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Original Research Article

Role of Thoracic Sonography in Treatment Planning: Single Centre Experience from South India

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Abstract

Background: Conventional chest radiography remains the primary imaging modality for evaluation of pediatric thoracic diseases, while computed tomography (CT) is reserved for advanced assessment. However, radiation exposure and the need for sedation limit their frequent use in children.

Objective: To evaluate the role of thoracic ultrasound as a non-ionizing, bedside imaging modality in the diagnosis and treatment planning of pediatric chest pathologies.

Materials and Methods: This observational study was conducted at a tertiary pediatric care center in South India. Children presenting with suspected thoracic pathology underwent chest radiography followed by thoracic ultrasonography. Both low-frequency curvilinear and high-frequency linear probes were used depending on the pathology. Ultrasound findings were correlated with clinical features and used for treatment planning, interventions, and follow-up.

Results: Thoracic ultrasound provided valuable diagnostic information in pulmonary, pleural, mediastinal, and chest wall pathologies. It significantly reduced the requirement for repeated radiographs and CT scans. Ultrasound effectively guided interventional procedures such as intercostal drain insertion, pleural fluid aspiration, and mediastinal biopsy. Bedside ultrasound in the emergency room and intensive care units improved decision-making and reduced radiation exposure and sedation requirements.

Conclusion: Thoracic ultrasonography is a reliable, radiation-free imaging modality that plays a crucial role in diagnosis, treatment planning, and follow-up of pediatric chest diseases. It can serve as a first-line imaging tool in many clinical scenarios and effectively supplement conventional radiography.

Keywords: Pediatric thoracic ultrasound, Chest sonography, Radiation-free imaging, Pediatric chest pathology, Treatment planning.

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Introduction

Imaging is central to evaluating pediatric thoracic disease. Chest radiography is usually the first investigation, and computed tomography (CT) is used when detailed anatomical assessment is required.

In children, repeated ionizing radiation exposure and the occasional need for sedation make CT a less desirable modality for routine follow-up. Thoracic ultrasonography offers a practical, radiation-free alternative with real-time bedside assessment and growing evidence of diagnostic accuracy [1,2].

With improved probes and technique, ultrasound can assess pleural fluid, peripheral lung consolidation, chest wall lesions, the diaphragm, and selected mediastinal conditions. Prior pediatric studies report good diagnostic performance for pneumonia and pleural disease, in many settings comparable to chest radiography and sometimes reducing the need for CT [3–5].

Point-of-care lung ultrasound is particularly useful in the emergency room and intensive care unit, where rapid decisions are needed and transporting an unstable child for CT is challenging. Standardized approaches and international guidance support its use as an adjunct in critically ill neonates and children [6–8].

In this study, we describe our institutional experience with thoracic ultrasound across a spectrum of pediatric chest pathologies and

highlight how sonographic findings influenced treatment planning and follow-up while limiting radiation exposure.

Objectives

1. To assess the diagnostic utility of thoracic ultrasound in pediatric chest pathologies.
2. To evaluate its role in treatment planning and ultrasound-guided interventional procedures.
3. To analyze its impact on reducing repeated radiographs and CT utilization in children.

Materials and Methods

This observational study was conducted at a tertiary pediatric care center in South India. Pediatric patients presenting with suspected thoracic pathology were included in the study.

Inclusion Criteria:

- Children with pulmonary, pleural, mediastinal, or chest wall pathologies.
- Patients evaluated using both chest radiography and thoracic ultrasound.

Ultrasound Technique: Thoracic ultrasound was performed using curvilinear low-frequency probes for deeper structures and high-frequency linear probes for superficial lesions. Examinations were carried out in radiology suites as well as bedside in emergency and intensive care units.

Assessment Parameters:

- Nature and extent of pleural effusion
- Lung consolidation and collapse
- Mediastinal lesions
- Chest wall abnormalities
- Diaphragmatic movement and integrity

Ultrasound findings were used to guide therapeutic decisions, including interventional procedures and follow-up imaging.

Ethical Consideration: The study was conducted in accordance with institutional ethical guidelines. As this was a retrospective observational study using routine clinical data, formal ethics committee approval was waived.

Results

Thoracic ultrasound yielded actionable findings across a broad range of pediatric chest conditions. It delineated pleural effusion (including loculations), empyema, and peripheral consoledations with/without necrosis, pneumothorax, diaphragmatic dysfunction, congenital diaphragmatic hernia contents, and chest wall lesions. Overall, the sonographic patterns observed were in keeping with published pediatric lung ultrasound evidence [3,4,9].

