

Sedation and General Anesthesia

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Sedation and general anesthesia constitute essential modalities in contemporary dental practice, aimed at facilitating the safe and effective management of patients who are unable to tolerate routine dental procedures under local anesthesia alone. These approaches are particularly valuable in reducing pain, anxiety, and psychological distress, thereby improving patient cooperation and overall treatment outcomes. Sedation encompasses a spectrum of pharmacologically induced states ranging from minimal anxiolysis to deep sedation, in which patients retain varying degrees of consciousness and protective reflexes. In contrast, general anesthesia involves a controlled state of unconsciousness accompanied by the loss of protective reflexes, necessitating advanced airway management and continuous monitoring.

Modified Dental Anxiety Scale (MDAS)

The Modified Dental Anxiety Scale (MDAS) is a reliable and widely accepted instrument used to quantify dental anxiety in clinical and research settings. It consists of five structured questions that evaluate a patient's anxiety in relation to specific dental situations, including anticipation of treatment and exposure to common dental procedures such as drilling and local anesthetic injection. Each item is scored on a Likert scale ranging from 1 (not anxious) to 5 (extremely anxious), yielding a total score between 5 and 25. Higher scores indicate greater levels of dental anxiety, with established thresholds aiding in the identification of patients with moderate to severe anxiety or dental phobia. The application of MDAS in dental practice facilitates early recognition of anxious patients, enabling clinicians to tailor appropriate management strategies, including behavioral techniques, pharmacological sedation, or referral for general anesthesia when necessary. Consequently, the MDAS serves as an essential tool in improving patient-centered care, enhancing treatment compliance, and optimizing clinical outcomes (Table 1 shows the MDAS questions).

Sedation

Sedation is a drug- induced reduction in consciousness (medications that help the patient feel less stressed during dental procedures.), This altered state of consciousness can be achieved with a myriad of agents, in a number of different settings, to enable a wide range of procedures to be performed.

In sedation dentistry, the patient is awake and able to respond to questions, but don't notice pain. It's sometimes called conscious sedation dentistry or twilight sleep.

Table 1: Modified Dental Anxiety Scale (MDAS)

1. If you went to your dentist for treatment tomorrow, how would you feel?					
Not Anxious	Slightly Anxious	Fairly Anxious	Very Anxious	Extremely Anxious	
2. If you were sitting in the waiting room (waiting for treatment), how would you feel?					
Not Anxious	Slightly Anxious	Fairly Anxious	Very Anxious	Extremely Anxious	
3. If you were about to have a tooth drilled, how would you feel?					
Not Anxious	Slightly Anxious	Fairly Anxious	Very Anxious	Extremely Anxious	
4. If you were about to have your teeth scaled and polished, how would you feel?					
Not Anxious	Slightly Anxious	Fairly Anxious	Very Anxious	Extremely Anxious	
5. If you were about to have a local anesthetic injection in your gum above your upper back tooth, how would you feel?					
Not Anxious	Slightly Anxious	Fairly Anxious	Very Anxious	Extremely Anxious	

Sum of all five items, ranging from 5 to 25 (Not Anxious = 1; Extremely Anxious = 5). A total score of 19 or greater indicates a highly dentally anxious patient or possibly a dental phobic

Indications: Dentist recommend sedation if the patient have:

1. Fear of dental treatment
2. Fear of needles
3. Very sensitive gag reflex
4. Very sensitive teeth
5. Claustrophobia that makes it hard for you to relax while sitting in a treatment chair
6. Difficulty controlling your movements
7. Have physical, behavioral or cognitive needs that make it difficult for you to relax

Sedation techniques

Sedation is administered via several routes to produce relaxation and analgesia during medical or dental procedures. IV is the most common for rapid onset and titration, while inhalation (e.g., nitrous oxide) is often used for children.

Routes of Administration

- **Intravenous (IV):** such as Propofol The most common method for moderate to deep sedation, offering rapid onset (1–2 minutes) and allowing for precise titration (dose adjustment) to the desired effect.
- **Inhalation:** Typically uses nitrous oxide and oxygen (laughing gas). It is fast-acting, safe, and easily reversed, making it ideal for dental procedures.

- **Oral (PO):** Simple and non-invasive, commonly using benzodiazepines (like midazolam) for anxiety control, but has a slower, less predictable onset.
- **Intranasal (IN):** Agents are absorbed directly into the bloodstream, bypassing the digestive system for a faster, more efficient onset than oral administration (an example is Dexmedetomidine).
- **Intramuscular (IM):** such as Ketamine. Used when IV access is difficult, often in pediatric patients, although it cannot be titrated once given.
- **Sublingual (SL):** such as fentanyl. A tablet or liquid is placed under the tongue for rapid absorption.

