


LETTER



# Lung ultrasound for daily monitoring of ARDS patients on extracorporeal membrane oxygenation: preliminary experience

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Dear Editor,

Lung imaging is crucial for daily monitoring of acute respiratory distress syndrome (ARDS), for both primary disease assessment and early identification of complications [1]. Chest X-ray has poor accuracy and a CT scan is highly irradiating and requires potentially harmful transportation to the radiology department. These limitations are more evident in severe ARDS on extracorporeal membrane oxygenation (ECMO) [1]. Lung ultrasound (LUS) has a growing role in the assessment and monitoring of ventilated patients [2]; it allows one to distinguish four patterns of progressive loss of aeration [3]. A LUS score may be computed by examining 12 thoracic areas; each area's score ranges from 0 (normal aeration) to 3 (complete loss of aeration), depending on the visualized pattern [4]. The LUS score corresponds to the sum of each area's score and ranges from 0 to 36, allowing semi-quantification of lung aeration. A correlation between LUS score and a quantitative CT scan has been shown [5].

In this pilot study, we monitored five severe ARDS patients daily from the day veno-venous ECMO was started (population details in e-Table 1). Written consent for data publication was obtained from each patient or surrogate. All the patients underwent ECMO for refractory impairment of gas exchange during protective mechanical ventilation with high PEEP.

In transverse scans, we employed a 10-MHz linear probe unless a tissue-like pattern was visualized, in which

case this was examined with a 2.5-MHz phased-array probe. The on-duty consultant/resident was in charge of LUS as this is a common skill in our unit. All patients were supine.

Daily LUS score values and trends and corresponding ventilator/ECMO settings are shown in Fig. 1. Median LUS score at ECMO cannulation was 25.0 [IQR 25.0–27.0]. All patients showed initial worsening of lung aeration, associated with ultraprotective ventilation (tidal volume, TV < 4 ml/kg) with a peak LUS score of 28.0 [28.0–29.0] after 4.0 [3.0–4.0] days. Four patients were successfully weaned from ECMO after 15.5 [11.5–19.8] days, according to adequate gas exchange during a test-off procedure (zero sweep gas flow of the membrane lung) under protective mechanical ventilation with moderate PEEP ( $\leq 12$  cmH<sub>2</sub>O) and FiO<sub>2</sub> ( $\leq 0.5$ ). In weaned patients, after peak value a progressive reduction of LUS score was observed, corresponding to progressive lung re-aeration and recovery. At decannulation, all patients had a score of 15 or lower, with a median value of 14.0 [12.8–14.3]. Weaned patients were discharged from ICU after 39.5 [18.0–60.5] days and from hospital after 45.5 [29.5–64.0] days.

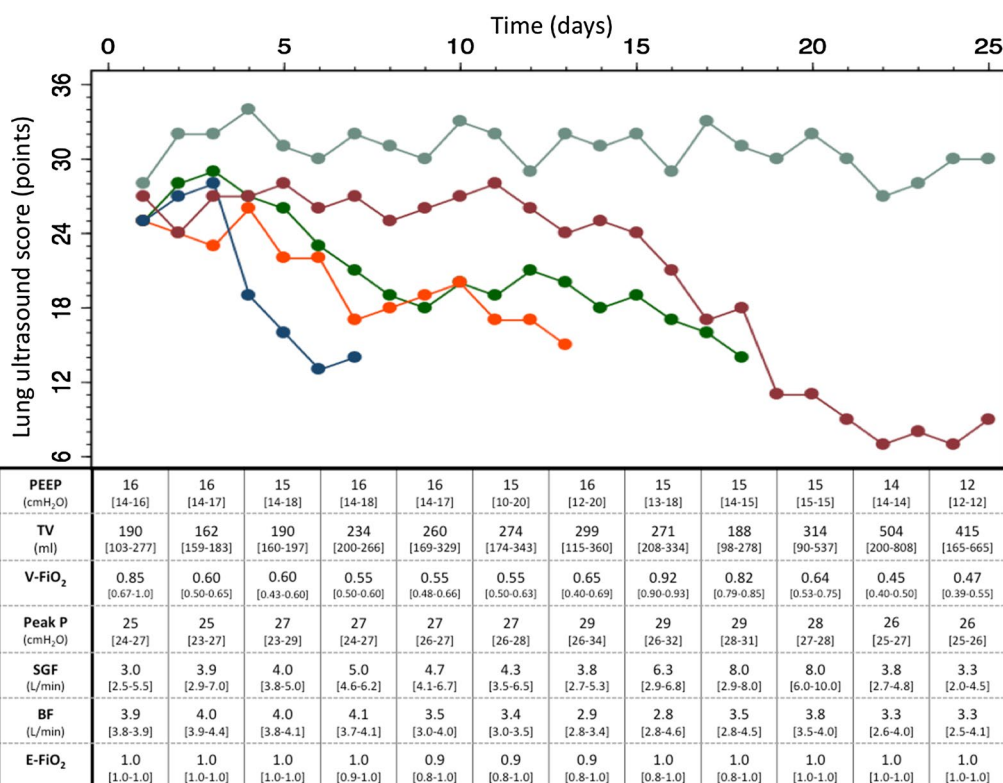
One patient never presented a clinical indication for ECMO weaning; her initial LUS score was the highest (28), indicating the most severe loss of aeration (> 75% of lung areas completely de-aerated). Her LUS score increased to 34 in 4 days (> 90% of lung areas completely de-aerated) and remained at least 25 for 36 days, corresponding to no substantial improvement in lung aeration. She died on ECMO for multiple organ failure.

In conclusion, LUS is a promising tool for daily monitoring of aeration in ARDS patients. It provided

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**Fig. 1** Trends of lung ultrasound score during extracorporeal membrane oxygenation (ECMO) and corresponding ventilator/ECMO settings in 5 severe ARDS patients. Data are reported as median values and interquartile range in square brackets. PEEP positive end-expiratory pressure, TV tidal volume, V-FiO<sub>2</sub> fraction of inspired oxygen on the ventilator, SGF sweep gas flow, BF blood flow on ECMO, E-FiO<sub>2</sub> fraction of inspired oxygen on ECMO

significant information about absolute severity of loss of aeration before cannulation and allowed monitoring of the disease course and the eventual lung recovery. A persistent high LUS score, i.e. no improvement in lung aeration, corresponded to a negative outcome.

#### Electronic supplementary material

The online version of this article (doi:10.1007/s00134-017-4941-7) contains supplementary material, which is available to authorized users.

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#### Compliance with ethical standards

#### Conflicts of interest

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

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