Ultrasound also supported procedure planning and real-time guidance for thoracic interventions, including pleural aspiration, intercostal drain placement, and selected biopsies, and helped characterize pleural collections to inform the therapeutic approach [2,5].

Serial ultrasound follow-up during clinical course reduced the need for repeat radiographs and avoided CT in several situations, thereby lowering cumulative radiation exposure.

Figures 1–9 illustrate representative cases from our cohort: an abscess cavity with internal air and fluid (Figure 1); pulmonary sequestration with a feeding vessel (Figures 2 and 9); simple pleural effusion (Figure 3); organized/loculated pleural collections (Figures 4 and 8); necrotic changes within consolidation (Figure 5); and vascular chest wall lesions (Figures 6 and 7).

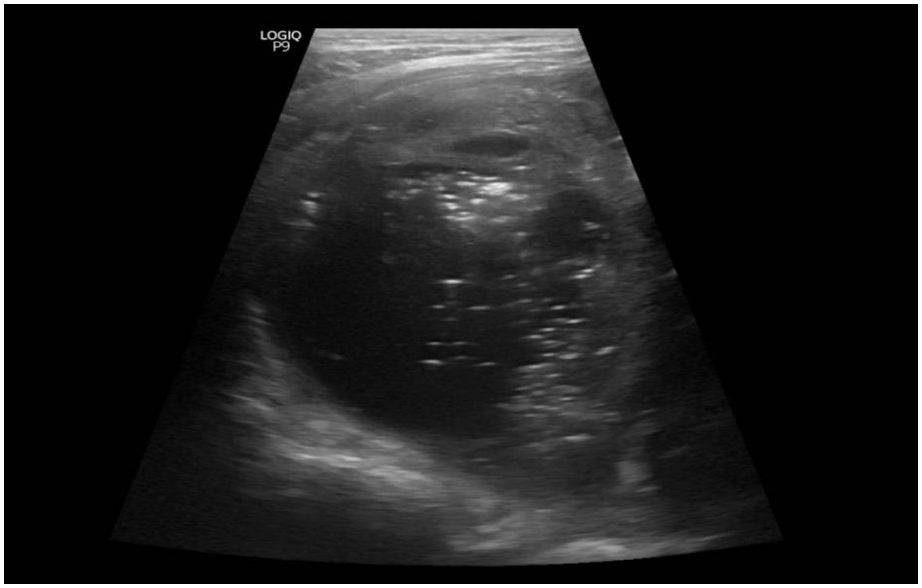

Figure 1: USG image showing irregular abscess cavity with air pockets and fluid contents.

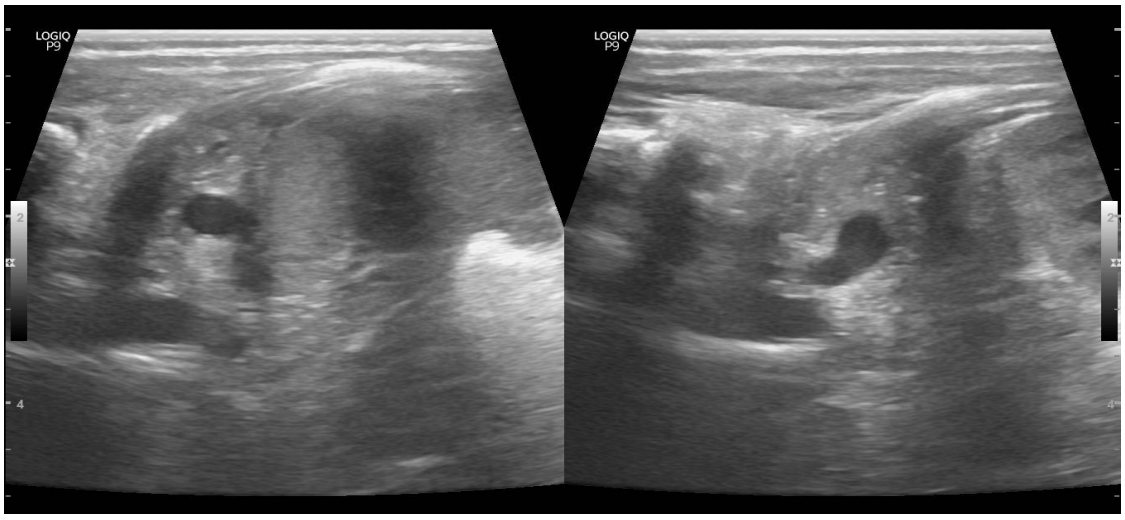

Figure 2: USG axial image showing pulmonary sequestration with prominent internal feeding vessel.

