

## Unmet Needs in Lung Ultrasound

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Received: May 20, 2016

Revised: June 18, 2016

Accepted: June 20, 2016

Published online: September 16, 2016

### ABSTRACT

Despite lung ultrasound is accurate for many respiratory indications, this technique carries specific unmet needs. The first one is a technological gap due to the fact that research on lung ultrasound has mainly been conducted by the use of machines and software conceived to explore anatomical districts different from the lung. Secondly, sonographic diagnoses are made through the analysis of lung “artefacts” regularly occurring under certain conditions. Albeit some artefacts are known since the first uses of ultrasounds, the aetiology of lung artefacts remains incompletely understood. A last issue concerns the heterogeneity of ultrasound teaching. Often in dedicated training programs the teaching of chest and lung ultrasound consists of a list of sonographic signs of heterogeneous accuracy, while complex clinical issues, such as the approach to acute respiratory failure, are frequently oversimplified thus leading to potential inaccuracies. In this editorial we highlighted these gaps as

they could be filled through research and dialogue between academic world, respiratory medicine societies, and ultrasound stakeholders.

**Key words:** Lung ultrasound; Sonography; Ultrasound teaching

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Sferrazza Papa GF, Tursi F, Marchetti G, Soldati G, ADET\*Study Group. Unmet Needs in Lung Ultrasound. *Journal of Respiratory Research* 2016; 2(3): 73-74 Available from: URL: <http://www.ghrnet.org/index.php/jrr/article/view/1731>

### INTRODUCTION

Lung ultrasound is a radiation-free technique, which may be performed bedside for many respiratory indications. Moving forward from the traditional, mandatory use in the management of pleural effusion, recent studies suggest that the technique is also accurate in the diagnosis of pneumonia and pneumothorax, and in the distinction between exacerbation of chronic obstructive pulmonary disease (COPD) and heart failure<sup>[1,2]</sup>. Ultrasound employment in the management of this wide range of conditions would result in an improvement of our approach to acute respiratory failure<sup>[3,4]</sup>. However, most of these studies have been performed by field experts. It is yet to be demonstrated if similar results will be confirmed outside the reference centers which the data are referred to. If so, the scientific community will have to consider lung ultrasound as a challenge to the current paradigms of many respiratory diagnoses, possibly in a similar way as echocardiography has revolutionized cardiology.

Yet, unlike other fields, lung ultrasound carries specific unmet needs that should be addressed. The first one concerns a technological gap: research on lung ultrasound has mainly been conducted by the use of machines, software and probes designed to explore different anatomical districts and organs. While for general ultrasound systems the goal is to amplify slight differences in tissues’ acoustic impedance, this is completely different when a high impedance interface such as the pleural plane is approached.

This requires a rethinking of what we mean by lung ultrasonography since, outside pneumonia detection through visualization of lung consolidations, other above mentioned sonographic diagnoses are made through the analysis of “artefacts” regularly occurring under certain conditions. Some artefacts are known since the first uses of ultrasounds and recent progress has been made in the comprehension of their underlying mechanisms<sup>[5,6]</sup>. However, the aetiology of lung artefacts remain not fully understood both in normal lung and in the occurrence of diseases<sup>[5,6]</sup>.

Secondly, it should be reminded that the lung is a heterogeneous organ, which may be affected by a wide spectrum of diseases. In order to improve clinical management of respiratory conditions, ultrasound should be integrated with other imaging techniques (and not used as a stand-alone technique). Chest radiography continues to provide a quick panoramic view of the thorax, the heart and mediastinum, while computed tomography (CT) may provide high-resolution details of the lung parenchyma, interstitium, and vessels in selected patients. While chest radiography remains the first imaging approach and CT scan the gold standard for thoracic imaging, the role of lung ultrasound in current diagnostic pathways seems promising, yet requires to be fine-tuned through further studies. Moreover, in chronic diseases, the execution of imaging tests should possibly be integrated with a complete lung function evaluation. In the pulmonary function tests laboratory, spirometry, with assessment of lung volumes, and DLCO assessment provide key information on the overall lung function. These information should all be integrated to solve the clinical diagnostic puzzle, tailor patients’ monitoring and therapies.

These considerations require a consistent and shared definition of each lung ultrasound sign, based on both the physical nature and anatomical substrates from which signs arise<sup>[7]</sup>. On this ground, lung sonography, fully integrated into clinical ultrasound equipment, may become a reliable tool to improve the bedside physical examination detection of diseases, not as a stand-alone imaging technique, but as an epistemic mediator<sup>[8]</sup> towards safer, faster and inexpensive diagnoses.

A last issue concerns the heterogeneity of ultrasound teaching. Current dedicated training programs frequently do not take into account the above-mentioned gaps, and often the teaching of chest and lung ultrasound consists of a simple list of sonographic signs of heterogeneous accuracy. Moreover, complex clinical issues, such as the approach to acute respiratory failure, are frequently oversimplified thus leading to potential diagnostic inaccuracies. All this may contribute to justified criticisms towards lung ultrasound<sup>[9]</sup>. In medical schools, ultrasound (particularly of the lung) is not always integrated in students’ curricula. However, recent studies provided striking results<sup>[10]</sup>. After specific training in basic ultrasound techniques, students showed better accuracy than certified specialists in the recognition of several common diagnoses<sup>[10]</sup>. Nevertheless, the learning curve may not be steep for all indications and caution is required. If it is easy to distinguish effusion from solid organs, integrating ultrasound semeiotics into clinical management of a patient with dyspnea and acute respiratory failure requires advanced skills. Thus, well-structured training program and skill certification should be encouraged.

We highlighted these gaps as they could be filled through research

and dialogue between academic world, respiratory medicine societies, and ultrasound stakeholders. Many think that a widespread, clinically oriented use of lung ultrasound may lead to a potential improvement in clinical practice while sparing biological and economic costs due to reduction of unnecessary radiations. In order to achieve this, the above-mentioned unmet needs should be addressed on priority.

## CONFLICT OF INTERESTS

The authors have not conflicts of interest to declare.

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