

Comparison of Chest X-Ray and Ultrasonography in Evaluating Lower Respiratory Tract Infections in Children

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Abstract:

Background Common lower respiratory tract infections in children are pneumonia and bronchiolitis. Most common causes of LRIs are respiratory syncytial viruses, which tend to be more seasonal, unlike parainfluenza viruses. Diagnosis is mainly based on clinical symptoms and is usually verified with a chest X-ray. Ultrasonography (USG) is an alternative method which can be used for the early detection of pneumonia complications like pleural effusion. Since studies on comparison of chest X ray and USG are less in India, the current study was undertaken, this study was done to correlate findings of chest X ray with USG in detecting lower respiratory tract infections among children.

Materials and Methods: This is an observational study conducted on 65 children suffering from lower respiratory tract infections aged 1 to 14 years of either sex. The study was done at tertiary care teaching hospital named NRI Institute of medical sciences, Visakhapatnam, Andhra Pradesh from September 2021 to September 2022. Age, gender, symptoms, area of residence, immunization status, chest x ray, chest USG findings were assessed and compared.

Results: Most of the children were aged below 3 years. Most of the children were males. Most of the children were completely immunized. Sensitivity of USG in detecting pneumonia was 97.83%, specificity was 78.95%. Accuracy was 92.31% in detecting pneumonia. Sensitivity of CXR in detecting pneumonia was 76.47%, specificity was 64.29%. Accuracy was 73.85% in detecting pneumonia.

Conclusion: We conclude that chest USG detects more findings of lower respiratory tract infections compared to chest x ray. We recommend getting chest USG compared to CXR as it lacks radiation and has more accuracy compared to chest x ray.

Key Words: Chest X Ray, ultrasonography, lower respiratory tract infections, observational study, children

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I. Introduction

Acute respiratory infections (ARIs) are classified into upper respiratory tract infections (URIs) or lower respiratory tract infections (LRIs). Lower respiratory tract covers trachea and bronchi to the bronchioles and the alveoli. ARIs are commonest causes of both illness and mortality in children below 5 years, who average three to six episodes of ARIs annually irrespective of where they live or what their economic condition is. [1] Around 10.8 million children die every year due to LRIs. Among 1.9 million who died due to ARIs, 70% belonged to Africa and Southeast Asia [2]. Common LRIs in children are pneumonia and bronchiolitis. Most common causes of LRIs are respiratory syncytial viruses, which tend to be more seasonal, unlike parainfluenza viruses. Vuori-Holopai review [3] found that *S. pneumoniae* and *Hemophilus* constitute for 13 to 34 percent and 1.4 to 42.0 percent of bacterial pneumonia. In one study done at Gambia, 37% of radiological pneumonia was prevented by vaccination. [4] Difficulty in breathing, subcostal and intercostal retractions, suprasternal retractions, and usage of accessory muscles of respiration are also common in pneumonia. Symptoms of bacterial pneumonia occur due to direct invasion of bacteria into chest cavity. Correct diagnosis, appropriate, timely treatment, and identification of complications are considerably important in LRI. Diagnosis is mainly based on clinical symptoms and is usually verified with a chest X-ray. Ultrasonography (USG) is an alternative method which can be used for the early detection of pneumonia complications like pleural effusion. [5-6] USG is a better diagnostic modality for early detection of LRI compared to Chest X-Ray and that patient exposure to harmful radiations are nil as per Taghizadieh et al. [7] Jones et al. [8] did a randomized controlled trial and found that chest USG as a feasible and safe substitute for chest xray for evaluating children with suspected pneumonia. Biagi et al. [9] reported good accuracy of USG in diagnosing pneumonia among children with

bronchiolitis. Since studies on comparison of chest X ray and USG are less in India, the current study was undertaken. **Aim:** To correlate findings of chest X ray with USG in detecting lower respiratory tract infections among children.

