

Comparison of chest X-ray with lung ultrasound in the diagnosis of pneumonia in children aged 02 months to 12 years

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^{1,2,3,4,5,6} Experimentation/Study conduction

^{1,2,3,4,5,6} Analysis/Interpretation/Discussion

^{1,2,3,4,5,6} Manuscript Writing

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^{1,2,3,4,5,6} Facilitation and Material analysis

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Article Processing

Received: 10/11/2020

Accepted: 25/02/2021

Cite this Article: Sharif, M., Saeed, T., Khan, K., Hussain, M., Hussain, A. Comparison of chest X-ray with lung ultrasound in the diagnosis of pneumonia in children aged 02 months to 12 years (26.12.20). *Journal of Rawalpindi Medical College*. 30 Mar. 2021; 25(1): 87-90.

DOI: <https://doi.org/10.37939/jrmc.v25i1.1510>

Conflict of Interest: Nil

Funding Source: Nil

Access Online:



Abstract

Objective: To observe the reliability of lung ultrasound in diagnosing pneumonia as compared to chest X-ray.

Materials and Methods: This Prospective cohort study was carried out over a period of three months in the Paediatric Department of Benazir Bhutto Hospital Rawalpindi. One hundred patients, 2 months to 12 years of age were enrolled in the study. All the patients were subjected to chest X-ray and lung ultrasound within 12 hours of admission. Data was recorded on predesigned Performa and processed on SPSS version 25. Sensitivity, specificity, positive and negative predictive values were calculated for chest X-ray and lung ultrasound.

Results: LUS was found to be more efficient in detecting consolidations (64 out of 100) as compared to CXR (50 out of 100). In 14 patients CXR was not able to detect consolidations but LUS detected the same. Fourteen patients in whom lung ultrasound was positive for consolidations but CXR was negative were subjected to CT chest. Out of these 14 CT scans, 11 were positive and 3 were negative for consolidations. Lung ultrasound was found to have a Sensitivity of 100%, the specificity of 92.30%, PPV 95.31%, NPV of 100%, and accuracy of 97% as compared to Sensitivity of 81%, the specificity of 100%, PPV 100%, NPV of 78% and accuracy of 89% for CXR in the diagnosis of pneumonia in children.

Conclusion: Results from our study confirmed by many other studies on the same research question allow us to conclude that Lung ultrasound is a fast, low cost, reliable, radiation-free alternative to chest x-ray in the diagnosis of pneumonia in children.

Keywords: Chest X-Ray, Lung ultrasound, Pneumonia.

Introduction

Pneumonia in children has a major contribution to morbidity and mortality especially in children less than five years of age throughout the world.¹ Globally in children under 5 years of age an estimated 920,000 deaths occur each year.² Most of these fatalities occur in developing countries like Pakistan. Community-acquired Pneumonia in children usually presents with fever, cough, and respiratory distress. If not properly diagnosed and treated, it can result in complications like respiratory failure, heart failure, cardiac arrhythmia, and septicemia, therefore correct diagnosis, appropriate and timely treatment and identification of complications are of utmost importance.³ The diagnosis of pneumonia is mainly confirmed on chest X-ray chest. However, chest radiography cannot be considered a gold standard for diagnosis of pneumonia due to wide inter and intra-observer variability when interpreting results, differing radiologic manifestations of pneumonia, and possible lack of sensitivity and specificity.^{4,5}

Many studies show that lung ultrasonography (LUS) accurately diagnoses most cases of pneumonia in children and young adults and it may eventually replace x-rays for diagnosis.^{6,7} Lung Ultrasound has the potential benefits over chest radiography of being radiation-free, subject to fewer regulatory requirements, relatively lower cost, and with immediate bedside availability of results.⁸ A study by Cui Yan et al. on ultrasound lung vs. chest X-ray in children with suspected pneumonia has found that lung ultrasound is noninvasive and a simple method for the diagnosis of suspected pneumonia in children.⁹ Another study by Will Bogus showed a sensitivity and specificity of 93.4% and 97.7% respectively for lung ultrasound in the diagnosis of pneumonia.¹⁰

A recent meta-analysis by Pereda et al. has shown that when lung ultrasound was compared with a reference standard of either chest radiography alone or a combination of chest radiographs, the overall sensitivity was 96% (95% confidence interval [CI]: 94–97%) and specificity was 93% (95% CI: 90–96%), with the positive and negative likelihood of ratios of 15.3 (95% CI: 6.6–35.3) and 0.06 (95% CI: 0.03–0.11), respectively.¹¹

The current study aimed to compare chest X-ray with lung ultrasound for the diagnosis of pneumonia in children aged 2 months to 12 years who presented with fever, cough, respiratory distress, and chest indrawing and was diagnosed clinically as per the

guidelines provided by the American Thoracic Society and The Infectious Diseases Society of America.

Materials and Methods

Objective: To compare sensitivity, specificity, negative and positive predictive value of chest X-ray and ultrasound chest for diagnosis of pneumonia in pediatric age group patients (2 months to 12 years of age).

