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Capnometry after an inspiratory breath hold, $_{PLAT}CO_2$, as a surrogate for P_{aCO_2} in mild to moderate pediatric acute respiratory distress syndrome: A feasibility study

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Abstract

Objective: Accurate and reliable noninvasive methods to estimate gas exchange are necessary to guide clinical decisions to avoid frequent blood samples in children with pediatric acute respiratory distress syndrome (PARDS). We aimed to investigate the correlation and agreement between end-tidal P_{CO_2} measured immediately after a 3-s inspiratory-hold ($_{PLAT}CO_2$) by capnometry and P_{aCO_2} measured by arterial blood gases (ABG) in PARDS.

Design: Prospective cohort study.

Setting: Seven-bed Pediatric Intensive Care Unit, Hospital El Carmen de Maipú, Chile.

Patients: Thirteen mechanically ventilated patients aged ≤15 years old undergoing neuromuscular blockade as part of management for PARDS.

Interventions: None.

Measurements and Main Results: All patients were in volume-controlled ventilation mode. The regular end-tidal P_{CO_2} (P_{ETCO_2}) (without the inspiratory hold) was registered immediately after the ABG sample. An inspiratory-hold of 3 s was performed for lung mechanics measurements, recording P_{ETCO_2} in the breath following the inspiratory-hold. ($_{PLAT}CO_2$). End-tidal alveolar dead space fraction (AVDSf) was calculated as $[(P_{aCO_2}-P_{ETCO_2})/P_{aCO_2}]$ and its surrogate (S)AVDSf as $[(_{PLAT}CO_2-P_{ETCO_2})/_{PLAT}CO_2]$. Measurements of P_{aCO_2} were considered the gold standard. We performed concordance correlation coefficient (ρc), Spearman's correlation (rho), and Bland–Altmann's analysis (mean difference ± SD [limits of agreement, LoA]). Eleven patients were included, with a median (interquartile range) age of 5 (2–11) months. Tidal volume was 5.8 (5.7–6.3) mL/kg, PEEP 8 (6–8), driving pressure 10 (8–11), and plateau pressure 17 (17–19) cm H_2O. Forty-one paired measurements were analyzed. P_{aCO_2} was higher than P_{ETCO_2} (52 mmHg [48–54] vs. 42 mmHg [38–45], $p < 0.01$), and there were no significant differences with $_{PLAT}CO_2$ (50 mmHg [46–55], $p > 0.99$). The concordance correlation coefficient and Spearman's correlation between P_{aCO_2} and $_{PLAT}CO_2$ were robust (ρc = 0.80 [95%

confidence interval [CI]: 0.67–0.90]; and rho = 0.80, $p < 0.001$.), and for P_{ETCO_2} were weak and strong (ρc = 0.27 [95% CI: 0.15–0.38]; and rho = 0.63, $p < 0.01$). The bias between $_{PLAT}CO_2$ and P_{aCO_2} was −0.4 ± 3.5 mmHg (LoA −7.2 to 6.4), and between P_{ETCO_2} and P_{aCO_2} was −8.5 ± 4.1 mmHg (LoA −16.6 to −0.5). The correlation between AVDSf and (S)AVDSf was moderate (rho = 0.55, $p < 0.01$), and the mean difference was −0.5 ± 5.6% (LoA −11.5 to 10.5).

Conclusion: This pilot study showed the feasibility of measuring end-tidal CO_2 after a 3-s end-inspiratory breath hole in pediatric patients undergoing controlled ventilation for ARDS. Encouraging preliminary results warrant further study of this technique.

KEYWORDS

acute respiratory distress syndrome, capnography, carbon dioxide partial pressure, critical care, mechanical ventilation