Published in final edited form as:

Crit Care Med. 2015 February ; 43(2): e54–e55. doi:10.1097/CCM.0000000000000804.

Chest Wall Elastance in the estimation of the transpulmonary pressure: How should we use it?

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Keywords

acute respiratory distress syndrome; esophageal pressure; transpulmonary pressure; chest wall elastance; respiratory system elastance; estimation

To the Editor

We thank Drs. Liu and Mu (1) for their thoughtful analysis of the mathematics and physiology underlying the elastance-based method for determining transpulmonary pressure. They describe the flawed mathematics and logical inconsistency of the simplified formula that we presented (their Equation 1) relating transpulmonary pressure (P_L) to airway pressure (P_{aw}) and the ratio of lung elastance to total respiratory elastance (E_L/E_{rs} or E_L/E_{tot}). They go on to derive the correct expression (their Equation 2) relating transpulmonary pressure to elastances of chest wall and respiratory system including measured values of airway and esophageal pressure (thereby including the constant of integration). Drs. Liu and Mu support the validity of this equation by citing our previous article (2), concluding, "... the value of [transpulmonary pressure during end-expiratory occlusion], which was completely ignored [in Equation 1 presented] by Gulati et al. (3) was the most important determinant of the value of [transpulmonary pressure at end-inspiratory plateau]..."

We agree with this analysis by Drs. Liu and Mu. However, we would emphasize that the elastance-based method now in use is, in fact, the simplified and mathematically incomplete Equation 1 presented in our report! This method, originally described in articles by Gattinoni et al. (4, 5) and used by others (6, 7) is summarized by the equations " $P_{pl} = P_{aw} \times E_{cw} / E_{tot}$ " (6) and " $P_L = P_{aw} \times E_L/E_{rs}$ " (5), in which pleural (P_{pl}) and transpulmonary pressures are calculated from elastances and airway pressure. Although the correct Equation 2 is based on an equation presented by Chiumello et al. (8), that article only reports changes in transpulmonary pressure and presents no equation that directly relates transpulmonary pressure to elastances. Recent articles using the elastance-based method show that measured values of pleural (esophageal) and transpulmonary pressure are not used in the calculation. For example, Grasso et al. (6) calculated transpulmonary pressure at the end-inspiratory plateau from E_{cw}/E_{rs} and plateau pressure values only. The elastance-based method is also

evident in the calculated values of transpulmonary or pleural pressure at various lung volumes, which are nearly proportional to airway pressure (6, 7, 9).

The correct Equation 2 is consistent with the conventional “direct” method of calculating transpulmonary pressure (3, 10), which requires measuring and using the actual values of transpulmonary (or esophageal) pressure, not just tidal changes in those pressures. Finally, we agree that the clinical utility of either method can only be determined through clinical trials.

Acknowledgments

Copyright form disclosures: Dr. Loring received support for article research from the National Institutes of Health (NIH). Dr. Talmor received grant support from the NHLBI and received support for article research from the NIH.

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