometimes pneumonia occurs by hematogenous way caused by endocarditis of tricuspid valve for example, infected pleural cavity or mediastinum.

Mechanical factors, pharyngeal and cough reflex are very important in the formation of physiological defense. Inhaled particles had to pass through the upper part of respiratory tract. Hairs, turbinates, mucociliary clearance and local antibacterial factors of airway lining of the branching tracheobronchial tree traps, clear or destroy the potential pathogen. Resident alveolar macrophages with surfactant proteins that are produced by alveolar epithelial cells are the next barrier for the pathogens. Engulfed by macrophages pathogenic agents are destroyed or eliminated due to defense function of mucociliary or lymphatics. Pneumonia as inflammatory response clinical syndrome becomes manifest when the capacity of alveolar macrophages is exceeded. Fever symptom is connected with releasing of inflammatory mediators IL-1 and TNF. Releasing of neutrophils with their attraction to the lungs leads to alveolar capillary localized leak and are stimulated by chemokines IL-8 and G-CSF. These processes attended by peripheral leukocytosis, increased purulent secretions. Erythrocytes can cross the alveolar capillary membrane producing hemoptysis. The alveolar capillary leak results in pneumonic infiltration discernible at X-ray picture, moist rales, crepitation fixed on auscultation, hypoxemia due to intraalveolar exudation. Severe hypoxemia, increased respiratory drive, bronchospasm leads to evident dyspnea.

So, the process of inflammation includes the following stages: alteration of lung tissue; microcirculatory disorders with exudation and emigration of blood cells; proliferation. Morphological and functional manifestations depend on pathogens biological properties and the patient's response to those pathogens.

Pathology. The first (initial) phase of pathological inflammation process is *edema* with intraalveolar exudation. It is very short because of transition to the *red hepatization* phase due to presence of erythrocytes in the cellular intraalveolar exudate. Pathogenic microorganisms sometimes are found during this phase. The third phase name *grey hepatization* connected with presence of lysed and degraded erythrocytes without new ones. The dominant cells are neutrophils, fibrin deposition is prevalent, bacteria have disappeared. The fourth (final) phase is *resolution*. The dominant cells in the alveolar space are macrophages, the debris of bacteria, neutrophils, fibrin has been cleared.

This pathology may not apply to pneumonia of all etiologies, especially viral or Pneumocystis, best for lobar pneumococcal CAP. A bronchopneumonia pattern is most common in nosocomial pneumonias. In VAP X-ray apparent lung infiltrate is arise due to respiratory bronchiolitis.

Classification. There are some general forms of pneumonia according to the conditions of the development, lung tissue infection's peculiarity, so as the state of patient's immune reactivity.

Pneumonia that develops outside the hospital setting is considered *community-acquired pneumonia (CAP)*.

Pneumonia developing 48 hours or more after admission is termed nosocomial or *hospital-acquired pneumonia (HAP)*.

Pneumonia that develops more than 48 to 72 hours after endotracheal intubation is *ventilator-associated pneumonia (VAP)*.

Widespread uncontrolled use of potent oral antibiotics formed multidrug-resistant (MDR) pathogens, general aging of population, extensive immunomodulatory therapies has led to *health-care-associated pneumonia (HCAP)* such as transition form between classic CAP and HAP.

Clinical symptoms. The general symptoms of bacterial pneumonia can develop quickly and may include: fever, shaking chills, dry cough, chest pain, muscle aches, difficulty breathing, breathlessness, tachycardia, nausea/vomiting. Some symptoms may indicate a medical emergency. These symptoms include: skin with bluish tone (from lack of oxygen), blood in sputum (coughed-up mucus), labored breathing, high fever (103°F or higher), confusion, tachycardia.

Diagnosis. Physical Examination. Crackling and bubbling rales sounds in the chest during breathing are usually indicators of pneumonia. Wheezing may also be present.

Diagnostic Tests. Chest X-rays can be used to determine if infection is present in the lungs. However, chest X-rays won't show the type of pneumonia. **Blood tests** can provide a better picture of the type of pneumonia. Also, blood tests are necessary to see if the infection is in patient's bloodstream.

Chest computed tomography (CT scan). A CT scan is similar to an X-ray, but the pictures provided by this method are highly detailed. This painless test provides a clear and precise picture of the chest and lungs.

Sputum test. This test will examine the sputum (the mucus cough up) to determine what type of pneumonia is present.

