

20. Bhat TA, Kalathil SG, Bogner PN, Blount BC, Goniewicz ML, Thanavala YM. An animal model of inhaled vitamin E acetate and EVALI-like lung injury. *N Engl J Med* 2020;382:1175–1177.

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In Patients with ARDS, Optimal PEEP Should Not Be Determined Using the Intersection of Relative Collapse and Relative Overdistention

To the Editor:

With great interest, we read the article by van der Zee and colleagues suggesting an individualized approach for setting the correct amount of positive end-expiratory pressure (PEEP) in ventilated patients with coronavirus disease (COVID-19) (1). In their cohort of 15 mechanically ventilated patients with COVID-19, they used electrical impedance tomography to study the relative overdistention and relative collapse curves. The authors state that optimal PEEP for these patients is at the intersection of these curves and close to the values suggested in the high PEEP/ Fi_{O_2} table. This intersection has indeed been used to set optimal PEEP but only for mechanical ventilation during surgery (2).

Using the intersection of relative collapse and relative overdistention suggests that both phenomena are equally harmful for patients with acute respiratory distress syndrome. Unfortunately, there is no evidence in the literature that supports this assumption. In fact, several studies and reviews suggest the opposite: overdistention may be more harmful (3–5).

We fully agree with the authors that an individualized approach for mechanical ventilation for patients with COVID-19 (or any form of acute respiratory distress syndrome for that matter) is very important. But instead of recruitment of the lung with high PEEP, prone positioning with lower PEEP levels could be considered to improve oxygenation and to recruit parts of the lung. In 14 patients admitted to our ICU, we have shown that using more PEEP often leads to reduction in lung compliance and increase in dead space ventilation, which suggests overdistention of alveoli (6).

In conclusion, although atelectrauma decreases with higher levels of PEEP, hyperinflation increases, which is potentially even more harmful. Therefore, using the intersection of the relative overdistention and relative collapse with electrical impedance tomography in patients with COVID-19 is not the technique to determine optimal PEEP for the individual patient. What van der Zee and colleagues do very elegantly show us with their research, however, is that there is always a tradeoff with higher levels of PEEP. ■

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References

- van der Zee P, Somhorst P, Endeman H, Gommers D. Electrical impedance tomography for positive end-expiratory pressure titration in COVID-19-related acute respiratory distress syndrome [letter]. *Am J Respir Crit Care Med* 2020;202:280–284.
- Pereira SM, Tucci MR, Morais CCA, Simões CM, Tonelotto BFF, Pompeo MS, *et al*. Individual positive end-expiratory pressure settings optimize intraoperative mechanical ventilation and reduce postoperative atelectasis. *Anesthesiology* 2018;129:1070–1081.
- Bellani G, Guerra L, Musch G, Zanella A, Patroniti N, Mauri T, *et al*. Lung regional metabolic activity and gas volume changes induced by tidal ventilation in patients with acute lung injury. *Am J Respir Crit Care Med* 2011;183:1193–1199.
- Gattinoni L, Quintel M, Marini JJ. Volutrauma and atelectrauma: which is worse? *Crit Care* 2018;22:264.
- Chiumello D, Carlesso E, Cadringer P, Caironi P, Valenza F, Polli F, *et al*. Lung stress and strain during mechanical ventilation for acute respiratory distress syndrome. *Am J Respir Crit Care Med* 2008;178:346–355.
- Roesthuis L, van den Berg M, van der Hoeven H. Advanced respiratory monitoring in COVID-19 patients: use less PEEP! *Crit Care* 2020;24:230.

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Reply to van den Berg and van der Hoeven

From the Authors:

We thank van den Berg and van der Hoeven for the opportunity to further discuss our research letter in which positive end-expiratory pressure (PEEP) was titrated at the level of lowest relative alveolar overdistention and collapse based on electrical impedance tomography (EIT) (1). In their comment, the authors argue that PEEP should not be set at the minimum level of both alveolar overdistention and collapse, as alveolar overdistention is potentially more harmful.

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We fully agree that alveolar overdistention is harmful to our patients. The Alveolar Recruitment Trial showed us that systematically performed recruitment maneuvers, known to cause alveolar overdistention, increased mortality rate in patients with acute respiratory distress syndrome (ARDS) (2). However, the amount of alveolar overdistention or collapse prior to the application of high airway pressures was unknown. Determining alveolar overdistention and collapse is crucial, as PEEP titration approaches are based on the assumption that there is an optimal compromise between alveolar recruitment (i.e., limit the amount of collapse) and minimizing alveolar overdistention.

