**Original Research Paper**

**Radiology**

# CORRELATION AND OUTCOME OF LUNG ULTRASONOGRAPHY AND CHEST X-RAY IN PNEUMONIC HOSPITILIZED CHILDREN

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**ABSTRACT**   **Background:** The objective of the study was to correlation and outcomes of lung USG and chest x-ray in pneumonic children to define the accuracy of LUS as compared to chest X-ray (CXR) in diagnosing of pneumonia.

**Methods:** It was a hospital based prospective study done at department of paediatrics, NSCBMch Hospital, Jabalpur. A total of 100children between 2 months to 14 years of age admitted with diagnosis of Pneumonia .

**Results:** Of 100 patients, LUS characteristically shows sub pleural consolidation (absolute consolidation or with other findings) in 79 % (79/100), confluent B-lines abnormalities 41% (41/100), pleural line abnormalities in 12% (12/100), and pleural effusion in 12 % (12/100) patients, while LUS was indicative of pneumonia in 97 (97%), CXR was suggestive of pneumonia in 84(84%) patients (p <0.01).

**Conclusions:** LUS was highly accurate for the diagnosis as well as for follow up of Pneumonia. Therefore, the use of ultrasound needs to be encouraged not just as a valid diagnostic alternative but as a necessary ethical choice.

**KEYWORDS** : Lung ultrasound, Chest x-ray,

## I. Introduction-

Pneumonia is the leading cause of childhood morbidity and mortality worldwide. Each year, approximately 1.4 million children die from pneumonia and pneumonia accounts for almost 15% of childhood mortality[1]. Diagnosis of pneumonia is done clinically but with poor diagnostic specificity[2,3]. Chest X-ray (CXR) is considered as the first imaging step for further evaluation. The interpretation of CXR findings is dependent on the quality of the film and the expertise of the reader.[4,5]. The use of ultrasound for the evaluation of the lung is relatively recent. Lung ultrasound (LUS) is inexpensive, portable and non-ionizing imaging tool.

LUS is being increasingly studied in children and neonates in various thoracic conditions.[8,9]

To our best knowledge, no previous such studies have been published from India.

**METHODS**-It was a hospital based prospective observational study done at department of paediatrics, nscb mc hospital, Jabalpur from February 2016 to january 2017. Children between 2 months to 14 years of age who hospitalized for clinical suspicion of Pneumonia were enrolled. Diagnosis of pneumonia was confirmed on the basis of initial presentation and follow up clinical course. In all patients, LUS was done on the day of the admission, defined as day 1, within 24 hours of obtaining CXR. Follow up LUS was done between days 3 and 6, 7 and 10, and 11 and 14. LUS was performed using 3-7 MHz linear probe. Data was collected with reference to clinical examination, routine investigations, CXR findings and LUS findings.

### Inclusion criteria

- Clinical signs and symptoms suggesting Pneumonia.
- Children aged 2 months ≤14 years.

### Exclusion criteria

- Unwilling parents/guardians.
- Patients with congenital or acquired heart disease, chronic lung diseases and/or metabolic disorders.
- Seriously ill patients or patients with multi organ failure.
- >24 hours duration between first LUS and CXR.

## RESULTS-

**Table 1: Baseline characteristics of patients.**

| Patients no.(%) | 100(100%) |
|---|---|
| Sex,<br>Female<br>male | No.(%)<br>63(63%)<br>37(37%) |
| Weight,mean9±5%CL, kg median, kg | 12.76 ± 1.62<br>9.2 |
| Geographical distribution<br>Rural<br>Urban<br>Slum | No. (%)<br>83(83%)<br>7 (7.00%)<br>10 (10%) |
| Immunization status<br>Complete immunization<br>Partial immunization<br>Unimmunized | No. (%)<br>44 (44.%)<br>53 (53.%)<br>3 (3.00%) |
| Localization of LUS characteristic<br>Right<br>Left<br>Both | No. (%)<br>35(35.3%)<br>43 (43.1%)<br>22 (22%) |
| Lung consolidation shown by<br>LUS<br>CXR<br>p value | No. (%)<br>79(79%)<br>57(57%)<br>0.001 |

**Table – 2 LUS finding on day 1**

| LUS characteristics | No. of patients (%) N=139 |
|---|---|
| Sub pleural lung consolidation | 36 (36%) |
| Confluent B-lines + consolidation | 30 (30%) |
| Confluent B-lines + Pleural line abnormalities | 4 (4%) |
| Consolidation + pleural line abnormalities | 12 (12%) |
| Pleural effusion + consolidation | 8 (8%) |
| Focal or multiple confluent B-lines | 7 (7%) |
| Confluent B-lines + Pleural effusion | 2 (2%) |
| Normal | 1 (1%) |



**X-Ray**          **USG Images**

## CONSOLIDATION

**Table 3: Comparison of chest X-ray and LUS characteristic findings for the diagnostic findings of pneumonia.**

| USG Positive | USG Positive | USG negative | Total | p value |
|---|---|---|---|---|
| Chest X-ray positive | 83 | 1 | 84 (84%) | |
| Chest X-ray negative | 14 | 2 | 16 (16%) | |
| **Total** | **97(97%)** | **3(3%)** | **100 (100%)** | **<0.001** |

