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Benefits and harms of capnography during procedures involving moderate sedation

A rapid review and meta-analysis

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ABSTRACT

Background. Patient safety is a priority in dentistry. Evaluating the benefits and harms associated with the addition of capnography to standard monitoring during moderate sedation for adult patients in the dental practice setting is needed.

Types of Studies Reviewed. The authors used rapid review methodology to identify relevant systematic reviews, which they updated through a systematic search by using the same search strategy as the identified reviews. The authors searched PubMed and Google Scholar and through the references of the identified systematic reviews, which yielded 2,892 studies. Inclusion criteria were that the article was available in English, was original research in adult humans who had undergone moderate procedural sedation, and involved comparing standard monitoring with the addition of capnography.

Results. Sixteen studies were eligible, involving 3,866 adults undergoing procedural sedation. The authors used the Grading of Recommendations Assessment, Development and Evaluation approach to evaluate the evidence and rate it as being of moderate to low quality because of high risk of bias and heterogeneous effects for the outcomes of hypoxemia and adverse respiratory events. Capnography had higher sensitivity to detect adverse respiratory events than did standard monitoring alone (0.92; 95% confidence interval, 0.65 to 0.99) and may reduce the risk of developing hypoxemia by 31% (risk ratio, 0.69; 95% confidence interval, 0.57 to 0.82). Capnography did not affect the risk of developing serious adverse events, procedure time, sedation quality, or patient satisfaction.

Conclusions and Practical Implications. Adding capnography to standard monitoring of adults during moderate sedation may reduce the risk of developing hypoxemia, increase detection of adverse respiratory events, and is not associated with additional harms. These findings suggest routine use of capnography during moderate sedation has the potential to reduce adverse anesthetic outcomes in dental practice.

Key Words. Capnography; moderate sedation; procedural sedation; hypoxemia; respiratory events; sedation quality.

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Capnography provides a continuous measure and display of the partial pressure of exhaled carbon dioxide. Monitoring carbon dioxide provides confirmation of ventilation and airway patency. Although the need for capnographic monitoring unless precluded by the nature of the patient, procedure, or equipment during moderation sedation was a matter of discussion,[1,2] it has long been required for patients during deep sedation.[3] There is, however, recognition that patients who are sedated have the potential to progress to deeper levels of sedation, and the ability to recognize early warning signs may provide critical opportunity to intervene and prevent sedation-related morbidity and mortality.[4] The Oral and Maxillofacial Surgery National Insurance Company closed-claims data indicate that the most frequent reason for transfer of a patient who had received anesthetic to an emergency department was respiratory distress.[5] Early detection of respiratory

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events decreases the likelihood of progression to hypoxemia, cardiac arrest, or death.[6] Investigators have documented the usefulness of capnography to improve detection of hypoventilation in patients who were moderately sedated before changes in vital signs or clinician observations, but whether such episodes are clinically significant or whether earlier detection with capnography has an effect on patient outcomes is unclear.[7]

We performed a systematic review and meta-analysis to facilitate decision making about the need to use capnography routinely during moderate sedation of adults in dental practice. In this work, we include updates of 2 previously published systematic reviews[8,9] to include more recently published literature, use more conservative study inclusion and modeling methods, and exclude pediatric patients. The aim was to determine whether adding capnography to standard monitoring influences the risk of developing hypoxemia, adverse respiratory events, serious adverse events, quality of sedation, and patient satisfaction. Data available from clinical trials involving dental patients are limited. However, anesthetic-related complications during dental care are similar to those reported for the hospital operating system environment.[10] Therefore, we chose to use all data concerning evaluation of the effect of capnography for adults undergoing a procedure with use of moderate sedation.

METHODS

Search strategies

We used a rapid review[11] to evaluate the benefits and harms of capnography monitoring for adults undergoing procedures with moderate sedation. We conducted a search in PubMed in February 2016 for the terms *capnography* AND *systematic review*, limited to English-language articles published after 2011. We identified 53 articles. Of these, 2 were relevant systematic reviews and meta-analyses.[8,9] The search strategies in these 2 articles were similar, excepting that Conway and colleagues[8] were less restrictive regarding patient population and publication language.

In February 2016, to update the existing systematic reviews,[8,9] we conducted systematic searches in PubMed and Google Scholar for clinical trials involving adult humans, limited to English-language articles published in the prior 10 years. This search strategy combined key words, synonyms, and subject headings for the concept *capnography* with key words, synonyms, and index terms for each of the following 2 concepts: (procedural sedation and analgesia or patient-controlled analgesia) or (ambulatory surgical procedures or biopsies or refractive surgical procedures or tracheostomy or tracheotomy or paracentesis or surgical procedures, minimally invasive or endoscopy or electroconvulsive therapy or electric countershock or debridement or ablation techniques or induced abortion or dental). We scanned the reference lists of studies selected for inclusion for additional relevant studies.

Study selection

We included randomized controlled trials or observational studies in which the investigators enrolled adult (18 years or older) patients who received procedural sedation and in which they reported respiratory events with use of capnography and standard monitoring. Standard monitoring may have included visual assessment of skin color, airway patency and chest movements, pulse oximetry, or auscultation of breath and heart sounds by using a pretracheal stethoscope. We included all types of medication used for procedural sedation and anesthesia in adults. For inclusion in the meta-analysis for risk of developing hypoxemia, studies had to be randomized controlled trials with parallel group or crossover design. After removing duplicates, we downloaded titles and abstracts that met the inclusion criteria into a database (EndNote, Clarivate Analytics) and reviewed them for eligibility.

Data extraction

Three ADA staff members independently extracted data to a standardized form and resolved disagreements through discussion and consensus. The form included the main characteristics of the studies, including the study design, population, medical procedure, whether routine supplemental oxygen was used, sedation agents, and the study's definition of hypoxemia. The outcomes we extracted were hypoxemia, adverse respiratory events, serious adverse events, and the quality, duration, and satisfaction with sedation. Study investigators used varying definitions of hypoxemia, from arterial oxygen saturation (Spo_2) less than 90% to Spo_2 less than 93%. They defined an adverse respiratory event as an incident of respiratory depression, apnea, oxygen desaturation,

ABBREVIATION KEY

ADA: American Dental Association.
$ETco_2$: Partial pressure or maximal concentration of carbon dioxide at the end of an exhaled breath.
GRADE: Grading of Recommendations Assessment, Development and Evaluation.
NA: Not applicable.
Spo_2: Arterial oxygen saturation.