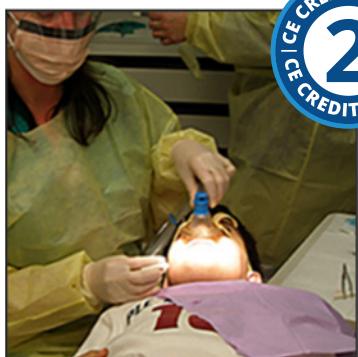


Effective Nitrous Oxide/Oxygen Administration for Children



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Conflict of Interest Disclosure Statement

- Dr. Jayakumar Jayaraman reports no conflicts of interest associated with this course. He has no relevant financial relationships to disclose.
- Dr. Schwartz was a member of the dentalcare.com Advisory Board.

Introduction - Nitrous Oxide/Oxygen for Children

Administration of nitrous oxide/oxygen analgesia/anxiolysis is a safe and effective technique for reducing and eliminating anxiety during dental treatment. This course on Effective Nitrous Oxide/Oxygen Administration for Children will describe the objectives, indications and contraindications, and technique for successful administration of nitrous oxide to the pediatric patient.

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Overview

Despite many advances in pain control in dentistry there is a population of children, and some adults that exhibit great anxiety when faced with dental treatment. A pediatric patient may express anxiety by exhibiting uncooperative behavior during dental treatment.

Administration of nitrous oxide/oxygen analgesia/anxiolysis is a safe and effective technique for reducing and even eliminating anxiety during dental treatment. This CE course will describe the objectives, indications and contraindications, and technique for successful administration of nitrous oxide to the pediatric patient.

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Understand the characteristics and properties of nitrous oxide.
- Discuss the indications and contraindications for nitrous oxide/oxygen analgesia/anxiolysis.

- Discuss the objectives of nitrous oxide/oxygen analgesia/anxiolysis.
- Choose the right patient for nitrous oxide/oxygen analgesia/anxiolysis.
- Discuss the administration technique for nitrous oxide/oxygen analgesia/anxiolysis.

Introduction

The majority of pediatric dental patients can be managed utilizing basic behavior management techniques such as desensitization (tell, show, do), voice control (alteration of voice volume, tone or pace), nonverbal communication (alteration of posture, facial expression and body language), positive reinforcement (reward, distraction, diverting the patient's attention from the procedure) and parental presence/absence.¹

For overly anxious patients that cannot be adequately managed by the above techniques, the American Academy of Pediatric Dentistry (AAPD) recognizes nitrous oxide/oxygen analgesia/anxiolysis inhalation (minimal sedation) as a safe and effective technique to reduce anxiety, produce analgesia and enhance effective communication between a patient and the health care provider. Almost 90% of pediatric dentists administer nitrous oxide to their patients to reduce or eliminate anxiety and pain during dental procedures. Nitrous oxide/oxygen administration provides multiple benefits to both patient and dentist. For the patient, nitrous oxide/oxygen provides anxiety relief and analgesia (pain control) that is safe and quickly reversed with minimal side effects. For the dentist, its administration to patients is relatively simple and safe with only moderate expense.²

Characteristics and Properties of Nitrous Oxide

The characteristics and properties of nitrous oxide are as follows:

- It reduces or eliminates anxiety.
- It cannot produce profound surgical anesthesia. It can be used as a substitute to local anesthesia in minor procedures (small restorations and a supplement to local anesthesia) but not in extensive procedures (extractions).

- It reduces the gag reflex but not the cough reflex.
- There is minimal or nonexistent toxicity when used on healthy patients for a reasonable length of time.
- It is highly insoluble in blood and water (resulting in quick absorption and elimination by the patient).
- Ninety-nine percent of its elimination from the body is through the lungs without significant biotransformation (has minimal effect on other organ systems).
- It is not metabolized through the liver (little interaction with other drugs except for enhancing the effects of sedative and anti-anxiety drugs).
- It is heavier than air with a specific gravity of 1.53. This property is helpful when introducing nitrous oxide/oxygen to an extremely anxious patient by placing the nasal hood a few inches above an anxious patient with the nitrous oxide to descending into the patient's nose, enabling gradual desensitization to the experience.
- Is gas at room temperature, but when compressed into a cylinder becomes a liquid.
- Is non-flammable; however, it can support combustion. (If placed near an open flame, will burn brighter.)
- At extreme altitudes (above 10,000 feet), there is a need for an increase in concentration (~5%) to obtain the same effect.
- Nitrous oxide is a colorless and virtually odorless gas with a faint, sweet smell. It causes central nervous system (CNS) depression and euphoria with little effect on the respiratory system.
- The analgesic effect appears to be initiated by neuronal release of endogenous opioid peptides with subsequent activation of opioid receptors and descending Gamma-aminobutyric acid type A (GABA_A) receptors and noradrenergic pathways that modulate nociceptive processing at the spinal level. The anxiolytic effect involves activation of the GABA_A receptor either directly or indirectly through the benzodiazepine binding site.
- Nitrous oxide has rapid uptake, being absorbed quickly from the alveoli and in a simple solution in the serum.
- It is relatively insoluble, passing down a gradient into other tissues and cells in the body, such as the CNS.
- As nitrous oxide is 34 times more soluble than nitrogen in blood, diffusion hypoxia may occur and administering 100% oxygen to the patient for 3-5 minutes once the nitrous oxide has been terminated is important.
- Nitrous oxide causes minor depression in cardiac output while peripheral resistance is slightly decreased, thereby maintaining blood pressure.