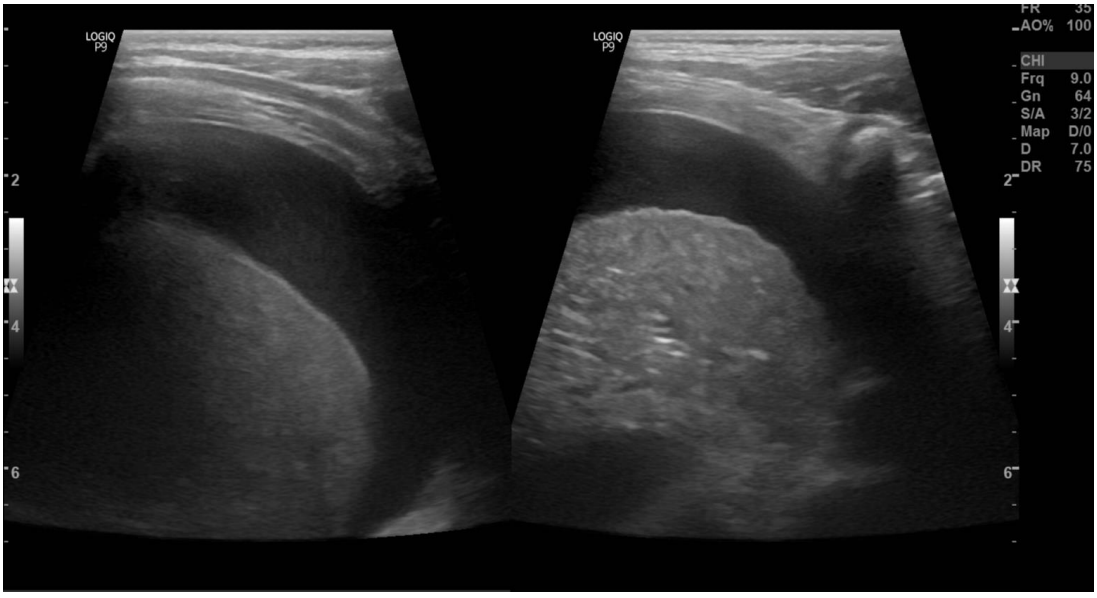

Figure 3: USG image showing significant pleural effusion with minimal internal echoes.

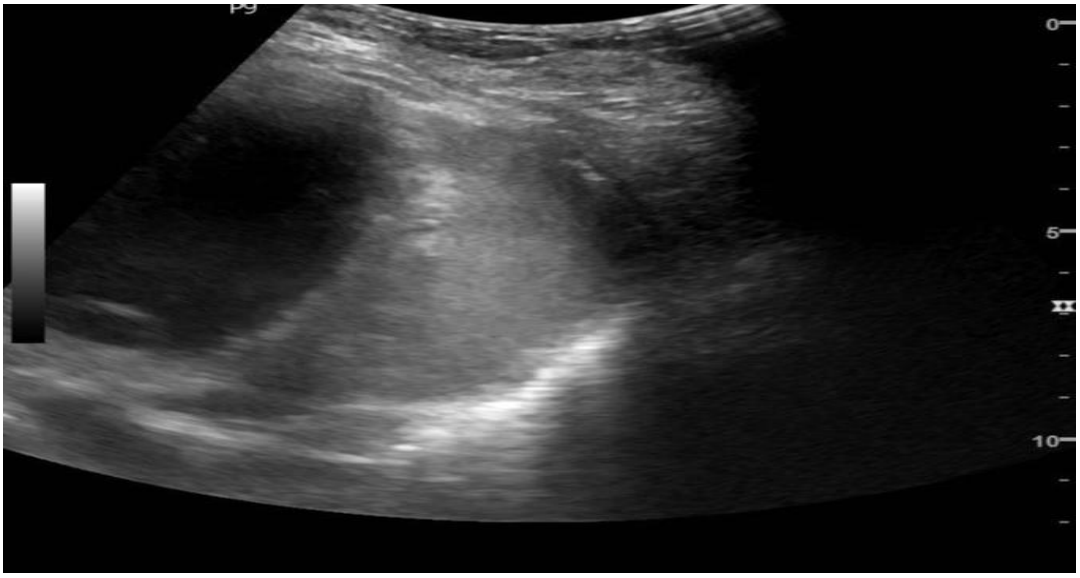

Figure 4: USG image showing left paracardiac echogenic organized loculated collection.