Nitrous oxide

Inhaled nitrous oxide (N_2O) has the longest history of use in the field of sedation, being first used in 1844. Its use remains widespread in dental practice today for anxiolysis, and for minimal sedation in children and adults. It can be safely used in community dental practice as well as the pre- hospital and hospital environment. Also referred to as relative analgesia, N_2O is generally delivered in concentrations of 20– 50% (though up to 70% can be delivered) in a mixture with oxygen. The concentration of N_2O can be titrated to effect in increments of 5– 10%, with the patient remaining responsive throughout. It requires cooperation with the patient to tolerate the nasal mask, mouthpiece, or face mask. For procedures in the oral cavity, a nasal mask is required. For single- agent use of N_2O in dentistry, an operator- sedationist technique can be used, in conjunction with a trained assistant to help monitor the patient. Nausea and vomiting are common side effects, especially when used in combination with fentanyl. Consideration of gas scavenging is important— N_2O is an environmental hazard as it depletes the ozone layer

N_2O Interaction with Body Systems and Conditions

Nitrous oxide has been in continuous use as an anxiolytic drug because it is a safe drug. It is compatible with human physiology, and when administered with oxygen, it actually improves a patient's perfusion while decreasing his or her anxiety.

Basic knowledge of nitrous oxide is important to keep one aware of potential interactions with new drugs sure to find their way into the marketplace. Therefore, in today's world of increasing human longevity, nitrous oxide finds its use across the spectrum from pediatric to geriatric and from healthy to medically-compromised patients.

Contraindications for Use of N₂O/O₂ Sedation***Absolute Contraindications***

- Pneumothorax
- Cystic fibrosis
- Chronic obstructive pulmonary disease (COPD)
- Recent pneumoencephalography (PEG)
- Suspected/known pernicious anemia or vitamin B12 deficiency
- Significant bowel obstruction
- First trimester of pregnancy
- Cancer therapy using bleomycin sulfate
- Psychological impairment
- Current psychotropic drug use
- Current or recovering drug use/addiction
- Patient in shock, semi-conscious or with serious head/facial injuries
- Inability to understand procedure or unwilling to consent to procedure

Relative Contraindications

- Current upper respiratory tract infection (—such as a cold, cough, sinus infection, bronchitis, or allergy-related symptoms—may occlude the nasal passages such that adequate air exchange at the alveolar level will be incomplete).
- Middle ear disturbance/surgery (e.g., grafting)
- Recent eye surgery using perfluoropropane or sulfur hexafluoride

1. Cardiovascular System

N₂O does not negatively affect the cardiovascular system to produce any significant physiologic changes.

Nitrous oxide has a minimal effect on **heart rate**. Similar to its effects on **blood pressure**, heart rate may decrease as anxiety is lowered. The potential of decrease in blood pressure is a result of relaxation, because N₂ O does not have any direct effect on the myocardium or voluntary skeletal muscle.

Blood flow to major organs is not significantly affected

Conclusion: Currently, no conditions involving the cardiovascular system should indicate medical consultation or postponement of N₂ O/O₂ use.

2. Respiratory System

When intended for minimal sedation, nitrous oxide does not depress ventilation.

Because the route of administration is inhalation, airway patency is mandatory. Upper respiratory tract infections or conditions commonly compromise air exchange through the nose. If the patient is unable to breathe through the nose, insufficient amounts of N_2O/O_2 will enter the respiratory system.

There has never been a reported allergy to N_2O . Its use is not contraindicated for asthma patients, because it is nonirritating to mucous membranes. In fact, the sedative nature of N_2O/O_2 has a positive influence on asthmatic patients, because anxiety can trigger an asthmatic episode.

- Nitrous oxide/oxygen sedation should be avoided for patients with ***pneumothorax*** or ***cystic fibrosis***.
- N_2O/O_2 sedation should be postponed for patients experiencing ***acute sinusitis*** or ***upper respiratory tract infections***.
- Medical consultation is advised for patients with any type of ***chronic obstructive pulmonary disease (COPD)*** (e.g., emphysema, chronic bronchitis).

3. Central Nervous System (CNS)

N_2O , like other anesthetics, has the ability to depress the CNS; however, the exact mechanism is unknown.

N_2O 's effects on ***cerebral blood flow***, ***intracranial pressure***, ***cerebral blood velocity***, ***cerebral perfusion pressure***, and ***O₂ consumption*** have been compared with other anesthetics. Most effects seem to be less significant than those of other inhaled anesthetics (these effects are not significant).