The objectives of nitrous oxide/oxygen inhalation include:

- Reduce or eliminate anxiety.
- Reduce untoward movement and reaction to dental treatment.
- Enhance communication and patient cooperation.
- Raise the patient's pain reaction threshold.
- Increase tolerance for longer appointments.
- Aid in the treatment of the mentally/physically disabled or medically compromised patient.
- Reduce gagging.
- Potentiate the effects of sedatives.³

Choosing the Right Pediatric Patient for Nitrous Oxide/Oxygen Administration

Nitrous oxide is indicated for selective patients. Indications for use with the pediatric patient are:

- **The fearful or anxious, yet cooperative patient.** Cooperative pediatric dental patients will exhibit a range of behaviors and emotions. Some patients will run into the treatment room, jump into the chair, open their mouth, and practically beg for treatment. Others will step warily into the treatment room, holding back tears while clinging to their parent's leg. They are full of anxiety but will remain cooperative until they experience even the smallest amount of discomfort and then the floodgates will open. This is an optimal situation for nitrous oxide/oxygen analgesia/anxiolysis. If administered before a potentially uncomfortable procedure is attempted,

nitrous oxide/oxygen analgesia/anxiolysis can prevent a behavior malfunction. However, the dentist should not assume that plopping a nitrous oxide face mask on an anxious child will magically eliminate potential problems. As will be discussed in a later section, basic behavior management techniques must be used to introduce the pediatric patient to the nitrous oxide experience.

- **The patient with a strong gag reflex.** A strong gag reflex can interfere with the most basic treatments; clinical examination (the child gags while the mouth mirror is still outside the mouth), radiographic examination, prophylaxis, and fluoride treatment, sealants, and restorative dentistry. The etiology of a strong gag reflex is attributed to physiologic, psychologic, and genetic factors. If distraction techniques (watching the procedure in a mirror, humming, or asking the patient to wiggle their toes) doesn't work, the dentist can turn to the gag reflex reduction properties of nitrous oxide. Although nitrous oxide reduces or eliminates the gag reflex it has no effect on the cough reflex so the risk of aspiration of foreign objects during treatment is not compromised.
- **The patient that is fearful of specific procedures.** The dentist will encounter patients (children and adults) that are cooperative and accepting of the dental experience, except for specific procedures, such as the "needle or shot" or the drill. The analgesic and anxiolytic properties of nitrous oxide can reduce or eliminate the difficulty in accomplishing these procedures. For those patients that are afraid of local anesthesia, nitrous oxide can raise the patient's pain threshold to the point that mildly uncomfortable procedures (periodontal scaling, curettage, and minor restorative treatment) can be accomplished without the use of local anesthesia. For those procedures where the use of local anesthesia cannot be avoided, the analgesic and anxiolytic properties of nitrous oxide can help the patient accept the discomfort and psychologic trauma of the "shot" or "drill."
- **Aid in the treatment of the mentally/physically disabled or medically compromised patient.** Patients suffering

from a mentally/physically, disabling or medically compromising condition may benefit from the use of nitrous oxide/oxygen analgesia/anxiolysis. Its effectiveness will vary from patient to patient. It may reduce the level of activity in a hyperactive child or extend the treatment time available for a patient with cerebral palsy. It is worth attempting before progressing to deep sedation or general anesthesia for treatment.

- **A patient for whom profound local anesthesia cannot be obtained.** There are times when local anesthesia is ineffective. There may be an acute infection present, or the patient may have a low pain threshold. Nitrous oxide analgesic properties raise the patient's pain threshold. Not only will it add in pain management during an uncomfortable procedure, administering nitrous oxide prior to injection may allow the dentist to administer a more comfortable injection.
- **A cooperative child undergoing a lengthy dental procedure.** Younger children may not have the ability to sit for extended periods of time. Nitrous oxide not only distorts one's perception of time, but it also improves the success of hypnotic suggestion, especially the use of imagery and storytelling.

