The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 7, 2025

DIAGNOSTIC ACCURACY OF POINT OF CARE ULTRASONOGRAPHY AND CHEST X-RAY FOR RESPIRATORY DISTRESS IN THE EMERGENCY ROOM

Sara Hasan Jamil[*1], Faheem ur Rehman[2], Syeda Zainab[3], Muhammad Umer Javed[4], Kainat Rashid[5], Maroona Syed[6]

[*1]*MBBS, Trainee FCPS Emergency Medicine PEMH Rawalpindi*
[2]*HOD Emergency Medicine PEMH, MBBS, FCPS Medicine*
[3]*MBBS, Trainee FCPS Emergency Medicine, PEMH Rawalpindi*
[4]*MBBS, Trainee Emergency Medicine PEMH Rawalpindi*
[3]*MBBS, Trainee FCPS Emergency Medicine, PEMH Rawalpindi*
[6]*MBBS, Trainee FCPS Radiation Oncology, CMH Rawalpindi*

[*1]sarahassanjamil@gmail.com, [2]drfaheem.amc11@gmail.com, [3]szsgillani93@gmail.com, [4]umarniazi1995@gmail.com, [5]iqra.janjua000@gmail.com, [6]maroonasyed23@hotmail.com

DOI: https://doi.org/10.5281/zenodo.19080779

Keywords
Accuracy, chest, diagnosis, distress, respiratory, ultrasound, x-ray

Article History
Received: 01 July2025
Accepted: 13 July 2025
Published: 18 July 2025

Corresponding Author: *
Sara Hasan Jamil

Abstract

Objective: *To compare the sensitivity, specificity and diagnostic accuracy of point of care ultrasonography (POCUS) and X-ray chest in patients presenting with suspected respiratory distress in the emergency room (ER) keeping HRCT chest as reference standard*

Study Design: *Diagnostic validation study*

Place and Duration of Study: *Department of Emergency Medicine (EM), Combined Military Hospital, Rawalpindi from Jan- June 2025*

Methodology: *A total of 90 patients were analyzed in the final assessment protocol who underwent POCUS, CXR, and HRCT chest. Primary study outcome was sensitivity, specificity, positive, negative predictive value and diagnostic accuracy of point of care ultrasonography (POCUS) and X-ray chest in patients presenting with suspected respiratory distress in the emergency room (ER) keeping HRCT chest as gold standard.*

Results: *Compared to the gold standard HRCT chest, CXR showed a sensitivity of 57.7%, specificity of 90.6%, a positive and negative predictive value of 71.4% and 84.1%. The overall diagnostic accuracy was 81.1%. POCUS when compared to gold standard HRCT chest showed a sensitivity of 88.5%, specificity of 93.8%, with a positive and negative predictive value of 85.2% and 95.2% respectively. The overall diagnostic accuracy was 92.2%.*

Conclusion: *Compared to HRCT, POCUS showed higher sensitivity, specificity and overall diagnostic accuracy when compared to CXR findings. POCUS also has the advantage of being easily portable, available at bedside, with no radiation exposure making it an attractive diagnostic tool in the emergency room with the appropriate training.*

INTRODUCTION

The emergency department poses very different dynamics to approaching patients. The acute setting, high receiving rates and critical condition require fast turnover, early diagnostics and goal directed therapy till patients can be shifted to the appropriate medical setting in the hospital. [1] Techniques which provide diagnostic insights in the ER should be portable, robust, and easily available since resource constraints at various setups do not allow advanced diagnostics. [2]

Recent data indicate that acute respiratory distress accounts for 7-9% of all admission in the emergency department (ED). [3] The conditions requires acute need for early intervention to prevent morbidity and mortality. Chest X-ray remains a staple initial diagnostic option due to general availability, speed and ease of use with portable X-rays providing more access in the ED. [4] But limitations exist and reported sensitivity to pick causes of respiratory distress compared to gold standard HRCT chest is only around 49% although sensitivity is high at 92%.[5] Recently introduced point of care ultrasound (POCUS) has been reported to offer bedside, clinician directed focused diagnostics with higher sensitivity and specificity especially for causes of respiratory distress at 63.1% and 94.2% respectively. [6] It also offers the advantage of being available bedside with no radiation exposure and can be used for a more holistic picture in the acute setting. [7] But gap in literature show that POCUS accuracy also varies depending on the scanning protocol, operator skill and interpretation experience with no standardization techniques for diagnostic protocols especially in the ER. [8] There is also a paucity of data from low resources countries, and we aim to carry out this study evaluating sensitivity, specificity and diagnostic accuracy of point of care ultrasonography (POCUS) and X-ray chest in patients presenting with suspected respiratory distress in the emergency room (ER) keeping HRCT chest as reference standard to better recommend diagnostic guidelines.