Pleural fluid test. If there is fluid apparent in the pleural space, a fluid sample can be taken to help determine the causative agent.

Pulse oximetry. This test measures the level of oxygen blood saturation by attaching a small sensor to the finger. Pneumonia can prevent normal oxygenation of blood.

Bronchoscopy. When antibiotics fail, this method is used to view the airways inside the lungs to determine if blocked airways are contributing to the pneumonia.

Differential diagnosis. Several diseases can present with similar signs and symptoms to pneumonia, such as acute bronchitis, exacerbation of chronic bronchitis/COPD, asthma, heart failure/pulmonary edema, bronchiectasis, lung cancer, radiation pneumonitis and pulmonary emboli. Unlike pneumonia, asthma and COPD typically present with wheezing, pulmonary edema presents in patients with history of cardiac disease, abnormal electrocardiogram, cancer and bronchiectasis present with a cough of longer duration, pneumonitis such as lung tissue injury after irradiation carcinoma treatment, pulmonary emboli presents with acute chest pain onset and significant breathlessness.

Differential-diagnostic signs of pneumonia, infiltrative pulmonary tuberculosis and pulmonary infarction

sign	<i>Pneumonia</i>	<i>Tuberculosis</i>	<i>Pulmonary infarction</i>
Anamnesis	Hypothermia, SARS	Contact with infected patients	Thrombosis, endocarditis, atrial fibrillation
Start	acute	gradual	sudden
Chest pain	Heaviness, compression	Absent	acute
Temperature	Fever, low-grade	low-grade	In 1 day, seldom rises
Sweating	not characterized	Characteristic	not characterized
Face	Hyperemia	pale	Cyanosis
Herpes	Often	Rarely	not typical
hemoptysis	Rarely	Often	Often
Localization	The lower and middle sections	The upper sections	The lower and middle sections
roentgenogram	Form hearth wrong	Rounded	The triangle with the apex to the top
	Contours blurred	clear	clear
	The path to the root of the missing	Characteristic	not characterized
	The roots of the lungs expanded	not extended	Most pleural effusion

leukocytosis	Expressive	not typical	It appears later
Sputum	Puromucous	Contaminated	Dark bloody
Elastic fibers in sputum	Missing	present	present

Complications. *Pleural effusion* is a complication of pneumonia. Occasionally, microorganisms will infect this fluid, causing an *empyema*.

In rare circumstances, bacteria in the lung will form a cavity with puss fluid - a *lung abscess*. Abscesses typically occur in aspiration pneumonia, and often contain several types of bacteria.

Pneumonia can cause *respiratory failure* by triggering *acute respiratory distress syndrome (ARDS)*, which results from a combination of infection and inflammatory response. The lungs quickly fill with fluid and become stiff. This stiffness, combined with severe disorders of gases exchange due to the alveolar fluid, may require long periods of mechanical ventilation for patient's survival.

Sepsis is a potential complication of pneumonia but occurs usually in people with poor immunity or hyposplenism. The most commonly involved pathogens are *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Klebsiella pneumoniae*. Other causes of the symptoms should be considered such as a myocardial infarction or a pulmonary embolism.

Treatment.

Group of patients with community acquired pneumonia allocated for standard empirical antibiotic therapy

<i>Groups of patients</i>	<i>The most likely pathogen</i>	<i>Featured products</i>
In the outpatient setting		
Group I - IR light flow in patients without comorbidity, and those who did not take the last 3 months antimicrobials	<i>S. pneumoniae</i> , <i>M. pneumoniae</i> , <i>SS. pneumoniae</i> , <i>H. influenzae</i> , respiratory viruses	Drug of choice: Oral: amoxicillin or macrolide. Alternative medication: Oral: 1. macrolides or doxycycline or a fluoroquinolone III-IV generation of the ineffectiveness aminopenicillin 2. aminopenicillin or fluoroquinolone III-IV generation after failure of macrolide
Group II - NP easy flow in patients with concomitant diseases and / or those who I received in the last 3 months of antibiotics	<i>S. pneumoniae</i> , <i>H. influenzae</i> , <i>M. pneumoniae</i> , <i>SS. pneumoniae</i> , <i>S. aureus</i> , <i>M. catarrhalis</i> , Enterobacteriaceae family, respiratory viruses	1. Drug of choice: oral: amoxicillin / clavulanic acid or cefuroxime axetil 2. Alternative medication: Oral: to add to the β -lactam macrolide or fluoroquinolone monotherapy III-IV generation
In the hospital		
Group III - NP moderate flow (in the treatment of conditions therapeutic or pulmonary branches)	<i>S. pneumoniae</i> , <i>H. influenzae</i> , atypical pathogens, Gram-negative enterobacteria, respiratory viruses	1. Preparat choice: parenteral application (in / m / w): aminopenicillin (mostly protected) + macrolide (per os) or III generation cephalosporin + macrolide (per os) 2. An alternative drug: I / O management: fluoroquinolone III-IV generation or carbapenems (inactive for <i>Pseudomonas aeruginosa</i> ertapenem) + macrolide (per os)

