Clinical practice guidelines for mechanical ventilation in adult patients with ARDS

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Acute respiratory distress syndrome (ARDS) is characterized by an inflammatory pulmonary edema resulting in severe hypoxemia. The recent LUNG SAFE study showed that ARDS is common in the ICU, occurring in 10% of all patients admitted (1).

Take-away messages

In the absence of new therapies to treat ARDS, the focus is on applying lung-protective strategies to reduce the incidence of VILI.

A recently published guideline provides recommendations in relation to six specific aspects of treating adult ARDS patients with mechanical ventilation.

The guideline makes strong recommendations in favor of limiting tidal volumes and inspiratory pressures, as well as prone positioning in severe ARDS patients.

Conditional recommendations are made for the use of higher PEEP and recruitment maneuvers in patients with moderate or severe ARDS.

Observational studies report a hospital mortality rate of more than 40% amongst patients with moderate or severe ARDS (2). Mechanical ventilation remains one of the primary means of managing ARDS patients, but is associated with ventilator-induced lung injuries (VILI) and may thus contribute to higher mortality rates. In the absence of new or more effective therapies to treat ARDS, the focus today is to apply lung-protective strategies to reduce the incidence of VILI in mechanically ventilated ARDS patients. In 2017, an official clinical practice guideline was published containing recommendations made by a multidisciplinary panel from the American Thoracic Society, the European Society of Intensive Care Medicine and the Society of Critical Care Medicine (3). Six specific treatment questions were answered in the form of recommendations based on evidence obtained from a systematic review and meta-analyses of relevant research.

1. Should patients with ARDS receive mechanical ventilation using LTVs and inspiratory pressures?

With the aim of reducing VILI, mechanical ventilation strategies have been developed to target both lower tidal volumes (LTV) and inspiratory pressure. Secondary analyses of nine randomized controlled trials (RCTs) including 1,629 patients demonstrated a clinically important benefit of LTV. The tidal volume should initially be set to 6 ml/kg PBW, with an increase in spontaneously breathing patients up to 8 ml/kg in the case of double triggering or inspiratory airway pressure falling below PEEP. In addition, the combination of LTV and a high PEEP cointervention was shown to be associated with a greater survival than just LTV alone.

The guideline recommends applying strategies that limit tidal volumes to 4-8 ml/kg
predicted body weight (PBW) and plateau pressure to less than 30 cmH2O in adult patients with ARDS (strong recommendation).

2. Should patients with ARDS receive prone positioning? Prone positioning may improve oxygenation and lung recruitment in ARDS patients, particularly in more severe cases. A primary analysis of eight RCTs showed no significant difference in mortality between the two groups (prone and supine); however, a subgroup analysis showed mortality to be reduced where the duration was more than 12 hours per day and the patients were suffering from moderate or severe ARDS. Two risks, namely endotracheal tube obstruction and pressure ulcers, were significantly associated with prone positioning but only considered modest in terms of undesirable outcomes. The guideline therefore recommends the use of prone positioning for more than 12 h/d in severe ARDS patients (strong recommendation). No recommendation was made with respect to patients with moderate ARDS.

3. Should patients with ARDS receive high-frequency oscillation ventilation? An analysis of six RCTs showed no significant difference in mortality for the HFOV and control groups. However, of the two most recent multicenter RCTs, one showed no benefit with HFOV, while the other used LTV combined with higher PEEP in the control group and showed significantly higher mortality with HFOV. The guideline recommends that HFOV should NOT be used as a routine form of therapy in patients with moderate or severe ARDS (strong recommendation).

4. Should patients with ARDS receive higher, as compared with lower PEEP? The benefits of higher positive end-expiratory pressure (PEEP), including better alveolar recruitment and less lung stress and strain, must be weighed up against the potential risks, such as injury caused by alveolar overdistension. An analysis of eight RCTs comparing higher and lower PEEP strategies showed no significant difference in mortality, barotrauma, new organ failure or ventilator-free days, but significantly higher oxygenation in the higher PEEP group. However, a meta-analysis of three of these trials showed significantly lower mortality for patients with moderate or severe ARDS in the higher PEEP group. The panel noted that clinicians should bear in mind that changes to PEEP levels will influence inspiratory plateau pressure, and assess the effect of increasing PEEP for each individual patient if plateau pressure is $\geq 30$ cmH2O.

The guideline suggests the use of higher PEEP in patients with moderate or severe ARDS (conditional recommendation).

5. Should patients with ARDS receive RMs? Recruitment maneuvers (RMs) use a transient increase in transpulmonary pressure to open those areas of the lung that are either poorly or not aerated at all. RMs and higher PEEP may serve to reduce atelectasis, which is frequently observed in ARDS patients and a known cause of VILI. Short-term benefits of RMs must be weighed up against the possible complications, including hemodynamic
compromise and barotrauma. An analysis of six RCTs showed RMs to be significantly associated with lower mortality and higher oxygenation, but in five of those trials a higher PEEP cointervention was used. Although there was no significant association found between RMs and hemodynamic compromise, the guideline indicates caution should be exercised in patients with pre-existing hypovolemia or shock. The guideline suggests the use of RMs in adult patients with moderate or severe ARDS (conditional recommendation).

6. Should patients with ARDS receive extracorporeal membrane oxygenation? Although the use of ECMO in ARDS patients is on the rise, evidence supporting its use is limited. Neither the single RCT nor a subanalysis of observational studies, which compared mechanically ventilated patients with those who underwent ECMO, showed a significant difference in mortality. Due to the limitations of the RCT, the panel concluded that there was insufficient evidence to make a definitive recommendation for or against the use of ECMO. Until more evidence is available, the panel recommends the implementation of lung-protective strategies before using ECMO in severe ARDS patients.

While these recommendations may aid clinicians in managing the treatment of ARDS patients, they should not be considered mandatory and can never take into account all the features of the individual patient. Therefore, clinicians should always personalize their decisions for each patient by assessing the risks and benefits of a particular intervention for the specific patient, and the potential for combining it with another treatment for greater effect.

Ventilators from Hamilton Medical offer a range of tools and features that not only enable clinicians to apply the interventions recommended in this guideline, but to customize ventilation therapy to each individual patient. The advanced ventilation modes Adaptive Support Ventilation (ASV®) and INTELLiVENT®-ASV* automatically adjust ventilation to lung mechanics and apply lung-protective strategies. Recent evidence has shown that these modes select lower tidal volumes and maintain driving pressure ($\Delta P$) below a safe threshold for all lung conditions (4). The Protective Ventilation Tool (P/V Tool®) provides data from a pressure-volume curve to assess lung recruitability and can be used to apply sustained inflation for recruitment maneuvers. Selected ventilators are also equipped with an auxiliary port for connection of an esophageal balloon catheter for measuring esophageal pressure. Based on this, the ventilator automatically calculates and displays the transpulmonary pressure. The combination of P/V Tool and transpulmonary pressure measurement is useful for titrating recruitment maneuvers and determining appropriate settings for PEEP and tidal volume.

*Not available in the US and some other markets

References

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