Contraindications for Use with the Pediatric Patient

Contraindications for use with the pediatric patient are:

- **Chronologically immature child.** The effectiveness of nitrous oxide/oxygen analgesia/anxiolysis is largely dependent on psychologic reassurance. The patient, especially one who is anxious, must understand what nitrous oxide is all about and what to expect during the procedure. This can only be accomplished if the patient can understand verbal communication. Very young children (under the age of two years) may not have the maturity and ability to understand the goals and effects of nitrous oxide/oxygen analgesia/anesthesia. Physically restraining a hysterical toddler and administering a high concentration of nitrous oxide will not result in a cooperative patient. However, nitrous oxide/oxygen analgesia/anxiolysis is effective in the younger child

- when used as an adjunct to conscious sedation. (Conscious sedation should not be attempted unless the dental provider has undertaken appropriate training in its administration).
- **Behaviorally immature child.** The behaviorally immature child is one that does not behave in a manner appropriate to his/her age for reasons not due to mental retardation or physical disability. Using common terminology, the child could be described as overindulged or obstinate. This child will be uncooperative for dental treatment, not because of excessive fear or anxiety or a physical or mental disability, but because they just don't want to. Nitrous oxide/oxygen analgesia/anxiolysis cannot be successfully administered on this child until an appropriate behavior modification technique (voice control, non-verbal communication, positive reinforcement) is used to gain the child's cooperation.
 - **Specific medical conditions.** There are certain medical conditions in which nitrous oxide is contraindicated. Any condition that causes nasal obstruction such as the common cold or enlarged tonsils or adenoids that would reduce an effective amount of gas from reaching the patient's lungs is contraindicated. Nitrous oxide should be administered with caution to patients with chronic respiratory problems such as emphysema, chronic bronchitis, pneumothorax, and cystic fibrosis because of hypoxia due to increased airway resistance.
 - **Nitrous oxide is not contraindicated in patients with asthma.** It is nonirritating to the mucous membranes and since anxiety can trigger an asthmatic episode, its anti-anxiety effects can reduce the possibility of an occurrence. The same holds true for patients with sickle cell anemia. The increased levels of oxygen during nitrous oxide/oxygen analgesia/anxiolysis may reduce the occurrence of a crisis.
 - **Severe emotional disturbances or drug related dependencies.** Nitrous oxide should be administered with caution to patients under psychiatric or psychologic care. Many patients are treated with anti-depressant or psychotropic drugs. While there is minimal risk of interaction with prescribed drugs, the nitrous oxide may exacerbate the underlying condition. Nitrous oxide can be administered to these patients with medical consultation. Because of the possibility of these patients hallucinating under the influence of nitrous oxide, it is imperative that a third party remain in the room during the administration.
 - **Middle ear and ophthalmic disturbances.** Because nitrous oxide infiltrates the rigid, noncompliant area of the middle ear, increased pressure results. Also, the negative pressure from the rapid departure of nitrous oxide from the spaces at termination of administration can result in negative pressure. Therefore, nitrous oxide should be avoided in patients that have undergone surgical procedures and recent ear, nose, or throat infections. The same holds true for patients that have undergone recent ophthalmic surgery.
 - **Treatment with bleomycin sulfate.** Bleomycin sulfate is an antineoplastic agent used for the treatment of lymphomas, testicular tumors, and squamous cell carcinoma. An increase in pulmonary fibrosis and disease may occur with nitrous oxide/oxygen administration.
 - **Latex sensitivity/allergy.** Components of the nasal hoods used in nitrous oxide delivery may contain latex. For patients that are latex allergic or sensitive, non-latex delivery products may be substituted.
 - **Pregnancy.** Nitrous oxide can interfere with Vitamin B12 metabolism, which is necessary for DNA production and subsequent cellular reproduction. Therefore, it should not be administered during the first trimester of pregnancy and only after medical consultation in subsequent trimesters.
 - **Children under 3 years of age.** The FDA's Anesthetic and Life Support Drugs Advisory Committee is investigating data from animal studies suggesting that exposure to anesthetic agents during the period of rapid brain growth produces widespread neuronal apoptosis with possible long-term functional consequences. When contemplating administration of nitrous oxide to pregnant women and to patients under three years of age the benefits and risks of the surgeries

should be considered and explained to patients/parents. For medically necessary or emergency conditions, surgeries for pregnant women in the third trimester and children under three should not be delayed, however the exposure to the sedative or anesthesia should not last longer than 3 hours and should not exceed more than one exposure.^{4,5}

Pre-administration Preparations

Before proceeding with the administration of nitrous oxide/oxygen analgesia/anxiolysis, a preoperative assessment must be performed. The assessment consists of a medical history and measurement of the patient's vital signs. The medical history provides information regarding the patient's:

- Allergies and previous allergic or adverse drug reactions
- Current medications including dose time, route, and site of administration
- Diseases, disorders, or physical abnormalities and pregnancy status
- Previous hospitalizations including dates and reasons

Vital sign measurements include:

- Blood pressure
- Pulse
- Oxygen saturation (patients' receiving greater than 50% nitrous oxide/oxygen concentration should be monitored)
- Respiratory rate
- Lungs - clear or congested
- Nasal airway – clear or obstructed, nasal or mouth breather. Nitrous oxide/oxygen is inhaled through the nose. Any obstructions or tendencies that interfere with nasal breathing will reduce the amount of gas reaching the lungs and ultimately the brain.

