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What's new in... Capnography Monitoring for Dental Conscious Sedation: A Clinical Review

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Abstract

Capnography monitoring during conscious sedation is not currently required for dentistry in Britain and Ireland. Other countries have introduced guidelines and standards requiring capnography monitoring for procedural sedation. This review highlights the variability of procedural sedation including the setting, the position on the sedation continuum, and the routine use of supplemental oxygen. Specific research is required for conscious sedation in a dental setting to support standards and guidelines with regard to capnography monitoring.

The Academy of Medical Royal Colleges and their Faculties emphasise that each specialty must produce its own guidance for the use of sedative techniques.[1] Clinical practice guidelines for the monitoring and safe practice of sedation vary by specialty and institution. Standards are generally set from the best available evidence based research. There is a growing body of literature that recognises the potential additional value of capnography ($ETCO_2$) monitoring during procedural sedation in different settings and for different sedation techniques.[2-5] In these studies, capnography reduced the incidence of hypoxaemia during procedural sedation. A meta-analysis published by Waugh et al. (2010) concluded that end-tidal carbon dioxide monitoring is an important addition in detecting respiratory depression during procedural sedation.[6] A more recent systematic review by Conway et al. (2016) concluded that patients monitored with capnography in addition to standard monitoring had a reduced risk of hypoxaemia compared to those with only standard monitoring.[7] However, it has to be noted that both the Waugh and Conway reviews contained substantial statistical heterogenicity which is likely to affect the quality of the evidence.

As research evidence for capnography monitoring from the medical settings studied became available, new standards for capnography monitoring were introduced in several countries (Table 1).

Table 1: Sedation Guidelines and Standards

	American Society of Anesthesiologists	Royal College of Surgeons and Royal College of Anaesthetists	Canadian Anesthesiologists Society	Australian Dental Association
Level of statement	Standards	Standards	Guidelines	Guidelines
Year written/updated	2015	2015	2012	2014
Assessment of depth of sedation	Required	Required	Required	Required
Pulse oximetry	Required	Required	Required	Required
Capnography	Moderate and deep sedation required unless precluded or invalidated by the nature of the patient, procedure, or equipment	Not required for conscious sedation in ASA I & II May be recommended ASA III & IV and with supplemental oxygen	Required for conscious sedation	Required for conscious sedation

The American Society of Anesthesiologists amended its standards for basic monitoring, in October 2010, to include the capnographic assessment of ventilation during moderate or deep sedation.[8] Following suit, in 2012 the Canadian Anesthesiologists Society published "Guidelines to the Practice of Anesthesia – Revised Edition 2012" which included an important amendment in the section regarding required monitors – CO_2 monitoring (capnography) during conscious sedation.[9] The Australian Dental Association in its policy statement in 2010, regarding conscious sedation stated: *"All patients undergoing sedation must be monitored continuously with pulse oximetry, blood pressure and $ETCO_2$."*[10] This may have been prompted by a widely publicised death of a patient under dental intravenous sedation in New South Wales, Australia, in 2002 while being treated by a dentist with appropriate training in intravenous conscious sedation, (Graduate Diploma in Clinical Dentistry; Conscious Sedation and Pain Control, University of Sydney) which brought into question the safety of Intravenous sedation. The cause of death was irreversible cerebral hypoxia following a cardiac arrest, which was precipitated by numerous periods of ever-deepening hypoxaemia.[11]

Despite growing pressure for capnography to be used universally in the U.K., it is not currently required for conscious sedation in dentistry. The U.K. issued new guidance on Standards for conscious sedation in the provision of dental care which were published in April 2015 by the dental faculties of the Royal Colleges of Surgeons and the Royal College of Anaesthetists.[12] The report stated the following with regard to capnography: *"its routine use for ASA grade I and II dental patients lacks high level scientific validation and cannot be recommended."*

Dental sedation in the U.K. and Ireland lies in the mild to moderate range of the sedation continuum (conscious sedation), in contrast to the U.S.A. and Canada where deep sedation is possible in a dental setting. According to the Standing Dental Advisory Committee: *"Any technique resulting in the loss of consciousness is defined as general anaesthesia and in the UK "deep sedation" is considered within this category. The practice of general anaesthesia under the guise of Conscious Sedation is totally unacceptable and must be strongly deprecated in view of the risk of jeopardising patient safety".*[13]

Previous capnography studies are difficult to summarise, due to variations in sedation techniques, settings and varying patient populations. When we set out to conduct this review, it was with the intention of performing a meta-analysis looking at capnography monitoring specifically for conscious sedation. However, we found that the diversity of the study settings and variability of the sedation techniques of published research studies were not easily comparable and therefore not suitable for meta-analysis. We present here three studies which demonstrate the variability and difference of the procedural sedations from that of conscious dental sedation.