METHODOLOGY:

This diagnostic validation study was carried out at the Department of Emergency Medicine (EM), Combined Military Hospital, Rawalpindi from July-December 2025 after approval from the ethical review board vide letter no. The sample size was calculated keeping the confidence interval at 95%, power of test at 80% with anticipated sensitivity of POCUS versus CXR compared to gold standard HRCT at 87% versus 62% respectively. [9] Minimum sample size according to WHO calculator came out to be 44 patients. We included 90 patients in the final study protocol keeping margin for lost to follow-up and inconclusive results for the diagnostic tests.

Inclusion criteria included all patients ages 18-65 years of age presenting in the emergency room with signs of respiratory distress

Exclusion criteria included patients severely unstable to undergo CXR or HRCT, patients with severe cardiac or kidney disease, patients on inotropic supports, patients with respiratory distress due to established causes other than respiratory, patients lost to follow-up and non-consented to be included in the study

The study method included all patients as per the inclusion criteria furnished. A written informed consent was taken from all patients, and they were counselled in detail regarding radiation exposure for Chest X-ray and HRCT chest. They were also counselled about the need for the investigations and the study protocol but not the study outcomes to ensure blinding and prevent study bias. After having consented to be included in the study, patients were sent either on oxygen support or intubated as per respiratory condition for X-ray chest and HRCT to the radiology suite accompanied by a resident emergency medicine unaware of the study protocol. In the radiology suite, X-ray chest posteroanterior view was taken in all patients in the supine position while holding breath at maximum possible inspiratory effort and in case of intubated patients, the resident used the anesthesia machine to provide positive pressure to the chest and hold it till the end of the procedure keeping plateau pressures less than 40 cmH20 with the patient paralyzed. [10] This was followed by computed tomography (CT) of the chest in high resolution on a 256 slice multidetector (MDCT)

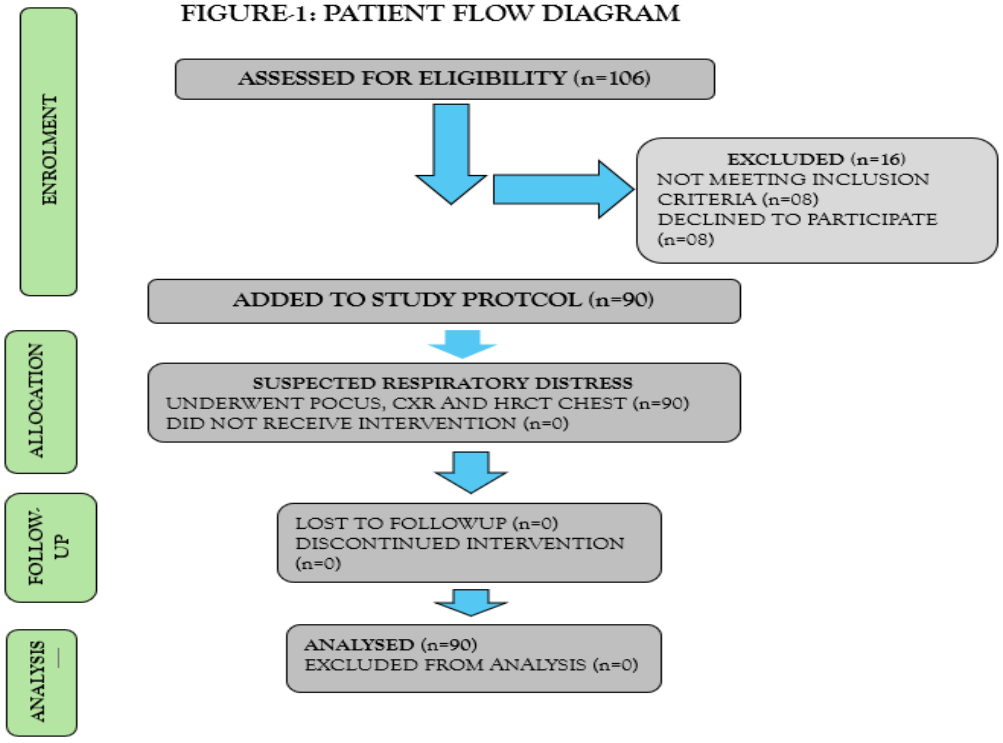
scanner using standard procedure protocol under the supervision of a CT scan technologist. [11] All slices were taken in the supine position with the patient holding the breath at maximal inspiratory effort till the end of the scan and in the case of intubated patients, the resident used the anesthesia machine to provide positive pressure to the chest and hold it till the end of the procedure keeping plateau pressures less than 40 cmH20 with the patient paralyzed. The patients were then brought back to the ER and a consultant emergency medicine with at least 3 years post-fellowship experience and at least 1 year of POCUS experiences performed the diagnostic test on all patients to look for signs of respiratory distress.