II. Materials And Methods

This observational study was carried out in the Department of pediatrics at a tertiary care center named NRI Institute of Medical Sciences, Visakhapatnam, Andhra Pradesh from September 2021 to September 2022.

Study Design: Observational study.

Study Location: This study was done at a tertiary care teaching hospital-in the Department of Pediatrics, at NRI Institute of Medical Sciences, Andhra Pradesh, India.

Study Duration: September 2021 to September 2022

Sample size: 65 patients.

Sample size calculation: As per various studies done previously, the prevalence of ARI ranged from 20 to 30%^[10-12]

Considering the prevalence as 30%, error as 10% at confidence levels of 90%, the minimum sample size came to be 58. So, we included 65 children considering few losses to follow up.

Subjects & selection method: Children coming to the outpatient unit or admitted with lower respiratory tract infections diagnosed clinically were selected to participate in the study after getting consent from parents or legally accepted representatives.

Inclusion criteria:

1. Children aged 1 to 14 years
2. Either sex
3. Children diagnosed to have lower respiratory tract infections as per clinical symptoms (fever, cough, chest pain).
4. Children of parents who provided informed consent

Exclusion criteria:

1. Children with serious renal, liver, cardiac problems that interfere with data collection.
 2. Children with known pulmonary tuberculosis
 3. Children with current COVID positive status
- Exclusion criteria is based on RT PCR report, symptoms, medical history taken from parents.

Procedure methodology

After getting written informed consent, this study was conducted. Thorough history and clinical examination were done. Children who presented with LRI were selected as per inclusion and exclusion criteria. After selecting 65 children, they were subjected to chest X ray, chest USG and CT. CT scan was taken as gold standard. Treatment was initiated after that.

Ethical considerations: Permission was obtained from the Institutional ethical committee attached to NRI Institute of Medical Sciences, Visakhapatnam before conducting the study. Every parent was explained the whole process and advantages of the study. After he/she accepts, an informed consent form is given in local language or the patient understandable language and the person was asked to sign it or put a thumb impression.

Statistical analysis:

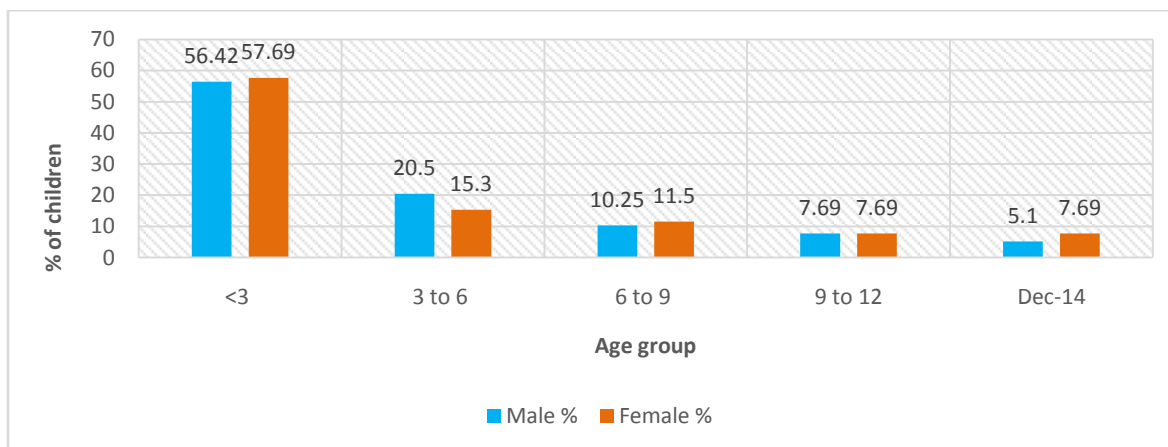
Statistical analysis was done using Epi info software version 7.2.5. Results were expressed as frequencies and percentages. Sensitivity, specificity, diagnostic accuracies were assessed.

III. Results

Sixty-five children aged 1 to 14 years with LRI were included. Most of the children were aged below 3 years. Next most common age group was 3 to 6 years, followed by 6 to 9 years. The least common age group was 12 to 14 years.