Group IV - NP heavy flow (treatment intensive therapy unit)	<i>S. pneumoniae</i> , <i>Legionella</i> spp., <i>H. influenzae</i> , <i>S. aureus</i> , <i>M. pneumoniae</i> , Gram-negative enterobacteria, <i>Pseudomonas</i> spp., polymicrobial association	1. Drug of choice: intravenous: protected aminopenicillin + macrolide or cephalosporin generation III + macrolide or macrolide ertapenem + If you suspect that <i>P. aeruginosa</i> intravenous administration: cephalosporin III-IV generation (active against <i>Pseudomonas aeruginosa</i>) + aminoglycoside or ciprofloxacin (levofloxacin) 2. An alternative drug: in / under the jurisdiction of fluoroquinolone III-IV generation lactam + B-. If you suspect that <i>P. Aeruginosa</i> - intravenous administration: (Imipenem, meropenem, doripenem) + aminoglycoside or ciprofloxacin (levofloxacin)
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Prognosis.

Mortality rate is from <1% (outpatient) to 10% for patients requiring hospitalization (inpatient).

The prognosis of HCAP is closer to the HAP and VAP.

Community-acquired pneumonia.

Etiology. In more than 50% cases of CAP the etiologic agent can't be determined, but most cases are caused by several pathogens, such as aerobic "typical" gram-positive *S. pneumoniae*, *Haemophilus influenzae*, *S. aureus*, gram-negative *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*; and "atypical" *Mycoplasma pneumoniae*, *Chlamidia pneumoniae*, *Legionella*; respiratory viruses (*influenza viruses*, *adenoviruses*, *human metapneumovirus*, *respiratory syncytial viruses*, *parainfluenza viruses*). Anaerobes more often may be etiologic agent with aspiration such as the most common way. Influenza infection can be complicated by *S. aureus* pneumonia. *Methicillin-resistant Staphylococcus aureus (MRSA)* at last time is one of the primary etiologic agents for severe just necrotizing pneumonia.

Epidemiology. Morbidity in adults varies over a wide range: from 1-12 per 1,000 young and middle-aged to 25 - 44 cases per 1,000 older persons (65 or older) according to the international epidemiological studies. In the United States each year registered about 5 million affected patients, about 20% of which are hospitalized. More than 55,000 persons die each year directly from the CAP among them. During the year, the total number of adult patients (18 years and older) in 5 European countries (UK, France, Italy, Germany, Spain) exceeds about 3 million people.

The lowest mortality rate ($\leq 1\%$) registered in young and middle age patients without comorbidity states. In older age groups the presence of comorbidities (cardiovascular disease, chronic obstructive pulmonary disease, cancer, alcoholism, diabetes mellitus, kidneys and liver diseases, etc.) and in the case of severe course, mortality rate may reach into 15-30 %.

Epidemiologic risk factors for CAP: alcoholism, tobacco smoking, COPD, severe destructive lung diseases (bronchiectasis, lung abscess), epidemiological active influenza period. Risk factors include immunosuppressive states, elder age (>65 years), comorbidities (heart failure, cerebrovascular disorders, dementia, seizure disorders, renal failure, HIV infection). Risk factors for *Legionella infection* are diabetes mellitus, hemoblastosis, cancer, uremia, HIV infection, ship cruise at previous 2 weeks.

Clinical symptoms. Clinical manifestation can vary due to the severity of the inflammatory process development from the mild to fatal.

In the case of CAP the patients more often are febrile, sometimes chills and sweats take place, tachycardia, breathlessness, cough may be dry (nonproductive) or with production of mucus, purulent or bloody sputum. Significant hemoptysis may be the sign of MRSA caused CAP.

