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Original Research Article

Agreement Between Lung Ultrasound and Chest X-Ray in Diagnosing Pneumonia Among Neonates

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Name of Author:
Dr Amna Masood[1], Dr M. Saad Rizwan[2], Dr Asad Maqbool Ahmad[3], Dr Jawad Jalil[4], Dr Fawad Ahmad Khan[5], Dr Masaba Masood[6]

Affiliation: *[1]Pediatric Resident, Department of Pediatric Medicine, Combined Military Hospital, Lahore*
[2]Cardiology Resident, Department of Cardiology, Army Cardiac Centre, Lahore.
[3]Neonatologist, Classified Pediatrician, Combined Military Hospital, Lahore
[4]Classified Pediatrician, Combined Military Hospital, Lahore
[5]Classified Pediatrician, Combined Military Hospital, Lahore
[6]Oncology Registrar, Midland Regional Hospital, Tullamore

Corresponding Author:
Dr Amna Masood

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Abstract: ***Objective***: To determine the agreement between lung ultrasound and chest x-ray in diagnosing pneumonia among neonates. ***Study type***: Cross sectional study ***Place***: Neonatal Intensive Care Unit in Department of Pediatric Medicine, CMH, Lahore. ***Duration***: September 23, 2025, to December 22, 2025. ***Methodology***: Total 130 children with pneumonia of both genders were included. Exclusion criteria included patients with dysmorphism, neurometabolic disorders, congenital heart disease (CHD), RDS, anomalies of the chest wall, renal failure, and severe sepsis or meningitis that caused respiratory distress. Fetal age, newborn weight, gender, meconium-stained amniotic fluid (MSAF) (yes/no), premature rupture of membranes (PROM) of >18 hours (yes/no), and delivery method (spontaneous vaginal delivery (SVD)/caesarean section (CS)) were among the biodata gathered. Each patient had a single anteroposterior (AP) chest X-ray and a lung ultrasound at the patient's bedside as part of the standard evaluation of pneumonia; these procedures were completed within four hours of one another, and the patient's care was continued in accordance with the department's pneumonia protocol. ***Results***: The mean gestational age in this study was 35.25 ± 2.56 weeks. With a male to female ratio of 1.2:1, 72 (55.38%) of the 130 patients were boys and 58 (44.62%) were girls. Our study's mean weight was 2251.09 ± 564.53 grams. In our study, 129 (99.23%) patients had pneumonia on lung ultrasound and 124 (95.38%) patients on chest x-ray. in children with down syndrome. Agreement between lung ultrasound and chest x-ray in diagnosing pneumonia among neonates was found to be 94.62%. ***Conclusion***: This study shows that when diagnosing pneumonia in neonates, lung ultrasonography and chest x-rays have a high degree of agreement.

Keywords: Chest ultrasound, chest X-ray, pediatric pneumonia.

INTRODUCTION

One of the most common causes of hospitalized newborn diseases, pneumonia is responsible for 14% of all neonatal deaths. Despite its high frequency and high global healthcare costs, poorer countries account for the majority of pediatric pneumonia-related mortality. A chest X-ray (CXR) is still the recognized radiological test for suspected newborn pneumonia, despite the dangers of radiation exposure.1 For many years, the use of lung ultrasonography (LUS) was restricted since it was believed to be challenging due to the fact that air and bone reflect ultrasonic signals. However, an increasing amount of research has refuted that idea, demonstrating that LUS can be useful in the pulmonary evaluation of critically ill patients.2,3 Since then, lung ultrasonography (LUS) has been used as a stand-in method to detect a variety of respiratory conditions. LUS studies have increased significantly, especially in neonatology, because to its ability to rapidly rule out issues (such pneumothorax,

PTX) and significantly reduce radiation exposure in this susceptible population.3 The Developmental Origins of Health and Disease Hypothesis states that prenatal exposures, including radiation, influence the development of avoidable illnesses in both children and adults, particularly in light of the 21st century's longer life expectancy. Therefore, some potential benefits of LUS over CXR include lower radiation exposure for neonates, particularly with repeated LUS, faster detection of severe diseases (like PTX), comparable diagnostic accuracy, and therapy advice (like surfactant for RDS).4,5 Point-of-care ultrasounds (POCUS) are ultrasounds performed at the patient's bedside that are directly interpreted by the attending physician. LUS may reduce ER stays and save health systems money when compared to CXR.5,6 Recent studies have shown that LUS has diagnostic accuracy comparable to chest CT. A study found that LUS can identify pneumonia with an accuracy of 87% and a sensitivity of 97.4%. The agreement between LUS and CXR.7 was fair (kappa = 0.34) and statistically significant ($p<0.05$).7

