Original Article:
Features of Clinical and X-ray Patterns of Community-Acquired Pneumonia in Children in Various Age Groups

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Abstract: This article presents the results of the analysis of anamnestic data, clinical examinations of patients, laboratory diagnostics, X-ray and computed tomography-examination of the chest, treatment in children with community-acquired pneumonia in hospital. It is established that pneumonia in children is more often registered at school age. The most common form of pneumonia in children remains focal and segmental forms, with a high prevalence of right-sided pneumonia. The most informative method to diagnose this disease is a computed tomography scan of the chest.

Key Words: Community-acquired pneumonia, Children, Clinic, Diagnosis, Treatment

Introduction:
Pneumonia is one of the most common acute infectious diseases of the bronchopulmonary system in children. The incidence of community-acquired pneumonia is 354.1 per 100 thousand population, while children and adolescents account for 181 313 cases (the incidence of 678.7 per 100 thousand population), of which 171 604 cases (the incidence of 762.3 per 100 thousand population) occur in children under 15 years according to epidemiological studies in the Russian Federation [1]. However, despite the significant development of clinical medicine and the achievements of the antibiotic era, pneumonia remains a serious and dangerous acute infectious disease of the respiratory system. [2,3]

In daily practice, the pediatrician is constantly faced with the problem of diagnosing pneumonia in children. The scientific and educational literature describes the classical picture of the disease: acute onset, prolonged febrile temperature, symptoms of intoxication, mixed shortness of breath, cough, characteristic percussion and auscultatory data, etc. [3,4] However, a number of authors in recent years have noted a change in this “classical standard” of pneumonia, an increase in the frequency of low-symptomatic, erased forms of the disease that complicate the early diagnosis, and, consequently, the timely initiation of treatment.[4,5] In our opinion, this is due not only to the peculiarities of the pathogenic action of numerous pathogens, but also to the impact on the child's body of adverse environmental factors, with the unjustified use of easily accessible drugs, which are not always safe for the child.

The presence of infection of varying degrees of severity, respiratory disorders, local physical changes in the lungs allow us to assume the presence of infiltrative changes in the pulmonary parenchyma in patients. However, the main method of radiological diagnosis of pneumonia in children is still chest radiography in two projections. It should be borne in mind that x-ray examination is not always informative (in 2-5% of patients, the x-ray picture is atypical or clinical manifestations similar to pneumonia are due to another pathological process). In such cases, it is necessary to conduct spiral computed tomography (SCT) with a detailed study of the pulmonary parenchyma.[6-8] Currently, there are a large number of studies devoted to the clinical features of the disease, as well as its etiological structure. However, in the available literature there is no data on the frequency of occurrence of individual morphological forms of pneumonia, so there is a need for research in this area. Knowledge of the features of the course of pneumonia in modern conditions is necessary for the doctor to diagnose the disease in a timely manner, and therefore to reduce the risk of complications to a minimum. And the study of morphometric features of this disease is important not only to describe the...
anatomical location, but also to develop modern approaches to its diagnosis.

The aim of our work was to study the features of clinical and radiological picture of community-acquired pneumonia in children.

Materials and Methods
To achieve this goal, 261 cases of children aged 1 month to 18 years who were admitted to the hospital with suspected community-acquired pneumonia were analyzed. This diagnosis was confirmed in 130 people. A thorough analysis of the anamnestic data, the results of clinical examination, laboratory diagnostics, radiological and SCT studies of the chest organs were carried out in all the patients. Special attention was paid to the volume of therapeutic measures before hospitalization and at the stage of inpatient treatment.

SCT was performed on the basis of Regional children's hospital in Rostov-on-Don in the Department of radiology using spiral computed tomography "NeuViz", 16 sections (Ltd. Company, China) with a slice thickness of 2 to 6 mm. Scanning was performed in different projections [6]. The resulting scans were recorded in DAIMC format on an optical disk. The scan analysis was performed on a personal computer using Radiant DICOM Viewer 1.99.21.9398 (BETA). All sagittal sections of the chest were studied in the examined patients for a detailed assessment of the morphometric structure of the chest.

The children were randomized into 4 age groups, taking into account the age morphology of the lungs for a detailed analysis of the radiological semiotics of pneumonia.

Group 1 comprised of children from birth to one year, and had 55 children (42.32%), including 40 boys and 15 girls. The morphological structure of the lungs in patients of this age group contains a significant amount of loose connective tissue, while the elastic frame is weakly expressed. In this case, the fibrous structure of the interlobular septa and pleura is expressed significantly. It should be noted that the structure of the lungs in children of this group retains the features inherent in the lungs of the fetus.