Beitz et al (2012): The primary goal of this randomised, controlled study was to determine whether intervention based on additional capnography monitoring reduces the incidence of arterial oxygen desaturation during sedation for colonoscopy. A total of 760 patients were enrolled at three German endoscopic centres. Patients received 2L/min of supplemental oxygen. The intention-to-treat analysis revealed a significant reduction in the incidence of oxygen desaturation in the capnography arm in comparison with the conventional arm (38.9% vs. 53.2%). The study conclusion was that additional capnography monitoring reduces the incidence of oxygen desaturation and hypoxemia during propofol sedation for colonoscopy.[2]

Deitch et al (2010): This randomised, controlled trial took place in an emergency room setting. A total of 132 patients took part in the study. Hypoxia was defined as an SpO_2 < 93% for 15 sec. The incidence of oxygen desaturation in the capnography arm in comparison with the conventional arm was 25% vs. 42%. All patients received supplemental oxygen (3L/min). The study conclusion was that the addition of capnography to standard monitoring in this setting reduced the incidence of hypoxia and provided advanced warning for all hypoxic events.[3]

Qadeer et al (2009): This randomised trial sought to determine whether intervention, based on microstream capnography would decrease hypoxemia during endoscopy. A total of 247 patients took part in the study. They showed a significantly reduced rate of hypoxia (46% vs 69%), defined as an oximetry reading < 90% for 15 sec. Significant risk factors for hypoxemia in multivariate analysis were higher age, female gender and blinded arm of capnography. The level of sedation in this study was not quantified and there was a relatively large cohort of ASA 3 patients in the study with comorbidities. 147 patients received supplemental oxygen during the procedure. The study conclusion was that capnography monitoring of respiratory activity improves patient safety during procedural sedation for elective endoscopy.[5]

Conscious Sedation in a dental setting differs significantly from other procedural sedation settings with respect to the following;

Different patient populations

In the standard dental sedation technique, ASA 1 & 2 adult patients up to 65 years of age receive sedation. The reviewed studies contain many elderly patients. Elderly patients are known to be more sensitive to sedative drugs and more likely to have significant co – morbidities (ASA3).

Supplemental oxygen

For the standard dental sedation technique most patients breathe room air. Supplemental oxygen is not routinely administered unless indicated to correct hypoxia. In the reviewed studies most of the patients received supplemental oxygen during the procedure (2–3 L/min). Supplemental oxygen is likely to have resulted in a decreased sensitivity of the pulse oximeter as a surrogate monitor of hypoxia due to respiratory depression. There are only a few studies where supplemental oxygen is not administered and patients are administered sedatives breathing room air. Van Loon et al (2014) in a relatively large clinical trial with 427 patients enrolled for gynaecological procedures, concluded that they were unable to confirm an additive role for capnography in preventing hypoxaemia during elective propofol sedation in healthy women in whom supplemental oxygen is not routinely administered.[14] This is in agreement with the study by Sivilotti et al (2010) with 63 patients enrolled in an emergency room setting.[15] Therefore, in studies where patients were breathing room air during their sedations and not routinely receiving supplemental oxygen, the addition of capnography did not decrease the rate of oxygen desaturation.

