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Investigation of the Chest Radiograph Findings in Children with Pneumonia Hospitalized in a Children's Hospital, Tabriz, Iran

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ABSTRACT

Introduction:
Pneumonia has been regarded as the leading cause of death among the elderly, very young children, and those who suffer from chronic diseases. Among the underlying causes, viral infections have been addressed as the most frequent cause of pneumonia in children.

Materials and Methods:
This study investigated a total of 300 subjects with pneumonia hospitalized in Tabriz Children's Hospital, Tabriz, Iran. Moreover, a comparison was made between the type of pneumonia and associated radiologic features. Age, gender, performed laboratory tests, symptoms, and final interpretations of the chest x-ray (CXR) images were included in the checklist.

Results:
The mean age of the patients was 6.09 2.45 years. Moreover, the mean erythrocyte sedimentation rate was estimated at 27.86±22.73 mm/h. In this study, 174 (58%), 57 (19%), 50 (16.7%), and 19 (6.3%) patients were C-reactive protein (CRP) negative, CRP (+), CRP (++), and CRP (+++), respectively. Furthermore, in 238 (79.3%) patients, white blood cell (WBC) count in serum was within the normal range, whereas high WBC count was reported in 62 individuals (20.7%). In addition, four positive blood cultures as well as 27 (9%) cases with pleural effusion were identified in this study. Reticulonodular involvement was recognized in up to 246 (82%) subjects. It should be noted that 63 (21%) and 237 (79%) patients showed unilateral and bilateral involvement in chest radiography, respectively. Regarding the frequency of radiographic evidence, the most common patterns of involvement in descending frequencies were reticulonodular and lobar alveolar.

Conclusion:
The most common pattern of involvement in children's CXRs with pneumonia is a reticulonodular pattern associated with bilateral peribronchial cuffing.

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Introduction

Pneumonia is regarded as the inflammation of the lung, especially the tiny air sacs called alveoli, which occurs as a result of infections caused by viruses, bacteria, and other microorganisms (i.e., fungi, parasites) (1).

This inflammation is the leading cause of mortality among the elderly, very young children, and people with chronic diseases in developing countries (2).Most of the cases occur in children younger than 5 years of age as well as the elderly (3).

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Pneumonia may occur in one segment, one lobe, or either in several fragments or extensively in the alveoli (4). The most common underlying cause of pneumonia in children is viral infections. On the other hand, bacterial infections account for 10-40% of childhood pneumonia (5).

Microorganisms enter the lungs through the bloodstream or downward local expansion from the bronchial system (6). Viral respiratory infections are often followed by bacterial infections (5).

Streptococcus pneumonia is the most widespread cause of bacterial pneumonia. Staphylococcus aureus is among the rare causes of pneumonia in infants; however, it is associated with empyema, pneumatocele, respiratory failure, and critical general condition (1,7). Clinical manifestations of viral and bacterial pneumonia often differ. Tachypnea, cough, fainting and lethargy, pleuritic chest pain, and respiratory muscle retractions have been detected in both types (8). Alveolar opacities in viral pneumonia have been questioned, and they appear to be an indicator of severe interstitial lung disease which results in the compression of alveoli and form alveolar opacities (1,5).

Bacterial pneumonia is distinctively associated with coughing, high fever, shortness of breath, and auditory findings of pulmonary consolidation (reduced respiratory sounds, tubular sounds, dullness on percussion, and egophony in a limited area) (4,8). The chest x-ray (CXR) in bacterial pneumonia often shows lobar density and pleural effusion (1). Bacterial opacities usually begin in the form of ill-defined or fluffy foci, which are located peripherally and generally progress to the whole lobe involvement. However, whole lung involvement happens rarely (9,10). Bacterial childhood pneumonia is a space-occupying process, and therefore, in the acute phase of the disease, there is absent or only slight lung volume reduction which can be beneficial in distinguishing it from other underlying causes (4).

In pneumonia, white blood cells (WBC) count and neutrophils in particular increases as well. Pneumonia diagnosis is generally performed based on a combination of physical symptoms and CXR results (11). Nonetheless, the underlying cause may be difficult to confirm since there is no test to definitively differentiate between bacterial and non-bacterial causes (12). However, in patients with interstitial pneumonia, both viral and bacterial etiology are possible (13). In children, due to increased respiratory rate and chest indentation, there is more hearing sensitivity to detect crackles using a stethoscope. Nevertheless, findings may vary, and there are other patterns in other types of pneumonia (8). Radiological results may not be observed in the early stages of the disease, especially when there is excessive loss of body fluids. In addition, result interpretation may be difficult in patients having a medical history of respiratory diseases or suffering from obesity (14,15). The causes of focal alveolar consolidation (lobar and alobar) in very young children include bacterial pneumonia (Streptococcus pneumonia, Mycobacterium, Staphylococcus, and Haemophilus influenza) as well as non-bacterial infections, such as respiratory syncytial virus, tuberculosis, actinomycosis, and lung contusion (7,16-18). A multitude of studies has been carried out worldwide in this regard, and their findings have shown that there is a difference between the type of pneumonia and its radiographic findings that is to say it is possible to predict the type of pneumonia by examining the clinical and laboratory findings and their compatibility with radiology findings.

