The Value of Expired Gas Analysis Is Never Expired

Complications of mechanical ventilation increase with duration. Delayed weaning and premature weaning are both associated with increasing complications. In addition, adverse events and deterioration relating to the ventilator system could happen any time. Therefore, accurate monitoring of the patient's respiratory condition and adjustment of ventilator settings are essential during mechanical ventilation.[1] End-tidal CO_2 (P_{ETCO_2}) monitoring is useful in mechanically ventilated patients in many situations, such as intensive care and anesthesia. Although P_{ETCO_2} is not a replacement or substitute for assessing the arterial CO_2 (P_{aCO_2}), P_{ETCO_2} monitoring allows continuous evaluation of alveolar ventilation, severity of pulmonary disease, and response to therapy in mechanically ventilated patients.[2,3]

The closed-loop knowledge-based algorithm in the SmartCare automated ventilation and weaning system (Dräger Medical, Lübeck, Germany) was originally designed to continuously adapt the ventilatory assistance during pressure support ventilation to the patient's need, to manage a strategy of gradually decreasing the ventilatory assistance, and to indicate when the patient is able to breathe without assistance.[4] As compared to a physician-controlled weaning process, the SmartCare computer-driven system reduced mechanical ventilation duration and intensive-care-unit stay but did not change the re-intubation rate.[5] However, I still am not convinced that SmartCare is any better than skilled clinicians. When the SmartCare system was compared to weaning managed by experienced critical care nurses, with a 1:1 nurse-to-patient ratio, there was no substantial difference in weaning duration.[6]

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SmartCare uses P_{ETCO_2} as a safety parameter in addition to respiratory rate and tidal volume to automatically control the pressure support level. When the respiratory rate is low, for example, P_{ETCO_2} can help differentiate between central hypoventilation leading to hypercapnia and hyperventilation with hypocapnia. In this issue of the Journal, Galia and coworkers[7] extend the role of P_{ETCO_2} measurement in patients supported with the SmartCare system. Because a spontaneously breathing patient intermittently has higher individual P_{ETCO_2} values than the averaged P_{ETCO_2} value during prolonged expiration, they hypothesized that using the maximum P_{ETCO_2} value instead of the averaged P_{ETCO_2} value would improve P_{aCO_2} estimation and would improve the classification of ventilatory diagnosis in the SmartCare system. Galia et al monitored breath-by-breath P_{ETCO_2} in 36 patients and compared the maximum P_{ETCO_2} values, averaged P_{ETCO_2} values, and P_{aCO_2} values from arterial blood samples.

As they expected, the maximum P_{ETCO_2} was closer to P_{aCO_2} than the averaged P_{ETCO_2}. The averaged P_{ETCO_2} was smaller than P_{aCO_2} by 10 ± 6 mm Hg, whereas that discrepancy decreased to 6 ± 6 mm Hg with the maximum P_{ETCO_2}. They also observed that using the maximum P_{ETCO_2} value changed the SmartCare classification in 1.6% of the breaths. A great deal of interesting information was obtained in the study. They confirmed the role of P_{ETCO_2} in evaluating P_{aCO_2} in mechanical ventilated patients. The maximum P_{ETCO_2} may lead to more accurate adjustment of automated ventilation systems.

However, after reading the report I was left with several questions. First, can the findings be extrapolated to other patients with different backgrounds and severity of illness? Second, is the maximum P_{ETCO_2} value also useful in other ventilation modes, such as assist control ventilation and intermittent mandatory ventilation? How do auto-PEEP and other cardiorespiratory variables affect the role of the maximum P_{ETCO_2}? And finally, does use of the maximum P_{ETCO_2} value improve the weaning outcome in mechanically ventilated patients? The study by Galia et al[7] was a simple observational study, with no randomization. To clarify the role of the maximum P_{ETCO_2} value in the weaning process with the SmartCare system, further study may be warranted, using a randomized design and a larger number of patients. Although P_{ETCO_2} monitoring is useful in many clinical situations, the challenge to clinicians is to objectively determine when this monitoring is indicated.

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The author has disclosed no conflicts of interest.

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DOI: 10.4187/respcare.01237

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