Even while there is proof that lung ultrasonography may accurately diagnose pneumonia, research has occasionally been limited by small sample sizes, which restricts how broadly the findings can be used. Therefore, extensive study is needed to evaluate the efficacy and reliability of lung ultrasonography as a diagnostic tool on a larger scale. The current study looks at how well chest x-rays and lung ultrasonography diagnose pneumonia in neonates in an effort to fill this research gap. By comparing the results of the operation with chest X-rays, we hope to determine the diagnostic accuracy of lung ultrasonography while focusing on the potential benefits of removing radiation exposure. In the end, the findings of this study will improve clinical judgment and the general health of these vulnerable individuals by contributing to the expanding body of knowledge regarding the efficacy and safety of lung ultrasonography in the diagnosis of pneumonia in newborns. This study aims to assess the diagnostic effectiveness of lung Point of Care Ultrasonography (POCUS) lungs in neonates with pneumonia in comparison to radiographic standards, such as X-ray chest, and assist future researchers and clinicians in potentially switching to modalities with lower radiation exposure if the data supports it.

METHODOLOGY:

This descriptive cross-sectional study was conducted at the Neonatal Intensive Care Unit in the Department of Pediatric Medicine, CMH, Lahore, from September 23, 2025, to December 22, 2025, with ethical review committee clearance. The WHO sample size calculator shows that the sample size is 130 with the degree of agreement between the chest ultrasound and chest x-ray = 34.0%7, margin of error = 8.5%, and confidence level = 95%.

All newborns with pneumonia (including those with all of these conditions) who were admitted to the neonatal intensive care unit and whose weight was 1200g or more, had a respiratory rate greater than 60 breaths per minute at presentation, had increased work of breathing as indicated by recessions, and had a need for oxygen to maintain saturation greater than 90% were included in the study. Exclusion criteria included patients with dysmorphism, neurometabolic disorders, congenital heart disease (CHD), RDS, anomalies of the chest wall, renal failure, and severe sepsis or meningitis that caused respiratory distress.

Fetal age, newborn weight, gender, meconium-stained amniotic fluid (MSAF) (yes/no), premature rupture of membranes (PROM) of >18 hours (yes/no), and delivery method (spontaneous vaginal delivery (SVD)/caesarean section (CS)) were among the biodata gathered.

Each patient had a single anteroposterior (AP) chest X-ray and a lung ultrasound at the patient's bedside as part of the standard evaluation of pneumonia; these procedures were completed within four hours of one another, and the patient's care was continued in accordance with the department's pneumonia protocol.

The POCUS operation was performed using a linear probe-equipped Philips HD5 ultrasonography (Release 1.0.2). A posterior view of each hemithorax, two anterior views, and two lateral views examining distinctive features such as pleural lining, pleural thickness, pleural sliding, A-lines, B-lines, and consolidation comprised the six images that comprised the ultrasound assessment. A bedside commercial-grade X-ray machine was used for the procedure, and the radiographer chose the setting based on the baby's preferences.

In light of the clinical data, the treating physicians who are proficient in POCUS lungs and X-ray interpretation assessed the ultrasound images and recorded their conclusions, expressing their opinion as to whether they were consistent with pneumonia (B lines, thickened pleural, air bronchograms, consolidation, shred sign) or POCUS lungs. Then, in accordance with protocol, review the chest X-ray. A consultant or certified radiologist who is blind to the results of lung POCUS formally reported the chest X-ray. The treating physician then recorded the outcome of the radiologist's report. The treating physician then recorded the agreement between the two modalities, i.e., whether or not both suggested radiological findings of pneumonia in the neonate with clinical pneumonia. Following the collection of all the data, it was examined as detailed below.

The statistical analysis was conducted using version 27.0 of the Statistical Package for Social Science (SPSS). The data were displayed using the infant's weight and gestational age mean and standard deviation. Frequency and percentage were calculated for newborn gender, MSAF (yes/no), PROM >18 hours (yes/no), mode of delivery (SVD/CS), and agreement (yes/no). Cohen's kappa value was computed using OpenEpi software to assess the diagnostic agreement between lung USG and x-ray chest in the diagnosis of pneumonia in neonates.

Effect factors such gestational age, infant gender, newborn weight, MSAF (yes/no), PROM >18 hours, and mode of delivery (SVD/CS) were controlled for using stratification. Every result was computed at a 95% confidence level, and a p-value of less than 0.05 was regarded as statistically significant.