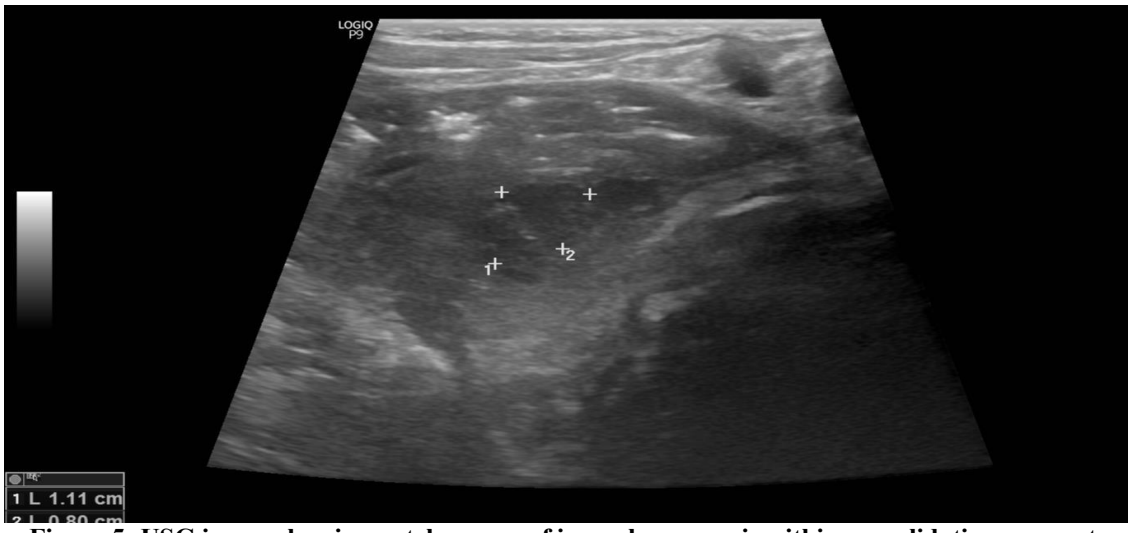

Figure 5: USG image showing patchy areas of irregular necrosis within consolidation segment.

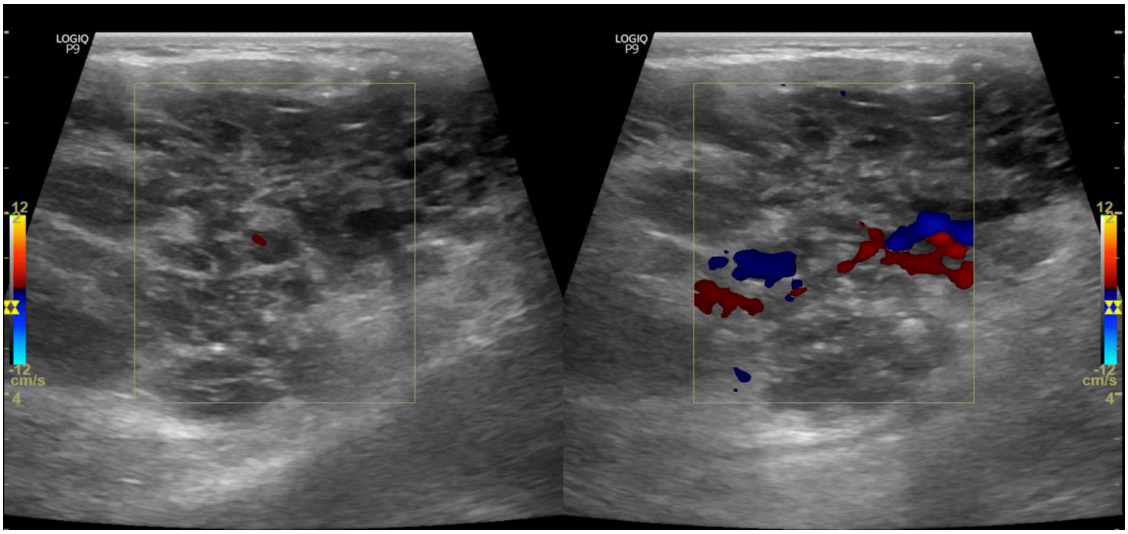

Figure 6: USG chest wall showing large mixed echogenic mass lesion with significant internal vascularity, suggestive of arteriovenous malformation.