N_2O/O_2 sedation is contraindicated for patients having undergone recent pneumoencephalography or for patients who are abusers of nitrous oxide.

4. Hematopoietic System

literature cites that some persons with subclinical ***vitamin B₁₂*** deficiencies have experienced postoperative effects following nitrous oxide/oxygen sedation with lower concentrations; reports indicate neurologic improvement increases over time and with vitamin B₁₂ supplementation. Therefore, it would be advantageous to inquire about the presence of pernicious anemia or other vitamin B₁₂ deficiency before use of N_2O/O_2 sedation and seek medical consultation for support of its use.

Conclusion: Nitrous oxide/oxygen sedation should be avoided or medical consultation is advised for patients with pernicious anemia or other vitamin B₁₂ deficiency

5. Endocrine System

Inhalation sedation with N₂O/O₂ has no negative effect on the endocrine system. ***Currently, no conditions involving the endocrine system indicate medical consultation or postponement of N₂O/O₂ use.***

6. Hepatic System

N₂O is not metabolized in the liver, nor does it affect the liver in the presence of liver impairment. ***Currently, no conditions involving the hepatic system indicate medical consultation or postponement of N₂O/O₂ use.***

7. Gastrointestinal System

Because of the expansive nature of the gas and its propensity for insufflating air spaces within the body. The gas entering nonrigid-walled air spaces in the body causes the spaces to expand. This expansion and possible pressure can be problematic.

If a patient has a bowel obstruction, it is less desirable to use N₂O/O₂ sedation, because the N₂O can affect the condition by increasing expansion, pressure, and discomfort.

Nitrous oxide/oxygen sedation should be postponed for patients with a significant bowel obstruction.

8. Genitourinary System

N₂O/O₂ sedation does not pose any negative effect on the genitourinary system itself. ***Currently, no conditions involving the genitourinary system indicate medical consultation or postponement of N₂O/O₂ use.***

9. Neuromuscular System

N₂O does not provide direct skeletal muscle relaxation, but it does so indirectly. However, Yoshida demonstrated a reduction in orofacial muscle tone during dental treatment with nitrous oxide in patients with cerebral palsy.

Currently, no conditions involving the neuromuscular system indicate medical consultation or postponement of N₂O/O₂ use.

10. Cancer

N₂O does not combine with any of the formed blood elements, nor does it affect metastatic cells.

N₂O/O₂ has been used in the final stages of life as an adjuvant to other pharmacologic methods for pain and anxiety management. In these situations, the untoward effects caused by chronic exposure to N₂O are irrelevant.

Patients currently receiving **bleomycin sulfate**, an antineoplastic agent used typically for the treatment of lymphomas, testicular tumors, and squamous cell carcinomas, can increase the incidence of pulmonary fibrosis and other pulmonary disease. This occurs only indirectly if O₂ is administered concomitantly with N₂O in concentrations greater than 30%. Although this is an unusual situation, it must be regarded.

Conclusion: Nitrous oxide/oxygen sedation should be avoided or postponed for patients receiving bleomycin sulfate therapy.

11. Allergies

For more than 160 years, there have been no known reported allergies to N₂O.

Persons sensitive to latex may experience contact dermatitis when using a nasal hood made from rubber products. Latex-free nasal hoods, conduction tubing, and reservoir bags are exclusively produced by each equipment manufacturer in the United States.

12. Others

○ Mind-Altering Conditions

N₂O/O₂ sedation is contraindicated for patients with mind-altering conditions, current/ recovering alcohol or drug addiction, antidepressant or psychotropic drug therapy, or presenting with a phobia that interferes with care (e.g., claustrophobia).

○ Middle Ear Disturbances

Because N₂O infiltrates the rigid, noncompliant area of the middle ear, increased pressure results. Complications have been noted in middle ear surgical procedures with N₂O. Significant damage, such as tympanic membrane rupture, graft displacement, and other complications, has been observed.

○ Eye Surgery

A safety alert was published about patients and recent ophthalmic surgery in which perfluoropropane or sulfur hexafluoride gas was used. In patients undergoing vitreoretinal procedures, typically a “gas bubble” is placed in

the eye to assist the healing process; this gas bubble could expand with N_2O and complicate healing or promote injury.

- **Pregnancy**

Pregnancy is a normal physiologic state that requires twice the demand for folate. Treatment considerations are important during organogenesis in the first trimester and when low O_2 tension levels are possible in the last trimester. Most pharmacologic agents cross the placental barrier; N_2O is no exception.

