Original Article

Chest ultrasound versus chest X-rays for detecting pneumonia in children

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Abstract

Background: Pneumonia is the most common infectious cause of mortality in children worldwide. **Aims and Objectives:** To study Chest ultrasound versus chest X-rays for detecting pneumonia in children. **Methodology:** This was cross-sectional study carried out in the Department of Radiology in the pediatric patients who were diagnosed as Pneumonia clinically were undergone two different diagnostic evaluation Group A- Chest X-ray and confirmed by CT-Scan and Group B- Chest Ultrasound (USG) and confirmed by CT-Scan. In the one year i.e. January 2015 to January 2016 near about 32 patients were referred out of that in each age group i.e. < 3 ,3-6,6-9,9-12 yrs. were equally i.e. 16 each and randomly undergone Group A And Group B evaluation .The Sensitivity and specificity of Chest-x-ray and Chest USG was compared in this study. **Result:** The Sensitivity of Chest- X-ray in the Diagnosis of Consolidation was 91.67% and Specificity was 75.00 % and Positive Likelihood Ratio was 3.67 and Negative Likelihood Ratio 0.11 and Positive Predictive Value was 91.67% and Negative Predictive Value was 75.00 % and the Sensitivity of Chest-USG in the Diagnosis of Consolidation was 90.91% and Specificity was 80.00 % and Positive Likelihood Ratio was 4.55 and Negative Likelihood Ratio 0.11 and Positive Predictive Value was 90.91% and Negative Predictive Value was 80.00 %. **Conclusion:** As per the sensitivity and Specificity Chest USG is comparable to Chest X-ray so it can be used for the diagnosis of Pneumonia in Children in Place of Chest X-ray as having less radiation risk .

Key Words: Chest ultrasound, Chest X-rays, Pneumonia in Children.

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INTRODUCTION

Pneumonia is the most common infectious cause of mortality in children worldwide. The World Health Organization predicts that pneumonia has a universal annual incidence of almost one million mortality cases in children, comprising approximately 15% of all deaths of individuals under 5 years of age.[1] Despite the introduction of the pneumococcal conjugate vaccine, community-acquired pneumonia is still considered as a common cause of morbidity among children aged ≤5 years in developed countries, where the incidence reaches from 10–40 cases per 1,000 subjects.[2] The presentation of pneumonia in children varies according to the child's age group and the culprit microorganism, creating a diagnostic challenge among clinicians.[3] Chest x-ray (CXR) has been used as a supplementary mode in the diagnosis of pneumonia in children.[2] However, CXR has major limitations. For instance, it exposes children to ionizing radiation, which may have tardive effects.[2–3] Moreover, deficiency of abnormalities on CXR does not eliminate the diagnosis, especially in cases when there is a high index of suspicion of clinical pneumonia.[3] In addition, it has been reported that CXR is not sensitive in detecting lung consolidations of ≤1 cm.[4] The lack of findings on CXR results in the over diagnosis of bacterial pneumonia and leads to a number of secondary problems, the most important of which is the overuse of unwarranted antibiotics.[2] Chest computed tomography scan is known to be more accurate than CXR for the diagnosis of pneumonia; however, its use has been discouraged due to high radiation, cost, and perhaps the need for sedation.[3]

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There has been enthusiasm among researchers in developing new devices designed to augment the usefulness and accuracy of the diagnosis of pneumonia, while concurrently reducing exposure to ionizing radiation. Lung ultrasound (LUS) has been shortlisted as an option for the diagnosis of pneumonia because it is safe, inexpensive, portable, and uncomplicated to learn and teach.[2]

Several authors studied the sensitivity and specificity of LUS compared to CXR in the diagnosis of pneumonia in children. Pereda *et al*[3] performed a meta-analysis to summarize evidence on the diagnostic accuracy of LUS for childhood pneumonia. A total of 765 children were included in the meta-analysis. The authors concluded that LUS had a sensitivity of 96% (95% confidence interval [CI], 94%–97%) and specificity of 93% (95% CI, 90%–96%) in accurately diagnosing pneumonia in children. In addition, the positive and negative likelihood ratios (LRs) were 15.3 (95% CI, 6.6–35.3) and 0.06 (95% CI, 0.03–0.11), respectively. Copetti *et al*[5] compared the diagnostic accuracy of LUS and CXR in children with suspected pneumonia. The study included 79 children with clinical pneumonia, who were subjected to both LUS and CXR. The results of the study showed that CXR was positive for the diagnosis of pneumonia in 53 patients, while LUS was positive in 60. Computed tomography of the chest verified the diagnosis of pneumonia in four patients with positive LUS and negative CXR

METHODOLOGY

After approval from institutional ethical committee this cross-sectional study carried out in the Department of Radiology in the pediatric patients who were diagnosed as Pneumonia clinically by written explained consent were undergone two different diagnostic evaluation Group A- Chest X-ray and confirmed by CT-Scan and Group B- Chest Ultrasound (USG) and confirmed by CT-Scan . In the one year i.e. January 2015 to January 2016 near about 32 patients were referred out of that in each age group i.e. < 3 ,3-6 ,6-9 , 9-12 yrs. were equally i.e. 16 each and randomly undergone Group A And Group B evaluation . Considering the CT -scan as gold standard the Sensitivity and specificity of Chest-x-ray and Chest USG was compared in this study.

RESULT

Table 1: Distribution of the Patients as per the Age

Age group	No.	Percentage (%)
<3	6	18.75
3-6	12	37.5
6-9	10	31.25
9-12	4	12.5
Total	**32**	**100**

The majority of the patients were in the age group of 3-6 i.e.37.5% followed by 6-9 were 31.25% and < 3 were 18.75% and 9-12 were 12.5%.