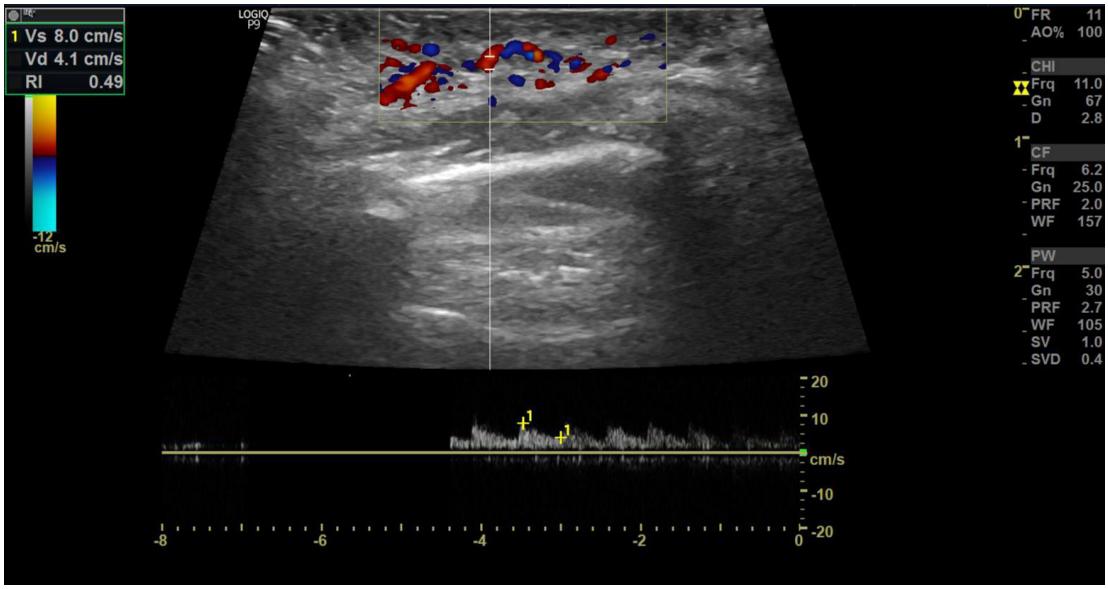

Figure 7: USG chest wall showing echogenic mass lesion with significant internal vascularity, suggestive

of hemangioma.

