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LUNG ULTRASOUND EVALUATION IN INTENSIVE CARE: DIAGNOSTIC PRINCIPLES, CLINICAL APPLICATION, AND AI-ASSISTED INTERPRETATION

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Background: Lung ultrasound (LUS) has become an essential bedside diagnostic tool in intensive care, allowing rapid, noninvasive, and repeated assessment of pulmonary conditions without ionizing radiation. Despite its clinical advantages, accurate interpretation requires a comprehensive understanding of ultrasound artifacts, standardized scanning protocols, and their integration into clinical decision-making. Recent advances in artificial intelligence (AI) offer additional opportunities to support image interpretation and improve diagnostic consistency.

Objective: To present an evidence-based educational approach to lung ultrasound in intensive care, integrating fundamental diagnostic principles, practical clinical applications, and emerging AI-assisted interpretation technologies.

Methods: A structured educational presentation was developed based on contemporary scientific literature, clinical protocols, and systematic reviews published through 2026. The educational framework combines ultrasound physics, recognition of normal and pathological sonographic patterns, standardized examination techniques, and clinical decision-making algorithms. Particular attention is given to the Bedside Lung Ultrasound in Emergency (BLUE) protocol and recent evidence concerning AI applications in lung ultrasound.

Results: The educational framework addresses key sonographic findings, including A-lines, B-lines, lung sliding, lung pulse, pleural abnormalities, and pulmonary consolidation. Their clinical interpretation is discussed in relation to acute respiratory failure, pneumothorax, pulmonary edema, pneumonia, atelectasis, acute respiratory distress syndrome, and pleural effusion. The presentation emphasizes dynamic monitoring of lung aeration and assessment of responses to mechanical ventilation, positive end-expiratory pressure adjustments, fluid management, and other therapeutic interventions. Emerging AI applications, including automated artifact detection, image classification, segmentation, and quantitative analysis, are examined alongside their current limitations, particularly insufficient external validation, variability in image acquisition, and limited generalizability across clinical settings.

Conclusion: A structured educational approach integrating ultrasound physics, standardized scanning protocols, clinical interpretation, and emerging AI technologies may support the effective application of lung ultrasound in intensive care. Although AI-assisted interpretation offers promising opportunities to improve diagnostic reproducibility, it should currently complement rather than replace clinical expertise. Integrating these concepts into medical education may strengthen bedside diagnostic skills and promote evidence-based clinical decision-making.

Keywords: Lung ultrasound; Intensive care; Point-of-care ultrasound; Artificial intelligence; Medical education.