In conclusion: N_2O/O_2 sedation is contraindicated for patients with recent tympanic membrane graft, with recent eye surgery using perfluoropropane or sulfur hexafluoride gas, in shock or a semiconscious state, with serious head or facial injuries, or in those patients taking medications to induce sleep or who are unwilling to consent. N_2O/O_2 sedation is contraindicated for pregnant patients in the first trimester and medical consultation is advised at any other time during a pregnancy.

Titration of N_2O and O_2 Gases

Nitrous oxide is mixed with oxygen (typically a 50/50 mix) during medical procedures to prevent hypoxia (oxygen deprivation). While nitrous oxide provides anesthesia and pain relief, it cannot support life on its own; oxygen is necessary to ensure the patient has sufficient oxygen to breathe, preventing harmful side effects and ensuring safe oxygen levels (at least 30% or higher)

The available delivery system for N_2O - O_2 administration has established safety limitations for the delivery of this drug. The administration of N_2O requires the minimal administration of 30% oxygen (O_2). Based on this established safety parameter, the maximal amount of N_2O that can be administered is 70%. Generally, most patients will experience an adequate effect from this drug in the range of 30% to 40% N_2O .

Titration is defined as: The administration of incremental doses of drug until the desired therapeutic effect is reached, which is important for patient safety. Titration allows for maximum patient comfort while using a minimum amount of sedative. Titration is unpredictable with oral drugs, often resulting in oversedation. Usually, subsequent doses are given before the first dose is fully absorbed and exhibiting a therapeutic effect.

- The Process: Begin with 100% O_2 for 2-3 minutes. Add N_2O at 20% concentration, decreasing O_2 proportionally.

- "Start Low, Go Slow": Increase by 5% increments every 1 to 2 minutes, allowing the patient to experience the effect, as peak effect takes time.
- Ideal Sedation Signs: Patient feels lightheaded, warm, relaxed, and shows reduced anxiety.
- Termination: After the procedure, administer 100% O₂ for 3–5 minutes (or 5–15 mins) to prevent diffusion hypoxia, which occurs when rapid nitrous oxide release lowers blood oxygen levels.
- Safety: Proper titration ensures the patient receives the minimum drug necessary to achieve effect, reducing the risk of over-sedation.

Complications, Emergencies, and Emergency Management

Despite its high safety margin, nitrous oxide sedation is not entirely free from complications. Adverse effects may arise from improper administration, excessive concentrations, patient-related factors, or inadequate monitoring. These complications are generally mild, transient, and reversible, but they require prompt recognition and appropriate management to ensure patient safety. Understanding the potential risks associated with nitrous oxide sedation, along with their prevention and management strategies, is essential for clinicians to deliver safe and effective care.

Common Side Effects

Most side effects are mild and resolve quickly once you stop inhaling the gas and breathe pure oxygen for a few minutes.

1. **Gastrointestinal:** Nausea and vomiting are the most frequently reported issues, affecting roughly 0.7% to 5.7% of patients, especially with given N₂O concentrations >50%, prolonged procedures, anxiety, or recent heavy meals.

Management: Stop nitrous oxide immediately, deliver 100% oxygen, and position the patient upright or in a lateral (recovery) position to prevent aspiration. Delay treatment if symptoms persist and ensure proper preoperative fasting guidelines.

2. **Neurological:** Dizziness, lightheadedness, fatigue, or a mild headache. May occur postoperatively due to mild hypoxia or dehydration.

Management: Administer oxygen at the end of the procedure and encourage adequate hydration. Analgesics can be used if necessary.

3. **Physical:** Excessive sweating, shivering, or a tingling sensation in the hands and feet.
4. **Cognitive:** Brief confusion, slurred speech, or minor hallucinations.
5. **Inadequate sedation or patient discomfort:** Some patients may not achieve sufficient anxiolysis due to individual variability or nasal obstruction.
Management: Adjust titration carefully, ensure proper mask fit, encourage nasal breathing, or consider alternative sedation techniques if ineffective.
6. **Over-sedation (excessive CNS depression):** Results from high concentrations or rapid titration, leading to symptoms such as dizziness, lethargy, poor response to verbal commands, or, rarely, loss of consciousness.
Management: Reduce or discontinue nitrous oxide, administer 100% oxygen, and verbally stimulate the patient. Monitor vital signs; recovery is usually rapid due to the low solubility of nitrous oxide.
7. **Claustrophobia or anxiety:** Some patients may feel confined or anxious due to the nasal mask, particularly children or anxious individuals.
Management: Provide reassurance, explain the procedure beforehand, allow the patient to acclimatize, or remove the mask if symptoms persist. Alternative behavior management or sedation methods may be needed.

