Matching Minute Ventilation in Hypermetabolic State of Dinitrophenol Poisoning

To the Editor:

We read with interest the report by McGillis and colleagues describing a case of poisoning due to dinitrophenol, an ionophore and potent decoupler of oxidative phosphorylation (1). One aspect that caught our attention was the assessment and management of the patient's ventilatory status. The patient presented with a respiratory rate of 44 breaths/minute (of unknown tidal volume) and an arterial partial pressure of carbon dioxide (Pa_{CO_2}) of 38 mm Hg. The respiratory rate then increased to 60 breaths/minute, and he was intubated. Immediately after rapid sequence intubation and institution of mechanical ventilation, the respiratory rate declined to 30 breaths/minute and the Pa_{CO_2} climbed to 130 mm Hg. The authors attribute the rise in CO_2 to increased CO_2 production rather than reduced alveolar ventilation. We propose that this attribution is unwarranted and may lead to therapeutic harm when patients who have very high minute ventilation are intubated.

An alternative analysis posits that CO_2 production from dinitrophenol poisoning remained constant immediately after intubation, leading to a different but equally tenable conclusion. Pa_{CO_2} is proportional to CO_2 production divided by alveolar ventilation. Using the postintubation minute ventilation of 23 L per minute, we can estimate the minute ventilation before intubation assuming a constant level of CO_2 production (2, 3) (indeed, CO_2 production may *decline* with sedation and paralysis). When corrected for a normal dead space volume of 150 cc, the postintubation alveolar ventilation was approximately 18 L at a respiratory rate of 30 (and a calculated tidal volume of 767 cc). For the Pa_{CO_2} to climb from 38 mm Hg to 130 mm Hg, a 3.5-fold increase, alveolar ventilation would have to have fallen to 29% of preintubation levels. Thus, preintubation alveolar ventilation would have to have been approximately 62 L/minute, and the addition of dead space yields a preintubation minute ventilation of 71 L. This would require the patient to have tidal volumes of 1,200 cc at a respiratory rate of 60 breaths/minute, which is a plausible value for maximal sustainable minute ventilation in an otherwise healthy 70-kg man (3). The onset of severe hyperthermia, perhaps the most logical marker of CO_2 production (4), occurred at 55 minutes, 20 minutes after intubation. Thus, our alternative scenario seems as likely as that proposed by the authors. However, even if CO_2 production did increase at the time of intubation, the postintubation minute ventilation of 23 L/minute was inadequate to support ventilatory demands.

A preintubation minute ventilation greater than 30 L per minute is very difficult to match with mechanical ventilation, and a worsening respiratory acidosis is a foreseeable result, with potentially catastrophic consequences. Even approximating such a high spontaneous minute ventilation in such patients (and, similarly, patients with severe metabolic acidosis) may require the use of tidal volumes, respiratory rates, flow rates, and alarm parameters outside of the comfort zone of many practitioners. Lung protective ventilation with tidal volumes of 6 cc/kg predicted ideal body weight, when used for ventilation during the course of acute respiratory distress syndrome (ARDS), confers a mortality benefit at 28 days (5). However, in the initial care of patients in extremis, especially those without ARDS, lung protective ventilation is subordinate to achieving immediate physiological stability, which may require temporary use of much higher tidal volumes until the underlying physiological disturbances are corrected. It appears that this patient was moribund, and the rapid onset of "rigor mortis" would have made any ventilatory strategy impossible. Nonetheless, this case is an opportunity to reflect on how the goals of ventilation and the ability to achieve them with mechanical ventilation may differ depending on the clinical scenario.

Author disclosures are available with the text of this letter at www.atsjournals.org.

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