Numerous bedside PEEP titration approaches have been described, but none have shown to improve patient survival in large randomized controlled trials. In addition, correlation between different approaches is poor. The explanation is that most bedside PEEP titration approaches have at least one of the following three limitations: 1) the approach does not quantify alveolar recruitment; 2) the respiratory system is assessed as a whole, and local lung inhomogeneities remain undetected; and 3) alveolar overdistention is not quantified.

EIT is a functional imaging tool that continuously assesses regional ventilation and lung volume changes at the bedside. As such, EIT is a bedside PEEP titration approach that quantifies both alveolar recruitment and alveolar overdistention and is able to detect local lung inhomogeneities. However, the amount of studies that used EIT to titrate PEEP in critically ill patients with ARDS is limited. In addition, there is no consensus on how to interpret EIT data.

Blankman and colleagues (3) compared several EIT-derived PEEP titration approaches in patients after cardiac surgery and proposed the intratidal gas distribution index to identify alveolar overdistention in the nondependent lung regions and to titrate PEEP. In a case series, Yoshida and colleagues (4) used a ventral-dorsal ventilation distribution of 50–50% to reach homogeneous ventilation and limit alveolar overdistention. In contrast, Francheineau and colleagues (5) aimed to limit the amount of relative collapse to 15% while maintaining the lowest percentage of overdistention in patients with extracorporeal membrane oxygenation. Alternatively, we could have aimed for the greatest amount of ventilated pixels or calculate the global inhomogeneity index. We chose to titrate PEEP at the lowest level of relative alveolar overdistention and collapse, as it is a simple and intuitive approach that has proven to be beneficial in mechanically ventilated patients during surgery (6). This approach resulted in low driving pressures and low transpulmonary pressures in all our patients.

We share the concerns of van den Berg and van der Hoeven that alveolar overdistention is harmful to the lungs. Therefore, we quantified the amount of alveolar overdistention before applying higher PEEP in our patients with coronavirus disease (COVID-19)-related ARDS. The Pleural Pressure Working Group's planned RECRUIT (Recruitment Assessed by Electrical Impedance Tomography: Feasibility, Correlation with Clinical Outcomes and Pilot Data on Personalised PEEP Selection) project (<https://www.plugwgroup.org/>), which aims to compare the results of different bedside methods to titrate PEEP based on EIT, might provide us with some answers on how to titrate PEEP using EIT data. In the meantime, we agree with our colleagues to limit the amount of alveolar overdistention in patients with COVID-19-related ARDS by applying prone positioning and quantifying the amount of alveolar overdistention during a PEEP trial. ■

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References

- van der Zee P, Somhorst P, Endeman H, Gommers D. Electrical impedance tomography for positive end-expiratory pressure titration in COVID-19-related acute respiratory distress syndrome [letter]. *Am J Respir Crit Care Med* 2020;202:280–284.
- Writing Group for the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART) Investigators; Cavalcanti AB, Suzumura EA, Laranjeira LN, Paisani DM, Damiani LP, Guimaraes HP, et al. Effect of lung recruitment and titrated positive end-expiratory pressure (PEEP) vs low PEEP on mortality in patients with acute respiratory distress syndrome: a randomized clinical trial. *JAMA* 2017;318:1335–1345.
- Blankman P, Hasan D, Erik G, Gommers D. Detection of 'best' positive end-expiratory pressure derived from electrical impedance tomography parameters during a decremental positive end-expiratory pressure trial. *Crit Care* 2014;18:R95.
- Yoshida T, Piraino T, Lima CAS, Kavanagh BP, Amato MBP, Brochard L. Regional ventilation displayed by electrical impedance tomography as an incentive to decrease positive end-expiratory pressure. *Am J Respir Crit Care Med* 2019;200:933–937.
- Franchineau G, Bréchet N, Lebreton G, Hekimian G, Nieszkowska A, Trouillet JL, et al. Bedside contribution of electrical impedance tomography to setting positive end-expiratory pressure for extracorporeal membrane oxygenation-treated patients with severe acute respiratory distress syndrome. *Am J Respir Crit Care Med* 2017;196:447–457.
- Pereira SM, Tucci MR, Morais CCA, Simões CM, Tonelotto BFF, Pompeo MS, et al. Individual positive end-expiratory pressure settings optimize intraoperative mechanical ventilation and reduce postoperative atelectasis. *Anesthesiology* 2018;129:1070–1081.

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An Expanded COVID-19 Telemedicine Intermediate Care Model Using Repurposed Hotel Rooms

To the Editor:

We read with great interest the recent article from Bruni and colleagues (1) describing a hotel-based cohort

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