Two methods for computing specific airway conductance and resistance

To the Editor: In their report on frequency dependence of plethysmographic volume, Rodenstein and Stânescu (2) come to a conclusion which is inconsistent with their methods. They assert that despite underestimation of changes in alveolar pressure by changes in mouth pressure, “both sGaw and sRaw are accurate, because the error in ΔPm/ΔVbox is canceled,” where sGaw and sRaw are specific airway conductance and resistance, respectively, Pm is mouth pressure, and Vbox is box volume. On the contrary, according to the method used by these authors, ΔPm/ΔVbox is not canceled.

They used the method of DuBois et al. (1) to measure airway resistance (Raw) and then used this Raw in computing sGaw. In the method of DuBois et al. (1), the resistance of the apparatus (Rapp) used to measure flow is “measured and subtracted from the total resistance to obtain airways resistance of the subject.” Although such a correction yields a more accurate estimate of Raw, inspection of the relevant equations reveals that the use of corrected Raw in computing sGaw ensures that ΔPm/ΔVbox is canceled.

The equation used to compute sGaw is

\[ s\text{Gaw} = \frac{1}{Raw} \times Vtg \]  

(1)

where Vtg is the thoracic gas volume at which Raw is measured. Substituting the formulas for plethysmographic Raw and Vtg gives

\[ s\text{Gaw} = \frac{\Delta Pm/\Delta Vbox}{\Delta Vm/\Delta Vbox} \times \frac{Pbar - PH_{2O}}{\Delta Pm/\Delta Vbox} \]  

(2)

calibration factors excluded, where Vm is flow at the mouth, Pbar is barometric pressure, and PH2O is water vapor pressure. Using Eq. 2, ΔPm/ΔVbox is canceled, so sGaw is unaffected by incorrect estimates of changes in alveolar pressure. Using the method of DuBois et al. (1) changes Eq. 1 into

\[ s\text{Gaw} = \frac{1}{(Raw - Rapp)} / Vtg \]  

(3)

and changes Eq. 2 into

\[ s\text{Gaw} \left[ \frac{(\Delta Pm/\Delta Vbox - Rapp)}{(\Delta Vm/\Delta Vbox) \times \frac{Pbar - PH_{2O}}{\Delta Pm/\Delta Vbox}} \right]^{-1} \]  

(4)

Now ΔPm/ΔVbox is not canceled. Correction of Vtg for dead space volume of the apparatus, a practice recommended by some plethysmograph manufacturers, has a similar effect.

Equation 4 indicates that sGaw is inversely related to ΔPm when computed from a value of Raw measured by the method of DuBois et al. (1). The degree to which sGaw computed from corrected Raw is affected by ΔPm increases with increasing values of Rapp/Raw. Thus the influence of ΔPm decreases with bronchoconstriction, increases with bronchodilation, and increases when ΔPm underestimates changes in alveolar pressure.

From this perspective it appears that Rodenstein and Stânescu’s claim (2) that “both sGaw and sRaw are accurate” is not true when sGaw and sRaw are computed by the method they use.

REFERENCES


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REPLY

To the Editor: We thank Dr. J. Green for his letter. We have previously demonstrated that in moderate to severe airway obstruction, during rapid panting against a closed airway, mouth pressure (Pm) changes underestimate alveolar pressure swings, as measured indirectly by an esophageal balloon (3, 4). When Pm changes are used to measure thoracic gas volume (TGV) and airway resistance (Raw) with the body plethysmographic technique of DuBois and colleagues (1, 2), this results in overestimation of TGV and underestimation of Raw. We mentioned that the error in the ΔPm/ΔVbox ratio is canceled when specific airway conductance (sGaw) and specific airway resistance (sRaw) are computed, and therefore these two indices are free of error. Dr. Green, in his letter, is right by pointing out that this is true except when instrumental resistance is subtracted from the measured airway resistance. In the latter case, ΔPm/ΔVbox changes are not canceled.

Dr. Green further emphasizes that sGaw computed from the corrected Raw (i.e., by subtracting instrumental resistance) is affected whenever ΔPm underestimates change in alveolar pressure. In fact, this influence is trivial. For example, we have computed that for a given sGaw (instrumental resistance being subtracted) of 0.116
cmH₂O⁻¹.s⁻¹, an underestimation of Pm by 20% would yield a value for sGaw of 0.122 cmH₂O⁻¹.s⁻¹ (a 5% change). The corresponding changes in corrected Raw (from 2.0 to 1.52 cmH₂O⁻¹.l⁻¹.s) are much higher.

REFERENCES


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