Pleuritic chest pain may experienced by the patient with lobar or multilobar pulmonary inflammatory consolidation. Some patients may have nausea, vomiting, diarrhea. General weakness, fatigue, headache, arthralgias, myalgias are the signs of intoxication syndrome.

Physical examination findings depended from the severity of inflammatory process. Breathlessness with increased respiratory rate (RR), accessory muscles participation in breathing act, the affected half of the chest lags in the act of breathing, decreased vocal fremitus; flat or dull percussion sounds due to underlying consolidated lung tissue and possible pleural effusion; crepitations, bronchial breathing, pleural friction rub may be determine at auscultation.

Diagnosis. Clinical, radiographic methods, laboratory techniques may help the physician in correct diagnosis. Specificity of clinical findings on *physical examination* is not so high.

Radiography may show the localization and spread of lung consolidation, possible complications, someone differential diagnostic signs. **Computed tomography (CT)** may be more informative in patients with suspected postobstructive by tumor or foreign body pneumonia.

Staining and culturing respiratory secretions. Gram's staining may identify some pathogens in expectorated sputum sample with determination of sensitivity to antibacterial medicines. **Blood tests** – neutrophilic with left shift leukocytosis, increasing of ESR, in **biochemical blood analysis** – increasing of acute-phase reactants (C-reactive protein, procalcitonin) **Blood cultures** may be positive in the patients with sepsis, septicemia. **Polymerase chain reaction (PCR)** can help to detect the respiratory viral infection, some bacterial ones and associated with increased risk of complications, unfavorable prognosis.

Treatment. Not all over the patients should be admitted to the hospital. According to severity-of-illness score CURB-65 which includes some criteria – confusion (C); urea >7mmol/L (U); respiratory rate (R); blood pressure (B) systolic<90, diastolic<60 mmHg; age>65 years. The patients with 0 balls at score can be treated at home (mortality rate is 1,5%); 2 balls – should be admitted to the hospital (mortality rate is 9,2%); 3 and more balls – should be directed into intensive care unit (ICU) (mortality rate is 22%).

Initial therapy for all groups of the patients is usually empirical. All over the patients with CAP can be divided into four groups: I – patients without comorbidities and without antibiotics using history at previous 3 months; II - patients with comorbidity states and with antibiotics using history at previous 3 months; III – patients with not dangerous course but with presence of unfavorable factors; IV – severely ill patients with possible grave complications.

Antibiotic therapy. For the I group outpatient site of treatment should be recommended by macrolide (clarithromycin 0,500 PO every 12 hours or azithromycin 0,500 first dose, then 0,250 every 6 hours) or doxycycline 0,100 PO every 12 hours;

For the II group outpatient site of treatment should be recommended by fluoroquinolone (moxifloxacin 0,400 PO every 6 hours, gemifloxacin 0,320 PO every 6 hours, levofloxacin 0,750 PO every 6 hours) or

Beta-lactam (amoxicillin 1,0 every 8 hours, or amoxicillin/clavulanate 2,0 every 12 hours;) or cephalosporines (cefuroxime 0,500 PO every 12 hours, ceftriaxone 1,0-2,0 IV every 6 hours)+ macrolide (clarithromycin 0,500 PO every 12 hours or azithromycin 0,500 first dose, then 0,250 every 6 hours) or doxycycline 0,100 PO every 12 hours;

For the III group inpatient non-ICU of treatment should be recommended by fluoroquinolone (moxifloxacin 0,400 PO or IV every 6 hours, levofloxacin 0,750 PO or IV every 6 hours)

Beta-lactam (ampicillin 1,0-2,0 IV every 4-6 hours), cefotaxime 1,0-2,0 IV every 8 hours, ertapenem 1,0 IV every 6 hours)+ macrolide (clarithromycin 0,500 PO every 12 hours or

azithromycin 0,500 PO first dose, then 0,250 PO every 6 hours; or azithromycin IV 1,0 first dose, then 0,500 every 6 hours). An alternative to the macrolides is doxycycline 0,100 IV every 12 hours;

For the IV group inpatient intensive care unit (ICU) of treatment should be recommended by beta-lactames (ampicillin/sulbactam 2,0 IV every 8 hours), cephalosporines (cefotaxime 1,0-2,0 IV every 8 hours, ceftriaxone 2,0 IV every 6 hours)+macrolide (azithromycin IV 1,0 first dose, then 0,500 every 6 hours) or fluoroquinolone (moxifloxacin 0,400 PO or IV every 6 hours, levofloxacin 0,750 PO or IV every 6 hours).