Males were more compared to females. 36 children were males and 29 children were females.

Graph 1 shows age and gender distribution of children



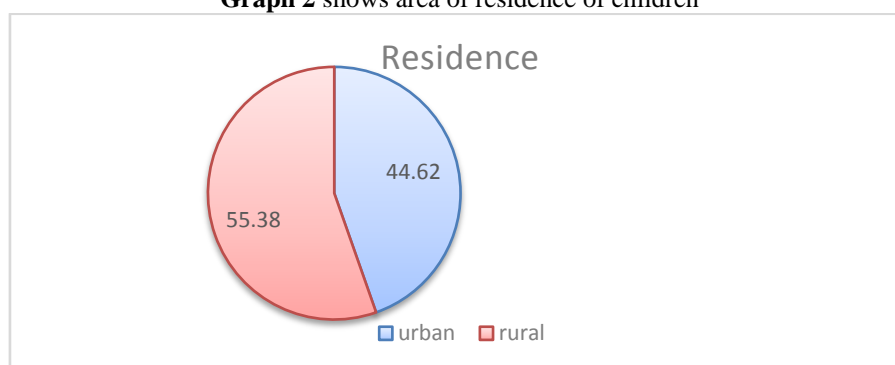
Symptoms: Most common complaint was cough, seen in all children. Fever was seen in 95.38% of children, tachypnoea was seen in 90.76% of children. Chest retractions were seen in 49.23% of children.

Table 1 shows symptoms among children

Complaints	Present	
	Count	Percentage
Cough	65	100
Fever	62	95.38
Tachypnoea	59	90.76%
Running nose	20	30.76
Retractions	32	49.23%

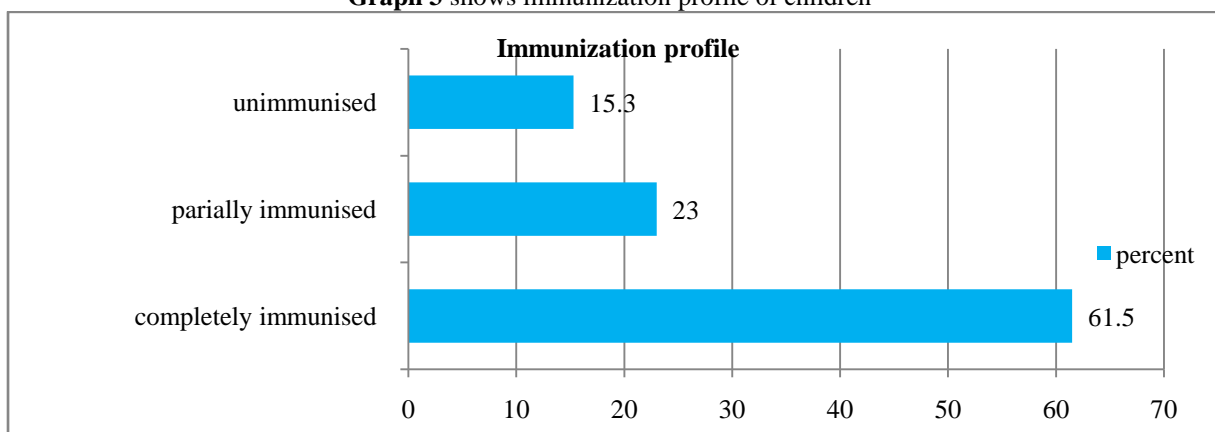
Area of residence: 44.62% of children belonged to urban area.

Graph 2 shows area of residence of children



Immunization profile of children: Most of the children were completely immunized.

Graph 3 shows immunization profile of children



USG findings:

The most common USG finding was Presence of B lines, followed by consolidation. B lines were seen in 72.3% of children and consolidation was seen in 61.5% of children. Normal findings were seen in 13.8% of children.

Table 2 shows USG findings among children.