RESULTS

The mean gestational age in this study was 35.25 ± 2.56 weeks. With a male to female ratio of 1.2:1, 72 (55.38%) of the 130 patients were boys and 58 (44.62%) were girls. Table I displays the distribution of patients with additional confounding variables. Our study's mean weight was 2251.09 ± 564.53 grams.

In our study, 129 (99.23%) patients had pneumonia on lung ultrasound and 124 (95.38%) patients on chest x-ray. in children with down syndrome (Table II). Agreement between lung ultrasound and chest x-ray in diagnosing pneumonia among neonates was found to be 94.62% (Figure I). Stratification of agreement between effect modifiers is shown in Table III

Table I: Distribution of different variables (n=130)

		Frequency	%age
Gestational age (weeks)	>32-<37	96	53.08
	≥37	34	46.92
Gender	Male	72	55.38
	Female	58	44.62
Weight (grams)	1500-2000	44	33.85
	>2000	86	66.15
MSAF	Yes	21	16.15
	No	109	83.85
PROM >18 hours	Yes	31	23.85
	No	99	76.15
Mode of delivery	SVD	26	20.0
	LSCS	104	80.0

Table II: Lung ultrasound and chest x-ray

	Pneumonia present	Pneumonia absent
Lung ultrasound	129 (99.23%)	01 (0.77%)
Chest x-ray	124 (95.38%)	06 (4.62%)

Figure I: Agreement between lung ultrasound and chest x-ray in diagnosing pneumonia among neonates (n=130).

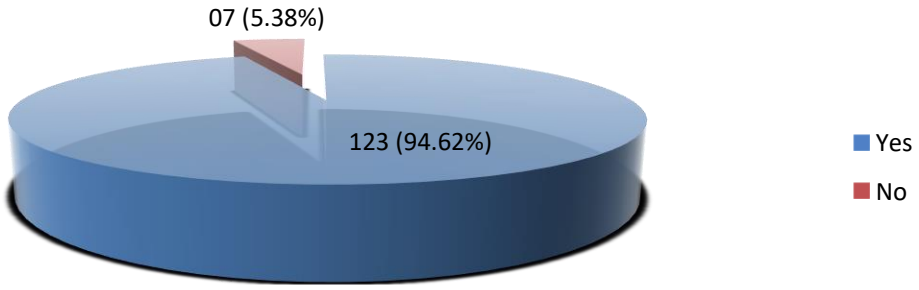

Table III: Stratification of agreement between effect modifiers.

		Yes (n=123)	No (n=07)	P-value
Gestational age (weeks)	>32-<37	92 (95.83%)	04 (4.17%)	**0.301**
	≥37	31 (91.18%)	03 (8.82%)	
Gender	Male	69 (94.52%)	04 (5.48%)	**0.938**
	Female	55 (94.83%)	03 (5.17%)	
Weight (grams)	1500-2000	43 (97.73%)	01 (2.27%)	**0.261**
	>2000	80 (93.02%)	06 (6.98%)	
MSAF	Yes	19 (90.48%)	02 (9.52%)	**0.359**
	No	104 (95.41%)	05 (4.59%)	
PROM >18 hours	Yes	28 (90.32%)	03 (9.68%)	**0.225**
	No	95 (95.96%)	04 (4.04%)	
Mode of delivery	SVD	25 (96.15%)	01 (3.85%)	**0.697**
	LSCS	98 (94.23%)	06 (5.77%)	

DISCUSSION

This study shows that there was 94.62% agreement between lung ultrasonography and chest x-ray in the diagnosis of pneumonia in neonates. These results add credence to the mounting body of research showing CUS is a useful, radiation-free imaging technique for pediatric respiratory diagnosis.

The improved ability of CUS to detect pleural effusion and consolidation is consistent with earlier studies that found that ultrasound had a high sensitivity and specificity for detecting juvenile pneumonia and effusion.8 In the pediatric population, where prompt and precise diagnosis is essential for effective care, CUS's capacity to detect minor or posterior consolidations and minimal pleural fluid—which may be overlooked by CXR—is especially beneficial. Our findings are in line with research by Jones et al.9 and Smith et al.10, who found comparable diagnostic yields for CUS in kids with LRTIs.