Linezolid or vancomycin can be added to the initial therapy when MRSA community-acquired pneumonia is suspected.

Successful treatment depends of the adequate hydration, oxygen therapy, glucocorticoid treatment also if it is necessary.

The course of treatment for the patients without any complications may be several days, but more often it is necessary 10-14 days to favorable treatment effect. The severely ill patients with complications, bacteremia, high virulent pathogen infection should be treated for a longer course.

Complications. Respiratory failure, multiorganic failure, shock, coagulopathy, comorbidities exacerbations are the common possible complications of severe CAP; lung abscess (more often in aspiration pneumonia), pleuritis/pleural effusion (empyema) connected with lung injury, rather unusual - metastatic infections (brain abscess, endocarditis).

Prognosis. The prognosis depends of the age, comorbidity diseases or conditions in a patient, and connected with inpatient or outpatient site of treatment. The prognosis of CAP in young patients without any comorbidities and in the case of uncomplicated pneumonia is more favorable, in 2-4 weeks full clinical and radiological recuperation is possible. In older convalescent patients the process of recuperation can take more time (sometimes may be 10-12 weeks). Mortality rate for outpatient group is less than 1%, for inpatients is about 10%.

Prevention. The strict observance of personal hygiene rules for all over the groups of population is very important at the active epidemiological period especially. The main primary preventive measure is vaccination. In the USA a pneumococcal polysaccharide vaccine (PPV23) which contains materials from 23 pneumococcal serotypes and a protein conjugate pneumococcal vaccine (PCPV13) which contains materials from the most widespread pneumococcal serotypes in children patients are the most recommended ones. PCPV13 should be recommended for the elderly and immunodeficiency patients also.

Intramuscular influenza inactivated vaccine and intranasal live-attenuated cold-adapted vaccine (contraindicated in immunodeficiency patients) should be recommended for the patients at possible complication's risk group.

Hospital-acquired pneumonia (HAP). Pneumonia developing 48 hours or more after admission to the hospital and also termed nosocomial.

1. Actually nosocomial pneumonia:

- *Early nosocomial pneumonia* - occurs within the first 5 days (> 48-120 hours) from the time of hospitalization and due to pathogens that have been in the patient before admission to hospital - *S. pneumoniae*, *H. influenzae*, MRSA and other representatives of the oropharynx cavity normal flora. Most often, these pathogens are susceptible to antimicrobial agents, which are conventionally used, and pneumonia have a more favorable prognosis;

- *Late nosocomial pneumonia* - developed not earlier than 6 days of hospitalization (> 120 hours) and the resulting actual hospital microflora with a higher risk of having vysokovirulent and multi-drug resistant pathogens such as *P. aeruginosa*, *Acinetobacter* spp, representatives of the Enterobacteriaceae family, methicillin-resistant *S. aureus*. (MRSA). This GP is characterized by less favorable prognosis.

2. Ventilator-associated pneumonia.

3. Nosocomial pneumonia in patients with significant impairment of immunity:

- a) in recipients of donor organs;
 - b) in patients receiving cytotoxic therapy.
4. Hospital aspiration pneumonia.

Commonly hospital-acquired pneumonia is clinically rather similar to VAP but in nonintubated patients.

The main differences of HAP and VAP are etiological pathogens and the state of the patient's immune system. HAP is associated with comparatively lower frequency of MDR pathogens and relatively better immunity level in nonintubated patients.

Anaerobes are the pathogens that usually caused HAP due to the great risk of massive aspiration, but more often anaerobes are only contributors to polymicrobial pneumonias.

The etiological diagnosis in the patients with HAP is even more difficult because the majority of responsible underlying states are associated with inability to collect the lower respiratory tract samples for culture. Irrespective of some difficulties in diagnostics and treatment the mortality rate in the patients with HAP is lower than in VAP patients.

Health-care-associated pneumonia (HCAP) is the transition form between classic CAP and HAP. More common etiology agents are community-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) or multidrug-resistant (MDR) pathogens. In the case of culture-positive HCAP pneumonia the treatment is the same to that in the patients with nosocomial ventilator-associated pneumonia.

Ventilator-associated pneumonia (VAP).