According to what mentioned earlier, this study aimed to investigate CXR images in children hospitalized with pneumonia in Tabriz children's teaching hospital, Tabriz, Iran. It is hoped to gain a more detailed knowledge of radiological signs and take advantage of them in adopting new strategies as well as enlightening the path for future studies.

Materials and Methods

The study protocol was approved by the Ethics Committee of Tabriz University of Medical Sciences, Tabriz, Iran. Subsequently, informed consent was obtained from patients, and children with pneumonia hospitalized in Tabriz Children's Hospital were included in the study. On the other hand, the patients who were receiving antibiotics or suffering from other lung

diseases were excluded from the study. Following that, the records of 300 patients with pneumonia hospitalized in Tabriz Children's Hospital were extracted, and chest radiographs and their interpretations were included in the existing checklists. A comparison was made between the type of pneumonia and associated radiologic features, such as age, gender, accomplished tests, symptoms. Eventually, the final radiography analysis of CRX was included in the checklist followed by data analysis.

Results

The mean age of the patients was 6.09 2.45 years (age range: from 2 months to a maximum age of 13 years). The majority of the patients were male (n=179, 59.7%). Moreover, the mean erythrocyte sedimentation rate (ESR) in this study was obtained at 27.86±22.73 mm/h. In this study, 174 (58%), 57 (19%), 50 (16.7%), and 19 (6.3%) patients were C-reactive protein (CRP) negative, CRP (+), CRP (++), and CRP (+++), respectively. In 238 (79.3%) patients, the WBC count was in the normal range varying from 3900 to 28000 per mm3 or 92.4121±13.10984/mm3 on average.

It should be mentioned that 238 subjects were represented with WBC count within the normal range, whereas in 62 individuals (20.7%), high WBC count in serum was reported (normal range: 5000-15000/mm3). Out of 15 blood cultures, four positive samples were identified, and 26 patients (8.7%) had a history of preterm labor.

Furthermore, pleural effusion was observed in 27 patients (9%), and peribronchial cuffing and reticulonodular involvement were found in 246 (82%) individuals. It is worth mentioning that 63 (21%) and 237 (79%) patients showed unilateral and bilateral involvement in chest radiography, respectively.

The results of this study showed no significant relationship between age and type of lung involvement in CXR (reticulonodular, alobar, and lobar). Moreover, according to CXR images, no significant correlation was observed between ESR and type of lung involvement (reticulonodular, alobar, and lobar).

Discussion

This study investigated 300 children with pneumonia who were admitted to Tabriz Children's Teaching Hospital, Tabriz, Iran. The mean age of the patients was 6.45 years (age range: from 14 months to a maximum age of 13 years). Matti Korppi et al. appraised clinical manifestations to distinguish different types of pneumonia and declared that all children under 2 years of age, 91% of the children between 2-4 years old, and 71% of the 5-year-old children or older represented at least one respiratory symptom. According to their findings, alveolar infiltrates increase and interstitial infiltrate decreases with age.

In this study, concerning clinical symptoms, the most common presentations were cough and then crackleS. John et. al carried out a study on the spectrum of clinical symptoms and introduced crackles and dry cough as the most common manifestations (19). Falup-Pecurariu et al. reported coughing as the most common symptom in both children with alveolar infiltrates and the ones with non-alveolar infiltrates.

In the aforementioned study, considering the age distribution, children with pneumonia associated with alveolar infiltrates were on average older than their counterparts with interstitial infiltrates. Fever was observed in a greater proportion of children with alveolar infiltrates, compared to their counterparts with interstitial infiltrates (90.7% vs 87.7%). Regarding gender, no significant difference was found between the alveolar and reticulonodular groups (20). According to this study, age can be regarded as a predictive parameter in pneumonia with alveolar infiltrates, and alveolar pneumonia is more associated with the bacterial cause which is chiefly observed in older ages.

However, pneumonia with non-alveolar infiltrates is more common in younger children, and viral pneumonia affects mostly children under 2 years of age (20).

