

VIEWPOINT

Last Word on Viewpoint: Looking beyond macroventilatory parameters and rethinking ventilator-induced lung injury

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To Drs. Simpson and Zuo:

Thank you for your commentaries (see Ref. 6). We agree with you that there are multiple methods that can be attempted to identify the optimal PEEP (macroventilatory parameter) needed to stabilize alveoli in the microenvironment. Unfortunately, no current methods will definitively provide this information. You suggested that setting PEEP above the lower inflection point of the pressure-volume curve of the respiratory system may have merit, but in a study from our laboratory using in vivo microscopy, DiRocco et al. (1) showed minimal alveolar recruitment at the lower inflection point and reported that the upper inflection point on the deflation curve was a better indicator of what was occurring in the microenvironment. Although model-based recruitment tools are of great interest, it is our belief that it is better to apply protective mechanical ventilation as soon as the patient is intubated to “Never give the lung an opportunity to collapse.” If we can block the progressive lung collapse seen in acute lung injury at the time of endotracheal intubation and fully reinflate the lung quickly, then the difficulty of recruiting a lung with acute respiratory distress syndrome (ARDS) could be avoided. Our laboratory has reported that early application of airway pressure release ventilation (APRV) using a specific protocol prevented lung collapse and injury in a clinically relevant porcine ARDS model (5). Using this same ventilation protocol, we demonstrated that properly adjusted APRV maintained open and stable alveoli in the microenvironment (3). In our protocol, the brief expiratory duration, which is personalized to the degree of lung pathology using the slope of the expiratory flow curve, stabilizes alveoli by two mechanisms: *time* and *pressure*. An end-expiratory pressure is maintained because the lung does not have sufficient time to fully empty (a time-controlled PEEP: TC-PEEP) and the expiratory duration is so brief that alveoli do not have time to collapse (4). Thus we would argue that rather than looking into more recruitment

models, the alternative would be to avoid the need for lung recruitment altogether.

To Drs. Dominelli and Henderson:

Thank you for bringing up your comments (see Ref. 6) on regional differences in lung elastance and resistance, as well as the changes in these differences that may not be so evident from macroventilatory settings. The heterogeneity of acute lung injury is what makes it difficult to ventilate with a single mechanical breath without injuring some lung areas, while not ventilating others. Our proposal to this problem is the use of a time-controlled adaptive ventilation (TCAV) protocol with APRV (2). The extended time at inspiration will gradually reinflate the lung. Since this is a pressure-controlled breath, the tidal volume (V_t) is not set, so the initial measured V_t will be low due to a small and stiff lung. As the lung gradually recruits and the elastance decreases, the V_t will gradually increase. Thus the microenvironment is selecting the macroparameter of V_t . The brief expiratory duration used to stabilize alveoli is adjusted by changes in lung mechanics (i.e., the slope of the expiratory flow curve). By letting the changes in the lung physiology dictate the macrosettings, the TCAV protocol will maintain open and stable alveoli in the microenvironment and minimize VILI.

DISCLOSURES

P.L.A., G.F.N., M.K.S., and N.M.H. have presented and received honoraria and/or travel reimbursement at event(s) sponsored by Dräger Medical Systems, Inc., outside of the published work. P.L.A., G.F.N., and N.M.H. have lectured for Intensive Care Online Network, Inc. (ICON). J.V. has received research grants from Maquet. N.M.H. is the founder of ICON, of which P.L.A. is an employee. N.M.H. holds patents on a method of initiating, managing, and/or weaning airway pressure release ventilation, as well as controlling a ventilator in accordance with the same, but these patents are not commercialized, licensed, nor royalty-producing. The authors maintain that industry had no role in the design and conduct of the study; the collection, management, analysis, or interpretation of the data; nor the preparation, review, or approval of the manuscript.

AUTHOR CONTRIBUTIONS

M.C.K.-S. drafted manuscript; M.C.K.-S., P.L.A., J.S., L.A.G., J.V., G.F.N., and N.M.H. edited and revised manuscript; M.C.K.-S., S.V.J., P.L.A., J.S., L.A.G., J.V., D.D.B., L.G., G.F.N., and N.M.H. approved final version of manuscript.

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