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EDITORIAL

Dimitris Georgopoulos
Nectaria Xirouchaki
Giovanni Volpicelli

Lung ultrasound in the intensive care unit: let's move forward

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D. Georgopoulos (✉) · N. Xirouchaki
Department of Intensive Care Medicine, University Hospital of Heraklion, Medical School, University of Crete, Heraklion, Crete, Greece
e-mail: georgop@med.uoc.gr

G. Volpicelli
Department of Emergency Medicine, San Luigi Gonzaga University Hospital, Turin, Italy

Lung imaging in critically ill patients is challenging because the traditional techniques, such as thoracic computed tomography (CT) and bedside chest x-ray, present serial limitations which hamper their utility. Although thoracic CT is the gold standard for lung imaging, it is expensive and cannot be performed on a routine basis. Moreover, the transportation of critically ill patients to the radiology department and the radiation exposure both carry significant risks. Also, limitations of bedside chest x-ray are numerous. Very often in the intensive care unit (ICU) it is not possible to obtain high quality films, which impairs the efficacy of conventional radiology for the identification of important lung pathologies [1].

Lung ultrasound has emerged in recent years as a powerful, noninvasive, easily repeatable bedside diagnostic tool and therefore it is increasingly used in critically ill patients [2]. Studies have shown that in these patients, lung ultrasound has a high diagnostic accuracy in identifying pneumothorax, consolidation/atelectasis, interstitial syndromes (i.e., pulmonary edema of cardiogenic or noncardiogenic origin), pleural effusion, and, on the appropriate clinical grounds, it may help in the diagnosis of pneumonia [3–6]. Nowadays, lung ultrasound may be considered an alternative to thoracic CT when identifying pathological conditions commonly encountered in critically ill patients (Fig. 1) [4]. As a result, lung ultrasound is likely to have a significant impact on clinical decision making and therapeutic management of these patients [7]. Lung ultrasound may also be used to assess and monitor lung aeration, which is of particular importance in patients with acute respiratory distress syndrome [8, 9]. This application may guide the titration of positive end-expiratory airway pressure (PEEP) and may serve as a safeguard against excessive fluid loading in critically ill patients [10]. Finally, it has been shown that ultrasound may be used to measure the thickening fraction of the diaphragm during tidal breathing, which is useful as a noninvasive estimation of the work of breathing in critically ill patients [11].

Despite the proven diagnostic ability of lung ultrasound and its influence on decision making and therapeutic management, there are significant barriers to the widespread use of this pragmatic, noninvasive bedside tool. The fact that the interpretation of lung ultrasound findings is heavily dependent on operator experience represents one important limitation. Indeed, most of the studies showing high diagnostic accuracy of lung ultrasound have been performed by experts in the field, and this may limit the generalization of results in all ICUs. Thus, validation of new educational protocols is mandatory to spread the proper use of lung ultrasound in critically ill patients.

Recently, a consensus of experts introduced the examination of the lung as one of the required elements to achieve competence in general critical care ultrasound [12]. Although the technical and cognitive elements required for competence in lung ultrasound have been