USG findings	Frequency	Percentage
A lines	16	24.6%
B lines	47	72.3%
Consolidation	40	61.5%
Effusion	38	58.46%
Normal	9	13.8%

Chest X ray findings:

Most common chest X ray finding was increased bronchovascular markings, which was seen in 64.6% of children. Consolidation was seen in 53.8% of children. Normal findings were seen in 20% of children.

Table 3 shows chest X ray findings in children

CXR findings	Frequency	Percentage
Normal	13	20
Increased bronchovascular markings	42	64.61%
Consolidation	37	53.84%
Effusion	23	35.38%

Sensitivity, specificity of USG in detecting pneumonia:

These were detected using CT as gold standard measure. Pneumonia was seen in 50 children in CT scan. Sensitivity of USG in detecting pneumonia was 97.83%, specificity was 78.95%. Accuracy was 92.31% in detecting pneumonia.

Table 4 shows accuracy of USG in detecting pneumonia.

Statistic	Value	95% CI
Sensitivity	97.83%	88.47% to 99.94%
Specificity	78.95%	54.43% to 93.95%
Positive Likelihood Ratio	4.65	1.94 to 11.11
Negative Likelihood Ratio	0.03	0.00 to 0.19
Disease prevalence (*)	70.77%	58.17% to 81.40%
Positive Predictive Value (*)	91.84%	82.47% to 96.42%
Negative Predictive Value (*)	93.75%	68.04% to 99.06%
Accuracy (*)	92.31%	82.95% to 97.46%

Sensitivity, specificity of CXR in detecting pneumonia:

Sensitivity of CXR in detecting pneumonia was 76.47%, specificity was 64.29%. Accuracy was 73.85% in detecting pneumonia.

Table 5 shows accuracy of CXR in detecting pneumonia.

Statistic	Value	95% CI
Sensitivity	76.47%	62.51% to 87.21%
Specificity	64.29%	35.14% to 87.24%
Positive Likelihood Ratio	2.14	1.04 to 4.39
Negative Likelihood Ratio	0.37	0.19 to 0.69
Disease prevalence (*)	78.46%	66.51% to 87.69%
Positive Predictive Value (*)	88.64%	79.17% to 94.12%
Negative Predictive Value (*)	42.86%	28.54% to 58.48%
Accuracy (*)	73.85%	61.46% to 83.97%

CXR findings:



Figure 1: Right middle lobe pneumonia with air bronchogram



Figure 2: Patchy consolidation in CXR



Figure 3: Multifocal Pneumonia

USG Findings:

