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Driving pressure in ARDS patients

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ARDS is characterized by lung collapse and consolidation leaving just a small portion of aerated lung remaining, which is at risk of ventilator-induced lung injuries (baby-lung concept).

Take-away messages

- ✓ Driving pressure (ΔP) represents the ratio between tidal volume and respiratory system compliance, and is calculated as the difference between plateau pressure and total PEEP
- ✓ A multilevel mediation analysis of data from 2,365 ARDS patients showed that ΔP was the ventilator variable associated most strongly with hospital survival
- ✓ Results from 2,377 patients enrolled in the LUNG SAFE study showed that ΔP less than 14 cmH2O was associated with lower hospital mortality in both moderate and severe ARDS patients
- ✓ In the absence of strong recommendations based on data from prospective randomized controlled trials, it seems reasonable to aim at keeping ΔP below 14 cmH2O
- ✓ Recent evidence has shown that driving pressure was automatically limited to less than 14 cmH2O in 95% of patients ventilated in Adaptive Support Ventilation (ASV) mode

As the aerated lung has normal compliance, the reduction in respiratory system compliance is mainly due to the non-aerated part of the lung, and can serve as an estimation of the end-expiratory lung volume. In turn, the ratio between tidal volume and end-expiratory lung volume represents the strain applied to the lung. Therefore, the ratio between tidal volume and respiratory system compliance – also called driving pressure (ΔP) – can be considered a substitute for lung strain. Driving pressure is calculated as the difference between plateau pressure and total PEEP, and can be measured quite easily using end-inspiratory and end-expiratory occlusions respectively.

A multilevel mediation analysis of individual pooled data from 2,365 ARDS patients included in four randomized controlled trials showed that ΔP was the ventilator variable associated most strongly with hospital survival. Any change in tidal volume or PEEP affected the outcome only when associated with a decrease in ΔP (1).

A large observational study aimed at better understanding the global impact of acute respiratory failure (the LUNG SAFE study) was conducted in 459 intensive care units in 50 countries around the world. Results showed that ARDS occurs in 10% of all patients admitted to the ICU, with a hospital mortality of 40% (2). The 2,377 ARDS patients enrolled in the study who received mechanical ventilation and fulfilled the ARDS criteria on day 1 or 2 were included in a subsequent analysis to determine the risk factors for mortality, with the focus placed on ventilator settings (3). The mean tidal volume used was found to have no effect on hospital mortality for any patient group, whereas PEEP of less than 12 cmH2O was associated with higher hospital mortality in the subgroup of moderate ARDS patients. Driving pressure below 14 cmH2O was associated with lower hospital mortality in both moderate and severe ARDS patients, while plateau pressure below 25 cmH2O was also associated with lower hospital mortality in severe ARDS patients. In a multivariate analysis including only passively ventilated patients, both a higher ΔP and higher plateau pressure were independently associated with higher hospital mortality. The slope of the curve for risk of mortality was relatively flat up to a ΔP of 10 cmH2O, and increased linearly above this value. This study corroborates the relevance and external validity of using ΔP in a clinical setting.

These results, however, should not be seen as implying that tidal volume is of no importance for lung protection. Most of the patients included in this study did indeed receive low tidal volumes. What the study does show is that when a low tidal volume is used, ΔP is an important variable to monitor for assessing the risk of hospital mortality. Although there is no data from prospective randomized controlled studies available to provide strong recommendations as to what the ΔP should be, it would seem reasonable to advocate keeping ΔP below 14 cmH2O.

There are several methods available for limiting ΔP, such as muscle relaxants, use of the prone position, decreasing instrumental dead space, veno-venous extracorporeal CO2 removal, and ECMO (4). Efficient lung recruitment and adequate PEEP titration are also associated with a decrease in ΔP (5).

Adaptive Support Ventilation (ASV®) and INTELLiVENT®-ASV* select the tidal volume according to respiratory mechanics. If respiratory system compliance is decreased, the automatically selected tidal volume will be lower. Results of a prospective observational study focusing on the ΔP selected by ASV in 245 patients with different lung conditions were recently presented in abstract form (6). Median ΔP was below or equal to 10 cmH2O for all lung conditions and 95% of all patients were ventilated with ΔP below 14 cmH2O.

* Not available in the US and some other markets

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