The use of nitrous oxide/oxygen analgesia/anxiolysis should be well documented. Before administration a written informed consent should be obtained from the parent or guardian. Pretreatment dietary precautions, if indicated, should be recorded. Unless the patient has a history of vomiting, there are no fasting requirements for patients. It is recommended patients be instructed

not eat for two hours before nitrous oxide administration to minimize the possibility of vomiting and aspiration.

Additional information recorded in the chart includes:

- Reasons for recommendation of nitrous oxide/oxygen analgesia/anxiolysis (poor behavior, anxiety, extensive treatment)
- The percent of nitrous oxide/oxygen ratio and the flow rate
- Duration of the procedure
- Duration of post-treatment oxygenation
- Status of patient upon discharge (active and alert, lethargic, accompanied by adult)
- Pulse oximeter readings – pulse rate, oxygen saturation (for concentrations greater than 50% nitrous oxide/oxygen)
- Clinical observations of the patient's reaction to nitrous oxide/oxygen analgesia/anxiolysis:
 - Response to commands
 - Skin color
 - Respiratory rate and rhythm
 - Musculo-skeletal changes
 - Behavior

Table 1 and Table 2 provide a summary of characteristic patient responses to nitrous oxide/oxygen analgesia/anxiolysis.

There are three states or levels of consciousness during nitrous oxide/oxygen administration.

The first level is the Active Alert Consciousness or Induction stage. The patient is beginning to experience the sensations felt during the initial administration of nitrous oxide/oxygen analgesia. This is an introductory or preoperative stage and the patient is not ready to undergo treatment.

The second level is the Altered State of Consciousness or Maintenance stage. The patient is correctly titrated and is receiving the ideal concentration of nitrous oxide/oxygen. This is the stage the patient is most comfortable. Once the patient describes the body and sensory responses associated with this level, treatment may commence.

Chart 1. Characteristic Body Responses During N₂O/O₂ Administration.

| State of Consciousness | Age Levels | Muscles of Facial Expressions | Muscles of Mastication | Extremities |
|---|-----------------|---|--|---|
| Active Alert Consciousness (AAC) Induction Non-operating phase | Adult | No changes in these muscles. | Patient can elevate and depress mandible normally. | Parasthesia of toes, fingertips, thighs in approximately 40% of patients. Warm feeling in body. |
| | Child | There are no subjective somatic changes in children. | | |
| Altered State of Consciousness (ASC) Maintenance Operating phase | Adult | Facial expressions take on two forms. 1. If the eyes are closed the patient will exhibit a sleep-like expression. 2. If eyes remain open, there is a "trance-like" appearance due to reduced blink responses. | Mandible tends to elevate and the mouth closes more easily. However, mouth props are generally not needed for dental procedure. | Extremities feel heavy and relaxed. Arm and hand may rotate laterally and roll out of chair arm rests. Fingers may take on various positions for long periods of time. Feet may abduct. |
| | Child | Trance expression is profound. | | Mouth tends to close easily. Feet abduct. |
| Loss of Consciousness (LC) Non-operating Phase | Adult and Child | May exhibit an expression of pain due to contraction of <i>Corrugator Supercili</i> i producing the furrowed brow. <i>Orbicularis Oculi</i> contraction produces the "crows-feet" effect around the eyes. | Contraction of Temporalis, Masseter and Pterygoid closes mouth so that it cannot be forced open. Patient displays a clenched jaw appearance. | Arm and leg muscles may contract and take on a stiffened appearance. |

The third level is the Loss of Consciousness

stage. In this stage the nitrous oxide/oxygen concentration administered to the patient is too high and the patient expresses discomfort verbally and through bodily responses. If the patient exhibits these responses, treatment is stopped, the concentration of the nitrous oxide/oxygen concentration reduced and the patient is instructed to breathe through the mouth, to enhance nitrous oxide/oxygen by dilution with room air. Once the patient elicits positive responses again, treatment is continued at the reduced nitrous oxide/oxygen level.

Technique Sequence

There are two choices of induction techniques: the standard titration technique and the rapid induction technique. Both techniques use the same introductory dialogue but differ in the initial administration of gases.

