Should lung ultrasound be always performed in older patients with possible COVID-19 disease?

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COVID-19 is the name of the disease caused by the new coronavirus. Old age is a well-known risk factor for developing a symptomatic COVID-19 disease [1, 2] and for more severe disease with poor prognosis and high mortality [3, 4]. Available evidence show that COVID-19 mortality sharply increases with age [5–7]. For these reasons, it is extremely important to rapidly identify SARS-CoV2 infection to achieve a point-of-care diagnosis and establish appropriate treatment. Lung ultrasound (LUS) could be invaluable in allowing a quick evaluation of patients with suspected or confirmed COVID-19 disease in different settings, starting from the Emergency Department (ED). First, clinical presentation of SARS-Cov2 infection is different in advanced age compared to the rest of population. In older patients, typical symptoms such as fever or cough [8] might be blunted or even absent [9]. Often atypical symptoms, such as fatigue, anorexia, delirium, falls, and functional decline, might be present [8, 10]. Therefore, the initial diagnosis is more difficult. Moreover, delirium, which is a well-known presenting condition of COVID-19 infection in older subjects [11], might hinder the diagnostic evaluation and treatment. In older patients with delirium or dementia, even a chest X-ray can be difficult to perform, and even more so, exams such as computed tomography (CT) that require patient collaboration. On the other hand, the use of sedative or antipsychotic medications to perform these diagnostic exams may be counterproductive due to the possibility of adverse effects like, for example, prolongation of the QTc interval or impairment of respiration. On the other hand, a longer stay in the ED is associated with negative outcomes in older patients, such as delirium or falls [12]. For this reason, rapid and noninvasive diagnostic strategies are important to make an early diagnosis in the ED. Lung ultrasound fulfills all these requirements. It is well established and validated that the Bedside Lung Ultrasound in Emergency (BLUE) protocol [13] plays a pivotal role in the assessment of all patients presenting with acute respiratory failure (ARF) in emergency/urgency integrating perfectly with the physical examination [14].

Lung ultrasound could be also valuable to support COVID-19 diagnosis and monitoring in out of hospital settings, i.e., at home or in nursing homes, reducing the need to be admitted to the hospital [15–18]. A recent observational research involving 48 older nursing home residents, aged a mean of 84.1 ± 9.8 years, undergoing LUS examination made within 3 days from the positivity of nasopharyngeal swab test for COVID-19, demonstrated that LUS plays a significant role in predicting mortality in nursing home residents affected by COVID-19. This study underlines the need to use routinely LUS in this scenario instead of other diagnostic techniques available only in the hospital [16]. There are also practical experiences on how it is possible to carry out lung ultrasound at home in patients affected by SARS-CoV2 [19]. In non-hospital settings, lung ultrasound allows to carry out a noninvasive instrumental monitoring by visualizing in real-time any modification of lung patterns and consequently providing precious information about patient clinical conditions, evolution and prognosis, allowing to detect deterioration as well as patient improvement [20].

Concerning the approach to perform LUS in older patients with suspected COVID-19, hereafter practical information is provided, on the basis of the available scientific evidence and experience gained at our center [21]. LUS examination can be performed using high-frequency linear or convex transducers, depending on the need to study better the pleural line or to get a panoramic vision of the lung, as well as operator preference [21]. It is advisable to put the probe along the longitudinal axis using an intercostal approach. This conventional position allows to visualize the upper and lower ribs as reference points and to scan...
the entire corresponding intercostal space and consequently the portion of lung included in the aforementioned intercostal space. Different findings have been reported during LUS in patients with Covid-19 infection: thickening and irregularity of the pleural line; the presence of B-lines with different distribution; focal, multifocal or confluent B-lines evolving in white lung; the presence of focal or multifocal, small or larger consolidations and further classified into translobar or non-translobar. At variance, pleural effusion is an uncommon finding [22]. During the recovery phase a progressive reappearance of A-lines instead B-lines [23] has been reported. The signs and artifacts observed with LUS in COVID-19 patients are similar to those previously reported in patients affected from pneumonia [24] and in patients with acute respiratory distress syndrome (ARDS) [25] and acute lung injury (ALI) [26] presenting a wet lung. The eChoVid study, published as a preliminary report of work on medRxiv, showed that LUS enables identification of lung lesions like chest CT in COVID-19 patients [27].

Concerning the best approach to perform LUS there are discordant views in the literature.

Some authors suggested to study 12 lung areas, 6 areas for each side: anterior upper area and anterior lower area, lateral upper area and lateral lower area, posterior upper area and posterior lower area [23]. At variance, Soldati et al. proposed to evaluate 16 areas (8 for each lung) represented from: anterior midclavicular approach (apical, medial and basal), lateral axillary approach (apical, medial and basal) and posterior paraspinal approach (apical, medial and basal) [28]. In different studies, the chest was divided into 6 points (BLUE protocol), 6 zones, 8 zones, 12 zones or 28 zones [23, 24, 29]. To date, there is no universal agreement on which of these protocols is better to use. We retain that all approaches are valid since they are aimed at obtaining a lung aeration score (LUS) useful to measure lung aeration loss for each pathological conditions [30, 31]. This is a semiquantitative score represented from the sum of all area and posterior lower area [23]. At variance, Soldati et al. proposed to evaluate 16 areas (8 for each lung) represented from: anterior midclavicular approach (apical, medial and basal), lateral axillary approach (apical, medial and basal) and posterior paraspinal approach (apical, medial and basal) [28]. In different studies, the chest was divided into 6 points (BLUE protocol), 6 zones, 8 zones, 12 zones or 28 zones [23, 24, 29]. To date, there is no universal agreement on which of these protocols is better to use. We retain that all approaches are valid since they are aimed at obtaining a lung aeration score (LUS) useful to measure lung aeration loss caused by different pathological conditions [30, 31]. This is a semiquantitative score represented from the sum of all areas, that allows us to establish the infection severity and to predict the prognosis [32].

However, particularly in an ED setting, a rapid examination is preferred and we suggest to scan 12 lung areas (6 for each lung: 2 anterior, 2 lateral and 2 posterior) because the use of protocols with too many zones is too complicated to perform and it is time consuming.

In conclusion, bedside LUS applied to the older patient with suspected interstitial pneumonia secondary to SARS-CoV2 infection is coming of age and it should be widely implemented both in hospital and out of hospital settings since it provides relevant information, by defining the extent of lung involvement, the disease evolution and supporting the stratification of the risk of death [33].

**Declarations**

**Conflict of interest** The authors report no conflicts of interest.

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