The mean ESR was estimated at 27.86±22.73 mm/h ranging from 3 to 105 mm/m. Out of 300 patients, 174 (58%), 57 (19%), 50 (16.7%), and 19 (6.3%) cases were CRP negative, CRP (+), CRP (++), and CRP (+++), respectively. Moreover, the WBC counts of

238 (79.3%) patients in serum were within the normal range varying from 3900 to 28000 per mm3 or 92.4121± 13.10984/ mm3 on average (within normal range: 4000-14000/mm3).

In total, 62 subjects (20.7%) displayed an elevated WBC count. Falup-Pecurariu et al. examined children with alveolar pneumonia and reported CRP>70, elevated WBC count, and ESR in the majority of the patients as their findings (19). In the same vein, Korppi et al. stated that the CRP is of little value in the differential diagnosis of pneumococcal and non-pneumococcal pneumonia (21). Nohynek et al. indicate that children with bacterial infection are older than those with viral infection (1.5 vs 2.5 years).

In this study, differentiating between bacterial and viral infections was performed by taking advantage of blood culture, as well as antibody and antigens procedures, and they found that symptoms last longer in children with bacterial infection (4.6 days vs 3.6 days). There was no significant difference between the groups with bacterial and viral infections in terms of mean ESR. Moreover, no statistically significant difference was observed among the groups regarding WBC counts (22).

Coughing was a common symptom in both groups. According to this study, in terms of inflammatory parameters, the criteria mostly overlapped and could not be used to differentiate between bacterial and viral causes. This may be attributed to the high prevalence of bacterial and mixed infections (22). Similarly, in our study, no relationship was noticed between these markers and radiographic evidence.

In terms of radiographic evidence, the most common findings in our examination include reticulonodular changes, alveolar alobar opacity, and alveolar lobular opacity in descending order. In this study, no significant relationship was found between the variables and radiographic findings. John et al. carried out a study in which radiographic evidence of mycoplasma pneumonia was varied and there was no specific finding. However, local unilateral reticulonodular opacity was more prevalent (19). Moreover, Andrade et al. in their study concluded that children with radiologically confirmed pneumonia had a higher frequency of infection by streptococcus pneumonia, compared to those with a normal chest radiograph (23).

Korppi et al. suggested that antibiotic therapy should be initiated in patients with alveolar involvement. Patients with interstitial infiltrate represent bilateral infiltrates in 80% of the cases. In interstitial infiltrates, both bacterial and viral infections are possible. Therefore, in such cases, treatment should be accomplished based on clinical manifestations and laboratory findings (21). In the same line, Hazir et al. conducted a study in which they had included 2000 children diagnosed with non-severe pneumonia. They reported that 82% of the subjects displayed normal radiography, and only 14% of the study population showed radiographic evidence of pneumonia. Lobar opacity was observed in 26 children, and the majority of them displayed parenchymal change which was compatible with the diagnosis of bronchiolitis (24). Kiekara introduced alveolar and interstitial infiltrates as the indicators of bacterial infections and both types of infections, respectively. Difficulties in interpreting radiography images in children with bronchiolitis or bronchitis, peribronchial changes, and small areas of atelectasis, complicate pneumonia diagnosis (25). Generally, pneumonia diagnosis is difficult with radiographic evidence, particularly in newborns with interstitial pneumonia. Pleural effusion was detected in 27 patients (9%).

In a study conducted by John et al., they reported that 17% of the subjects were represented with pleural effusion. According to other studies, they also reported the prevalence of pleural effusion as 5-20%. However, in most cases, the clinical presentation of pleural effusion is temporary and spontaneously resolved. Therefore, it appears to offer little clinical value. In this study, no significant statistical relationship was detected between clinical presentations and the presence or absence of pleural effusion in CXR (19).

It is worth mentioning that children with pneumonia often recover quickly and completely, and CXR findings return to normal conditions within 6-8 weeks. Regarding the limited number of our sample

size, a larger statistical population is required in order to investigate more precisely the relationship between the variables and the type of involvement. Moreover, future studies should focus on the effects of various geographical areas in different regions. It is also suggested to compare the children diagnosed with pneumonia with those whose treatments have been initiated based on radiographic evidence in terms of different variables.

Conclusion

According to the findings, variables of this study (i.e., age, gender, clinical presentations, and laboratory test results) showed no correlation with radiographic findings and their types (reticulonodular, alobar, and lobar alveolar). The most common pattern of involvement in children's CXRs with pneumonia is the reticulonodular pattern associated with bilateral peribronchial cuffing.

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