Step 1 - Introduction to Nitrous Oxide

If this is the patient's first exposure to the nitrous oxide experience, the dentist must provide a full description of the experience. This will reduce anxiety in the apprehensive patient and desensitize (tell, show, do) the first-time patient to the procedure. The patient is

Chart 2. Characteristic Sensory Responses During N₂O/O₂ Administration.

| State of Consciousness | Age Levels | Descriptive | Olfactory | Ocular | Auditory | Mouth, Throat, Voice |
|---|-----------------|---|--|---|--|--|
| Active Alert Consciousness (AAC) Induction Non-operating phase | Adult | Tingling of fingers and toes. Warm sensations. | Some patients describe a sweet odor to N ₂ O. | Occasional lacrimation. At times tear will roll down sides of face. | Normal | Occasional paresthesia of the lower and upper lip. |
| | Child | | There are no subjective somatic changes in children. | | | |
| Altered State of Consciousness (ASC) Maintenance Operating phase | Adult | Floating Dreaming Relaxed | Normal | Sclera of eye may show prominent blood vessels. Pupils react to light normally. Peripheral vision is blurred. Blink reflex is normal. | Variety of auditory hallucinations. Distant sounds may appear louder. Occasionally patient hears a buzzing or a humming sound. | Speaks more slowly and quietly. Speaks with hesitation. Gag reflex is reduced. Cough reflex is normal. |
| | | | Normal | Sclera does not show prominent blood vessels. | No auditory hallucinations. | Reluctant to speak. Gag reflex is reduced. |
| Loss of Consciousness (LC) Non-operating Phase | Adult and Child | Fading away. Blacking out. | Undetermined because of communication barrier. | Eyes closed. | Cannot hear. | Does not speak, may laugh, grunt or groan. Approximately 10% of patients will laugh with intensity. |

told in terms he/she can understand, what to expect. A typical scenario follows:

"Hi. Today I'm going to fix one of your broken teeth and I want to make sure that nothing bothers you. The way I'm going to do that is by having you doing three things. First, I'm going to have you breathe some special air that's going to make you feel very relaxed and happy that you're here. As a matter of fact, to make sure you're happy, while you're breathing the happy air, I want you to think of something you really like doing. It could be playing with a friend, going on a vacation with your family, playing a video game or watching a movie."

The child patient is introduced and allowed to touch the various components of the delivery unit, dials, reservoir bag and, of course, the nasal hood. Nasal hoods come in a variety of styles, sizes, shapes, and scents. Some are disposable and some can be sterilized. When administering nitrous oxide to children, it is recommended nasal hoods be scented for a more pleasurable experience.

"We're going to start by having you blow up this balloon (the reservoir bag). You're going to do that by breathing into this funny nose (nasal hood). Now we do weird things here, so I'm going to let you pick your nose and

not get scolded (The patient usually laughs). I have different flavored noses. There's orange, bubble gum, grape, and cherry (The nasal hoods are wrapped in protective plastic to allow the child to smell the different scents without contaminating them). So go ahead and pick your nose."

For patients that are extremely apprehensive, the nasal hood is given to them to take home prior to the restorative visit. This allows them to become further desensitized to the nitrous oxide experience.

Step 2a - Standard Titration Technique

Connect the nasal hood to the hoses and adjust the flow of oxygen to a flow rate that would approximate the patient's minute respiratory volume. The minute respiratory volume is the amount of new air a person breathes in a minute. It is calculated by multiplying the patient's tidal volume (the volume of air in a normal breath) by the patient's respiratory rate per minute.

A patient's minute respiratory volume will vary with body size and age. An adult may have a greater tidal volume than a child, however, a child has a greater respiratory rate than an adult therefore the minute respiratory volumes are not that different between a child and an adult (Table 3).

It is most important that gas is flowing before placing the nasal hood over the patient's nose. It is nothing more disconcerting to an anxious patient than the inability to breathe. Unless the gas is flowing, the patient cannot breathe. One hundred percent oxygen is administered. The nasal hood is gently placed and fitted over the patient's nose so there are no leaks of gas into the surrounding environment (Figure 1,2).

Attention is now drawn to the reservoir bag. If there is sufficient flow of gas to the patient, the bag will be inflated half of its full volume and inflate and deflate in synchronization with the patient's inhalation and exhalation pattern. If too little gas is flowing, the bag will collapse. If too much gas is flowing, the bag will overinflate. Once the proper flow rate is established it remains constant throughout the procedure.

Table 3. Minute Respiratory Volume.

| | Tidal Volume | Rate | Total |
|---------------|--------------|-----------|------------------|
| Infant | 75-125 ml | 30/min | 2250-3750 ml/min |
| Child | 200-250 ml | 20-24/min | 4000-6000 ml/min |
| Adult | 400-450 ml | 12-18/min | 4800-8100 ml/min |



Figure 1. Nasal hood in correct position (side view)



Figure 1. Nasal hood in correct position (front view)

Once the correct flow rate is determined the patient's optimum nitrous oxide/oxygen concentration is titrated. The titration process begins by decreasing the oxygen flow and increasing the nitrous oxide flow to obtain a concentration of 20% nitrous oxide and 80% oxygen.