Etiology. More frequent etiologic agents are MDR pathogens, oral anaerobes, gram-negative enteric bacteria, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, community-acquired methicillin-resistant *Staphylococcus aureus* (MRSA).

Epidemiology. The risk of VAP development is very high in the ICU mechanical ventilation patients especially at first several days. In the patients who must be ventilated more than 1 month the rate of VAP risk development is rather high.

Pathogenesis. Colonization of the nasopharyngeal area by pathogenic microorganisms, aspiration of the oropharynx's content to the lower parts of the respiratory tract, the decreasing of patient's defense mechanisms are the basic pathogenic links. Very serious risk factor is endotracheal intubation, the tube protects from physiological defense and from treatment by antibiotics and take part in carrying bacteria to the distal airways.

Clinical symptoms. The clinical picture is the same as in all other forms. Fever, breathlessness, increased bronchial secretions, the signs of lung consolidation at physical examination, neutrophilic leukocytosis, increased acute-phase reactants, radiographic pulmonary infiltration, tachypnea, tachycardia, decreased oxygenation are the main clinical criteria of VAP diagnosis.

Diagnosis. The most common mistakes with VAP hyperdiagnostic is connected with possibility of oropharynx, tracheobronchial high colonization by pathological microorganisms in the endotracheal intubated patients, another causes of high fever or radiographic lung infiltration in this group of patients with more often critically states.

Differential diagnosis. Pulmonary edema, pulmonary contusion, alveolar hemorrhage, hypersensitivity pneumonitis, acute respiratory distress syndrome (ARDS), pulmonary embolism are the states with similar to VAP clinical manifestations. Presence of bacteria in gram-stained endotracheal aspirate samples makes pneumonia as a real cause of fever, pulmonary consolidation, lung infiltration.

The Clinical Pulmonary Infection Score (CPIS) was developed to control the risk level and rather often used for VAP treatment tactics and prognosis. The main criteria of CPIS are fever, leukocytosis, oxygenation level, results of chest radiography, tracheal aspirate samples culture investigation.

Treatment. VAP could be treated such as severe CAP in the case of infection by MDR microorganisms is in the low risk. Some pathogens may have the ability to form resistance to all

more often used antibiotics or may have the properties to create resistance forms during treatment (*P.aeruginosa*).

Empirical antibiotic monotherapy can be provided in the patients without high risk for MDR/MRSA pathogens (ceftriaxone 2,0 IV every 24 hours or cefotaxime 2,0 IV every 6-8 hours; or moxifloxacin 0,400 IV every 24 hours or ciprofloxacin 0,400 IV every 8 hours or levofloxacin 0,750 IV every 24 hours; or ampicillin/sulbactam 3,0 IV every 6 hours; or ertapenem 1,0 IV every 24 hours).

In the patients with risk for MDR pathogens infections initial three antibiotics are recommended (two directed against *P.aeruginosa* and one against MRSA). At these schemes are proposed beta-lactams, cephalosporins, carbapenems, aminoglycosides, fluoroquinolones (ceftazidime 2,0 IV every 8 hours or cefepime 2,0 IV every 8-12 hours; or piperacillin/tazobactam 4,5 IV every 6 hours; or imipenem 0,500 IV every 6 hours or 1,0 IV every 8 hours or meropenem 1,0 IV every 8 hours)+(gentamicin or tobramycin 0,007/kg IV every 24 hours or amikacin 0.020/kg IV every 24 hours; or ciprofloxacin 0,400 IV every 8 hours or levofloxacin 0,750 IV every 24 hours)+(linezolid 0,600 IV every 12 hours or vancomycin 0,015/kg IV every 12 hours initially with doses correction).

Etiological treatment can be provided after the positive results of quantitative culture. In the case of CPIS level decreasing during 3 days, antibiotic therapy should be finished at 8 days to protect formation of antibiotic-resistant strains.

Complications. Most complications connected with underlying disease and with necessity of mechanical ventilation prolongation (prolonged rehabilitation, inability for independent function). The development of purulent pleural empyema, broncho-pleural fistula formation, lung abscess, sepsis, and septic shock.

Prognosis is very often unfavorable and associated with high mortality that may be connected more with underlying disease than with pneumonia. Fatal prognosis may be inevitable in the cases of MDR associated pneumonia and in the immunocompromised or immunodeficiency patients.

Prevention. To use noninvasive ventilation methods or to minimize the duration of endotracheal intubation if it possible.