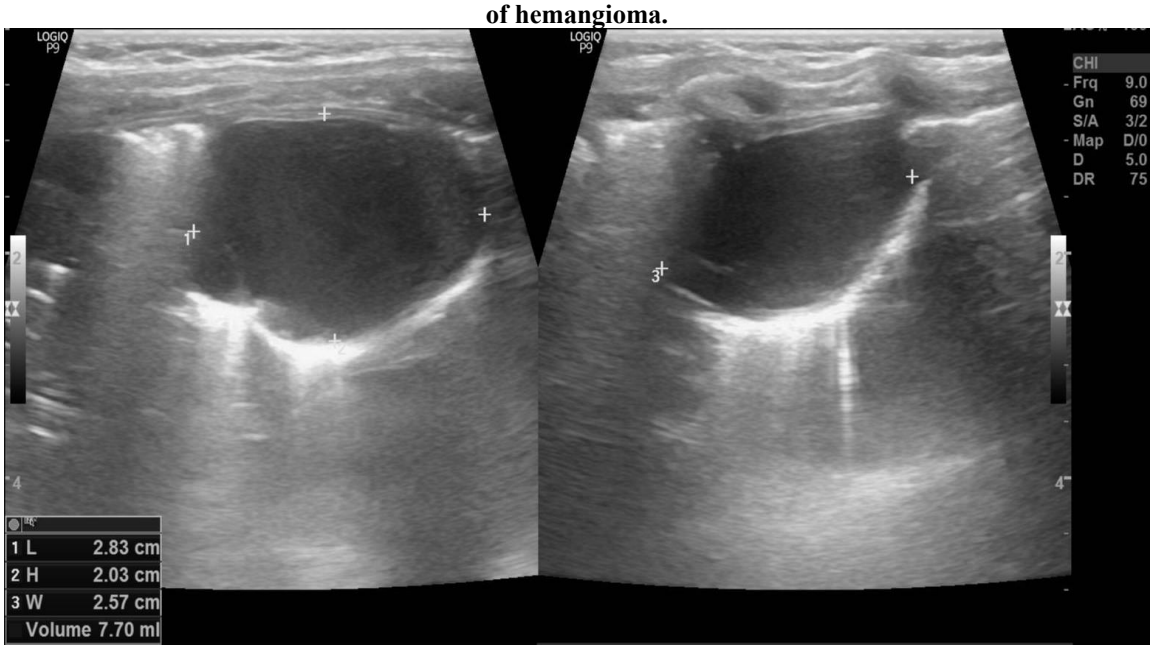

Figure 8: USG image showing loculated echogenic pleural collection.

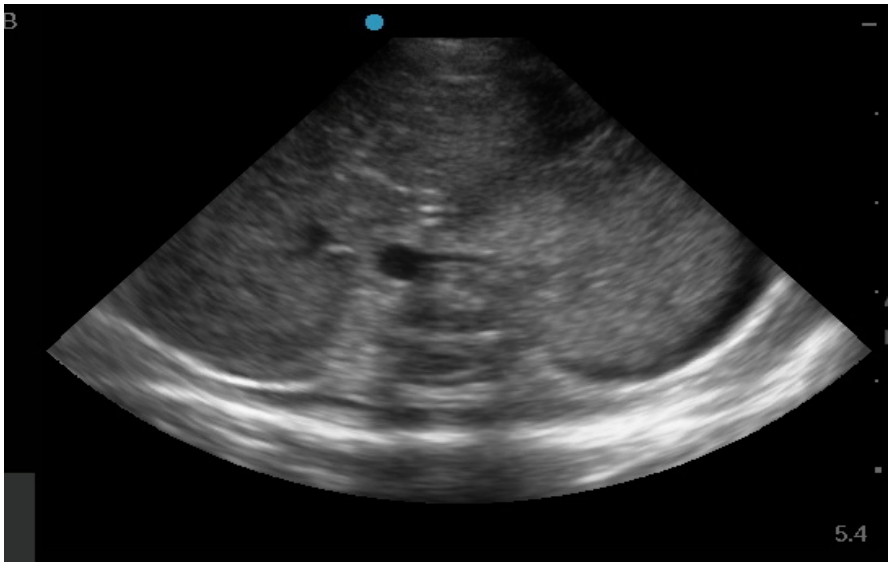

Figure 9: USG chest showing left lower lobe sequestration with prominent feeding vessel.

Discussion

Our experience supports thoracic ultrasound as more than an adjunct in pediatric chest evaluation. Because it is radiation-free, portable and repeatable, it is well suited for children and for serial assessment. Published data also show good accuracy for detecting peripheral consolidation, pleural effusion and pneumothorax, often comparable to conventional imaging in appropriate clinical contexts [1,3,4].

In emergency and intensive care settings, bedside ultrasound can shorten decision time and reduce the need to transport unstable children for CT. Standardized bedside approaches (including the BLUE framework) have improved the consistency and clinical uptake of lung ultrasound in acute respiratory failure [6]. Ultrasound does have limitations—particularly for deep mediastinal pathology and complex chest wall lesions—where CT or MRI may still be required. However, as an initial test it can clarify whether a finding is fluid, consolidation or soft-tissue, and may prevent unnecessary cross-sectional imaging, for example when a normal thymus is mistaken for pathology in young children [2,7]. Overall, integrating thoracic ultrasound into routine pediatric chest workflows can improve treatment planning, guide interventions, and reduce cumulative radiation exposure, especially when combined with clinical assessment and selective use of radiography/CT.

Conclusion

Thoracic ultrasonography is a safe, effective, and radiation-free imaging modality that significantly contributes to diagnosis, treatment planning, interventional guidance, and follow-up of pediatric chest diseases. Its routine use can substantially reduce radiation exposure and improve patient care in pediatric settings.

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