Figure 3. Overly inflated.

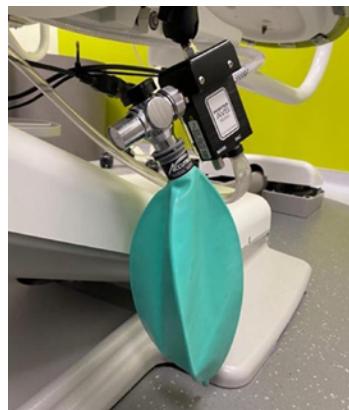


Figure 4. Under-inflated.



Figure 5. Correctly inflated.

This concentration remains at this level for three minutes. There should be minimal communication between the patient and dentist and/or auxiliary. Talking should be minimized so nasal breathing is maximized and the nitrous oxide/oxygen level remains constant during this period. At the end of three minutes, the dentist inquires of the patient what symptoms, if any, do they feel. Leading questions should be avoided, i.e., Do you feel tingling? Lightheaded? Relaxed? Asking such questions when the anxious patient is not feeling the effects of the nitrous oxide will just make the patient more anxious, for fear the gas is not working properly. The patient is asked to describe what they feel. If they respond there is no difference, the nitrous oxide/oxygen levels are adjusted to 30% nitrous oxide and 70% oxygen. The process is repeated and after three minutes the patient is once again asked to describe what they feel. If they respond in the negative, the nitrous oxide/oxygen concentration is increased to 40% nitrous oxide and 60% oxygen. This process may be repeated until the patient expresses positive symptoms. However, the concentration of nitrous oxide/oxygen may not exceed 70% nitrous oxide and 30% oxygen due to the fail-safe limitations set on the delivery unit.

Step 2b - Rapid Titration Technique

The rapid titration technique is useful for patients that are extremely anxious or are claustrophobic about having their nose covered with the nasal hood. As nitrous oxide is 1.53 times denser than air it will drop when released

into the atmosphere. If the patient expresses claustrophobia with placement of the nasal hood directly on the nose, administration is initiated with a 50% oxygen/50% nitrous oxide concentration prior to seating of the nasal hood (Figure 6). The nasal hood is positioned approximately three inches above the patient's nose. The nitrous oxide, being denser than air, will drop onto the patient's nose, the patient will inhale the gas, and hopefully, relax. As the patient relaxes, the nasal hood is brought closer to the nose until it is comfortably positioned on the patient's nose. The 50%/50% concentration is maintained for 2-3 minutes and then adjusted to 60% oxygen/40% nitrous oxide. The patient is asked to describe what they feel. As above, the concentrations and gas flow volume are adjusted until the patient feels comfortable and the reservoir bag is properly inflated.



Figure 6. Oxygen: Nitrous oxide concentration for Rapid titration technique

Step 3 - Commencing with Treatment

Once the patient exhibits the responses described in the Altered State of Consciousness section of Table 1, treatment may be commenced. Every effort should be made to maximize nasal breathing to maintain a steady level of nitrous oxide/oxygen. This includes minimal conversation with the patient and the use of rubber dam to minimize oral breathing.

Step 4 - Completion of Treatment

Five minutes prior to completion of treatment the nitrous oxide flow is terminated, and 100% oxygen is administered to the patient. Because nitrous oxide is highly insoluble and is not readily absorbed by the blood, when the flow of nitrous oxide is terminated it is rapidly removed through the lungs. During this process, nitrous oxide exits faster than the atmospheric nitrogen that replaces it, thereby, diluting the supply of oxygen and reducing the oxygen blood saturation. This condition is referred to as diffusion hypoxia and in some patients can lead to post-treatment dizziness (vertigo), headache, lethargy, and nausea. The administration of 100% oxygen for five minutes before termination of the procedures may prevent or minimize these symptoms.

Step 5 - Termination of Nitrous Oxide Administration

After five minutes of 100% oxygen administration, if the patient does not complain of dizziness, headache, nausea or lethargy, the nasal hood and the flow of gas may be discontinued. The proper sequence is removal of the nasal hood, followed by termination of gas flow. This is the reverse of the sequence at the initiation of gas administration. At the start of the procedure, the administration began by turning on the gas flow and then placing the nasal hood over the patient's nose to prevent patient anxiety due to the inability to inhale gas. Similarly, to the very last moment of the procedure we want to avail the patient of the ability to breathe normally.⁶

Adverse Effects and Toxicity

For the most part, nitrous oxide/oxygen analgesia has very few adverse effects. Nausea

and vomiting are the most common adverse effects found in 1-10% of patients and are associated with nitrous oxide concentrations more than 50% and multiple repeated fluctuations in concentration increases and decreases. Unlike general anesthesia, fasting is not required prior to administration, however patients may be advised to limit their food intake to a light meal within 2 hours of the appointment.

