

Is capnography mandatory during sedation for endoscopy?

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Bibliography

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Sedation during endoscopic procedures needs to ensure adequate tissue oxygenation, which depends on good cardiovascular and respiratory function. These parameters need to be monitored non-invasively as it is difficult to predict how a certain patient will respond to sedation. Tissue oxygenation is monitored using oximetry. Cardiovascular function is monitored by measuring blood pressure and pulse. Finally, respiratory function is monitored by assessing airway patency and respiratory rate in cases of spontaneous ventilation and with capnography when a patient is intubated and mechanically ventilated.

A capnograph monitor measures the partial pressure of end tidal CO₂ (P_{ETCO_2}) in the expired air at any given moment and expresses it as a graph usually depending on time (capnography). The absolute values of P_{ETCO_2} and the curve shape offer information on metabolic, respiratory, and cardiovascular function [1]:

- ▶ P_{ETCO_2} increases as a result of metabolic causes (malignant hyperthermia, severe sepsis), cardiovascular causes (CO₂ insufflation, treatment of acidosis), and respiratory causes (hypoventilation, chronic obstructive pulmonary disease (COPD), asthma).
- ▶ P_{ETCO_2} decreases as a result of metabolic causes (hypothermia, metabolic acidosis), cardiovascular causes (profound hypovolemia), and respiratory causes (hyperventilation, pulmonary edema).

In intubated and ventilated patients P_{ETCO_2} values and curve shape also offer information when technical malfunction occurs.

- ▶ For a sedated patient in spontaneous ventilation, hypoventilation (by airway obstruction or central respiratory depression) will likely precede hypoxemia. Hence, if the patient is monitored using a capnograph machine, when hypoventilation occurs, P_{ETCO_2} increases and the shape of the capnography curve is modified. This may trigger an adequate response from

the person monitoring the anesthesia (chin thrust, sedative dose modification, oxygen supplementation) so as to prevent hypoxemia. As hypoxemia is an adverse reaction to sedation in endoscopy, are we doing enough for respiratory (as well as metabolic and cardiovascular) monitoring for patients under spontaneous respiration? Do we need capnography for these patients? If the answer is yes, then the subsequent questions will be:

- ▶ Should we use it for moderate (midazolam) sedation, deep (propofol) sedation or both?
- ▶ Should we use it for anesthesiologist, for non-anesthesiologist (nurse) administered sedation or both?
- ▶ Should we use it for some "high risk" procedures or for all?
- ▶ Should we use it for some "high risk" patients or for all?
- ▶ What should the precise trigger be for intervention in capnography monitoring? What should the exact intervention be to prevent hypoxemia?
- ▶ And finally, (when) is it cost efficacious?

The American Society of Gastrointestinal Endoscopy (ASGE) does not endorse the use of capnography for moderate sedation, or for moderate risk procedures (routine endoscopy and colonoscopies), but only for endoscopic retrograde cholangiopancreatography (ERCP) or endoscopic ultrasound procedures [1–3]. Even so, the utility of capnography monitoring for ERCP procedures has recently been questioned by Klare et al. [4]. In their comparative prospective study on 242 patients with propofol-based sedation, hypoxemia incidence was not significantly reduced in the additional capnography arm compared with standard monitoring in intent to treat analysis (38.0% vs. 44.4%, $P=0.314$). Additional capnographic monitoring only resulted in improved detection of apnea compared to standard monitoring (64.5% vs. 6.0%, $P<0.001$). However, one pa-

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tient receiving standard monitoring experienced apnea episodes before the development of hypoxemia and cardiac arrest, which subsequently led to his death. It is worth mentioning that, in a retrospective analysis of more than 70 000 procedures, Goudra et al. [5] have shown that most cardiac arrests (72%) were airway management related and occurred mostly during propofol-based sedation (90%). So capnography may also be beneficial for prevention of cardiovascular related events.

Conway et al. [6] have recently reviewed the homogenous pooled data on three comparative randomized controlled trials on 1823 adults undergoing (mostly) colonoscopies, with (mostly) nurse administered propofol sedation by Beitz et al. [7], Slagelse et al. [8], and Friedrich-Rust et al. [9]. It has been proven that capnography monitoring with hypoventilation triggering prompt supplemental oxygen significantly reduces hypoxemia from 207/1000 to 120/1000 cases, relative risk (95%CI) 0.59 (0.48–0.73), $P < 0.001$. Can this effect, valid for nurse administered propofol, be extended to anesthesiologist monitored sedation? However, non-anesthesiologist administered propofol sedation is still not endorsed academically in Europe [10, 11].

In this issue of EIO, Saunders et al. [12] have designed a comprehensive model taking into account the American Society of Anesthesiology (ASA) risk group, age, and body mass index (BMI) distribution in a hypothetical cohort of 8000 patients. The model was used to simulate adverse events and costs during endoscopy procedures under deep and moderate sedation, with and without the use of capnography. The authors proved that capnography is cost effective even for moderate sedation, with 27.2% and 18.0% reductions in the proportion of patients experiencing an adverse event during deep and moderate sedation, respectively. The median number needed to treat to avoid any adverse event was 8 for deep sedation and 6 for moderate sedation. This resulted in cost savings per procedure of USD 85 (deep) or USD 35 (moderate) that accounted for the additional upfront purchase cost, but the cost savings were only realized if more than 300 procedures were performed. Aspects of their findings were communicated in abstract form at the International Society for Pharmacoeconomics and Outcomes Research 2015 meeting, in a study funded by Covidien/Medtronic, the manufacturers of capnograph machines [13].

The question still remains open, at least for midazolam-based sedation, as very recently, Barnett et al. [14] did not find any advantages of capnography monitoring in their comparative study on 966 patients undergoing colonoscopy: similar adverse events (8.2% no capnography vs. 11.2% with capnography, $P = 0.115$) with an increased cost of 11.8 USD per case.

In conclusion, there are still many questions waiting to be answered. There are apparently discordant trial results, as one should take into account many confounding variables – patient, procedure, sedation, and physician related. Capnography, as a measure of both cardiovascular and respiratory function, does

not appear to increase the procedure risk. The jury is still out on whether it decreases the risks and if this decrease is cost-effective.

Competing interests: None.

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