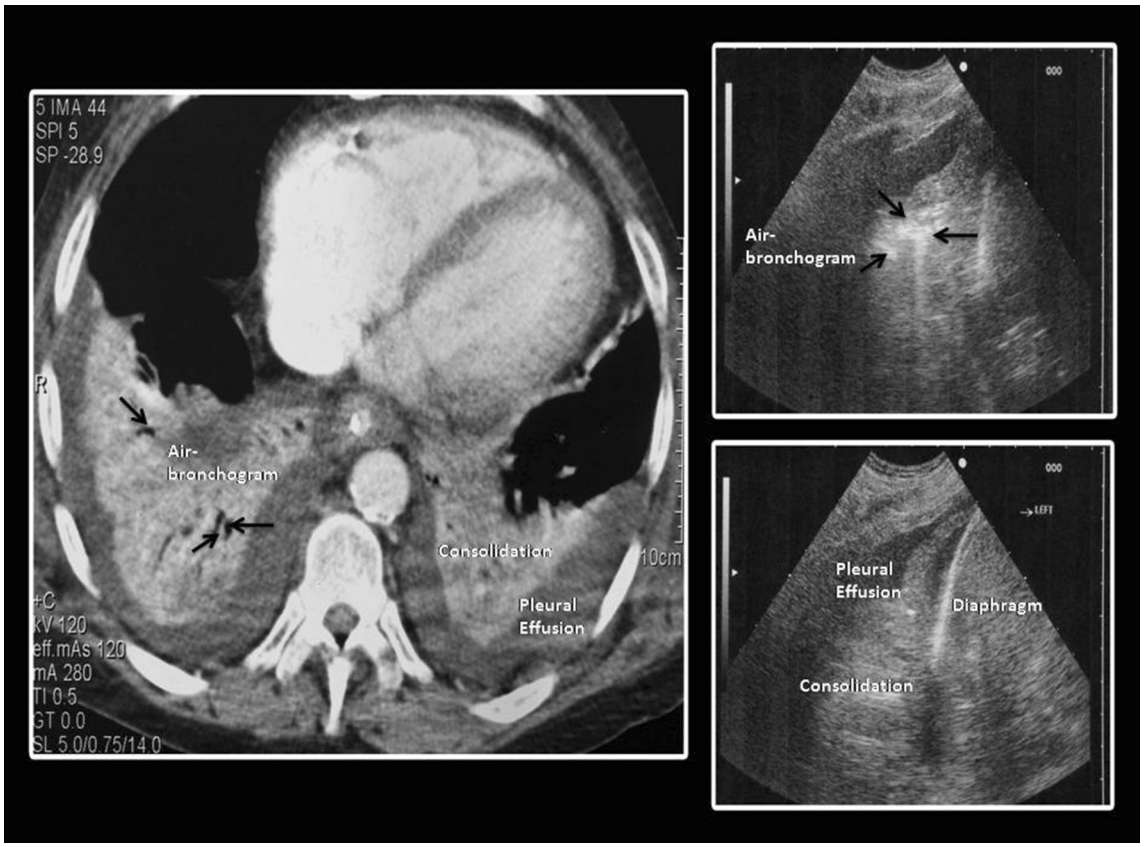

Fig. 1 *Left* multiple detector computed tomography after intravenous contrast material revealed bilateral consolidations with air bronchogram (*arrows*), associated with pleural effusions. *Right* lung-ultrasound longitudinal scan at the lower lateral regions. The main ultrasound features included bilateral consolidations with air bronchogram (*arrows*) and pleural effusions

described in a statement issued by two critical care societies, detailed educational protocols to achieve this competence have not been fixed [13]. Conversely, several training programs have been reported for teaching basic critical care echocardiography. Among these, a 12-h training program that has been recently described and adequately validated may serve as a guide for future similar educational projects [14]. The program is tailored for noncardiologist residents without any experience of ultrasound, and includes blending didactics, interactive cases, and tutored hands-on sessions [14].

Along these lines, the study by Begot et al. [15] published recently in *Intensive Care Medicine* is more than welcome. Using ultrasonography, these investigators applied a 3-h, focused training program for resident novices in ultrasound aimed at identification and quantification of unloculated pleural effusions in critically ill patients. The training program was simple and well described, and included 1 h of didactics with a special emphasis directed towards the identification of pitfalls, 30 min of illustrative cases, and 90 min of tutored hands-on practice in at least five critically ill patients. The competence of the residents after the program was evaluated in 147 critically ill patients (78 % of whom were mechanically ventilated). Overall, there was a good to excellent diagnostic agreement between trainees and experts, and a concordant semiquantitative assessment of unloculated pleural effusion. When compared to experienced operators, residents had only 9 false negatives and 20 false positive results. Not surprisingly, the diagnostic agreement increased on increasing the size of pleural effusions. It is noteworthy that no case of intra-abdominal or pericardial effusion was erroneously identified as pleural effusion, a misdiagnosis that may have devastating consequences for the patient. Notwithstanding that patients with inadequate acoustic window or loculated pleural effusions were excluded, this study sets the framework for the development of further training programs, aimed at achieving competence in lung ultrasound. Validated training ultrasound programs for the identification of other lung pathological entities, more complex than unloculated pleural effusion, are urgently needed. We believe that this step represents the most important weapon in our arsenal to break the barriers that currently

prevent the widespread application of lung ultrasound in the ICUs for critically ill patients. There is accumulated evidence in the literature supporting the pivotal role of lung ultrasound in the management of critically ill patients, and experts in this field are not available around the clock in ICUs. It is time to establish a validated educational program dedicated to ICU residents that covers the basics of lung ultrasound. Let's move forward!

Conflicts of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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