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Diagnosis and treatment of pneumonia in children

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Abstract : Early diagnosis and rational therapy pneumonia in children is an urgent task of pediatrics. For diagnosing a bacterial infection, especially a severe one, assessing the appearance and behavior of the child is much more important than reading a thermometer [6,7]. Signs that allow to assess the severity of intoxication, common with a bacterial infection, include a rapid disturbance violation of the general condition, a decrease in the activity of the child; irritability (screaming when touched), lethargy, drowsiness (sleep longer), lack of eye contact of the child during examination, the child refuses to eat and drink. The severity of the condition is determined by the severity of tachycardia, muffled heart sounds, hypo- or hyperventilation, cough, dyspnea, bronchophony and local rales, violation of microcirculation, peripheral cyanosis, incessant vomiting. Amoxicillin is effective against most of the pathogens that cause community-acquired pneumonia. Patients in the presence of underlying diseases or taking antibiotics in the previous 3 months are prescribed amoxicillin / clavulanate in monotherapy or in combination with macrolides (azithromycin, clarithromycin). Macrolides should also be used when mycoplasma or chlamydial pneumonia is suspected.

Key words: community-acquired pneumonia; bacterial; viral; antibacterial drugs; amoxicillin; macrolide

Introduction. Diagnosis and therapy of community-acquired pneumonia (CAP) in children are actual problems in pediatrics due to the relatively high morbidity and mortality [1, 2, 4]. The majority of pneumonias (77–83%) have a bacterial etiology, although in some cases they develop against the background of acute respiratory viral infections (ARVI), which play the role of a contributing factor.

   CAP (synonyms "home", "outpatient") - is an acute infectious disease of the lungs of various etiologies that developed outside the hospital or in the first 48–72 hours of hospitalization, accompanied by fever and symptoms of lower respiratory tract lesions (dyspnea, cough and physical findings), if present infiltrative changes on the radiograph. The majority of pneumonias (77–83%) that meet this definition have a bacterial etiology, although in some cases they develop against the background of acute respiratory viral infections (ARVI), which play the role of a contributing factor. This approach makes it possible to exclude viral lesions of the lower respiratory tract (bronchitis, bronchiolitis) that do not require antibacterial treatment [2, 3].

   In accordance with ICD 10 and the "Classification of clinical forms of bronchopulmonary diseases in children", the following forms of CAP are distinguished by etiology: bacterial, viral, fungal, parasitic, chlamydial, mycoplasmal, mixed. Insufficient information content and a significant duration of microbiological studies, a common practice of taking antibacterial drugs before seeking medical help are the reasons for the absence of an etiological diagnosis in 50–70% of patients [1, 5].

   According to morphological forms, there are: focal, focal-confluent, segmental, polysegmental, lobar and interstitial pneumonia. By severity, CAP is classified as moderate and severe, which is determined by the severity of clinical manifestations and the presence of complications: pleural (pleuritis), pulmonary (cavitary formations, abscess), pulmonary-pleural (pneumothorax, pyopneumothorax), infectious-toxic shock. Pathogenic microorganisms can enter the lungs in several ways: aspiration of nasopharyngeal secretions, inhalation of an aerosol containing microorganisms (more often), and hematogenous spread of a microorganism from an extrapulmonary focus of infection (less often and of little practical importance). The main problem that the doctor solves in a feverish child with acute respiratory disease (ARI) is the likelihood of a bacterial infection, while the fight against fever, if it is justified, is a secondary task. In 70–80% of children with acute respiratory infections, symptoms allow at least a presumptive diagnosis to be made at the patient's bedside. For diagnosing a bacterial infection, especially a severe one, assessing the appearance and behavior of the child is much more important than reading a thermometer [6,7]. Signs that allow to assess the severity

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of intoxication, common with a bacterial infection, include: a rapid disturbance violation of the general condition, a decrease in the activity of the child; irritability (screaming when touched); lethargy, drowsiness (sleep longer); lack of eye contact of the child during examination; the child refuses to eat and drink; bright light causes pain [3, 5, 6].

When assessing the severity should also take into account: the severity of tachycardia, muffled heart sounds; hypo- or hyperventilation; violation of microcirculation, peripheral cyanosis, slowing down the filling of nail capillaries; incessant vomiting. Given the similarity of the clinical manifestations of many viral and bacterial infections, in some patients the final assessment on the need to prescribe antibiotics has to be made taking into account a number of laboratory parameters. Figures above 15×10^9 /l should be considered characteristic of bacterial infections, as well as the absolute (and not relative) number of neutrophils above 10×10^9 /l and stab neutrophils above 1.5×10^9 /l. The level of C-reactive protein in patients with acute respiratory infections, bronchitis, is 15–30 mg/l, so that an increase of > 30 mg/l should be considered a significant increase for the diagnosis of a bacterial infection. Procalcitonin is considered as a predictor of bacterial infection at levels > 0.5 ng/mL [3, 4, 7].