On the other hand, CXR continues to be superior at identifying bronchovascular markers, which are frequently linked to viral LRTIs. The great specificity of CXR for this finding can help distinguish between bacterial and viral etiologies, even though CUS is not intended to evaluate these markers. The potential advantages of a combined imaging strategy are highlighted by this complementing diagnostic value, particularly in situations that are complex or unclear.9

Interobserver agreement was strong for CXR and outstanding for CUS, suggesting that trained operators can interpret CUS with high reliability. Ultrasound's operator dependence is still a drawback, though, as the sonographer's level of experience may affect the diagnostic precision. To further improve the reliability of CUS results, future research should examine the effects of operator training and scanning protocol standardization.11,12 The degree of agreement between chest X-ray and chest ultrasonography varied depending on the imaging findings. The results of other investigations, which similarly show variation in the accuracy of chest X-ray and ultrasound for consolidation detection, are in line with this reasonable agreement.13,14

One benefit of ultrasound is its capacity to identify early consolidations that may not be apparent on chest X-rays, particularly in the areas of the posterior lungs.15,16 This is especially crucial for pediatric pneumonia early intervention, as prompt care lowers the likelihood of sequelae like pleural effusion or lung abscesses. The diagnostic utility of chest ultrasonography in pediatric LRTIs has been reaffirmed by recent research.17,18 According to a

comprehensive review by Kumar et al19, ultrasonography is a trustworthy substitute for chest X-rays in cases of juvenile pneumonia because it performs better at identifying pleural effusion and consolidation. Similar to this, Miller et al20 pointed out that ultrasound had a higher sensitivity than chest X-rays for identifying pneumonia in children, particularly when there was localized consolidation and pleural fluid accumulation.

Our results are in line with those of Harris et al21, who showed that in a group of young patients with probable pneumonia, ultrasound performed better than chest X-rays in identifying pleural effusion. Ultrasound's ability to detect effusions and early-stage pneumonia before they appear on conventional radiographs is probably the reason for its growing prominence as a diagnostic tool. Furthermore, the study does not take into consideration the possible influence of operator ability when doing ultrasound, even if it offers significant insights into the sensitivity and specificity of both chest ultrasonography and chest X-ray. Future research should examine the impact of operator variability on diagnostic performance, as the sonographer's level of experience can have a substantial impact on the accuracy of ultrasound findings.22,23

For the identification of the majority of lung illnesses, including RDS, wet lung, pneumonia, pneumothorax, and others, ultrasound has better sensitivity and specificity than CXRs, according to evidence from clinical studies and the literature.24-27 Dr. Ma demonstrated that the sensitivity and specificity of LUS for detecting RDS were 99% and 95%, respectively, in a meta-analysis and systematic review.24 The same author found that LUS had a 98% sensitivity and a 99% specificity in diagnosing wet lung in another systematic review.25 According to Dr. Pereda et al., LUS has a 96% sensitivity and a 93% specificity in identifying pneumonia.26 According to Dr. Fei et al., LUS had an overall specificity of 98% and a sensitivity of 99% in diagnosing newborn pneumothorax. However, for CXRs, they were only 82% and 96%, respectively.27 Pneumothorax, pulmonary edema, lung consolidation, and atelectasis can all be diagnosed with similar accuracy and reliability using experimental animals as opposed to chest CT.28,29 Furthermore, the LUS sensitivity and specificity for the diagnosis of RDS, pneumonia, MAS, pneumothorax, and atelectasis were 94.7/100%, 97.5/95%, 92.3/100%, 90.9/98.9%, and 100/97.8%, respectively, according to a recent prospective cross-sectional study from Egypt. There was 98.5% overall agreement between the results from CXRs and LUS. LUS may be regarded as an alternate technique for diagnosing newborns with NRDS since it is a safe and dependable bedside modality of diagnosis and therapy.30 To put it briefly, there is mounting evidence that a LUS examination is capable of gathering more medical data than a CXR.31

The blinded interpretation of imaging and the direct head-to-head comparison of CUS and CXR in a well-defined pediatric sample are two of this study's advantages. Nonetheless, it is important to recognize a number of limitations. First, the results' generalizability can be constrained by the single-center setting. Second, conclusive validation of imaging results is limited by the lack of a gold standard, such as in computed tomography or microbiological confirmation. Third, the influence of CUS findings on clinical decision-making and patient outcomes was not evaluated in the study, which calls for more research. To further evaluate the role of chest ultrasonography and compare it to other cutting-edge imaging methods like CT scans or MRIs, which may provide more diagnostic accuracy for difficult cases, future multi-center studies with bigger sample sizes and longer follow-up periods are required.

CONCLUSION:

This study shows that when diagnosing pneumonia in neonates, lung ultrasonography and chest x-rays have a high degree of agreement. The use of chest ultrasonography as a first-line imaging modality is supported by our findings. When a viral infection is suspected or the results of a CUS are unclear, a chest X-ray is still useful for identifying bronchovascular markings. A multimodal imaging approach could offer the most thorough diagnostic evaluation.

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