Group 2 comprised of children from 1 to 3 years, with 20 children (15.38%), including boys and girls the same number. In this age range, there is a significant increase in pulmonary lobes and segments, accompanied by an increase in the length and width of the respiratory bronchi and alveolar passages, and, consequently, the volume of functioning alveoli. In children of this group, the alveolar interstitium of maturity and the volume of individual segments is recorded.

Group 3 comprised of children from 4 to 7 years, having 35 children (26.92%), including 20 boys and 15 girls. At this age, the pulmonary frame and parenchyma are improved: connective tissue in the septum disappears, aciniuses, interalveolar communication, Kon pores (they play a significant role in collateral ventilation in violation of bronchial patency) are finally formed.

Group 4 comprised of children from 7 to 18 years, and had 20 children (15.38%), including 14 boys, 6 girls. The formation of the architectonics of the ends of the lungs patients of this age group.

According to the SCT, the lesion volume was determined by the projection of infiltration on the chest wall in accordance with the accepted division of the lung into lobes and segments. The difference between segmental pneumonia was the triangular shape of the airless area, in which the apex was located to the root of the lung, and the base to the chest wall. Lobar pneumonia retained the anatomical shape of the infiltrated parts of the lung.

Ethical examination
The study was conducted in compliance with all ethical standards (all parents of children and adolescents over 15 years of age signed an informed written consent to participate in the study, approved by the local ethical Committee of the Rostov State Medical University).

Statistical processing was carried out using a set of applications "Microsoft Office 2000Pro" for Windows OSR 2 on PC Intel Pentium-166 (Microsoft Office 97 Professional, 1997). A computer program "STATISTICA 6.0" was also used for statistical analysis.

Results and Discussion
Our study found that the highest incidence of community-acquired pneumonia was observed at the age of 6 to 12 years, boys get sick more often than girls. In our opinion, the incidence is due to the adaptation of children to the new team and their relative independence. We noticed that the maximum rise in the incidence is in January, March and November, and the decline - in the summer. Analyzing the clinical picture of pneumonia, we found that most of them proceeded with an increase in body temperature to febrile numbers more than 3 days (64%) and cough (90%), so parents and pediatricians treated children with antibacterial drugs, of which preference was given to antibiotics penicillin series, more often prescribed amoxicillin. All this contributed to a later treatment in the hospital. The examination revealed frequent unproductive cough in 88% of cases, shortness of breath and cyanosis in 22%, which does not coincide with the opinion of many authors, indicating shortness of breath as one of the main symptoms of the disease [3-5].

At the same time, local auscultative changes in the lungs were observed in the vast majority of cases - 88%, most often small-bubbly rales (48%) and weakened breathing (39%) were recorded, while crepitation was observed only in 1% of patients. The shortening of percussion sound was observed in 69 of 130 children (53.08%), which indicates that the absence of percussion changes does not exclude the presence of infiltrative changes in the pulmonary parenchyma. In our opinion, this is due to the limited volume of lung damage, in which it is difficult to determine the change in percussion tone due to vicar emphysema. Indirectly, this is confirmed by the fact that such children also determined the box tone of the percussion sound.

Changes in the hemogram included leukocytosis (37%) and ESR elevation (27%), with lymphocytosis in 27%, and neutrophilia in 54%. These data indicate the prevalence of viral and bacterial etiology of the disease. Therefore, the lack of specific changes in the hemogram, unfortunately, complicates the etiological interpretation of pneumonia. Therefore, the most informative and currently available method of diagnosis of community-acquired pneumonia is X-ray examination of the chest.

To confirm the clinical diagnosis and clarify the form of acute pneumonia, X-ray and SCT examination of the chest organs was carried out in all patients. The data of radiographs were comparable with the results of SCT studies. It was found that the most common is right sided community acquired pneumonia (68%), followed by bilateral in 20% and much less recorded was left-sided forms in 12%. Moreover, bilateral forms were more common in patients of the first age group (80%), while in the second and third groups they were not encountered.

Analysis of data on morphological structure found that focal (36%) and segmental forms (32%) predominate, polysegmental pneumonia was observed in 16%, lobar pneumonia in 8%, interstitial and pleuropneumonia only in 4% of patients. It is important to note that the most frequent infiltration was recorded in the middle lobe (80%), while in the lower was 24% and in the upper only 4% of patients.