Pneumonia is an acute illness, usually with cough and fever, which, unlike a viral infection, lasts more than 3 days without treatment; rhinitis and other signs of ARVI are often absent. Without fever (but with severe dyspnea), atypical pneumonia occurs in children 1–6 months of age, caused by C. trachomatis. Since pneumonia often occurs in a "silent" manner - without the classic physical symptoms - the general symptoms should be taken as the basis for diagnosis. Pneumonia is characterized by a combination of the following clinical signs: an acute onset with a fever of 38.0°C and above, chills, loss of appetite, cough, dyspnea in the absence of bronchoobstructive syndrome. Physical symptoms of pneumonia, such as shortening of the percussion sound, bronchial breathing, bronchophony and local rales, are detected in 40-80% of patients. Uncomplicated pneumonia is diagnosed in the presence of dyspnea in the absence of an obstructive syndrome ($\geq$ 60 per minute in children under 2 months; $\geq$ 50 per minute - from 2 months to 1 year; $\geq$ 40 per 1 minute - from 1 year to 5 years) and / or classic physical symptoms - shortening of percussion sound, weakened or bronchial breathing, crepitus or rales in the lungs. Each clinical symptom, taken separately, cannot serve as evidence in favor of the presence or absence of pneumonia in a given patient. A combination of clinical symptoms is more helpful in making a diagnosis. Criteria for the diagnosis of community-acquired pneumonia are presented in Fig. 1 [1, 4, 6].
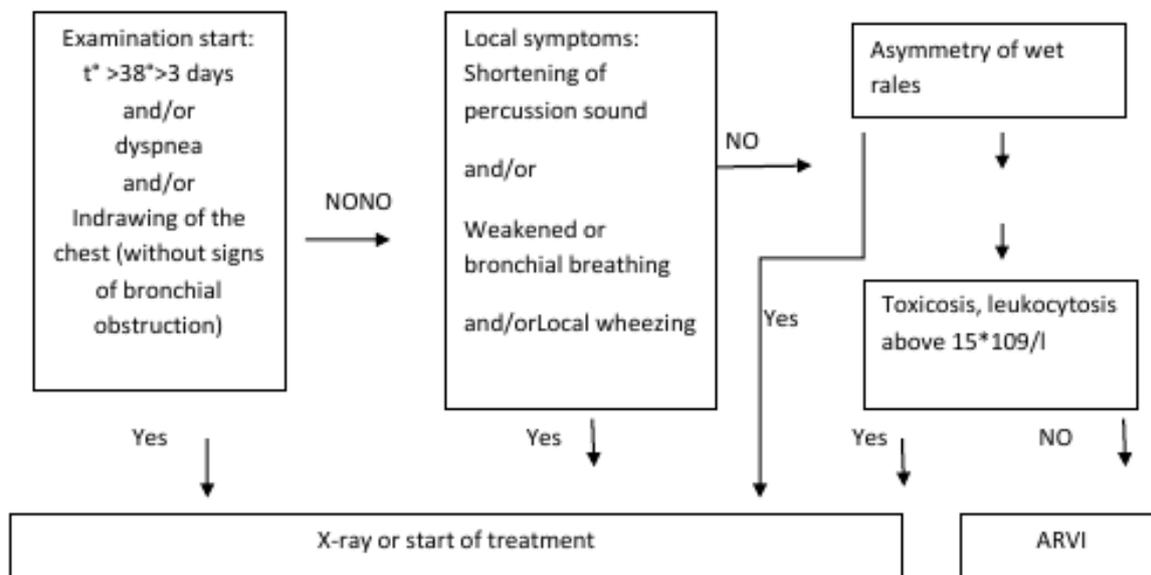

Fig.1. Algorithm for the clinical diagnosis of pneumonia [Clinical guidelines for the diagnosis and treatment of acute respiratory diseases (ARI); treatment of pneumonia in children]

A. Reliable: detection of lung tissue infiltration on a chest x-ray plus the presence of two of the following criteria: 1) fever above 38 ° C for three or more days; 2) cough with sputum; 3) physical symptoms of pneumonia; 4) leukocytosis > 15×10^9 /l and (or) p / neutrophils > 10%. **B. Probable** - along with fever and

