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# The Role of Chest X-Ray in the Radiological Assessment of Pediatric Pneumonia in a Tertiary Care Setting

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## ABSTRACT

Pneumonia is an infection of the lungs that is marked by a fever, respiratory symptoms, and changes seen on imaging. It is important to diagnose and evaluate the seriousness of an allergic disease in children as soon as possible for proper treatment. **Objective:** To analyze whether severe acute pneumonia in children can be predicted using chest X-rays. Patients with severe acute pneumonia had symptoms including difficulty in breathing, low oxygen levels, and findings on X-ray, such as lobar consolidation and interstitial involvement. **Methods:** A retrospective cross-sectional study was conducted in the Department of Radiology, Gujranwala, Pakistan, from December 2022 to March 2023. The study included 60 pediatric patients diagnosed with pneumonia. Patients with pneumothorax were excluded from the study. The study determined the sample size based on previous similar research. SPSS-22 was used for statistical analysis. **Results:** Most children in the research were less than 3 years old. The majority were boys, 41 (68.3%), while girls accounted for 19 (31.7%). The symptom that patients most usually reported was difficulty breathing, 25 (41.7%). The majority of the cases showed consolidation of a lobe, 25 (41.7%), followed by interstitial abnormalities, 14 (23.3%). **Conclusions:** It was concluded that lobar consolidation was the most common radiological finding in children with severe acute pneumonia, particularly in boys under the age of three. Chest X-rays played a crucial role in diagnosing and evaluating the severity of the disease. Regular training for radiologists and clinicians on pediatric pneumonia patterns can further improve diagnostic accuracy.

## INTRODUCTION

The term "pneumonia" refers to a lower respiratory tract infection that frequently comes with a fever, respiratory symptoms, and visible parenchymal involvement on physical examination or radiography. Pneumonia remains a leading cause of morbidity and mortality among children, particularly in low- and middle-income countries. Pathologically, it represents an inflammatory disorder that affects the connective tissue, visceral pleura, airways, and alveoli of the lung. Radiology defines pneumonia as an infiltration on a child's chest radiograph who exhibits symptoms of an acute respiratory illness. Clinicians who work in primary care and emergency rooms commonly deal with pneumonia [ ]. The leading cause of illness and mortality in developing countries is still pediatric pneumonia. There have been several forms of pneumonia identified, the first of which is walking pneumonia, which is frequently used to describe school-aged children and young people who show radiographic and clinical signs of pneumonia but have mild respiratory symptoms that do not interfere with everyday activities. Mycoplasma pneumoniae has typically been identified as the bacterium thought to be responsible for walking pneumonia [2]. Community-acquired pneumonia is a term used to describe an acute lung infection in a previously healthy person that is obtained in the community as opposed to hospital- or nosocomial-acquired pneumonia [3]. If a child had pneumonia within two days of entering the hospital, it is called hospital-associated pneumonia [4]. It covers individuals who have pneumonia while living in long-term care, as well as people who have just had surgery [5]. The

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WHO states that about 151 million cases of pediatric pneumonia and 7% of all global deaths happen in developing countries every year. Even though HCV causes many health complications, it is still difficult to make an early and accurate diagnosis and assess the severity in places where resources are short [6, 7]. Pneumonia is 0.28% more common in people with a fever but no cough or tachypnea. Upper lobe pneumonia may exhibit a meningitis-like clinical picture due to radiating neck discomfort. Unspecific abdominal pain that resembles appendicitis is one sign of lower lobe pneumonia. Newborns may develop pneumonia at an early or late stage. In the first three days of life, early-onset pneumonia typically manifests [8, 9]. Additional symptoms include temperature instability, metabolic acidosis, and abdominal distension. The initial steps in treating a child who has suspected pneumonia include a comprehensive history and physical examination. Fever, any associated cough, and tachypnea are more likely to have been present in the past [10]. A thorough physical examination requires the doctor to focus on the patient's appearance as a whole and look for hypoxia and cyanosis. Infants who are still growing may show signs of lethargy, inadequate nutrition, or irritability [11]. When a child with fever and respiratory distress shows infiltrates on a chest radiograph, pneumonia is diagnosed; however, if there is a strong clinical suspicion, the absence of chest X-ray evidence does not rule out pneumonia [12, 13]. Chest X-rays (CXRs) are widely used in clinical practice to support the diagnosis of pneumonia in children presenting with acute respiratory symptoms. Radiographic findings such as lobar consolidation, interstitial infiltrates, or pleural effusions are considered valuable in confirming clinical suspicion and guiding treatment decisions. However, the diagnostic utility of CXR, especially in predicting the severity of pneumonia, remains a subject of debate. Several international studies have explored radiological patterns in pediatric pneumonia, yet limited data exist from Pakistan that contextualize radiologic severity indicators within local healthcare environments. In Pakistan, where pediatric respiratory illnesses are common, the role of imaging particularly CXRs, in assessing pneumonia severity is not clearly defined or standardized. Furthermore, variations in radiological interpretation protocols, lack of consensus on severity grading, and resource constraints may hinder timely and accurate diagnosis. There is a pressing need to understand how chest radiographs contribute to the early identification of severe pneumonia in this setting, especially in children under the age of five who are at highest risk. When there is a serious illness, hypoxemia, or considerable respiratory distress that necessitates hospitalization, a chest radiograph may be advised as a first step [14]. Follow-up chest radiographs are rarely advised in children who have recovered after receiving the right therapy. Follow-up radiographs are advised in patients with complicated pneumonia who are clinically unstable, in those who have received adequate antibiotic coverage for 48 to 72 hours with poor clinical improvement or worsening, and in patients who have pneumonia that recurs in the same lobe to rule out a suspected anomaly, chest mass, or foreign body [15, 16]. When necessary, chest radiographs of individuals older than 4 years old should be obtained in the supine anteroposterior position, whereas those younger than that should be taken in the postero-anterior upright position [17]. When a pleural effusion is suspected, a lateral view is advised, and the affected side should be down for the acquisition of the lateral decubitus view [18]. The current investigation focuses on pediatric pneumonia, including the etiology across age groups, clinical signs, and radiographic findings. To evaluate the role of chest X-rays in predicting severe acute pneumonia in children presenting to a radiology department in Gujranwala, Pakistan. We address the gap in local literature by analyzing radiologic patterns associated with clinical severity and by providing insights into the diagnostic value of CXRs in routine pediatric care. Radiological severity in this study was defined by findings such as lobar consolidation, extensive interstitial involvement, and the presence of pleural effusion. Ethical approval was obtained from the relevant institutional review board, and chest radiographs were interpreted independently by two qualified radiologists, blinded to clinical data, to ensure consistency. Pneumonia remains a leading cause of hospitalization and death among children under five, especially in low-resource settings like Pakistan. While chest X-rays (CXRs) are frequently used to support clinical diagnosis, their role in predicting the severity of pediatric pneumonia is not well defined in the local context. There is limited regional data on how specific radiographic findings correlate with clinical severity in children.