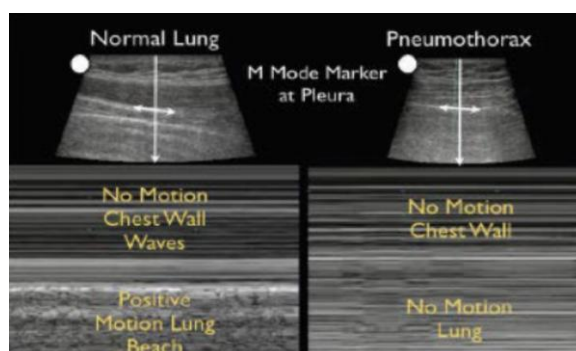


Figure 4: Showing Pneumothorax in USG

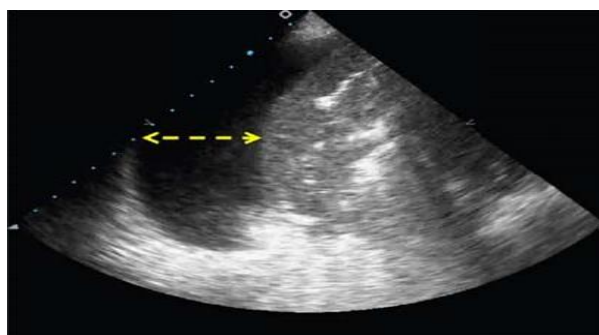


Figure 5: Showing pleural effusion on USG

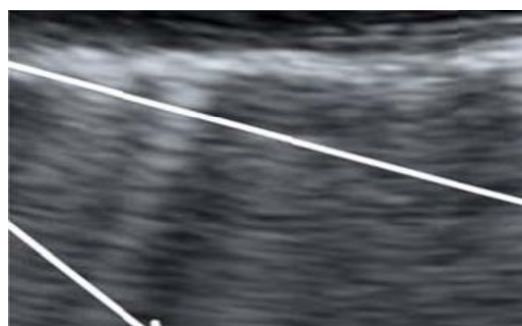


Figure 6: Showing B lines on USG

IV. Discussion

In the current study we correlated findings of USG and chest X ray among 65 children with lower respiratory tract infections diagnosed clinically.

In our study, most of the children were aged below 3 years, followed by 3 to 6 and 6 to 9 years.

Most of the children were males. This implies that LRI was more commonly seen in children aged below 6 years and among males. **Tirdia PR et al**^[13] reported mean age in his study as 3.28 ± 0.62 years. Females were 34.5% and males were 65.5%. Male preponderance was similar to our study.

Cough was seen in all children. Fever and chest pain were also seen in most of the children. **Rahmati MB et al**^[14] found that fever in 80%, Cough in 97% and rhinorrhea and nasal congestion in 65% of children with lower respiratory tract infections.

61.5% of children in our study were completely immunized in our study. **Tirdia PR et al**^[13] reported complete immunization in 43.8%, partial immunization in 48.2% and no immunization in 7.91% of children with lower respiratory tract infections. In their study, partial immunization was more common, in contrast to our study.

The most common USG finding was Presence of B lines, followed by consolidation. B lines were seen in 72.3% of children and consolidation was seen in 61.5% of children. Normal findings were seen in 13.8% of children in our study.

Francesca Realiet al. ^[15] reported that among children with a final diagnosis of community acquired pneumonia, sonographic findings include subpleural consolidation with dynamic air bronchogram among 70 children and B lines among 6 children among 107 children included.

Most common chest X ray finding was increased bronchovascular markings, which was seen in 64.6% of children. Consolidation was seen in 53.8% of children. Normal findings were seen in 20% of children in our study.

Tirdia PR et al ^[13] reported consolidation in 76.9% of children with LRI. Peribronchial thickening was seen in 10.07%, pleural effusion in 11% of children. In our study, no child had peribronchial thickening.

In our study, pneumonia was seen in 50 children out of 65 children. **Shah et al** ^[6] reported low incidence of pneumonia in their population study (18%), in contrast to our findings.

Sensitivity of USG in detecting pneumonia was 97.83%, specificity was 78.95%. Accuracy was 92.31% in detecting pneumonia. Sensitivity of CXR in detecting pneumonia was 76.47%, specificity was 64.29%.

Accuracy was 73.85% in detecting pneumonia. **Iorio G et al.** ^[16] reported USG sensitivity as 96.5%, specificity as 95.6% in diagnosing pneumonia. **Caiulo et al.** ^[17] described sonographic features of community acquired pneumonia and bronchiolitis in hospitalized children.

Lung ultrasound was positive in diagnosing pneumonia in 88 of 89 children. USG showed subpleural lung consolidations in 44 of 52 patients affected by bronchiolitis. Furthermore, in a multicenter study, **Reissig et al.** and **Reissig and Copetti et al** ^[18-19] found a sensitivity of 93% and a specificity of 98% for the sonographic diagnosis of pneumonia.

Larger studies with more sample size, and comparing CXR and USG taking CT as gold standard mode of diagnosis are recommended in future.

V. Conclusion

We conclude that chest USG detects more findings of lower respiratory tract infections compared to chest x ray. We recommend getting chest USG compared to CXR as it lacks radiation and has more accuracy compared to chest x ray.

The study is self-sponsored.

There were no conflicts of interest.

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