CORRESPONDENCE

Transcutaneous carbon dioxide monitoring during procedures requiring sedation and future implications for patients at risk of respiratory depression

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To the Editor,

Patients are at risk of respiratory depression and acute hypercapnia during sedation and recovery from anesthesia. Desaturation on pulse oximetry is a late sign and can be significantly masked by administration of supplemental O₂.¹ Global standards vary on the use of end-tidal or expired CO₂ measurement during sedation;^{2,3} however, traditional CO₂ measurement can be technically challenging depending on the airway management technique and the procedure itself in the case of the shared airway. Transcutaneous CO₂ partial pressure (tcpCO₂) is a non-invasive surrogate measure that correlates well with PaCO₂ on arterial blood gas analysis.^{4,5} Transcutaneous CO₂ partial pressure offers a more accurate measure of CO₂ compared with capnography with nasal prongs because of the open circuit arrangement of the latter. We aimed to evaluate the change in tcpCO₂ during sedation for gastrointestinal endoscopy.

Following ethics approval (HREC LNR/17/PMCC/97), we conducted a prospective observational cohort study using tcpCO₂ monitoring (Radiometer TCM5, Denmark) in addition to standard Australian and New Zealand College

of Anaesthetists' monitoring for patients undergoing gastrointestinal endoscopy during a five-week study period. Sedation and airway management (nasal prongs [$n = 15$], Hudson mask [$n = 29$], high-flow humidified nasal oxygen [$n = 12$, flow 20–45 L]) were at the discretion of the treating anesthetist. Research personnel applied tcpCO₂ monitoring and recorded data, including: demographics, anesthetic management, baseline and peak tcpCO₂, duration of sedation, and occurrence and time to occurrence of pre-determined respiratory endpoints: hypercapnia (tcpCO₂ > 45 mmHg), hypoventilation (respiratory rate < 10 breaths·min⁻¹), and hypoxia (SpO₂ < 92%).

A total of 56 patients were investigated. Procedures included colonoscopy ($n = 31$; 55%), combined colonoscopy and gastroscopy ($n = 13$; 23%), gastroscopy ($n = 7$; 13%), and flexible sigmoidoscopy ($n = 5$; 9%). All patients received propofol; the majority received adjunct opioid (fentanyl or alfentanil; $n = 42$; 75%) and three patients also received midazolam. The mean duration of sedation was 27.6 (standard deviation 10.3) min.

We confirmed that tcpCO₂ is a successful method of non-invasively monitoring the response to dynamic respiratory changes associated with sedation. Nevertheless, only one of the six patients with hypoxia presented with hypercapnia, supporting findings that hypoxia is a separate phenomenon and so tcpCO₂ is unlikely to be a reliable monitor for rapid detection of intra-procedure hypoxia and adverse respiratory events.¹

While over half of our cohort became hypercapnic, this is unlikely to be clinically significant at the levels found during our study. Not surprisingly, we found a higher peak

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¹ Thomsen AM. The tcpCO₂ Handbook. Denmark: Radiometer Medical ApS, 2012.

Table Oxygenation and ventilation during endoscopy

Parameter	Whole cohort (<i>n</i> = 56)	Received opioids (<i>n</i> = 42)	No opioids (<i>n</i> = 14)
Baseline tcpCO ₂ [mean (SD)]	34.9 (4.5)	35.0 (4.8)	34.6 (3.5)
Peak tcpCO ₂ [mean (SD)]	47 (6.3)	48 (6.5)	44 (4.7)
Change in tcpCO ₂ [mean (SD)]	12.1 (5.4)	13.1 (5.3)	9.2 (4.6)
Hypercapnia (tcpCO ₂ > 45 mmHg); [number (%)]	30 (54%)		
Time to hypercapnia (min) (median [IQR])	5.8 [4.1–7.5]		
Hypoventilation (RR < 10) [number (%)]	18 (32%)		
Time to hypoventilation (min) (median [IQR])	3.5 [2.8–8.7]		
Hypoxia (SpO ₂ < 92%) [number (%)]	6 (11%)		
Time to hypoxia (min) (median [IQR])	4.1 [3.3–5.1]		

IQR = interquartile range; RR = respiratory rate; SD = standard deviation; tcpCO₂ = transcutaneous CO₂ partial pressure

tcpCO₂ in patients who had received opioids. Future areas for investigation include the application of tcpCO₂ monitoring in the postanesthesia care unit and in specific target populations, e.g., those with PCAs, intrathecal morphine, or in cases such as robotic or laparoscopic surgery, where systemic absorption of CO₂ may continue postoperatively.⁵ Overall, we believe that tcpCO₂ monitoring has the potential to be a useful tool in addition to expired CO₂ monitoring or in situations where traditional monitoring cannot be readily utilized.

Conflicts of interest None declared.

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