This Prospective cohort study was carried out in three months in the Paediatric Department Benazir Bhutto Hospital Rawalpindi after approval from the Research and ethics committee of Rawalpindi Medical University Rawalpindi. One hundred patients, 2 months to 12 years of age, of both genders diagnosed pneumonia clinically as per operational definition, who met study criteria were enrolled in the study. Patients with co-existing chronic lung disease (Bronchial asthma, Cystic fibrosis, bronchiectasis, etc), cardiac, Lung, or airway congenital anomalies, Severe complicated pneumonia, Severe malnutrition, and Patients who needed ventilator support were excluded. Non-probability consecutive sampling technique was followed. Written informed consent was taken from both parents for inclusion in the study. All the patients were subjected to chest X-ray and lung ultrasound within 12 hours of admission. Both of these tests were carried out in the BBH Radiology department. Chest X-rays were done on Toshiba DR model KXO-80S (DR) focal spot 0.6 mm and 1.2 mm Anode heat storage 600 KHU and 80 KW generator. Lung ultrasounds were performed on digital color Doppler ultrasound machine ESAOTE Model: My lab seven. Probe: linear probe with an operating bandwidth of 3-13 MHZ. All other necessary investigations were carried out and patients were managed as per standard protocols. A three-member committee of the senior pediatric faculty members who were not part of the research team evaluated all cases along with X-rays and divided subjects into confirmed pneumonia and non-pneumonia patients. Non-pneumonia cases were those in which the probable explanation for clinical signs and symptoms was other than pneumonia. The information required for the study was recorded on predesigned Performa which contains the patient's demographic and clinical information relevant for the study. The data was entered on SPSS version 25. Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy were calculated for chest X-ray and lung ultrasound.

Results

In this current research 100 patients, (69 males and 31 females) aged 2months to 12 years, meeting the study criteria were enrolled. All the patients were subjected to chest X-ray and lung ultrasound. Chest X-ray detected consolidation in 50 out of 100 patients. Thirty patients had consolidations in the right lung, 16 had consolidations in the left lung, and 4 patients had bilateral consolidations.

Table 1: Consolidations on CXR

Positive CXR	Number	Percentage
RT. Lung	30	60%
LT. Lung	16	32%
Bilateral	04	08%
Total	50	100%

Lung ultrasound was positive for consolidations in 64 out of 100 patients. Thirty-six had consolidations in the right lung, 21 in the left lung, and bilateral consolidations were detected in 7 patients.

Table 2: Consolidations on Ultrasound

Positive Lung Ultrasound	Number	Percentage
RT. Lung	36	56%
LT. Lung	21	33%
Bilateral	07	11%
Total	64	100%

While comparing the results of both the modalities, LUS was found to be more efficient in detecting consolidations (64 out of 100) as compared to CXR (50 out of 100). In 14 patients CXR was not able to detect consolidations but LUS detected the same. While LUS was able to detect consolidation in all the patients in whom CXR was positive.

Table 3: Comparison of Consolidations on CXR to LUS

	Total Patients	RT. Lung Consolidation	LT. Lung Consolidation	BIL. Lung Consolidation	Total
CXR	100	30	16	04	50
LUS	100	36	21	07	64

Fourteen patients in whom lung ultrasound was positive for consolidations but CXR was negative were

subjected to CT chest. Out of these 14 CT scans, 11 were positive and 3 were negative for consolidations.

Table 4: Consolidations on CT SCAN

CT Chest showing consolidation	Number	Percentage
Positive	11	78.5%
Negative	03	21.5%

Table 5: Comparison of CXR and LUS

	CXR	LUS
Sensitivity	81.96%	100%
Specificity	100%	92.30%
Positive Predictive Value	100%	95.31%
Negative Predictive Value	78%	100%
Accuracy	89%	97%

Discussion

Pneumonia is the leading cause of death in children. A key to reducing mortality is diagnostic accuracy, proper treatment, and complication identification. CT chest is the gold standard for the detection of pneumonia but cannot be employed routinely in children as they are very radiosensitive and are at a greater risk of radiations, compared to adults.^{14,15} the diagnosis of pneumonia in children is principally confirmed on chest X-ray. However, CXR lacks sensitivity and specificity in the detection of pneumonia.^{4,5} Therefore there has always been a need for an alternate diagnostic modality with reduced risk of radiation for pneumonia detection in children. The effectiveness of lung ultrasound in the diagnosis of pediatric pneumonia has been reported by many studies in the literature.^{16,17,18}

In this study, the sensitivity and specificity in the detection of consolidation by lung ultrasound and X-ray chest is compared using CT chest as a gold standard. The CT chest was done in the lung ultrasound positive but chest X-ray negative for pneumonia.

In our study, we have found a Sensitivity of 100 % and specificity of 92.30% for LUS in the diagnosis of pneumonia as compared to 81.96% sensitivity and 100% specificity of chest X-ray for the same. The results of our study are consistent with a number of research studies done recently in this context.^{19,20,21}

A study published in 2019 by Cui Yan, Ren Hui, and others conclude that Lung ultrasound has 0.906 sensitivity and 0.661 specificity as compared to 0.793 sensitivity and 0.559 specificity of CXR in the

diagnosis of pneumonia and concluded that LUS is a non-invasive and simple method for the diagnosis of pneumonia in children.²² The results of our study are virtually the same.

A recent meta-analysis by Reissig A et al. on LUS for the diagnosis of pneumonia in pediatric patients documented sensitivity of 96% and specificity of 93%. The higher sensitivity of LUS may be attributed to smaller thorax size and thin chest wall that helps in better visualization of the lung parenchyma by LUS.^{23,24}

Conclusion

Results from our study confirmed that lung ultrasound is a reliable alternative to chest X-ray for the diagnosis of pneumonia in children. Moreover, it has the advantage of being radiation free. Routine use of lung ultrasound, therefore, is not only reliable but reduces exposure to ionizing radiation.

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