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cough, there are local physical symptoms, but a chest x-ray is not possible. C. **Exclude pneumonia**: absence of radiographic and physical symptoms of pneumonia. In some patients, the clinical signs of pneumonia are very mild, and the nonspecificity of the initial manifestations of the disease, the prevalence of general symptoms of intoxication make it difficult to diagnose CAP [2, 5]. In some cases, false-negative results of X-ray diagnostics are observed, which may be due to dehydration, neutropenia, an early stage of the disease, as well as pneumonia caused by Pneumocystis jiroveci. In these cases, it is necessary to repeat the x-ray examination after 24 hours or perform a computed tomography of the lungs, which objectifies the diagnosis. However, all of these situations are associated with certain patient populations and are rarely observed in normal pediatric practice. In uncomplicated pneumonia, relief of fever and infectious toxicosis against the background of antibiotic therapy occurs in the first two days from the start of ABT, and physical symptoms - within 7-10 day [4, 7, 8].

Therefore, the control radiograph can be shown no earlier than in 2-3 weeks, since the resorption of the infiltrate occurs during this period. In uncomplicated pneumonia, relief of fever and infectious toxicosis against the background of antibiotic therapy occurs in the first two days from the start of ABT, and physical symptoms - within 7-10 days. Therefore, the control radiograph can be shown no earlier than in 2-3 weeks, since the resorption of the infiltrate occurs during this period. The use of ultrasound to monitor the course of pleuritis can reduce radiation exposure [3, 9].

Indications for hospitalization of children with CAP: 1) severity of the condition: cyanosis, dyspnea, increased respiration, groaning breath, SaO2 < 92%, decreased blood pressure, pulmonary-pleural complications, severe dehydration, refusal to eat; 2) the presence of severe concomitant diseases, immunocompromising conditions; 3) lack of response in patients with pulmonary infiltrate to starting ABT within 48 hours; 4) poor social conditions. The choice of antibacterial drugs (ABD) for the etiotropic therapy of the main causative agents of CAP is carried out taking into account the natural activity of the drugs, as well as the prevalence and resistance of pathogens. Principles of empiric therapy for CAP: early start of treatment, taking into account the most likely pathogen and its sensitivity to ABD in the region, the age of the patient, the presence of background diseases, as well as the toxicity and tolerability of ABD for a particular patient [3, 5, 8].

In outpatient settings, children who have not received ABD within the previous 3 months are optimally administered orally with amoxicillin or a macrolide. Amoxicillin is effective against most of the pathogens that cause CAP. Patients in the presence of underlying diseases or taking antibiotics in the previous 3 months are prescribed amoxicillin / clavulanate in monotherapy or in combination with macrolides (azithromycin, clarithromycin). Macrolides should also be used when mycoplasma or chlamydial pneumonia is suspected. II–IV generation cephalosporins can be used as alternative drugs (Tables 1, 2) [1, 2, 5, 10].

Duration of treatment uncomplicated typical pneumonia is about 5days (2 days after treatment uncomplicated typical pneumonia is about 5 days (2 days after decrease in body temperature. among children responding to initial treatment for outpatient CAP, a 5-day antibiotic strategy was superior to a 10-day strategy. The shortened approach resulted in similar clinical response and antibiotic-associated adverse effects, while reducing antibiotic exposure and resistance. According to the authors, among children responding to initial treatment for outpatient CAP, a 5-day antibiotic strategy was superior to a 10-day strategy. The shortened approach resulted in similar clinical response and antibiotic-associated adverse effects, while reducing antibiotic exposure and resistance. Treat atypical pneumonia in adolescents–2weeks (danger diffusion insufficiency), in children up to12years–1weeks. The main criterion for discontinuation of antibiotics is the regression of clinical symptoms. [8, 9, 11]

Tables 1
Etiology of pneumonia in children and empirical choice of antibacterial drugs

Age of the patient	Most common pathogens	Drugs of choice	Alternative drugs
Newborns	S. pneumoniae B, *Enterobacteriaceae*	Ampicillin amoxicillin/clavulanate ± AG	Cefotaxime ± AG, imipenem