Respiratory distress was diagnosed on CXR diagnosed by identifying features such as pulmonary edema, infiltrates, consolidation, pneumothorax, or pleural effusion. On POCUS, respiratory distress was diagnosed by detecting B-lines in pulmonary edema, pleural sliding absence in pneumothorax, dynamic air bronchograms in pneumonia, and effusion quantification. On HRCT, diagnosis was made by presence of fine parenchymal detail, ground-glass opacities, honeycombing, fibrosis, emboli, and small airway pathology. The reports for CXR and HRCT were provided by a consultant radiologist unaware of the study protocol and POCUS findings were endorsed by the emergency medicine consultant also blinded to study outcomes.

Primary study outcome was sensitivity, specificity, positive, negative predictive value and diagnostic accuracy of point of care ultrasonography (POCUS) and X-ray chest in patients presenting with suspected respiratory distress in the emergency room (ER) keeping HRCT chest as gold standard.

Demographic and clinical data including age and weight were expressed as mean±SD while signs, symptoms and oxygen support were expressed as frequency and percentage. A 2x2 table method was used to compare diagnostic results of CXR and POCUS with gold standard HRCT Chest findings to calculate sensitivity, specificity, positive and negative predictive value with diagnostic accuracy. All statistical All statistical calculations were performed using Statistical Package for Social Sciences 26.0

FIGURE-1: PATIENT FLOW DIAGRAM



RESULTS:

A total of 90 patients were analyzed in the final assessment protocol who underwent POCUS, CXR, and HRCT chest for diagnostic evaluation of respiratory distress. Mean age of the study group was 53.09±9.73 years and mean weight was 76.02±6.79 kg. Gender distribution revealed 52 (57.8%) males and 38 (42.2%) females. Signs and symptoms on presentation showed dyspnea/tachypnea in 50 (55.6%), nasal flaring in 29 (32.2%), chest retractions in 19 (21.1%), cough in 77 (85.6%), cyanosis in 10 (11.1%), and altered mental status in 14 (15.6%). Requirement for oxygen supplementation showed no supplementation was required in 23 (25.6%) patients, invasive support was required in 52 (57.8%) patients and intubation was required in 15 (16.7%) patients (Table-I).

Primary variables under study showed that compared to the gold standard HRCT chest, CXR showed a sensitivity of 57.7%, specificity of 90.6%, a positive and negative predictive value of 71.4% and 84.1%. The overall diagnostic accuracy was 81.1% (Table-II).

POCUS when compared to gold standard HRCT chest showed a sensitivity of 88.5%, specificity of 93.8%, with a positive and negative predictive value of 85.2% and 95.2% respectively. The overall diagnostic accuracy was 92.2% (Table-III).

TABLES

TABLE-I DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF THE STUDY GROUP (n=90)

VARIABLE	STUDY GROUP (n=90)
MEAN AGE (YEARS)	53.09±9.73
MEAN WEIGHT (KG)	76.02±6.79
GENDER	
• MALE	52 (57.8%)
• FEMALE	38 (42.2%)
SIGNS AND SYMPTOMS ON PRESENTATION	
• DYSPNEA/TACHYPNEA	50 (55.6%)
• NASAL FLARING	29 (32.2%)
• CHEST RETRACTIONS	19 (21.1%)
• COUGH	77 (85.6%)
• CYANOSIS	10 (11.1%)
• ALTERED MENTAL STATUS	14 (15.6%)
OXYGEN SUPPLEMENTATION	
• NO SUPPLEMENTATION	23 (25.6%)
• NON-INVASIVE SUPPORT	52 (57.8%)
• INTUBATION	15 (16.7%)