During clinical use for sedation at proper concentrations, nitrous oxide/oxygen has no toxic effects. Chronic exposure to nitrous oxide, especially recreational abuse, can produce neurotoxicity, impotency, and renal and liver toxicity. There is concern those dental personnel exposed to high ambient air levels of nitrous oxide during patient treatment can exhibit toxicity. Dentists and dental personnel exposed to high levels of nitrous oxide for more than 3 hours per week exhibited an increase in liver disease. Therefore, gas leakage should be reduced as much as possible. This can be accomplished by:

- Limiting patient mouth breathing using rubber dam and minimal conversation between the patient and dental personnel.
- Proper ventilation of the office environment and use to exhaust fans to eliminate ambient excessive nitrous oxide to the outside.
- Inspecting equipment each day to ensure that tubing and bags are hole free, and connections are tight.
- Using a scavenger system when administering nitrous oxide with a flow rate adjusted to 45L/min.
- Selecting an appropriately fitting mask to ensure a proper yet comfortable seal.
- Avoiding overfilling the reservoir bag.
- Schedule periodic inspections of the complete system every 3 months to check for leaks.
- Periodic monitoring of office personnel with the use of dosimetry badges.⁷

Conclusion

The availability of nitrous oxide/oxygen analgesia/anxiolysis to the pediatric patient results in a positive situation for the patient and dentist. The patient can experience dental treatment in a non-threatening comfortable environment, which will encourage returning for a lifetime of dental treatment without the anxiety and anticipation of discomfort. It provides the dentist with the opportunity to render optimum dental treatment by having the ability to concentrate on clinical technique, rather than behavior management, resulting in less stress and greater satisfaction. When used according to recommended guidelines, it is a safe method for managing patient anxiety associated with dental treatment.

Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: www.dentalcare.com/en-us/professional-education/ce-courses/ce92/start-test

- 1. Which of the following is true about nitrous oxide?**
 - A. It is soluble in blood
 - B. It is soluble in water
 - C. Biotransformation occurs in lungs
 - D. Biotransformation occurs in liver
- 2. Nitrous oxide is:**
 - A. Heavier than air
 - B. The same weight as air
 - C. Lighter than air
 - D. Its weight cannot be differentiated from the other components of air
- 3. To obtain the same effect at extreme altitudes (above 10,000 feet) the concentration of nitrous oxide must be:**
 - A. Reduced by 5%
 - B. Reduced by 10%
 - C. Increased by 5%
 - D. Increased by 10%
- 4. The analgesic action of nitrous oxide/oxygen is initiated by activation of the following receptor:**
 - A. GABA-type A
 - B. GABA-type B
 - C. GABA-type C
 - D. GABA-type D
- 5. Nitrous oxide is not indicated for a:**
 - A. Fearful or anxious, yet cooperative patient
 - B. A patient with a strong gag reflex
 - C. A 12 month child that is not cooperating
 - D. A mentally/physically disabled patient
- 6. Nitrous oxide may be administered to a patient:**
 - A. With a common cold
 - B. With an asthmatic condition
 - C. Taking bleomycin sulfate
 - D. In the first trimester of pregnancy
- 7. While being administered nitrous oxide a tear rolls down the patient's cheek. This is a sign to the dentist that:**
 - A. The patient is in the active alert consciousness stage
 - B. The patient is in the altered state of consciousness stage
 - C. The patient is entering the loss of consciousness stage
 - D. The patient is still frightened of the dental procedure to be performed

- 8. During nitrous oxide administration the patient's muscles take on a stiffened appearance. This is a sign to the dentist that:**
- A. The patient is in the active alert consciousness stage
 - B. The patient is in the altered state of consciousness stage
 - C. The patient is entering the loss of consciousness stage
 - D. The patient has recently undergone botox treatment
- 9. The ideal stage to render treatment to a patient receiving nitrous oxide is:**
- A. Active alert consciousness
 - B. Altered state of consciousness
 - C. Loss of consciousness
 - D. The second stage of anesthesia
- 10. Tidal volume is:**
- A. The volume of gas that remains in the lungs after complete expiration
 - B. The volume of gas inspired and expired with each normal breath
 - C. The volume of gas breathed after heavy exercise
 - D. The maximum volume of gas that can be inspired
- 11. Which category of patient has the largest tidal volume?**
- A. Infant
 - B. Child
 - C. Adult
 - D. They are all the same
- 12. Which category of patient has the greatest respiratory rate?**
- A. Infant
 - B. Child
 - C. Adult
 - D. They are all the same
- 13. A patient's minute respiratory volume:**
- A. Determines the concentration of nitrous oxide/oxygen administered to a patient
 - B. Determines the amount of gas administered to a patient
 - C. Is calculated by dividing the tidal volume by the patient's respiratory rate
 - D. Determines the smallest amount of gas needed to inflate the reservoir bag
- 14. Nitrous oxide should never be administered during the:**
- A. The first trimester of pregnancy
 - B. The second trimester of pregnancy
 - C. The third trimester of pregnancy
 - D. All three trimesters of pregnancy
- 15. Nitrous oxide is recommended for the following situations:**
- A. A child exhibiting a temper tantrum
 - B. A 14 month old presenting for extractions
 - C. A child sobbing quietly, yet cooperating, prior to the extraction of an abscessed tooth
 - D. All of the above.