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	(*E. coli* и др.)		
1 to 3 months	Viruses (respiratory syncytial, para-influenza, enteroviruses), *Enterobacteriaceae* (*E.coli* и др.), *H. influenzae*, *C. trachomatis*, *S. aureus*	Amoxicillin/clavulanate ampicillin ± macrolide	CS II–III
3 months to 5 years	Viruses, *S. pneumoniae*, *H. influenzae*	Oral: amoxicillin amoxicillin/clavulanate macrolide	Oral: cefuroxime ± macrolide. Parenterally: CS II–IV, carbapenem
Over 5 years	*S. pneumoniae*, *M. pneumoniae*, *C. pneumoniae*	Oral: amoxicillin macrolide	Oral: amoxicillin / clavulanate, cefuroxime. Parenterally: CS II–IV, carbapenem, lincosamide
Pneumonia complicated by pleuritis and destruction	*S. pneumoniae*, *H. influenzae*, *S. aureus*, *Enterobacteriaceae*	Parenteral: amoxicillin/clavulanate amoxicillin/sulbactam	Parenterally: CS II-IV, cefazolin + AG, lincosamide + AG, carbapenem

Abbreviations: CS II-IV (cefuroxime, cefotaxime, ceftriaxone, cefoperazone, cefepime), AG - aminoglycoside (netilmicin, amikacin)

Table 2
Doses of antibiotics in children

Drug Forms for oral administration	Dose, frequency of administration and maximum daily dose	Forms for oral administration
Amoxicillin/clavulanate	45–90 mg/kg/day. for 2 doses (for amoxicillin	Suspension 200 mg/400 mg or 600 mg in 5 ml, dispersible tablets
Cefuroxime axetil	30 mg/kg/day in 2 doses, the maximum daily dose is 500 mg	Suspension (per 5 ml) 125 or 250 mg, tablets 125 and 250 mg
Ceftibuten	9 mg/kg/day. 1-2 times a day	Capsules 0.4 g, powder for suspension 0.036 g/ml in vials
Cefotaxime	50–100 mg/kg/day 2-3 times a day;IM, preferably IV	Powder for solution for injection, 0.5 and 1 g

Ceftriaxone	5–12 years: 20–75 mg/kg/day once, with a body weight of 50 kg - 1-2 g / day, the maximum dose is 4 g	Powder for solution for injection, 0.25, 0.5, 1 g
Azithromycin	Up to 12 years: 10 mg / kg / day, the maximum course dose is 30 mg / kg. Over 12 years: 0.5 g / day.	Powder for suspension for oral administration 100 mg/5 ml, 200 mg/5 ml, capsules 0.25 g, coated tablets 0.5 g
Clarithromycin	Up to 12 years: 15 mg / kg / day. Over 12 years old: 0.5–1.0 g/day.	Tablets 0.25 and 0.5 g

There are no pronounced fluid losses in pneumonia (except for perspiration losses), so oral hydration is prescribed according to physiological need in all patients with uncomplicated pneumonia and in 80-90% of patients with complicated pneumonia. Antipyretics [paracetamol (at a dosage of 10–15 mg/kg, maximum daily dose 60 mg/kg), ibuprofen (at a dosage of 5–10 mg/kg, maximum daily dose 30 mg/kg)] are used situationally for pneumonia. It is absolutely contraindicated to prescribe them on a planned basis, as they create the illusion of well-being and make it difficult to assess the effectiveness of antibacterial treatment.

Drugs that reduce the viscosity of sputum and improve expectoration are indicated when the patient develops an intense, unproductive cough that worsens the patient's condition. It has been shown that ambroxol enhances the penetration of antibiotics (amoxicillin) into the lung tissue and stimulates the synthesis of surfactant. In children aged 5–6 years, it is used at a dosage of 7.5 mg 3 times a day, over 6 years old - 15 mg 3 times a day [2, 12, 13].

The use of bronchodilators is indicated in the presence of concomitant broncho-obstructive syndrome or in the event of pneumonia in a patient with bronchial asthma, as well as in some viral diseases. The use of short-acting β2-agonists as monotherapy (salbutamol) or as part of combined drugs (berodual) is recommended. The duration of therapy is determined by clinical symptoms [1, 2, 11].

When formulating a diagnosis of pneumonia, the following must be reflected: the nosological form with an indication of the etiology (presumed, verified); localization and prevalence of pulmonary inflammation; severity of pneumonia; the presence of complications (pulmonary and extrapulmonary); accompanying illnesses. For example: 1) community-acquired pneumonia (pneumococcal), focal, right-sided upper lobe, moderate; 2) community-acquired pneumonia, mycoplasma, bilateral segmental (s. 2, 3) of the right lung and (s. 4, 5, 6) of the left lung, severe.

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