TABLE-II SENSITIVITY, SPECIFICITY, PPV AND NPV OF CXR COMPARED TO HRCT CHEST (n=90)

	HRCT CHEST FINDINGS FOR RESPIRATORY DISTRESS	
	YES/POSITIVE	NO/NEGATIVE

CXR FINDINGS FOR RESPIRATORY DISTRESS • **YES/POSITIVE** • **NO/NEGATIVE**	15 11	06 58
Sensitivity= True Positive/(True Positive +False Negative) = 57.7% **Specificity**= True Negative / (True Negative +False Positive) = 90.6% **Positive Predictive Value**= True Positive/ (True Positive+ False Positive) = 71.4% **Negative Predictive Value**= True Negative/ (True Negative +False Negative) = 84.1% **Diagnostic Accuracy**= (True Positive +True Negative)/All Patients) = **81.1**%		

TABLE-III SENSITIVITY, SPECIFICITY, PPV AND NPV OF POCUS COMPARED TO HRCT CHEST (n=90)

	HRCT CHEST FINDINGS FOR RESPIRATORY DISTRESS	
	YES/POSITIVE	**NO/NEGATIVE**
POCUS FINDINGS FOR RESPIRATORY DISTRESS • **YES/POSITIVE** • **NO/NEGATIVE**	23 03	04 60
Sensitivity= True Positive/(True Positive +False Negative) = 88.5% **Specificity**= True Negative / (True Negative +False Positive) = 93.8% **Positive Predictive Value**= True Positive/ (True Positive+ False Positive) = 85.2% **Negative Predictive Value**= True Negative/ (True Negative +False Negative) = 95.2% **Diagnostic Accuracy**= (True Positive +True Negative)/All Patients = **92.2**%		

***CXR= CHEST X=RAY, POCUS= POINT OF CARE ULTRASOUND, HRCT= HIGH RESOLUTION COMPUTED TOMOGRAPHY**

DISCUSSION

The study concluded that compared to the gold standard HRCT chest for diagnosis of respiratory distress in patients coming to the emergency department, POCUS showed higher sensitivity, specificity and overall diagnostic accuracy when compared to CXR findings. POCUS also has the advantage of being easily portable, available at bedside, with no radiation exposure making it an attractive diagnostic tool in the emergency room with the appropriate training.

Comparison with local and international literature shows that Kizito et al. (2023) conducted a study in Uganda evaluating POCUS versus CXR against HRCT for patients with hypoxemia. Lung ultrasound demonstrated a sensitivity of 91% and specificity of 85%, compared to CXR which showed sensitivity of 68% and specificity of 72%. The authors highlighted that ultrasound outperformed X-ray in detecting pulmonary edema and consolidation while being significantly faster which goes in line with results of our study. [12] Bashir et al. (2023) assessed COVID-19 pneumonia using CXR, ultrasound, and HRCT in a cohort of 100 patients. POCUS achieved a sensitivity of 89% and specificity of 81%, closely mirroring HRCT findings, whereas CXR lagged with sensitivity of 62% and specificity of 75%. The study emphasized POCUS as a superior bedside modality during outbreaks. [13] Ruaro et al. (2021)

examined systemic sclerosis–associated interstitial lung disease (ILD). Lung ultrasound achieved a sensitivity of 85% and specificity of 82% against HRCT, whereas CXR failed to detect most early cases with sensitivity only 48%. They concluded that ultrasound could serve as a monitoring tool, though HRCT remained essential for detailed disease mapping. [14] Murali et al. (2023) reported that combined POCUS and CXR increased diagnostic yield in acute dyspnea patients. Individually, ultrasound showed sensitivity 90%, specificity 84%, while CXR had sensitivity 65%, specificity 70%. HRCT validated ultrasound findings, particularly for effusions and pneumothorax. [15] Sosa et al. (2022) compared modalities in ICU patients. POCUS showed sensitivity 92% and specificity 86%, far higher than CXR (sensitivity 59%, specificity 73%) for pneumothorax and alveolar syndromes, with HRCT as gold standard. [16] Nakao et al. (2021) examined acute heart failure patients. Lung ultrasound detected pulmonary edema with sensitivity 94% and specificity 88%, outperforming CXR (sensitivity 60%, specificity 68%). HRCT validated that early interstitial changes were missed by radiography and provides an excellent alternative to diagnose both respiratory and cardiac conditions at the bedside which is the recommendation with results of our study as well. [17]

