

Nitrous Oxide-oxygen Inhalation in Dental Practice: Sedation or Behavior Guidance?

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Dental fear and anxiety are dominant barriers in seeking dental care and negatively impact the outcome of dental diseases and treatment. Nitrous oxide-oxygen is used for inhalation during dental procedures to achieve anxiolysis and analgesia. This technique has a long-standing history of utilization in dentistry and has been termed differently by various countries (Table 1). In most European countries, including the UK, it is termed as nitrous oxide inhalation sedation, with its practice guidelines under the banner of conscious sedation.¹ In Australia, it is commonly known as relative analgesia² and in the US it is designated as nitrous oxide-oxygen anxiolysis/analgesia.³ In many countries which do not have their own guidelines yet, the use of nitrous oxide is categorized under the broad umbrella of “conscious sedation.”

This variation in terminology is disadvantageous for many countries which do not have their own guidelines for the use of nitrous oxide or for many dentists who refer to the existing guidelines while practicing this technique. Most of the nascent users of this technique feel that nitrous oxide is a tool to bring about “sedation” thereby meaning, a technique meant to “reduce consciousness” of a patient which would then aid in providing dental treatment to an uncooperative or fearful patient, especially if it is a pediatric patient. Is it appropriate to use the term “sedation” for a technique that is actually purposed for anxiolysis?

According to the American Society of Anesthesiologists (ASA) the entire sedation spectrum can be divided into four parts with anxiolysis, which is also termed as minimal sedation, at one end of the continuum of sedation and general anesthesia at the other end.⁴ Interestingly, minimal sedation or anxiolysis has been defined as a “drug-induced state” in contrast to moderate and deep sedation which are defined as “drug-induced depression of consciousness.” This signifies that sedation or “depression of consciousness” occurs in moderate sedation and deep sedation.

In dental practice, nitrous oxide-oxygen inhalation is meant to bring about anxiolysis or minimal sedation when used at a concentration of nitrous oxide being less than or equal to 50%, in a patient who is in ASA I or II category and without any use of premedication or concomitant use of analgesic, sedative or CNS depressant.⁵ At this juncture, it becomes imperative to emphasize that we do acknowledge that sedation is a continuum and minimal sedation cannot be clearly demarcated from moderate sedation. When nitrous oxide is administered there could be periods of moderate sedation which are clinically manifested by depression of consciousness and a verbal response from the patient that is elicited by a light tactile stimulus. The clinician can easily recognize these deviations by clinical observation at regular intervals and if required, reduce the concentration of nitrous oxide

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to maintain the patient in a state of minimal sedation or anxiolysis. Therefore, intermittent clinical observation is necessary when inhalational nitrous oxide is used to ensure that the patient is maintained in the plane of minimal sedation. This will be in tune with the ASA and AAP guidelines which state that “practitioners of sedation must have the skills to rescue the patient from a deeper level than that intended for the procedure.”⁵

Furthermore, as a consequence of biological variability, a patient can manifest depression of consciousness at a concentration of 30%, whereas another patient may not manifest that even at 70%. Consequently, it becomes imperative and critical to state that 50% alone cannot be considered as a yardstick to distinguish between minimal and moderate sedation. Rather, “depression of consciousness” in conjunction with purposeful response to verbal stimuli “accompanied with light tactile stimuli” should be considered as a clear indicator to differentiate moderate sedation from minimal sedation.

Nitrous oxide cannot induce deep sedation when used without any other sedative or premedication.⁶ This has been substantiated by certain studies which found that on EEG, the power of the delta band decreases paradoxically in the nitrous oxide sedation, unlike in the case of other general anesthetics.⁷ Intriguingly, there have been some reports in the literature where there have been instances of deep sedation with the use of nitrous oxide-oxygen inhalation.⁸ However, in these reports, the readers should give close and thoughtful attention to two variables, which are the concentration of nitrous oxide delivered and the type of mask used for the delivery of gases. Interestingly, in almost all these reports, nitrous oxide was used at a concentration of >50% using a full face mask (such a practice is done in pediatric medical emergencies rather than a dental practice). A concentration of more than 50%, as per ASA

Table 1: List of various documents containing guidelines on use of nitrous oxide in dentistry

