Letters

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Transcutaneous and End-Tidal Capnometry

In the October 2006 issue of RESPIRATORY CARE, Stein et al reported on transcutaneous and end-tidal capnometry in spontaneously breathing patients. The aim of their research was to evaluate the bias and precision of transcutaneous carbon dioxide measurement and exhaled gas carbon dioxide measurement (end-tidal CO_2 [P_{ETCO_2}]) against a blood measurement of carbon dioxide (P_{aCO_2}).[1]

It is well known that these 3 sampling techniques will not have 100% agreement. The data from Stein et al indicates that P_{ETCO_2} underestimates P_{aCO_2}. During normal conditions, the difference between P_{aCO_2} and P_{ETCO_2} is 2–5 mm Hg. This difference can increase with lung disease. It can also supply insight about ventilation-perfusion imbalance. Alternatively, a technical error, such as a leak in the collection system or incorrect filter lines, can lead to a shift in the P_{aCO_2} versus P_{ETCO_2} difference.

The large P_{aCO_2} versus P_{ETCO_2} difference (mean difference 14.1 $\pm$ 7.4 mm Hg) in the report by Stein et al is beyond convention. Stein et al suggest that the underestimation was attributable to dilution from other medical gas. However, there is no baseline or control data to confirm that their data sampling was correct. Therefore it is unclear, from the data presented, whether the recordings were collected from properly obtained measurements. When seeking minimal verification of the data-collection technique, their reference to manufacturers' guidelines was not completely cited regarding revision or year. It is not possible to verify from the citations if Stein et al did follow the manufacturers' guidelines with any of the devices in the study. There were no baseline measurements to ensure proper apparatus setup and use of the devices.

There is further confusion in the report, in that, "When using the oral/nasal cannula, sampling errors corresponding to mouth-breathing seem to be more pronounced. We regard this aspect as the essential factor in the P_{aCO_2} underestimations of the end-tidal method in the present study." Yet the report also reads, "There was no significant difference between sampling exhaled gas via face mask versus oral/nasal cannula." Those conflicting statements are confusing.

Changes in P_{ETCO_2} can be associated with lung pathology as well as ventilatory depression associated with anesthetic or sedative agents.[2] As pointed out by Stein et al, CO_2 monitoring has been recommended by national societies of anesthesia and is considered a standard of care in the operating room. Stein et al gave no explanation for the difference between their results and the published clinical practice guidelines.

Stein et al were also silent on the matter of timing transcutaneous CO_2 and P_{ETCO_2} measurements at 1-min intervals prior to blood draw for P_{aCO_2} measurement. There is no reference or validation that this is the appropriate method for data collection, nor is there any indication of sample size or statistical method validation.

From the report by Stein et al we cannot conclude that P_{ETCO_2} does not provide a good assessment of P_{aCO_2}. What is clear is that the P_{aCO_2} versus P_{ETCO_2} differences in the data presented by Stein et al are outside the normal range.

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The author reports no other conflict of interest related to the content of this letter.

REFERENCES

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2. Maddox RR, Williams CK, Oglesby H, Butler B, Colclasure B. Clinical experience with patient-controlled analgesia using continuous respiratory monitoring and a smart infusion system. Am J Health Syst Pharm 2006;63(2):157–164

The authors respond:

The procedure for measuring the partial pressure of end-tidal CO_2 (P_{ETCO_2}) during spontaneous breathing is affected by the fact that the expiratory gas flow occurs openly through the openings of the nose and mouth. The positioning of the gas sampling system, with its openings in the 2 nostrils and above the mouth, and the collection of the gas portion for analysis from a diffuse flow of gas, are limitations of the procedure. This was a point addressed by the manufacturer Oridion, through their further development of a sampling system with an enlarged mouthpiece. The version with the smaller mouthpiece was the Smart CapnoLine O_2 with O_2/CO_2 oral/nasal cannula. The version with the larger orifice is the Smart CapnoLine Plus O_2.

In addition, a gas flow in the opposite direction is also generated through the supply of oxygen. According to the manufacturer's manual[1] and the instructions for the smaller version of the gas sampling system, no effect on CO_2-measurement should occur up to a gas flow of 4 L/min. However, studies on test subjects by our own research group seem to confirm the presence of an effect on the variance of P_{ETCO_2} at 4 L/min.[2] The effect described here leads to a situation where the form of the capnograms is altered so that a predefined point for