EDITORIAL

# Combined Cardiopulmonary Ultrasound: A Treatment Changing Modality in Acute Respiratory Failure

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Acute respiratory failure (ARF) is the failure of the cardiopulmonary system to provide adequate ventilation or oxygenation of the blood and systemic organs. It can be objectively identified by the presence of respiratory rate >25/minute, $PaO_2$ <60 mm Hg, room air oxygen saturation <90% measured by pulse oximetry, or $PaCO_2$ <45 mm Hg and arterial pH <7.35.[1,2] More than half of the patients admitted to intensive care unit (ICU) suffer from the ARF during their stay.[3] ARF is a life-threatening condition with diverse possible etiologies and it is reasonable to strive for early etiological diagnosis to guide appropriate therapeutic interventions.

The inaccuracy of clinical examination has led researchers to explore other diagnostic modalities. The limited utility of arterial blood gas (ABG) analysis, inaccuracy of portable chest X-rays (CXR), and practical difficulties in obtaining computed tomography (CT) scan are well known. Point-of-care ultrasound (POCUS) is a rapid, reliable, and reasonably accurate diagnostic tool that adds important value to clinical examination in critically ill patients. Lung ultrasound is known to be more accurate than the standard clinical examination alone.[1] In patients with ARF needing intubation, lung ultrasound at the time of intubation has an excellent agreement with CT scan done within 24 hours of intubation.[4] Use of lung ultrasound in patients presenting to the emergency department with acute undifferentiated dyspnea had led to a change in therapeutic management in most (58%) of the patients.[5]

The bedside lung ultrasound in emergency (BLUE) protocol, which combines lung ultrasound with venous analysis can accurately differentiate between various pulmonary embolism (PE), pneumothorax, pneumonia, etc.[6] The addition of bedside echocardiography to lung and vascular ultrasound (FALLS protocol) increases the comprehensiveness of the diagnostic workup and also helps in tailoring the management especially in hemodynamically unstable patients.[7] Integrative cardiopulmonary ultrasound (CPUS) has shown to improve the diagnostic accuracy in ARF patients.[2] Cardiopulmonary ultrasound in critically ill patients within 24 hours of admission to the ICU has led to changes in both hemodynamic diagnosis (66%) and lung pathology diagnosis (58%) in most of the patients further leading to change in management in 65% of patients.[8]

Current evidence strongly indicates the use of CPUS in the management of ARF. A recent article by Barman et al. adds to our knowledge of diagnostic accuracy and the potential for change in the therapeutic management of ARF with CPUS.[9] They have demonstrated superior diagnostic accuracy of CPUS over clinical examination (88 vs 67.5%), change in diagnosis (37%) and management (36%) in more than one-third of the patients. Time from the ICU admission to the CPUS (8 ± 5 hours) in the study is significantly longer when compared with a previous study by Silva et al. (20 ± 6 minutes).[1,9] Therapy directed toward the ARF (diuretics, positive pressure ventilation, inotropes, etc.) has the potential for altering the ultrasound picture and hence it may be prudent to perform CPUS at the earliest, preferably after initial stabilization. The availability of an ultrasound machine at the bedside and training of intensivist and emergency physicians may help in the performance of early CPUS.

The study has used a lung ultrasound sign of pleura-based hypoechoic lesions for the diagnosis of PE. This method, previously described by Reissig and Kroegel in suspected cases of PE mandates the patient to be in sitting, followed by prone position and also requires breath-holding by the patient.[10] It would be interesting to look at the validity of this method in undifferentiated patients with ARF as both late PE and pneumonia can produce hypoechoic, non-homogeneous lesions.

To summarize, in patients presenting to the acute care setting with signs and symptoms of ARF, the use of CPUS helps in accurate diagnosis and early initiation of correct treatment in a significant number of patients. Cardiopulmonary ultrasound should be initiated at the earliest after initial stabilization as therapy used for ARF may change the CPUS picture. Training of intensivist and emergency physicians in CPUS may be the way forward for early CPUS. BLUE and FALLS protocols are well-validated in critically ill patients and should be preferably used. Other methods or protocols which are originally described in "non-critically ill" patients may be used with caution unless they are validated in critically ill patients.

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