

# Nasal End-tidal Carbon Dioxide Monitoring during Procedural Sedation: Is it time for Wider Adoption?

Namita Ravikumar<sup>1</sup>, Karthi Nallasamy<sup>2</sup>

**Keywords:** Children, ETCO<sub>2</sub>, Pediatric intensive care unit, Procedural sedation, Procedural sedation and analgesia.  
*Indian Journal of Critical Care Medicine* (2020); 10.5005/jp-journals-10071-23512

Procedural interventions are an integral part of monitoring and management in pediatric intensive care units (PICU). Striking a balance between optimizing pain control and comfort during procedures and minimizing the risk of sedation-related complications are indispensable, more so in a spontaneously breathing patient. Procedural sedation and analgesia (PSA) in children is challenging as it depends on cooperation from the child that varies with chronological age, behavioral, emotional, and cognitive development. Respiratory depression (4–5%) and the need for assisted ventilation (0.5–1%) during PSA have been reported especially when performed by nonanesthetists and outside the operation theater setting.<sup>1</sup> Visual assessment of respiratory rate, depth, accessory muscle use, and chest auscultation are informative regarding patient's respiratory effort; however, they are subjective. Objective measurements by pulse oximetry oxygen saturation (SpO<sub>2</sub>) are commonly performed in most centers. Abnormalities in ventilatory function and hypoventilation during PSA are detected earlier by end-tidal carbon dioxide (ETCO<sub>2</sub>) monitoring than by pulse oximetry, as hypoxemia would be a late sign given the physiology of oxygenation and the practice of supplemental O<sub>2</sub> during PSA. The American Society of Anesthesiologists Task Force on moderate PSA recommends continuous monitoring and recording of the level of consciousness, ventilation, and oxygenation as well as hemodynamic parameters by an additional person responsible for patient monitoring.<sup>2</sup> End-tidal carbon dioxide by mainstream as well as side-stream capnography is a standard of care during intubation and as a part of multiparameter monitoring in children on mechanical ventilation in PICU. A simple nasal cannula interface with side-stream capnography could be useful in nonintubated patients if it provides a good correlation with partial pressure of carbon dioxide in arterial blood (paCO<sub>2</sub>).

Aslan et al.,<sup>3</sup> in their simple yet informative study published in the current issue of the *Indian Journal of Critical Care Medicine*, have addressed this important aspect by examining the effects of sedation and analgesia on ETCO<sub>2</sub> measured by side-stream capnography in their PICU during the central venous catheter placement. Forty-four children who did not have significant organ failures were monitored for respiratory depression by comparing pre- and postsedation ETCO<sub>2</sub> (hypercarbia defined as >10 mm Hg rise) and SpO<sub>2</sub> (hypoxemia defined as <92%). They were reported as three groups based on the drugs received: midazolam alone, ketamine alone, or midazolam in combination with ketamine or fentanyl. Hypercarbia was detected in about 30% (*n* = 13) of the cases, and in 38% (*n* = 5) of them, it was not accompanied by hypoxia. Nearly half of all children who received combination drugs showed signs of respiratory depression with hypoxemia (54.5%) and hypercarbia (45.5%). Overall, there was a significant difference

<sup>1,2</sup>Department of Pediatrics, Advanced Pediatric Centre, Division of Pediatric Critical Care, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India

**Corresponding Author:** Karthi Nallasamy, Department of Pediatrics, Advanced Pediatric Centre, Division of Pediatric Critical Care, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India. Phone: +91-9814376716; e-mail: ny.karthi@gmail.com

**How to cite this article:** Ravikumar N, Nallasamy K. Nasal End-tidal Carbon Dioxide Monitoring during Procedural Sedation: Is it time for Wider Adoption? *Indian J Crit Care Med* 2020;24(8):611–612.

**Source of support:** Nil

**Conflict of interest:** None

in pre- and postsedation ETCO<sub>2</sub> levels in all groups; however, none of the children needed ventilatory assistance. The result of this study adds to our understanding that subclinical respiratory depression observed with the usage of sedo-analgesic drugs is not uncommon, and a rise in ETCO<sub>2</sub> from the baseline may be seen as an early indicator of alveolar hypoventilation. The findings also confirm that abnormal capnography frequently precedes desaturations and, if carefully monitored, can help in preventing progression to hypoxemia during moderate-to-deep sedation. The choice of sedative drugs and their varying effects on ETCO<sub>2</sub> were also reported, wherein the authors found higher incidence of hypercarbia and hypoxemia with the use of combination drugs; however, the study was underpowered to detect any statistically significant difference. The authors in this study, in line with previously published reports,<sup>4,5</sup> suggest capnography as a useful tool for early detection of respiratory depression and a measure to prevent hypoxemia during PSA.

