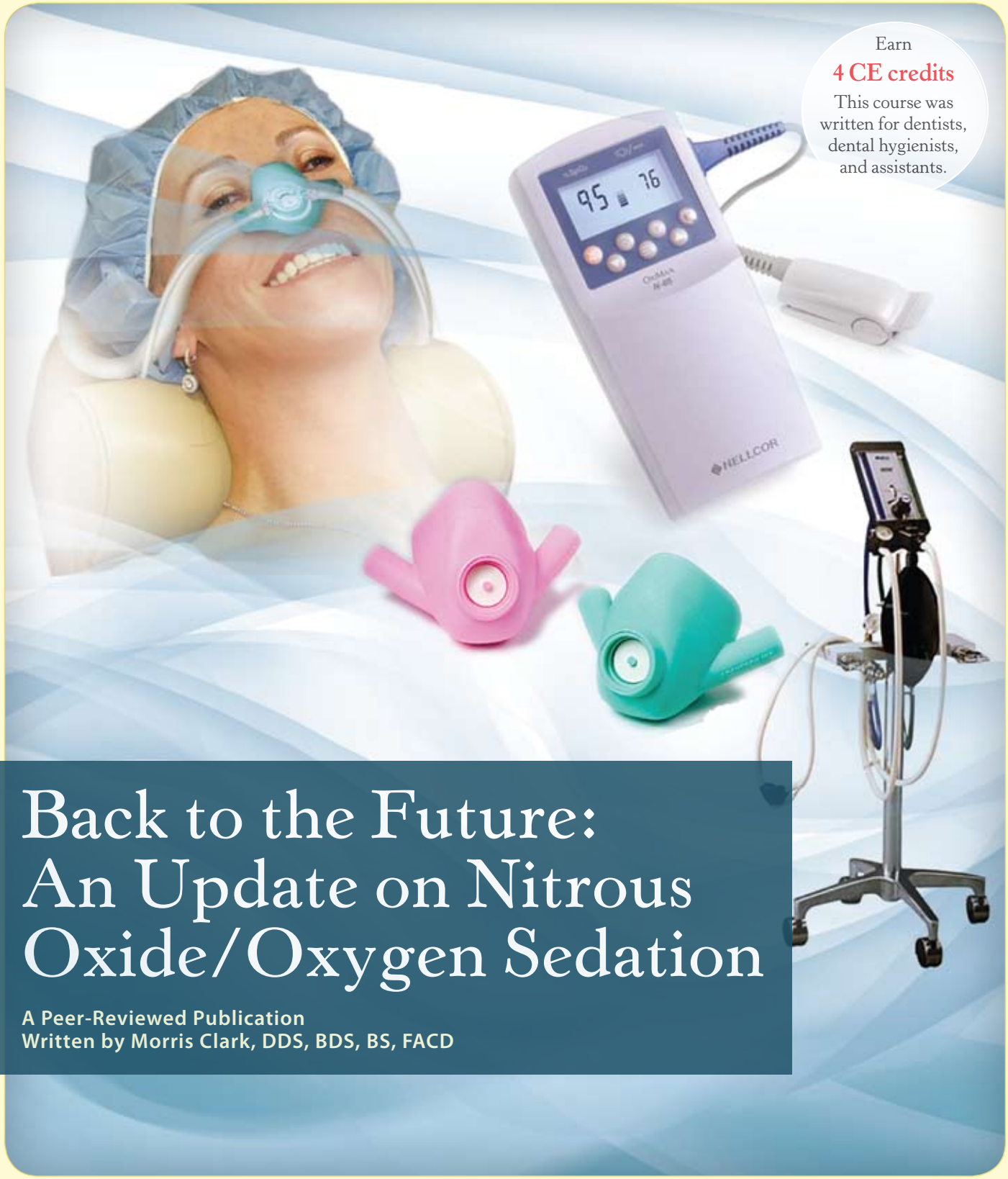

Back to the Future: An Update on Nitrous Oxide/Oxygen Sedation

A Peer-Reviewed Publication
Written by Morris Clark, DDS, BDS, BS, FACD

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Educational Objectives

Upon completion of this course, the clinician will be able to do the following:

1. Know and describe the indications for nitrous oxide/oxygen conscious sedation
2. Know and describe the contraindications for nitrous oxide/oxygen conscious sedation
3. Discuss the considerations and precautions for patients and staff associated with nitrous oxide use
4. Understand the physiology and method of administration of nitrous oxide, including any safety requirements

Abstract

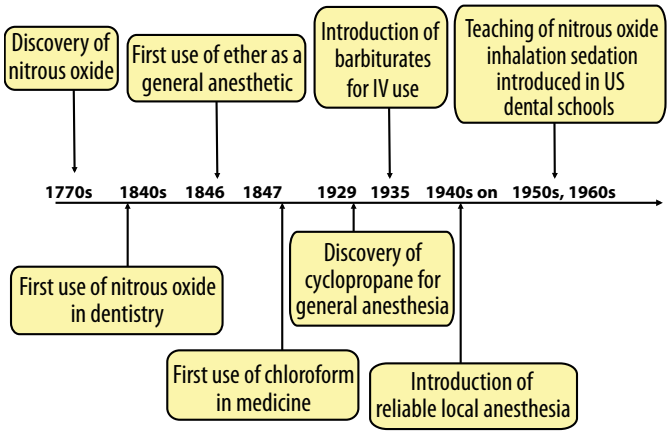
Modern general anesthesia and conscious sedation procedures are predictable, effective, and safe with appropriate patient selection, drugs and techniques. The use of conscious sedation in dentistry in office-based settings continues to increase. Nitrous oxide is the most commonly used inhalation anesthetic (sedative) used in dentistry, and has withstood the test of time with an excellent safety record. It reduces anxiety, pain, and memory of the treatment experienced, and is a valuable component of the armamentarium available to clinicians.