Analysis of the results in different age groups showed that in the first group polysegmental and share forms in the lower segments of the middle lobe were more often registered. Perhaps this is due to the peculiarities of the morphological
and functional structure of the bronchopulmonary system in children in this age group and the rapid processes of dissemination of the infectious agent caused by immaturity of both connective tissue structures and the immune system. It is important to note that in this group all forms of pneumonia were accompanied by toxemia and respiratory failure.

In the second and third groups segmental and focal forms in the middle and lower lobes were most common, the anterior and posterior segments of the lungs were affected equally often. From the point of view of anatomy, these segments are worse ventilated through the bronchi, and, consequently, pathogenic bacteria adhere to them and multiply more quickly [9, 10]. The degree of severity of clinical manifestations of the disease in this age group corresponded to the size of the infiltrate.

Segmental forms were more common in older patients, but pneumonuria was detected in 4% of patients in this age group. Perhaps this is due to the intensive development of the Kon pores at this age and the increase in the functional role of collateral ventilation, which promotes the spread of the infectious agent. We also conducted a thorough analysis of the transverse infiltrate sizes in each age group, taking into account the morphological forms of pneumonia (Table 1).

<table>
<thead>
<tr>
<th>Morphological form of pneumonia</th>
<th>Group 1 (until one year) n=55</th>
<th>Group 2 (1 to 3 years) n=20</th>
<th>Group 3 (4 to 7 years) n=35</th>
<th>Group 4 (7 to 18 years) n=20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focal pneumonia</td>
<td>10.2±2.4</td>
<td>15.3±1.7</td>
<td>19.8±4.8</td>
<td>23.4±4.5</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>15.5±3.5</td>
<td>20.2±2.7</td>
<td>24.7±2.9</td>
<td>31.2±1.6</td>
</tr>
<tr>
<td>Segmental pneumonia</td>
<td>24.1±2.4</td>
<td>39.2±3.7</td>
<td>30.3±2.7</td>
<td>31.0±3.9</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>25.5±2.1</td>
<td>41.5±3.8</td>
<td>37.8±1.5</td>
<td>42.8±3.6</td>
</tr>
<tr>
<td>Polysegmental pneumonia</td>
<td>32.9±1.64</td>
<td>38.7±2.6</td>
<td>41.8±3.7</td>
<td>45.3±5.4</td>
</tr>
<tr>
<td>Lobar pneumonia</td>
<td>50.8±5.8</td>
<td>65.2±3.6</td>
<td>51.8±3.7</td>
<td>52.8±4.7</td>
</tr>
</tbody>
</table>

The obtained data are supposed to be used in the further development of three-dimensional electrodynamic models of human chest organs with various pathologies and study of the passage of high-frequency and ultrahigh-frequency radiation of different frequencies for the development, simulation, methods and devices of harmless non-invasive diagnosis of diseases of the bronchopulmonary system with the possibility of localization of infiltration in the chest organs based on the technique of radio-frequency scanning [11-14].

All patients were treated with antibacterial therapy: penicillin antibiotics were more often prescribed (38%), cephalosporins took the second place (33%), cephalosporins of the third generation (Ceftriaxone) were most often used, macrolides took the third place (22% clarithromycin). Penicillin was ineffective in most of the children in 48-72 hours. This can be explained by the acquired resistance of microorganisms to them, the relatively narrow spectrum of their action, the possible presence of atypical pathogens. Antibiotics were more often administered parenterally, the average duration of treatment was 10-14 days.

Non-steroidal anti-inflammatory drugs, expectorants, vitamins, aerosols with saline solution were also used. Control x-ray examination was performed in 86% of cases. More than half of the cases of pneumonia ended with a full resolution of the process in the lungs, in 11% of cases residual infiltration remained with positive dynamics and in 34%, strengthening and thickening of the pulmonary pattern were found, which required further use of anti-inflammatory drugs. The results of repeated radiography indicate the adequacy and effectiveness of the therapy.

**Conclusion**

Our study showed that community-acquired pneumonia is more common in school-age children, with more boys among patients. The analysis of data on the morphological structure found that right-sided focal and segmental forms predominate, while infiltration was more often recorded in the middle lobe. The results of a comprehensive examination of patients found that the SCT of the chest is a highly informative x-ray method of diagnosis and dynamic control of pneumonia in children of different age groups, allowing not only timely diagnosis, establish the morphological form of pneumonia, but also to evaluate the effectiveness of etiotropic treatment. The data obtained in this study can be used to simulate the inflammatory process in the lungs and to develop modern methods of studying the bronchopulmonary system in children.

**Conflict of Interest:** None.

**Ethics:** No ethical issues relate to the present study.

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**References**