As we gather more evidence on capnography during PSA, a few previous observations on nasal ETCO<sub>2</sub> merit discussion. First, false low ETCO<sub>2</sub> measurement is a known limitation of sampling from nasal cannula devices. Factors such as cannula design, rate, and continuity of oxygen flow through the cannula and mouth breathing are reported to influence the measurement of ETCO<sub>2</sub> at the nasal level.<sup>6</sup> In this study too, lower ETCO<sub>2</sub> values (about 28–32 mm Hg) were observed at the baseline in all three groups, though the paired measurements helped in understanding the changes with sedation. Second, the nasal ETCO<sub>2</sub> abnormalities observed during sedation can be both hypercarbia and hypocarbia. Studies have found hypocarbia to be more frequent with nasal ETCO<sub>2</sub> measurements and defined respiratory depression when a low ETCO<sub>2</sub> level was not accompanied by an elevation in respiratory

rate during sedation.<sup>5,7</sup> Lastly, many abnormal ETCO<sub>2</sub> recordings detected by nasal capnography could be transient or were not associated with clinically meaningful events.<sup>7</sup> Despite these variations in observations, a meta-analysis of studies showed that capnography in addition to visual assessment and pulse oximetry reduced mild [risk ratio (RR) 0.77, 95% CI 0.67–0.89] and severe (RR 0.59, 95% CI 0.43–0.81) desaturations, as well as the use of assisted ventilation (OR 0.47, 95% CI 0.23–0.95) during PSA in non-ICU settings.<sup>8</sup> The study by Aslan et al., with its limited observations, extends a supporting hand from PICU for the adoption of end-tidal CO<sub>2</sub> monitoring as a valuable tool to enhance the safety of procedural sedation in nonintubated children.

## REFERENCES

1. Tham LP, Lee KP. Procedural sedation and analgesia in children: perspectives from paediatric emergency physicians. *Proc Singapore Healthc* 2010;19(2):132–144. DOI: 10.1177/201010581001900208.
2. Practice guidelines for moderate Procedural sedation and analgesia 2018: a report by the american society of anesthesiologists task force on moderate Procedural sedation and analgesia, the american association of oral and maxillofacial surgeons, american college of radiology, american dental association, american society of dentist anesthesiologists, and society of interventional radiology. *Anesthesiology* 2018;128(3):437–479. DOI: 10.1097/ALN.0000000000002043.
3. Aslan N, Yildizdas D, Horoz OO, Arslan D, Coban Y, Sertdemir Y. The effects of sedation and/or sedation/analgesic drugs on the end-tidal carbon dioxide levels measured by sidestream capnography in our PICU. *Indian J Crit Care Med* 2020;24(8):705–708.
4. Lightdale JR, Goldmann DA, Feldman HA, Newburg AR, DiNardo JA, Fox VL. Microstream capnography improves patient monitoring during moderate sedation: a randomized, controlled trial. *Pediatrics* 2006;117(6):e1170–e1178. DOI: 10.1542/peds.2005-1709.
5. Langan ML, Shabanova V, Li F-Y, Bernstein SL, Shapiro ED. A randomized Controlled trial of capnography during sedation in a pediatric emergency setting. *Am J Emerg Med* 2015;33(1):25–30. DOI: 10.1016/j.ajem.2014.09.050.
6. Roth JV. False low ETCO<sub>2</sub> measurements from carbon dioxide sampling nasal cannula and how to correct the situation. *Anesth Analg* 2017;125(2):696. DOI: 10.1213/ANE.0000000000002210.
7. Burton JH, Harrah JD, Germann CA, Dillon DC. Does end-tidal carbon dioxide monitoring detect respiratory events prior to current sedation monitoring practices? *Acad Emerg Med* 2006;13(5):500–504. DOI: 10.1197/j.aem.2005.12.017.
8. Saunders R, Struys MMRF, Pollock RF, Mestek M, Lightdale JR. Patient safety during procedural sedation using capnography monitoring: a systematic review and meta-analysis. *BMJ Open* 2017;7(6):e013402. DOI: 10.1136/bmjopen-2016-013402.