Sefic Pasic et al. (2023) evaluated neonatal respiratory distress, reporting ultrasound sensitivity of 96% and specificity of 89%, far surpassing CXR (sensitivity 67%, specificity 72%) with HRCT as comparator proving an excellent alternative in children without resorting to radiation heavy exposures. [18]

Local literature on the subject shows that Sharif et al. (2021) compared lung ultrasound and CXR for pneumonia in children aged 2 months–12 years, using HRCT in complex cases. They reported ultrasound sensitivity of 91% and specificity 83%, while CXR showed sensitivity 70% and specificity 78%.[19] Aslam et al. (2025) confirmed HRCT as the gold standard for lung abnormalities and reported that plain radiography had limited diagnostic accuracy (sensitivity 62%, specificity 74%). The authors emphasized that ultrasound, where available, offers better bedside accuracy. [20] Qureshi et al. (2020) prospectively studied COVID-19 pneumonia patients in Islamabad, reporting POCUS sensitivity of 88% and specificity 80%, compared to CXR (sensitivity 64%, specificity 70%) with HRCT validation. [21]

CONCLUSION:

The study concluded that compared to the gold standard HRCT chest for diagnosis of respiratory distress in patients coming to the emergency department, POCUS showed higher sensitivity, specificity and overall diagnostic accuracy when compared to CXR findings. POCUS also has the advantage of being easily portable, available at bedside, with no radiation exposure making it an attractive diagnostic tool in the emergency room with the appropriate training.

LIMITATIONS:

The limitations are that the study is single center only. Although ultrasound consistently outperforms chest radiography, its accuracy is operator-dependent, requiring adequate training for consistent results. Both POCUS and CXR struggle with central lesions, mediastinal masses, and subtle ground-glass opacities, which are best detected on HRCT. CXR remains accessible and inexpensive, but with poor sensitivity for early disease. HRCT, while gold standard, carries high radiation burden and limited availability in resource-constrained regions, including many centers in Pakistan. Therefore, an integrated strategy that leverages the rapid, radiation-free accuracy of POCUS with confirmatory HRCT imaging when available represents the most balanced approach.

CONFLICT OF INTEREST:

None.

REFERENCES

Asmara OD, Pitoyo CW, Wulani V, Harimurti K, Araminta AP. Accuracy of bedside lung ultrasound in emergency (blue) protocol to diagnose the cause of acute respiratory distress syndrome (ARDS): a meta-analysis. Acta Med Indones. 2022;54(2):266-272.

Caroselli C. Could lung ultrasound be a valid alternative to ionizing radiation or a complementary diagnostic choice in pediatric respiratory diseases? Translational Pediatrics. 2024;13(7):1273. https://doi.org/10.21037/tp-24-36

Fuller B, Mohr N, Miller C, Deitchman A, Levine B, Castagno N. Mechanical ventilation and acute respiratory distress syndrome in the emergency department: a multi-center, observational, prospective, cross-sectional, study. Chest. 2015;148(2):365-74. https://doi.org/10.1378/chest.14-2476

van den Berk IA, Lejeune EH, Kanglie MM, van Engelen TS, de Monyé W, Bipat S, et al. The yield of chest X-ray or ultra-low-dose chest-CT in emergency department patients suspected of pulmonary infection without respiratory symptoms or signs. Eur Radiol. 2023;33(10):7294-302. https://doi.org/10.1007/s00330-023-09664-3

Winkler MH, Touw HR, van de Ven PM, Twisk J, Tuinman PR. Diagnostic accuracy of chest radiograph, and when concomitantly studied lung ultrasound, in critically ill patients with respiratory symptoms: a systematic review and meta-analysis. Crit Care Med. 2018;46(7):e707-e14. https://doi.org/10.1097/CCM.0000000000003129

Boumans MM, Aerts W, Pisani L, Bos LD, Smit MR, Tuinman PR. Diagnostic accuracy of lung ultrasound in diagnosis of ARDS and identification of focal or non-focal ARDS subphenotypes: a systematic review and meta-analysis. Critical Care. 2024;28(1):224. https://doi.org/10.1186/s13054-024-04985-1

Rocca E, Zanza C, Longhitano Y, Piccolella F, Romenskaya T, Racca F, et al. Lung ultrasound in critical care and emergency medicine: clinical review. Advances in respiratory medicine. 2023;91(3):203-23. https://doi.org/10.3390/arm91030017

Ahmed T. Clinical Profiles and Outcomes of Patients Presenting with Acute Respiratory Distress in Emergency Care: A Cross-Sectional Analysis. Eur J Cardiovasc Med. 2025;15(2).