Materials for self-control:

A. Tasks for self-control

1. Patient of 32 y. visited the doctor. It was found that 4 days ago he caught a cold: there was a tickle in the throat, fatigue. The next morning there was a dry cough, increased body temperature to 38,2°S, lost appetite. Objectively: lower the right scapula dullness percussion sounds, moist fine bubbling sonorous rales were listened. What diagnosis is most likely?

A. Non-hospital right-sided pneumonia

- B. Asthma
- C. Acute bronchitis
- D. Lung Cancer
- E. Gangrene

2. The patient of 18 years complains of increased body temperature to 39°C, pain in the right side of the chest, dry coughing after hypothermia. Objectively: the skin is moist, pale; BP - 110/70 mm Hg, HR - 96 / min, RR - 27 / min. Dullness percussion sounds below the left shoulder blade angle, a weakened vesicular breathing with moist fine bubbling rales, crackles were auscultated. What is the diagnosis?

A. Community-acquired lobar left-sided pneumonia

- B. Aspiration right-sided pneumonia
- C. Immunodeficiency right-sided pneumonia
- D. Nosocomial (hospital) pneumonia
- E. Left lung abscess

3. The patient of 29 years is treated an outpatient with acute respiratory viral infection (ARVI), than the body temperature increased to 39 ° C, cough with "rusty sputum", breathlessness, faint developed. During the X-ray study infiltration in the lower lobe of the right lung was revealed. What is the complication developed in ARVI patient?

- A. Pneumonia**
- B. Exudative pleurisy
- C. Spontaneous pneumothorax
- D. Acute bronchitis
- E. Pulmonary atelectasis

4. The patient complains of a temperature to 38,9°C, cough, stabbing chest pain, more at the left. On examination, the left half of the chest is lagging in breathing act. Auscultation – lower the left shoulder blade angle bronchial breathing, moist fine bubblingrales were auscultated. CBC: RBC - 4.12×10^{12} / L, WBC - $10,2 \times 10^9$ / L, ESR - 28 mm / hr. What is the diagnosis?

- A. Left-sided lobar pneumonia**
- B. The left-sided pleural effusion
- C. Lung Cancer
- D. Left-sided infarct - pneumonia
- E. Pulmonary tuberculosis

5. Patient K. of 25 years complains of cough with a minor amount of muco-purulent sputum, shortness of breath, increased body T to 38,5°C, weakness. Felt ill 7 days ago after supercool exposure. Objectively: lungs examination - dullness percussion sound lower the right shoulder blade angle and right axillary area; weakened vesicular breathing, moist fine bubbling sonorousrales. What is the previous diagnosis of the patient?

- A. Community-acquired pneumonia**
- B. Acute bronchitis
- C. Right-sided pneumothorax
- D. Pleural effusion
- E. ARVI

6. The male patient of 26 years was acutely ill after a fishing trip. The disease associates with hypothermia, it all began with a headache, weakness. Then the fever and dry cough came. Objectively: consciousness is retained, facial flushing, RR - 19 per minute. The lung percussion: a dull sound lower the right scapula angle, auscultation - crepitus, moist fine bubblingrales. BP - 110/70 mm Hg, HR - 78 per minute, body temperature is 38,7°C. CBC: WBC. - 10×10^9 / L, ESR - 17 mm / h. Lungs X-ray: the homogeneous infiltrative blackout in the lower lobe of the right lung. Which of the following diagnoses is the most likely?

- A. Community-acquired right-sided lobar pneumonia, clinical group I, RF I st.**
- B. Community-acquired right-sided lobar pneumonia, clinical group II, Nam I st.
- C. Community-acquired C. sided lobar pneumonia, clinical group III, RF I st
- D. Community-acquired right-sided lobar pneumonia, clinical group IV, RF I st.
- E. Community-acquired sided lobar pneumonia, clinical group V, RF I st.