- 16. Which is not a contraindication for nitrous oxide?**
- A. Common cold
 - B. Patients undergoing psychiatric treatment
 - C. Emphysema
 - D. Sickle cell anemia
- 17. The suggested guidelines for clinical monitoring of the patient receiving greater than a 50% nitrous oxide/oxygen concentration includes:**
- A. Use of ECG monitor
 - B. Use of a capnograph
 - C. Use of an EKG monitor
 - D. Use of a pulse oximeter
- 18. The first step when administering nitrous oxide/oxygen to a patient is?**
- A. Relax the patient by explaining the involved equipment and the sensations the patient may feel during the procedure
 - B. Begin the flow of oxygen and adjust the nasal hood
 - C. Place the nasal hood and begin the flow of oxygen
 - D. Adjust the nasal hood and titrate the patient to the correct nitrous/oxide concentration
- 19. The correct order of steps when completing a nitrous oxide/oxygen administration to a patient is:**
- A. Oxygenate the patient, discontinue the oxygen flow from the delivery unit, remove the nasal hood
 - B. Oxygenate the patient, remove the nasal hood, discontinue the oxygen flow from the delivery unit
 - C. Flush the reservoir bag with oxygen, oxygenate the patient, discontinue the oxygen flow from the delivery unit and remove the nasal hood
 - D. Remove the nasal hood and ask to patient to breathe natural air for 5 minutes
- 20. To avoid diffusion hypoxia, at the termination of treatment, it is recommended to provide 100% oxygen for minimum of**
- A. 1 minute
 - B. 2 minutes
 - C. 3 minutes
 - D. 5 minutes

References

1. American Academy of Pediatric Dentistry. Behavior guidance for the pediatric dental patient. The Reference Manual of Pediatric Dentistry. Chicago, Ill.: American Academy of Pediatric Dentistry; 2020:292-310.
2. American Academy of Pediatric Dentistry. Use of nitrous oxide for pediatric dental patients. The Reference Manual of Pediatric Dentistry. Chicago, Ill.: American Academy of Pediatric Dentistry; 2020:324-9.
3. Clark MS, Brunick AL. Handbook of nitrous oxide and oxygen sedation. St. Louis, MO. Mosby, Inc. 2003.
4. Rappaport B, Mellon RD, Simone A, et al. Defining safe use of anesthesia in children. *N Engl J Med.* 2011; 364:1387-90.
5. FDA Drug Safety Communication: FDA approves label changes for use of general anesthetic and sedation drugs in young children. Issued on April 27, 2017. Accessed November 16, 2021.
6. Wright GZ, Kupietzky A. Behavior Management in Dentistry for Children. Ames, IA. Wiley Blackwell, 2014.
7. Baum VC. When nitrous oxide is no laughing matter: nitrous oxide and pediatric anesthesia. *Paediatr Anaesth.* 2007; 17:824-30.

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Dr. Jayaraman is a Pediatric Dentist with clinical and research training from India, Hong Kong, England and the United States. He obtained master's degrees in Pediatric Dentistry from the University of Hong Kong and the University of Texas Health San Antonio. Dr. Jayaraman also received his Diploma in Pediatric Dentistry and Fellowship at the Royal College of Surgeons of Edinburgh, United Kingdom where he also serves as an Examiner. For the past 10 years he has taught Pediatric Dentistry and supervised research projects for pre-doctoral, post-doctoral and PhD students in different countries. His research involves topics in Evidence-Based Dentistry, Forensic Dentistry, Human Biology & Anthropology. Dr. Jayaraman has published over 50 peer-reviewed scientific articles and reviewed articles for several leading pediatric, forensic, and multi-disciplinary journals. He serves as an Associate Editor for the *Frontiers in Dental Medicine* Journal and an Editorial Board Member of the *International Journal of Pediatric Dentistry*. Dr. Jayaraman is currently Associate Professor of Pediatric Dentistry at Virginia Commonwealth University, Richmond.

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Steven Schwartz, DDS



The P&G team wishes to express its sadness over the loss of our colleague and friend, Dr. Steven Schwartz, who passed away on October 25, 2018. He was a tremendous help on impacting thousands of dental professionals through CE, making dentalcare.com one of the best CE providers in the world. He was a wonderful person! We will miss him.

Dr. Steven Schwartz was the former director of the Pediatric Dental Residency Program at Staten Island University Hospital and was a Diplomate of the

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