**Table 4: Follow up of lung consolidation and pleural effusion as reported by LUS.**

| Maximum thickness of consolidation [pleural effusion] mm | No. of patients (%) | | | |
|---|---|---|---|---|
| | Day 1 | Day 3-6 | Day 7-10 | Day 11-14 |
| < 15 mm | 53 (53%) | 62 (62%) | 28 (28%) | 10 (10%) |
| 15 – 29 mm | 34 (34%) | 12 (12%) | 13 (13%) | 5 (5%) |
| ≥ 30 mm | 7 (7%) | 8 (8%) | 5 (5%) | 0 (0%) |
| **Total** | **94 (94%)** | **82 (82%)** | **46 (46%)** | **15 (15%)** |

**Table 5: Follow-up characteristics of LUS in patients.**

| LUS characteristics | No. of patients (%) | | | |
|---|---|---|---|---|
| | Day 1 | Day 3-6 | Day 7-10 | Day 11-14 |
| Confluent B-lines | 41 (41%) | 38 (38%) | 26 (26%) | 10 (10%) |
| Pleural line abnormalities | 12 (12%) | 10 (10%) | 10 (10%) | 3 (3%) |
| **Total** | **53 (53%)** | **48 (48%)** | **36 (36%)** | **13 (13%)** |

A total 100 patients were enrolled. Descriptive characteristics are given in Table 1. The most common symptom of pneumonia was cough (84%) and most common sign was tachypnea (91%). Most common finding on auscultation was crepitation (60%). Oxygen saturation of <90 % was observed in 12 (8.63%) patients.

CXR showed consolidation (absolute or with other abnormality) in 64%(70) patients, peribronchial thickening in 24% (12) and synpneumonic pleural effusion in 10.7% (15) patients. CXR was negative for pneumonia in 16 patient.

On day 1 LUS characteristically showed sub pleural consolidation (absolute or with other findings) in 79 % (100), confluent B-lines abnormalities 41% (53), pleural line abnormalities in 12% (53), and pleural effusion in 15.8% (22) patients. Overall LUS findings are tabulated in Table 2.

In this study, consolidation and pleural effusion were two characteristics findings common in CXR and LUS. Consolidation was reported in 79(79%) patients by LUS and in 57 (57%) patients by CXR and the difference was statistically highly significant (p<0.001).

Follow up LUS characteristic are summarized in Table 4 and 5. On day 1, LUS showed consolidation in 94 (94%) with maximum thickness of <15 mm in 53 (43.84%), between 15-29 mm in 34 (50.76%) while ≥30 mm in 7 (5.38%). During follow up between day 3-6, 7-10, and 11-14 of illness LUS shows consolidation in 83 (64.75%), 46 (27.34%) and 15 (8.63%) patients respectively. The size of consolidation steadily declined on subsequent follow-up LUS consistent with clinical improvement reflected by increase in number of patients with consolidation thickness <15 mm on day 3-6 as other patient who were initially have more severe findings falls in this category after treatment.

## DISCUSSION

Clinical examination is highly sensitive but lacks specificity and results in over diagnosis contributing to the overuse of antibiotics.[10] CXR is considered the test of choice for further evaluation. The main limitations of radiography is the risk of damage from ionizing radiation with a greater risk than adults because children have more rapidly dividing cells and increased life expectancy.5,6 Other concerns with radiography are great variability in the interpretation lack of reproducibility and delay in availability of the film.[4,5] Also in complicated pneumonia CXR is less reliable and chest computed tomography (CT) scan is known to be the gold standard.15 However, its use has been discouraged due to high radiation, high cost and the need for sedation in young children.

Weinberg et al first described the use of LUS in evaluating Pneumonia [12] Subsequent studies have demonstrated that LUS is able to diagnose pneumonia in adults with high accuracy.[6,7] Later on studies had demonstrated high efficacy of LUS in diagnosing pneumonia in children.[13,14] Recently LUS has been indicated as a clinically useful diagnostic tool in pediatric patients with suspected pneumonia.[15] The LUS features of pneumonia mainly included sub pleural lung consolidation, pleural line abnormalities,

MC Ho et al also found similar results with chest radiography able to detect 151 (92.6%), whereas LUS detected 159 (97.5%) out of 163 patients with pneumonia.20 Pereda in meta-analysis found that LUS had a sensitivity of 96% and specificity of 93% (21).

Caiulo et al and Stefania et al.22,23 In this study, LUS in seven patient initially showed increase in size of consolidation consistent with clinical deterioration then gradual decrease in size of consolidation due to change in treatment.

Thus, our study demonstrates that LUS is safe and accurate for the diagnosis suspected cases of CAP and it is more sensitive than CXR and allows a radiation free follow up of patients.

Some technical advantages such as shorter thoracic width, thinner chest wall, and small lung mass theoretically enable LUS examination in children easier than in adults.19 Pleural effusion, lung consolidation, interstitial syndrome, and pneumothorax are accessible to LUS. LUS is useful in the evaluation of lung consolidation as it can also differentiate consolidations due to pulmonary embolism, pneumonia, or atelectasis.[19] LUS also has the potential for diagnosing the nature of the effusion and differentiating bacterial and viral pneumonia.[20,21] LUS also had a consistently high diagnostic accuracy of pneumonia when compared with chest CT scan as the gold standard.

Recent advances in technology have made portable or handheld ultrasonography machines more available. This raises the potential for diagnostic capabilities in rural and remote settings where other imaging modalities are not available.

## CONCLUSION

Lung ultrasound shows high accuracy in the detection of pneumonia and possibility of a follow-up without exposure to ionizing radiation.

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