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Lung Carbon Dioxide Elimination Corralates With Physiologic Dead Space Volume During Mechanical Ventilatory Support

Murat SUNGUR
Muhammed GÜVEN
Department of Internal Medicine, Division of Intensive Care Medicine Faculty of Medicine, Erciyes University, Kayseri - TURKEY

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Authors

medsci@tubitak.gov.tr

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Abstract: Increased mean airway pressure (Paw) predisposes to increased alveolar dead space volume and, hence, physiologic dead space volume (V{Dphys}. This is the result of overdistending alveoli, converting Zone 2 and Zone 3 units to Zone 1 units. Lung carbon dioxide elimination (LCO_2) is a reflection of pulmonary capillary blood flow. It is hypothesized that as Zone 1 units form or V{Dphys} increases, LCO_2 decreases proportionately and eventually $PaCO_2$ increases. The purpose of this study is to determine if LCO_2 correlates with V{Dphys} during mechanical ventilation. Six sheep (66.3 ± 6.5 kg), anesthetized with sodium thiopental and paralyzed using pancronium, had pulmonary artery and arterial catheters inserted, and were intubated and ventilated [Fraction of inspired oxygen of 1.0, controlled mechanical ventilation]. Acute lung injury was induced by tracheal instillation of hydrochloric acid (pH 2.5, 0.25 mL/kg). Continuous positive airway pressure (CPAP) levels of 5, 10 and 20 cm H_2O were randomly applied. Cardiac output was maintained nearly constant at all CPAP levels. Data from flow/pressure and infrared capnometer sensors, positioned between the endotracheal tube and the \"Y\" piece of the breathing circuit, were directed to a commercially available respiratory monitor (Novametrix), which provided real time display of Paw and LCO_2 (area under the exhaled volume and CO_2 curve integrated over 1 min). V{Dphys} and the physiologic dead space volume to tidal volume ratio (VD/VT), calculated using the single breath CO_2 elimination technique, were also displayed on the monitor. Data were analyzed using regression analysis; alpha was set at 0.05 for statistical significance. Conclusion: CPAP increases Paw, which correlated positively with V{Dphys}. LCO2 correlated negatively and PaCO2 correlated positively with VD/VT. At VD/VT of approximately 0.5, LCO_2 began decreasing and $PaCO_2$ increasing. LCO_2 is simple to measure, and real time data provides useful clinical information, i.e., a noninvasive inference of changes in V{Dphys} and $PaCO_2$ following application of positive pressure.

Key Words: Lung carbon dioxide elimination, CPAP, Dead space

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