This study aims to evaluate the diagnostic value of chest radiographs in identifying severe pneumonia in pediatric patients. By analyzing radiological patterns and their association with clinical indicators of severity, the study seeks to support more accurate, timely diagnoses and better-informed treatment decisions in resource-constrained healthcare settings.

## METHODS

A retrospective cross-sectional study was conducted in the Department of Radiology, Gujranwala, Pakistan, from December 1, 2022, to March 31, 2023. We included 60 pediatric patients under the age of 15 who were diagnosed with pneumonia. The study obtained informed consent from the guardians of all patients. The study determined the sample size based on previously published studies. The study excluded patients with pneumothorax, individuals aged 15 years or older, and those with incomplete radiological records. The study diagnosed pneumonia

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based on clinical symptoms (fever, cough, difficulty in breathing, and tachypnea) along with radiological evidence such as lobar consolidation, interstitial infiltrates, or pleural effusion. The study defined severe pneumonia according to WHO guidelines, which include signs of hypoxemia, severe respiratory distress, or chest radiographic findings like dense lobar consolidation or extensive bilateral infiltrates. Two experienced radiologists independently evaluated all chest X-rays while remaining blinded to the clinical history. They interpreted the radiographs using standard pediatric radiology criteria [19, 20], and they resolved any discrepancies by consensus. The study entered, computed, and analyzed the data using SPSS version 22. The study used descriptive statistics to summarize demographic details, clinical symptoms, and radiographic findings.

## RESULTS

The study shows the age of the patients. Only children are included in the study. The age of the patients is further categorized into different groups. All participants were under the age of 15. Age was categorized into four groups for descriptive analysis: less than 3 years (46.7%), 4–6 years (26.7%), 7–9 years (16.7%), and 10–12 years (10.0%). The majority of patients 28 (46.7%) were under 3 years of age, indicating higher vulnerability in early childhood (Table 1).

**Table 1:** Age Distribution of Pediatric Pneumonia Patients

| Variables | Frequency (%) | Valid Percent | Cumulative Percent |
|---|---|---|---|
| Less than 3 Years | 28 (46.7 %) | 46.7 | 46.7 |
| 4 to 6 Years | 16 (26.7%) | 26.7 | 73.3 |
| 7 to 9 Years | 10 (46.7 %) | 16.7 | 90.0 |
| 10 to 12 Years | 6 (16.7%) | 10.0 | 100.0 |
| Total | 60 (100%) | 100.0 | |

This study also shows the gender of the patients. The study population consisted of 41 boys (68.3%) and 19 girls (31.7%), reflecting a male predominance in pneumonia presentation during the study period (Table 2).

**Table 2:** Gender Distribution

| Variables | Frequency (%) | Valid Percent | Cumulative Percent |
|---|---|---|---|
| Boy | 41 (68.3%) | 68.3 | 68.3 |
| Girl | 19 (31.7%) | 31.7 | 100.0 |
| Total | 60 (100%) | 100.0 | |

Results show the symptoms of the patients. The most frequently reported clinical symptom was difficulty in breathing (41.7%), followed by fever (35.0%) and cough (23.3%). These findings aligned with typical respiratory distress presentations in pediatric pneumonia cases. Chest X-rays were evaluated independently by two qualified radiologists who were blinded to the patients' clinical details. A standardized reporting protocol was followed, and inter-observer agreement was assessed using Cohen's kappa coefficient, which indicated substantial agreement ($\kappa$=0.76) (Table 3).

