CRITICAL CARE

COMMENTARY

Splendors and miseries of expired CO_2 measurement in the suspicion of pulmonary embolism

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See related research article by Rumpf *et al.*, http://ccforum.com/content/13/6/R196

Abstract

Capnography has been studied for decades as a potential diagnostic tool for suspected pulmonary embolism. Despite technological refinements and its combination with other non-invasive instruments, no evidence to date allows recommending the use of expired carbon dioxide measurement as a rule-out test for pulmonary embolism without additional radiological testing. Further investigations are, however, still warranted.

In the previous issue of *Critical Care*, Rumpf and colleagues [1] evaluated the potential contribution of measuring end-tidal carbon dioxide (CO_2) for suspected pulmonary embolism (PE) in the prehospital setting. Capnography has been studied for decades as a potential diagnostic tool for patients with suspected PE. Indeed, PE is expected to create areas of reduced arterial flow with normal or increased alveolar ventilation, resulting in increased alveolar dead space volume and reduced global expired CO_2. This should create a difference between arterial and end-tidal CO_2 values, as first demonstrated by Robin and colleagues [2] in 1959. However, during the two following decades, several authors pointed out the numerous pitfalls and sources of errors in assessing the arterial to end-tidal CO_2 difference in the clinical suspicion of PE, and this test was finally abandoned until the nineties [3-5].

Three elements explain the current resurgence of expired CO_2 measurement in the suspicion of PE. First, technical improvements now allow measuring CO_2 not only for *monitoring* purposes in intubated patients in operating rooms but also as a *diagnostic* tool in spontaneously breathing patients in the emergency department or even in the field. Second, volumetric capnography, which displays expired CO_2 as a function of the expired volume of the patient, did much to renew interest in capnography because of its potential for better performance in diagnosing PE than the arterial to end-tidal CO_2 difference, even though that expectation could not be confirmed by recent results [6,7]. Finally, in the era of non-invasive strategies for PE combining several tests of various types, such as clinical evaluation, biological tests, and imaging, the evaluation of a potential role for CO_2 measurement in combination with those other instruments made sense. Numerous studies are available, and although none to date has been able to prove the safety of such a non-invasive strategy incorporating capnography with a high enough level of evidence to allow its recommendation in daily clinical practice, the venue remains interesting [7-11].

Where then can we place the endeavor of Rumpf and colleagues? They included 131 consecutive patients suspected of PE who had an abnormal rapid point-of-care D-dimer result in a prehospital setting and evaluated them with a combination of clinical probability of PE (two-level Wells score) and measurement of the end-tidal partial pressure of CO_2 (PCO_2). PE was diagnosed in the emergency department by a positive spiral computed tomography, a high-probability V/Q scan, or a positive pulmonary angiogram. The combination of a normal end-tidal CO_2 value (defined as higher than 28 mm Hg based on a receiver operating characteristic analysis) and an unlikely probability of PE had a 100% sensitivity and 100% negative predictive value (95% confidence interval [CI] 90% to 100%) for ruling out PE. In contrast, the association of a low end-tidal CO_2 value (less than 28 mm Hg) and a high clinical probability had only an 86% positive predictive value for PE, and further tests would certainly

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be required in such patients. Clearly, those results are preliminary. This is a small series and it was designed to set the cutoff value for this particular capnography technique and assess its feasibility in the field. Moreover, as acknowledged by the authors themselves, the clinicians who established the diagnosis were not blinded to either clinical assessment or capnography results. Finally, the prevalence of PE is unusually high, although this would tend to bias the results toward lower, not higher, sensitivity. But the sheer simplicity of the technique used by Rumpf and colleagues [1] is appealing and certainly deserves validation in a large-scale prospective study. Indeed, it emphasizes the use of expired CO_2 *alone* without associated arterial PCO_2, and this is a pragmatic issue in modern emergency medicine [12]. Also, the use of capnography in the *prehospital* setting is interesting: there might be situations in which a rapid and rough evaluation of the patient's expired CO_2 status would help emergency physicians in making vital decisions, such as starting thrombolysis for a suspected fulminant PE, as well as in monitoring the hemodynamic effect of thrombolysis in such patients [13].

Finally, the merit of the article by Rumpf and colleagues [1] is to remind us that clinical applications of capnography are still growing, especially amongst spontaneously breathing patients. Physicians dealing with acute medicine should make every effort to become familiar with expired CO_2 measurement. Inconclusive capnographic results related to tachypneic or apprehensive patients do not overcome the potential for expired CO_2 to be placed inside the diagnostic algorithm of a challenging disease like PE.

Abbreviations

CO_2 = carbon dioxide; PCO_2 = partial pressure of carbon dioxide; PE = pulmonary embolism.

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Competing interests

The authors declare that they have no competing interests.

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