Table 2: Distribution of the Patients as per the Sex

Sex	No.	Percentage (%)
Male	19	59.37
Female	13	40.62
Total	**32**	**100**

The majority of the patients were Male i.e. 59.37 % and 40.62 % were female.

Table 3: Distribution of the patients as per Diagnosis by Chest- X-ray and CT-Scan

Chest- X-ray (Consolidation)	CT-Scan (Consolidation)		Total
	Present	Absent	
Positive	11	1	12
Negative	1	3	4
Total	**12**	**4**	**16**

From above table the Sensitivity of Chest- X-ray in the Diagnosis of Consolidation was 91.67% and Specificity was 75.00 % and Positive Likelihood Ratio was 3.67 and Negative Likelihood Ratio0.11 and Positive Predictive Value was 91.67% and Negative Predictive Value was 75.00 %

Table 3: Distribution of the patients as per Diagnosis by Chest-USG and CT-Scan

Chest-USG (Consolidation)	CT-Scan (Consolidation)		Total
	Present	Absent	
Positive	10	1	11
Negative	1	4	5
Total	**11**	**5**	**16**

From above table the Sensitivity of Chest-USG in the Diagnosis of Consolidation was 90.91%and Specificity was 80.00 %and Positive Likelihood Ratio was 4.55and Negative Likelihood Ratio 0.11and Positive Predictive Value was 90.91%and Negative Predictive Value was 80.00 %

DISCUSSION

Chest radiographs are commonly done for managing children with suspected lower respiratory tract conditions including pneumonia, although their value in uncomplicated cases is debatable. Diagnosis of pneumonia in developed countries relies heavily on radiologic 'confirmation', whereas the WHO recommends (for developing countries) clinical criteria alone. The crux of the problem is that neither clinical criteria nor radiographic findings can be considered foolproof for diagnosing pneumonia. Even attempts to introduce objectivity to clinical as well as radiologic

criteria have not improved the situation. For example, the recent Community Acquired Pneumonia Etiology Study (CAPES) [6] from India showed that only 44% children with WHO/IMNCI-defined pneumonia had WHO Class I X-rays (i.e consolidation and/or pleural effusion). Similarly other smaller studies identified radiological features of pneumonia in less than 40% children with clinical pneumonia[7]. In yet another study, almost half the children with clinical pneumonia [8] had normal chest X-ray (CXR); although two-thirds of those with normal CXR had crackles or rales on auscultation. Even a recent Cochrane review [9] reported that CXR do not affect the clinical outcome in children with clinical pneumonia (although this conclusion was based on limited data). The other major limitation with chest radiography is significant inter-observer variation in interpreting images [10,11].

Lung ultrasonography (LUS) is emerging as a potential alternative to CXR, being radiation-free, relatively affordable and feasible at the point-of-care. The critical issue is whether it is efficacious. Several studies [12-15]compared LUS against CXR, and emerging data suggests a slight superiority of LUS over CXR [16]. LUS is also reportedly superior to chest auscultation for identifying pneumonia [17]. However, an important limitation in such studies is the absence of appropriate reference standard(s) for labeling pneumonia. CXR findings are not the ideal reference standard because they suggest (but not necessarily confirm) pneumonia, but pneumonia can exist with normal CXR. The same limitation holds for clinical diagnosis, and also clinical plus radiographic diagnosis. Obviously, the WHO/IMNCI definition of pneumonia cannot be used as the reference standard for pneumonia as it has moderate sensitivity and poor specificity[18].

Some studies evaluating LUS vs CXR have the limitation that the reference standard for pneumonia diagnosis includes CXR findings as one of the criteria [19-21]. Even a recent meta-analysis [22]of eight studies, reporting excellent sensitivity and specificity of LUS, showed that the reference standards included clinical diagnosis plus CXR in five studies and CXR alone in the other three. While such data can give an overall impression of the utility of LUS, they are inappropriate for comparing LUS against CXR. In our study we have seen that the Sensitivity of Chest- X-ray in the Diagnosis of Consolidation was 91.67% and Specificity was 75.00 % and Positive Likelihood Ratio was 3.67 and Negative Likelihood Ratio 0.11 and Positive Predictive Value was 91.67% and Negative Predictive Value was 75.00 % and the Sensitivity of Chest-USG in the Diagnosis of Consolidation was 90.91% and Specificity was 80.00 % and Positive Likelihood Ratio was 4.55 and Negative Likelihood Ratio 0.11 and Positive Predictive Value was 90.91% and Negative Predictive Value was 80.00 %

These findings are similar to Ambroggio L et al. They found Of the 132 patients in the cohort, 36 (27%) had CT performed for a clinical reason. Pneumonia was clinically documented in 47 patients (36%). The IRR (95% CI) for lung consolidation was 0.55 (0.40, 0.70) for LUS and 0.36 (0.21, 0.51) for CXR. The sensitivity for detecting consolidation, interstitial disease, and pleural effusion was statistically similar for LUS and CXR compared with CT; however, specificity was higher for CXR. The negative predictive value was similar for CXR and LUS. The authors concluded that LUS has a sufficiently high IRR for detection of consolidation; and compared with CT, LUS and CXR have similar sensitivity, but CXR is more specific for findings indicating pneumonia but in our case the specificity of USG was higher as compared to CXR this may be difference in the Instruments and difference in inter observer variation.

CONCLUSION

As per the sensitivity and Specificity Chest USG is comparable to Chest X-ray so it can be used for the diagnosis of Pneumonia in Children in Place of Chest X-ray as having less radiation risk .

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