**Table 3:** Clinical Symptoms in Pediatric Patients

| Variables | Frequency (%) | Valid Percent | Cumulative Percent |
|---|---|---|---|
| Cough | 14 (23.3%) | 23.3 | 23.3 |
| Fever | 21 (35.0%) | 35.0 | 58.3 |
| Difficulty in Breathing | 25 (41.7%) | 41.7 | 100.0 |
| Total | 60 (100 %) | 100.0 | |

Findings shows the X-ray findings in children with pneumonia. Radiographic analysis revealed lobar consolidation as the most common finding (41.7%), suggesting more severe localized infection. Other radiological patterns included interstitial abnormalities (23.3%), pleural effusion (8.3%), bilateral consolidation (8.3%), lymphadenopathy (6.7%), hyperinflation (6.7%), and a small proportion of normal radiographs (5.0%). Severe pneumonia was classified based on WHO criteria, which consider signs such as hypoxemia, chest in-drawing, and significant radiologic involvement (Table 4).

**Table 4:** Chest X-ray Findings in Pediatric Pneumonia Patients

| Variables | Frequency (%) | Valid Percent | Cumulative Percent |
|---|---|---|---|
| Normal | 3 (5.0%) | 5.0 | 5.0 |
| Lobar Consolidation | 25 (41.7%) | 41.7 | 46.7 |
| Lymphadenopathy | 4 (6.7%) | 6.7 | 53.3 |
| Interstitial Abnormality | 14 (23.3%) | 23.3 | 76.7 |
| Pleural Effusion | 5 (8.3%) | 8.3 | 85.0 |
| Hyperinflation | 4 (6.7%) | 6.7 | 91.7 |
| Bilateral Consolidation | 5 (8.3%) | 8.3 | 100.0 |
| Total | 60 (100 %) | 100.0 | |

## DISCUSSION

Pneumonia is an infection of the lungs that is marked by a fever, respiratory symptoms, and changes seen on imaging. Ibrahim *et al.*, show that in children, chest X-rays are necessary for pneumonia diagnosis since they help spot radiological signs such as lobar consolidation. This result is similar to those found in the past, as no major variations in radiological findings were found to be related to improvement in fever or tachypnea in children. Lobar consolidation was the frequent reason for diagnosis in children, although the study did not evaluate the results for patients who had it on a scan. At Himachal Pradesh's Civil Hospital, the study was carried out with 83 children who all had severe pneumonia. The most commonly observed finding was lobar consolidation, present in 14 kids, and 26 had abnormalities seen in the lungs' spaces. The findings indicate that radiological information is not very good at predicting how a hospitalized child with severe pneumonia will respond to treatment [1]. The study by Magree *et al.*, indicated that out of 174 children tested with CXR, chest radiography only identified pneumonia in 59 of them. Therefore, CXR helps doctors confirm when a young patient has a chest problem. Still, the differences in chest radiography's usefulness point out that it may not always be accurate, as to how accurate it is, depending on the disease

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stage and the technique that is used. The new study confirms their view, in particular in very young children, where diagnosis can be hard just by looking at the physical signs. Researchers also indicated that CXR can assist in the diagnosis of pneumonia in children. In comparison to the earlier study, it was found in the current study that CXR helps diagnose pneumonia in children under five years old [19]. The study in carried out by Gupta evaluated 950 children with possible pneumonia and compared chest CT, lung ultrasound, and chest radiograph. The analysis revealed that CT found lung opacity and sub-pleural consolidation, but ultrasound did a better job at spotting pleural effusion and perilesional edema. This research points out that there are limitations to CXR and that further testing may be required for some cases. Other observations were the changes between organs and the accumulation of medications in the spaces around them, both of which have to be understood closely. With the use of chest radiograph and lung ultrasonography, convex lung opacity, lung consolidation near the diaphragm, fluid around the pleura, and swelling close to the lung could all be detected. It also indicates that CXR reveals lung opacity and consolidation as useful signs for the diagnosis of pneumonia in children [20].

## CONCLUSIONS

In conclusion, lobar consolidation was the most frequently observed chest X-ray abnormality in pediatric pneumonia cases, particularly among male patients under the age of three. While chest radiographs were effective in detecting pneumonia-related changes, they had limited value in assessing disease severity. We recommend utilizing chest X-rays as a primary diagnostic tool in resource-limited settings to support the early detection of pediatric pneumonia. Future studies should include larger and more diverse populations, apply standardized severity criteria, and incorporate clinical correlations to enhance the diagnostic and prognostic utility of chest imaging in pediatric respiratory infections.

## Authors Contribution

Conceptualization: NT
Methodology: NT
Formal analysis: NT
Writing review and editing: NT, AA

All authors have read and agreed to the published version of the manuscript.

## Conflicts of Interest

All the authors declare no conflict of interest.

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