Letters to the Editor

Sustainable inspiratory pressure test can be influenced by airway obstruction as well as by respiratory muscle endurance

To the Editor: The sustainable inspiratory pressure test (SIP) described by Nickerson and Keens (J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 52: 768–772, 1982) is potentially useful for the evaluation of respiratory muscle endurance. The test, however, is not independent of airway mechanics. Any inspiratory resistance will cause airway pressure changes to be lower than esophageal pressure changes during the SIP maneuver (because there is airflow) but not during the static maximal inspiratory pressure (MIP) maneuver.

Preliminary studies in our laboratory have indicated that esophageal pressure changes greatly exceed airway pressure changes during SIP maneuvers performed by subjects breathing through resistance (unpublished observations). Under such circumstances, the ratio of SIP to MIP will underestimate the true sustainable fraction of inspiratory muscle load, and SIP will not be a valid index of respiratory muscle endurance. The test, however, is not independent of airway mechanics. Any inspiratory resistance will cause airway pressure changes to be lower than esophageal pressure changes during the SIP maneuver (because there is airflow) but not during the static maximal inspiratory pressure (MIP) maneuver.

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REPLY

To the Editor: We agree with Aldrich that the sustainable inspiratory pressure (SIP) and maximal inspiratory pressure (MIP) are not totally independent of airway mechanics and that measurement of esophageal and transdiaphragmatic pressures provides additional valuable information. In normal adults, the pressure drop due to airways resistance would be expected to cause an underestimation of SIP/MIP of less than 5%. However, in subjects with severe airway obstruction, the effects of both airways resistance on SIP and air trapping on both MIP and SIP should be taken into account.

In our laboratories, children with asthma had lower SIP and MIP on days their they had increased residual volumes and airways resistance than on days when residual volume and airways resistance were normal. However, the magnitude of both of these corrections is less than when ventilatory muscle function is measured by volume methods and corrected by dividing by flow.

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Breath-by-breath determination of alveolar gas exchange

To the Editor: We are pleased that Drs. Beaver, Lamarra, and Wasserman (2) agree with our approach to breath-by-breath analysis of ventilation and gas exchange, particularly our conclusion that gas exchange measurement on a breath-by-breath basis is significantly improved if these measurements are not based on the assumption that the volume of inspired N₂ equals the volumes of expired N₂, i.e., constant functional residual capacity (FRC) from one breath to the next. As pointed out by Beaver et al. (2), the correction of gas exchange at the mouth necessary to arrive at alveolar gas exchange has two terms. Thus, for O₂, the correction volume of a single breath, ΔVlO₂ = ΔVL · FAO₂ + ΔFAO₂ · VL. The first term is always larger and can be quantified by evaluation of N₂ exchange at the mouth and the time course of the fractional concentration of O₂ (FO₂). In the smaller second term only the change in the alveolar PO₂ (ΔFAO₂) can be measured breath by breath. Lung volume (VL), which approximately equals FRC, remains elusive. One approach is to measure FRC independently and to assume that VL = FRC for each breath-by-breath correction. Here, errors stem from the deviation of the assumed constant VL from the actual value and are greater than ΔFAO₂ is also greatest. Attempts to continuously update VL so that VL of breath 1 is VL(1) = FRC + ΔVL(1) and VL(2) = VL(1) + ΔVL(2), etc., results in cumulative errors (1). Swanson's proposed method (3) based on estimation of an effective lung volume (EVL) is impractical, since it requires a prediction of the transient behavior of VL (step change, sinusoidal, etc.) and can only be made to work for sinusoidal variations when ΔFAO₂ is maximized by breathing maneuvers. If a correction is to be made the most practical compromise would probably be to assume that VL = FRC plus the ΔVL of each breath.

We have ignored the second term, ΔFAO₂ · VL, because VL cannot be accurately determined and more importantly because ΔFAO₂ and even more so ΔFAO₂ are almost always small numbers, i.e., of the order of 1/700 of less. Except during exercise transients from rest to work, alveolar O₂ and CO₂ partial pressures for the most part vary by less than 1 Torr from one breath to the next. Moreover, we (4) have shown that errors in the correction term ∆VO₂ and ∆VCO₂ applied to the gas exchange measured at the mouth for each breath must result in increased breath-by-breath variability in the respiratory exchange ratio (R). However, our data suggested only a minimal residual error after correction of the first term, ∆VLFAO₂, even if all variation of R was attributed to correction error. These results, coupled with the uncertainty of the correct value of VL, suggested to us that a further correction by ∆VLFAO₂ · VL would probably not improve the results materially. The apparent differences between our results and those of Beaver et al. (2) may be