# Intubation and Ventilation amid COVID-19: Reply

## In Reply:

We thank Dr. Rigatelli *et al.*[1] for their letter discussing the role of lung ultrasonography in mechanically ventilated coronavirus disease 2019 (COVID-19) patients. They elegantly presented the advantages associated with the use of bedside lung ultrasonography amid the current pandemic. Our paper published in Anesthesiology did not specifically discuss the experience of using lung ultrasonography in critically ill COVID-19 patients.[2] However, we had a letter published in *Intensive Care Medicine* that had specifically summarized our early experience of using lung ultrasonography in COVID-19 patients in Wuhan, China.[3]

The characteristic lung ultrasonographic findings in COVID-19 patients are (1) pleural line thickening, irregularity, and fusion; (2) focal, multifocal, or confluent B lines; (3) multifocal small, nontranslobar, and translobar (with occasional mobile air bronchograms) consolidations; and (4) A lines during the recovery phase.[3] The potential usage of lung ultrasonography in critically ill COVID-19 patients is as follows.

First, although the cause of respiratory failure in COVID-19 patients is primarily related to acute lung injury, other abnormalities involving the airway, chest cavity, chest wall compliance, pulmonary vasculature, and the heart cannot be ignored. Differential diagnosis of the cause of respiratory failure is essential throughout the treatment process, especially when lung injury itself cannot fully explain the whole picture. Lung ultrasonography can help to quickly screen for the potential causes of respiratory failure in COVID-19 patients.

Second, it is the current consensus that the timely application of appropriate gas exchange support is essential in COVID-19 patients complicated with acute hypoxemic respiratory failure. However, what is challenging and sometimes controversial is when to convert noninvasive gas exchange support (such as regular oxygen therapy, high-flow nasal cannula, and noninvasive ventilation) to intubation and invasive mechanical ventilation. Lung ultrasonography assists the decision of which method of gas exchange support to choose in hypoxemic COVID-19 patients. It dynamically monitors the disease progression and evaluates the effectiveness of the ongoing therapy based on the increase and decrease of B lines, B line zones, and consolidation area and volume.

Third, in mechanically ventilated COVID-19 patients, lung ultrasonography can comprehensively assess the potential of lung recruitment based on pulmonary lesions' uniformity and severity and the presence of dynamic air bronchograms and tidal recruitment. The potential is reduced if lung ultrasonography shows multiple sites of large-area consolidation or B line fusion. Lung ultrasonography also facilitates lung recruitment, based on qualitative or semiquantitative lung scores, to understand the condition, duration, and results of recruitment, avoid barotrauma, and adverse hemodynamic effect, and facilitate the titration of positive end-expiratory pressure.[4]

Last, lung ultrasonography facilitates the determination of the duration and frequency of prone position ventilation.[5] It assesses the effectiveness of lung recruitment of the gravity-dependent areas. The aeration of the inferior anterior lungs may representatively predict the effectiveness of ventilation-perfusion matching and the potential of oxygenation improvement. The ultrasonographic semiquantitative scores have also been used to predict the effectiveness of prone position ventilation.

Overall, lung ultrasonography has the potential and unique advantages in the diagnosis, treatment, and prognosis of COVID-19 patients who require gas exchange support. Moving forward, we need well-designed clinical studies to validate the use of lung ultrasonography in facilitating decision-making and improving outcomes in mechanically ventilated COVID-19 patients.

### Competing Interests

The authors declare no competing interests.

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