Tierney DM, Huelster JS, Overgaard JD, Plunkett MB, Boland LL, Hill CAS, et al. Comparative performance of pulmonary ultrasound, chest radiograph, and CT among patients with acute respiratory failure. Crit Care Med. 2020;48(2):151-7. https://doi.org/10.1097/CCM.0000000000004124

van Kesteren Z, Veldman J, Parkes M, Stevens M, Balasupramaniam P, van den Aardweg J, et al. Quantifying the reduction of respiratory motion by mechanical ventilation with MRI for radiotherapy. Radiation Oncology. 2022;17(1):99. https://doi.org/10.1186/s13014-022-02068-5

Shetty AS, Fraum TJ, Ludwig DR, Hoegger MJ, Zulfiqar M, Ballard DH, et al. Body MRI: imaging protocols, techniques, and lessons learned. Radiographics. 2022;42(7):2054-74. https://doi.org/10.1148/rg.220025

Kizito PM, Bagonza KD, Odakha JA, Nalugya LG, Opejo P, Muyingo A, et al. Diagnostic performance of point of care ultrasound compared to chest X-ray in patients with hypoxia at a teaching hospital emergency department in Uganda. African Journal of Emergency Medicine. 2023;13(2):61-7. https://doi.org/10.1016/j.afjem.2023.02.004

Bashir M, Inzamam W, Banday MK, Rasool SR, Bhat MH, Vladulescu C, et al. Lung ultrasonography is an acceptable imaging modality to diagnose COVID-19 and effectively correlates with HRCT chest—a prospective study. Diagnostics. 2023;13(12):2091. https://doi.org/10.3390/diagnostics13122091

Ruaro B, Baratella E, Confalonieri P, Confalonieri M, Vassallo FG, Wade B, et al. High-resolution computed tomography and lung ultrasound in patients with systemic sclerosis: which one to choose? Diagnostics. 2021;11(12):2293. https://doi.org/10.3390/diagnostics11122293

Murali A, Prakash A, Dixit R, Juneja M, Kumar N, Padaliya P. Lung ultrasound: a complementary imaging tool for chest X-ray in the evaluation of dyspnea. Indian Journal of Radiology and Imaging. 2023;33(02):162-72. https://doi.org/10.1055/s-0042-1759850

Sosa FA, Kleinert M, Matarrese A, Cheong I, Folco JJ, Saavedra S, et al. Diagnostic Accuracy of Bedside Lung Ultrasound and Chest Radiography Compared to Thoracic Computed Tomography in Critically Ill Patients. SN Comprehensive Clinical Medicine. 2022;4(1):256. https://doi.org/10.1007/s42399-022-01337-4

Nakao S, Vaillancourt C, Taljaard M, Nemnom M-J, Woo MY, Stiell IG. Diagnostic accuracy of lung point-of-care ultrasonography for acute heart failure compared with chest X-ray study among dyspneic older patients in the emergency department. The Journal of Emergency Medicine. 2021;61(2):161-8. https://doi.org/10.1016/j.jemermed.2021.02.019

Sefic Pasic I, Riera Soler L, Vazquez Mendez E, Castillo Salinas F. Comparison between lung ultrasonography and chest X-ray in the evaluation of neonatal respiratory distress syndrome. Journal of ultrasound. 2023;26(2):435-48. https://doi.org/10.1007/s40477-022-00728-6

Sharif M, Saeed T, Saheel K, Khan K, Hussain M, Sharif AHM, et al. Comparison of chest X-ray with lung ultrasound in the diagnosis of pneumonia in children aged 02 months to 12 years. Journal of Rawalpindi Medical College. 2021;25(1). https://doi.org/10.37939/jrmc.v25i1.1510

Aslam M, Anjum AA, Jabeen M. High-Resolution Computed Tomography in the Detection of Lung Abnormalities: Detection of Lung Abnormalities. Pakistan BioMedical Journal. 2025:23-7. https://doi.org/10.54393/pbmj.v8i5.1253

Qureshi AR, Bilal H, Sajid M, Ashraf Z. Diagnostic value of Transthoracic Ultrasonography for COVID-19 Pneumonia: A Prospective Study. Journal of Islamabad Medical & Dental College. 2020;9(3):158-67. https://doi.org/10.35787/jimdc.v9i3.581