7. A man of 56 years, acutely ill. The complaints of fever, cough with muco-purulent sputum. From history we know that he is sick with asthma for 20 years. Objectively: body temperature is 38,7°C, consciousness is retained, facial flushing, RR - 21 per minute. The lung percussion: a dull sound lower the right scapula angle, auscultation - crepitus, moist fine bubblingrales. BP - 110/70 mm Hg, HR - 78 per minute. CBC: RBC - 4.12×10^{12} / L, WBC - 11×10^9 / L, ESR - 24 mm / h. Lungs X-ray: the homogeneous infiltrative blackout in the lower lobe of the right lung. The most likely diagnoses:

- A. Community-acquired right-sided lobar pneumonia, clinical group II, RF Ist.**
- B. Community-acquired right-sided lobar pneumonia, clinical group I, RF Ist.
- C. Community-acquired right-sided lobar pneumonia, clinical group III, RF Ist.
- D. Community-acquired right-sided lobar pneumonia, clinical group IV, RF Ist.
- E. Bronchial asthma, persistent course, moderate severity, RF Ist.

8. The male patient of 26 years was acutely ill after a fishing trip. The disease associates with hypothermia, it all began with a headache, weakness. Then the fever and cough with "rusty" sputum came. Objectively: consciousness is retained, facial flushing, RR - 36 per minute. The lung percussion: a dull sound lower the right scapula angle, auscultation - crepitus, moist fine bubbling rales. BP - 100/70 mm Hg, HR - 98 per minute, body temperature is 38,7°C. CBC: WBC. - $14 \times 10^9 / L$, ESR - 24 mm / h. Lungs X-ray: the homogeneous infiltrative blackout in the lower lobe of the right lung. Which of the following diagnoses is the most likely?

- A. Community-acquired right-sided lobar pneumonia, III clinical group, RF II stage.**
- B. Community-acquired right-sided lobar pneumonia, II clinical group, RF II stage.
- C. Community-acquired sided lobar pneumonia, I clinical group, RF II stage.
- D. Community-acquired right-sided lobar pneumonia, IV clinical group, RF II stage.
- E. Community-acquired sided lobar pneumonia, V clinical group, RF II stage.

9. The male patient of 26 years was acutely ill after a fishing trip. The disease associates with hypothermia, it all began with a headache, weakness. Then the fever and cough with "rusty" sputum came. Objectively: consciousness is retained, facial flushing, RR - 36 per minute. The lung percussion: a dull sound at right side of the chest, auscultation - crepitus, moist fine bubbling rales. BP - 90/70 mm Hg, HR - 110 per minute, body temperature is 38,7°C. CBC: WBC. - $14 \times 10^9 / L$, ESR - 24 mm / h. Lungs X-ray: the homogeneous infiltrative entire blackout in the right lung. Which of the following diagnoses is the most likely?

- A. Community-acquired pneumonia, right-total, IV clinical group, RF II stage.**
- B. Community-acquired pneumonia, right-total, II clinical group, RF II stage.
- C. Community-acquired pneumonia, right-total, and clinical group, RF II stage.
- D. Community-acquired pneumonia, right-total, IV of clinical group, RF II stage.
- E. Community-acquired pneumonia, right-total, the V clinical group, RF II stage.

10. The male patient of 26 years was acutely ill after a fishing trip. The disease associates with hypothermia, it all began with a headache, weakness. Then the fever and dry cough came. Objectively: consciousness is retained, facial flushing, RR - 19 per minute. The lung percussion: a dull sound lower the right scapula angle, auscultation - crepitus, moist fine bubbling rales. BP - 110/70 mm Hg, HR - 78 per minute, body temperature is 38,7°C. CBC: WBC. - $10 \times 10^9 / L$, ESR - 17 mm / h. Lungs X-ray: the homogeneous infiltrative blackout in the lower lobe of the right lung.

Community-acquired right-sided lobar pneumonia, I clinical group, RF I st was diagnosed. What is the management tactics?

- A. Ambulatory treatment**
- B. Treatment in a therapeutic hospital
- C. The treatment at the intensive care unit(ICU)
- D. Treatment in a surgical department
- E. Treatment in a pulmonary hospital

Recommended literature

1. Harrison's Principles of Internal Medicine / D.Kasper, A.Fauci, S.Hauser, D. Longo.-19 ed. -N.Y.: McGraw-Hill Professional, 2015. - Vol. 1, Vol.2.-3000 p.

2. 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), McGraw-Hill Prof Med/Tech, 1867 p.
3. Clinical Pulmonology 2012 (The Clinical Medicine Series) by M.D., C. G. Weber (Oct 30, 2011) - Kindle eBook
4. Interstitial lung disease guideline: the British Thoracic Society in collaboration with the Thoracic Society of Australia and New Zealand and the Irish Thoracic Society/A.U. Wells [at all]//Thorax.2008.-P. 1-58