Country/organization	Year	Name of the document
UK National Guidelines 2002	2002	Use of conscious sedation in pediatric dentistry
EAPD section on nitrous oxide/oxygen inhalation sedation	2003	EAPD guidelines on sedation in dentistry
Intercollegiate advisory committee for sedation in dentistry The Dental Faculties of the Royal Colleges of Surgeons and the Royal College of Anaesthetists	2015	Standards for conscious sedation in the provision of dental care
SCOTLAND	2017	Conscious sedation in dentistry
American Dental Association Common guidelines for minimal sedation irrespective of drug used	2007	Guidelines for use of sedation and general anesthesia by dentists
American Academy of Pediatric Dentistry	2018	Use of nitrous oxide for pediatric dental patients.
Dental Council, New Zealand	2016	Sedation practice standard
ANZCA	2014	Guidelines on Sedation and/or Analgesia for Diagnostic and Interventional Medical, Dental or Surgical Procedures
Australian Dental Association. Policy statement 6.33	2019	Relative Analgesia in Dentistry
Canada (Nova Scotia)	2020	Use of sedation and general anesthesia in dental practice (section on nitrous oxide and oxygen conscious sedation)
Canada (Alberta Province)	2020	Standard of Practice: Use of minimal or moderate sedation deep sedation and general anesthesia in non-hospital dental practice
Malaysia Follows ANZCA guidelines	2012	Recommendations for sedation and analgesia by non-anesthesiologists College of Anesthesiologists, Academy of Medicine, Malaysia

guidelines, indicates that moderate-deep sedation is expected rather than minimal sedation or anxiolysis.⁵ Full face mask covers both nose and mouth leading to inhalation of almost the same percentage as being delivered by the flowmeter. Whereas, with the use of a nasal mask, as is done in dentistry, the concentration of nitrous oxide gas being inhaled is much lower than that reflected by flowmeter.⁹

The safety index of nitrous oxide is higher than any other agent which is administered to bring about minimal sedation, for example, Barbiturates.¹⁰ Nitrous oxide is an inhalation agent, and its clinical effects, if in excess of those desired, can be easily reduced by decreasing its concentration, due to its

pharmacological properties.¹¹ Maintaining the correct depth of sedation specifically for each patient is at the discretion of the operator. This is contrary to the clinical effects of orally administered sedative medications, the outcomes of which are dependent on the pharmacokinetics of the agent, implying that the effects cannot be reversed by the operator.

Depression of consciousness can be termed as an undesired effect of nitrous oxide when used in dentistry for anxiolysis. Sedative medications are usually categorized based on their multiple and desirable pharmacologic effects. To elaborate upon this with an example, in the WHO list of essential medicines¹² diazepam is categorized as medicine for pain and palliative care (category 2.3), anticonvulsant/antiepileptic (category 5), and medicine for mental and behavioral disorders (category 24.3). Unfortunately, nitrous oxide is listed only under the category 1.1.1 which is general anesthetics-inhalation medicine. This is although it is a very weak anesthetic agent and never used as the sole agent in general anesthesia for induction.

For dental procedures, analgesia is usually taken care of by use of local anesthetics, and consequently, it can be inferred that a state of minimal sedation/anxiolysis is apt to practice dentistry, which is achieved by using nitrous oxide-oxygen alone in a concentration of less than 50% (in most cases depending on bioavailability) along with clinical monitoring for signs of depression of consciousness. Considering this fact, the clinically relevant therapeutic role of nitrous oxide in dentistry is for behavior guidance. Not surprisingly, the American Academy of Pediatric Dentistry considers nitrous oxide/oxygen inhalation as a basic behavior guidance tool even though it is a pharmacological method of behavior management.¹³ Furthermore, ASA practice guidelines for sedation and analgesia by nonanesthesiologists excludes minimal sedation from its guidelines as it entails minimal risk.⁵

To reiterate, the beauty of using nitrous oxide lies in its rapid onset and recovery, which makes it possible to stick to the "objective" of using it (to achieve anxiolysis/ minimal sedation/ behavior guidance) and remove any unwarranted effects (depression of consciousness/ moderate sedation/ conscious sedation) in a matter of 1–2 minutes. Shouldn't the terminology of a procedure be dependent on the "objective for which drug is being used at a particular concentration," even though at a higher concentration, the pharmacological effect may vary? This is something that needs to be considered by educators, clinicians, and policymakers.

To conclude,

- The therapeutic purpose of using nitrous oxide-oxygen in dentistry is to reduce anxiety, if gases are administered by a nasal mask to an ASA I/II child, at a concentration of nitrous oxide which is less than or equal to 50% along with clinical monitoring and no other medication is concomitantly administered, with the exception of local anesthesia. This implies that the use of the term- conscious sedation, should be avoided as that's not the objective of using nitrous oxide.
- Guidelines for use of nitrous oxide-oxygen should always be clearly delineated from guidelines for other sedative agents as the operator has better control over the clinical effects of nitrous oxide by titrating the dose.
- Monitoring of patients required during nitrous oxide administration is less stringent than other sedative drugs. Hence, guidelines should be based on the expected level of sedation to avoid unnecessary burden on the patients and health care

system in terms of requirement of time, the potential cost, and manpower needs.

- Some oral sedatives may produce only minimal sedation but their safety index pales in comparison with that of nitrous oxide.
- The variation in terminology for a technique, which is practiced in a similar manner across the world, can add to uncertainty in many countries which are yet to formally accept a technique that has the potential to change the face of dentistry, especially pediatric dentistry.

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