Depth of sedation

The publication from the Academy of Medical Royal Colleges, Safe

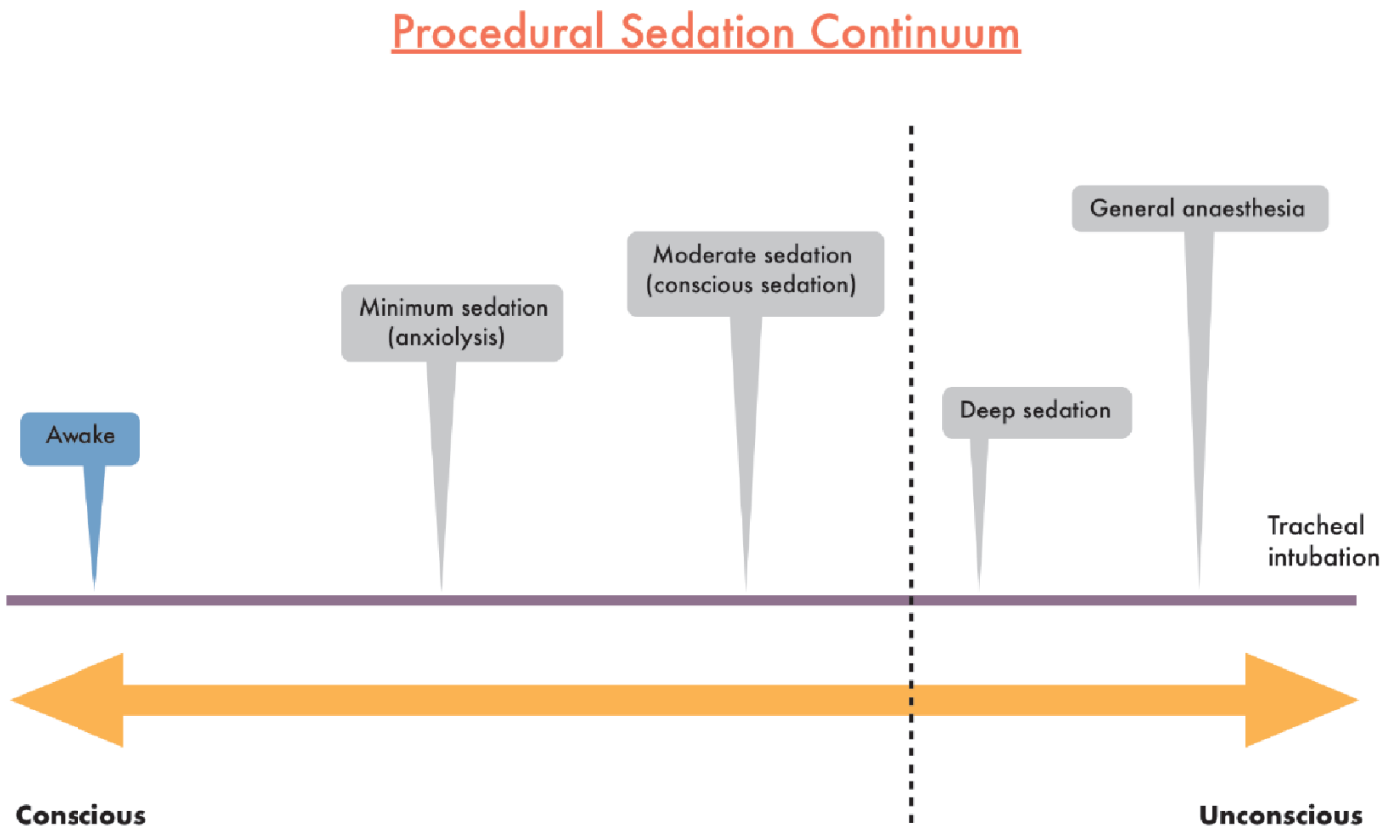

Figure 1: Sedation Continuum

Sedation Practice for Healthcare Procedures, gives the definitions of sedation and describes clearly the continuum from minimal sedation through to general anaesthesia, which is accompanied by increased depression of the physiological systems.[1] This increases the likelihood of adverse events

For the standard dental sedation technique, conscious or moderate sedation is the target state on the sedation continuum. However, it is recognised that sedated patients have the potential to progress to deeper levels of sedation and it has been suggested that the ability to recognise early warning signs may provide a critical opportunity to intervene and prevent sedation-related morbidity and mortality.[16] There remains, a relative paucity of research in the conscious sedation (minimum to moderate) end of the sedation spectrum. The few studies that exist in dentistry are of a low evidence base and there are no reported randomized controlled studies in this setting.[17-19] The reliability of extrapolating findings from other sedation settings and applying them to dental sedation is unknown.

Drugs

A titrated intravenous dose of midazolam is usually the first choice intravenous sedation technique for dentistry. A range of other sedative drugs were used in the reviewed studies e.g. propofol and ketamine. Drugs used in combination have the potential to act synergistically to produce significant respiratory depression. When combined with other drugs and in particular opioids, the possibility of respiratory depression is increased.

Analgesia

Local anaesthetic is given in dentistry to provide analgesia during sedation. In the reviewed studies, analgesia was often achieved with the use of intravenous agents such as opioids.[20]

Desaturation (SpO_2)

For the standard dental sedation technique an SpO_2< 95% is regarded as the threshold for early desaturation. This is a reasonable threshold in this setting where sedation is administered by a non-anaesthetist outside of the operating room setting. In some more medically supported environments the significance of this threshold is likely to be of less importance. Studies from other settings used varying thresholds for desaturation as the study outcome measure. For example, Deitch et al. (2010) used a threshold < 93% and Qadeer et al. (2009) <90%.[3-5]

The guidelines and recommendations that have been made requiring capnography for procedural sedation in North America are perhaps understandable as dental sedation in those countries may be practised by any dentist meeting appropriate training and permit requirements. Thus, sedation levels may encompass the entire anaesthesia continuum using a variety of drug classes. Since it is possible that patients may slip to a level of sedation beyond the desired intent, capnography serves as an early warning system for ventilatory compromise and aids in the early "rescue" of an obtunded patient. Additonally, sedation and anaesthesia is often practised by dentist anesthesiologists and oral and maxillofacial surgeons. The scope of practice of these clinicians is much broader than that of a dentist practising conscious sedation in the U.K. and Ireland. They often provide deep sedation and general anaesthesia in non-hospital settings e.g dentist's office. Therefore, it is likely that many patients will receive sedations in North America in the deep sedation end of the sedation continuum. In the dental conscious sedation setting as practised in the U.K and Ireland,

additional monitoring which may be of limited clinical benefit could potentially hinder attention to other important monitoring parameters.

In conclusion, a one size fits all approach to requiring capnography for procedural sedation is perhaps erroneous. There is emerging evidence in the literature that for patients receiving conscious sedation on room air, capnography is of little additional benefit in preventing hypoxaemia. Factors which make dental sedation as practised in the U.K. and Ireland significantly different to that of other procedural sedations include the position on the sedation continuum and the fact that patients do not routinely receive supplemental oxygen.

The benefits of capnography must be quantified in the target population, before its routine incorporation into practice. There is a need for dentistry specific research into capnography monitoring during conscious sedation.

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