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CORRESPONDENCE

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Technical problems with dynamic compliance evaluation in neonates and infants

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Dear Editor,
We read with interest the article by Tsapis et al. [1] showing how bedside evaluation of lung mechanics, through breath-to-breath measurement of dynamic compliance (C_{dyn}) and resistance (R_{dyn}), might be helpful. However, we found several technical problems with the published data.

Measurements were performed with a ventilator detecting flow at the Y-piece and pressures in the ventilator (i.e., upstream and downstream). The site of measurement is a main factor affecting the precision of C_{dyn} and R_{dyn} [2] that are estimated by breath-to-breath linear regression analysis of pressure, flow, and volume [3]. Such a separate flow/pressure system is less accurate (inaccuracy was 7–16 % in settings similar to that reported in [1]) than measurement with coupled sensors at the Y-piece [2]. Most modern ventilators have coupled pressure/flow sensors close to the patient or use algorithms taking into account the mechanical characteristics of the breathing circuit even if measurements are performed at the ventilator level. Thus, these instruments should be preferred for accurate measurements.

Second and more importantly, Tsapis et al. [1] considered measurements performed during spontaneous breathing assisted with mandatory ventilation. The used ventilator has no esophageal pressure transducer; therefore, we have no clue about the transdiaphragmatic pressure (P_{td}). Thus, along each respiratory cycle, the ventilator may accurately measure tidal volume (ΔV_T), but is only measuring the variation of airway pressure (ΔP) due to peak inspiratory (P_{IP}) and end-expiratory pressures (P_{EEP}) set by the clinician. If the baby is breathing spontaneously, a certain P_{td} will be generated contributing to the ΔP, but this contribution will not be considered. In other words, compliance calculation is based on the

$$\Delta V_T/\Delta P \text{ ratio.} \tag{1}$$

The ventilator considers the denominator in Eq. (1) as the difference between P_{IP} and P_{EEP}, but it is actually represented by

$$[P_{IP} - (-P_{td})] - P_{EEP} \tag{2}$$

where the negative P_{td} generated by the patient is added to the P_{IP} generated by the ventilator. Thus, the denominator will be underestimated if the spontaneous breathing effort is not considered. Therefore, measuring P_{td} is highly advisable or static measurements of compliance should be obtained by end-inspiratory occlusion. If this is not available, the transient avoidance of spontaneous breathing may be helpful to reach a "quasi-static" condition and improve measurement accuracy [4].

Third, because synchronized intermittent mandatory ventilation does not assist all breaths, the measurements will vary if we are looking at mandatory or unassisted breath, so the mechanical rate will affect measurement accuracy. The ventilator used by Tsapis et al. [1] is supposed to not show C_{dyn} and R_{dyn} if the spontaneous activity is too high [5]. However, there is no definition of a spontaneous breathing threshold and this will vary with the trigger sensitivity, representing another confounding factor. In critically ill infants and neonates with high and variable respiratory rates, these factors may be relevant and study results are not applicable to other ventilators with different software.

Finally, body length instead of weight was used to correct C_{dyn} in order to adjust for differences between study groups [1]. As a rule of thumb the normal respiratory system compliance of an infant is around 1 mL cmH_2O^{-1} kg^{-1} [6]. Several studies have shown the variation from the norm in critically ill babies [7]. Presenting findings as a ratio to the body length introduces another error because the relationship between C_{dyn} and length is not linear and the regression line has a marked negative intercept [7]. Hence, if corrected by length values, higher C_{dyn} values are obtained the shorter infant is. The notoriously inaccurate measurement of length in the first months of life would also throw doubts on the usefulness of authors' findings. Obviously, there is no perfect correction, and compliance expressed per kilo of body weight may be inaccurate for small gestational age neonates. However, we must consider that: (1) weight-corrected compliance is more commonly used and may be further adjusted for gestational or postnatal age; (2) the weight is a more internally reliable and easy-to-measure variable. More research is needed on this point: perhaps correcting compliance for an "ideal" body weight, taking into account the normal growth rate, body composition, and ethnical background could be more accurate.

Although real-time monitoring of pulmonary mechanics is useful, its interpretation needs to consider relevant technical limitations. Therefore, the findings of Tsapis et al. [1] carry significant degrees of imprecision and cannot be considered as normative data for future reference.

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