Rare & Serious Complications

Serious adverse events (SAEs) occur in approximately 0% to 0.3% of cases.

1. **Diffusion Hypoxia:** Occurs when nitrous oxide is discontinued abruptly, causing rapid diffusion from blood to alveoli, diluting oxygen and potentially leading to headache, dizziness, or mild hypoxia.
Management: Always administer 100% oxygen for at least 3–5 minutes at the end of the procedure. Monitor the patient until fully alert and oxygen saturation is stable.
2. **Respiratory Issues:** Includes airway obstruction or hypoventilation, especially in patients with upper respiratory infections, enlarged tonsils, or obstructive sleep apnea.
Management: Maintain airway patency, reposition the head, discontinue nitrous oxide, and administer oxygen. Postpone elective treatment in compromised patients.

3. **Vitamin B12 Inactivation:** Long-term exposure in dental staff may lead to vitamin B12 deficiency, megaloblastic anemia, or neurologic effects due to interference with methionine synthase.
Management: Use effective scavenging systems, ensure proper ventilation, regularly check equipment for leaks, and minimize exposure duration.
4. **Expansion of Air Spaces:** It can dangerously increase pressure in "closed" body spaces, making it unsafe for those with a collapsed lung (pneumothorax), bowel obstructions, or recent middle ear/eye surgeries.
5. **Contraindicated condition-related complications:** Nitrous oxide can expand closed air spaces (e.g., middle ear, sinus cavities, pneumothorax).
Management: Avoid use in patients with these conditions. If symptoms arise (e.g., ear pain), discontinue immediately and administer oxygen.

General Anesthesia in Dentistry

General anesthesia (GA) in dentistry is a controlled state of unconsciousness in which patients are unable to feel pain, respond to stimuli, or retain memory of the procedure. It is typically administered by a trained anesthesiologist in a hospital or specialized dental setting, ensuring continuous monitoring of vital signs. GA is particularly useful in managing patients who cannot tolerate dental treatment under local anesthesia or conscious sedation.

Types of General Anesthesia Used in Dentistry

General anesthesia in dentistry can be broadly classified into inhalational and intravenous techniques.

- **Inhalational anesthesia** involves the use of anesthetic gases such as sevoflurane or desflurane delivered through a mask or endotracheal tube. It is commonly used for induction, especially in pediatric patients.
- **Intravenous (IV) anesthesia** uses agents such as propofol, ketamine, or thiopental to induce and maintain anesthesia. It provides rapid onset and smooth recovery.
- **Balanced anesthesia** is often employed, combining inhalational agents, IV drugs, and muscle relaxants to achieve optimal depth of anesthesia and patient stability.

Advantages

General anesthesia offers several benefits in dental practice. It allows complete control over patient movement, ensuring high-quality and efficient treatment. It is particularly beneficial for extensive or multiple procedures, as all necessary dental work can be completed in a single session. Patients experience no pain, anxiety, or psychological trauma during the procedure, which is especially important for children and individuals with special needs. Additionally, GA improves access and working conditions for the dentist, leading to better clinical outcomes.

Disadvantages

Despite its advantages, GA has notable drawbacks. It carries higher risks compared to local anesthesia or sedation, including respiratory depression, cardiovascular complications, and rare adverse reactions. The need for specialized equipment, trained personnel, and a controlled environment increases the cost. Recovery time is longer, and patients may experience postoperative effects such as nausea, vomiting, or drowsiness. Furthermore, GA is not suitable for routine dental procedures due to its complexity and risk profile.

Indications

General anesthesia is indicated in specific situations where other methods are inadequate. These include very young children who cannot cooperate, patients with severe dental anxiety or phobia, and individuals with physical, intellectual, or developmental disabilities. It is also indicated for extensive oral and maxillofacial procedures, traumatic injuries, or cases requiring multiple extractions and restorations in one visit. Patients who have failed treatment under local anesthesia or conscious sedation may also benefit from GA.

Contraindications

GA is contraindicated in patients with certain medical conditions that increase anesthetic risk, such as uncontrolled cardiovascular or respiratory diseases. Patients with a history of adverse reactions to anesthetic agents should be carefully evaluated or avoided. It is generally not recommended for minor dental procedures that can be managed with safer alternatives like local anesthesia. Additionally, lack of proper facilities, equipment, or trained personnel is a contraindication, as patient safety cannot be ensured.