Introduction

Analgesics, sedatives, and anesthetics have been sought for centuries to control pain during surgical procedures and to relieve pain. The use of opium as an analgesic was recorded in Sumeria almost four thousand years ago, while approximately two thousand years ago a wine and mandrake combination was used before amputations.[1] In more recent times, English sailors were given rum to try to anesthetize them prior to limb amputation on board sailing vessels.[2] Two English scientists, Joseph Priestly and Sir Humphrey Davy, are credited respectively with discovering nitrous oxide, and realizing its potential use for anesthesia. Priestly discovered that by heating ammonium nitrate with iron filings mixed in he could create a gas, detoxify it by passing it through water, and store it as nitrous oxide. Later, Davy inhaled nitrous oxide and, after discovering some of its effects, introduced it to English society as a recreational drug, where it gained the name "laughing gas." Its first use in dentistry was in the 1840s by Horace Wells, an American dentist who inhaled nitrous oxide prior to the removal of one of his molar teeth.[3] During the procedure, Dr. Wells remained conscious but experienced no pain. He is recognized as the father of anesthesia. Subsequently, other agents were introduced that provided conscious sedation and/or pain relief, or general anesthesia. The first general anesthetic drug was ether, which was used on a patient in 1846 by another American dentist (Dr. William Morton) before the removal of a neck tumor.[4] Later, chloroform was introduced.

Since then, the science and practice of pharmacological anesthesia and conscious sedation have developed enormously. Modern general anesthesia and conscious sedation procedures are predictable, effective, and safe with good patient selection and the use of appropriate drugs and techniques. Their use has expanded in both hospital and office-based settings in recent years. In medicine, the number of office-based (ambulatory surgery center-based) anesthesia procedures is increasing more rapidly than are hospital-based procedures.[5] Conscious sedation is used for office-based patients in dentistry as well as in medicine. It has been found to be efficacious, reliable, and more cost-effective than general anesthesia.[6] The use of conscious sedation in dentistry in office-based settings continues to increase, with a number of agents available. Pharmacological agents and techniques used in dentistry for sedation include enteral sedation with benzodiazepines and intravenous conscious sedation using a variety of agents, including midazolam alone or with the addition of other agents (for example, fentanyl and propofol). With multiple drug regimens extra caution must be exercised.[7]

Figure 1. The development of anesthetic and sedation agents



Source: Clark MS, Brunick AB. Handbook of nitrous oxide and oxygen sedation. 3rd Edition, Mosby, 2008.

Of the three anesthetic/sedation agents first introduced – nitrous oxide, ether, and chloroform – only nitrous oxide is still used. Nitrous oxide is the most commonly used inhalation anesthetic (sedative) used in dentistry and has an excellent safety record.[8,9,10] It reduces anxiety, pain, and the memory of the treatment experienced.

Nitrous oxide reduces anxiety and pain and has an excellent safety record.

Indications for Nitrous Oxide in Dentistry

Nitrous oxide/oxygen conscious sedation is frequently used in oral surgery, particularly in the extraction of third molars, periodontal surgery, and in patients with behavioral or developmental issues.

Fear and Anxiety

Mild anxiety and fear are normal reactions to situations that a person finds threatening, while phobias are irrational.[11] Anxiety and fear experienced by dental patients range from mild anxiety to phobic fear, and represent a barrier to care. The main factors related to fear or anxiety about dental treatment are fear of pain,

needles, and/or the noise and sensation induced by the use of handpieces. Fear of needles and pain were responsible for up to 28% and 21% of adult patients, respectively, reporting in surveys not visiting the dentist.[12,13] A number of techniques are available to reduce fear and anxiety and increase cooperation with treatment. These include behavioral techniques and communication.[14] Hypnosis has been used to reduce fear, reduce the perception of pain, and to alter memory – although not all patients are suggestable for hypnosis; acupuncture and acupressure have also been used.[15,16] Noise masking, aural and visual stimulation, and virtual reality have all been used and collectively form distraction techniques. Pharmacological options include oral medications such as diazepam, taken shortly before dental visits, and conscious sedation with nitrous oxide.

The main indication for nitrous oxide conscious sedation is to reduce fear in patients. Conscious sedation with nitrous oxide/oxygen reduces pain and anxiety in anxious and fearful patients, including those who are phobic and unreceptive to other techniques and for whom the only other alternative may be general anesthesia.[17] In particular, phobic and fearful children who are too young and/or unable to cooperate or overcome their fears are candidates for conscious sedation to enable necessary care and without further trauma.[18,19] Nitrous oxide/oxygen sedation significantly improves cooperation in fearful children.[20] Restraint for children is an option that is controversial and traumatizes them, whereas conscious sedation reduces fear and anxiety and alleviates pain, which may encourage rather than discourage future cooperation.

Nitrous oxide/oxygen sedation can significantly improve cooperation with dental treatment.

Special Needs Patients

Functional and cognitive deficits can make dental treatment difficult for special needs patients. As with fearful patients, behavioral interventions may be helpful. In some circumstances, physical support or protective stabilization is used. Nitrous oxide/oxygen sedation is an effective method to enable treatment in patients with reduced mental development as well as other special needs patients.[21,22] Consideration must be given to the ability of the patient to communicate any changes and to understand the procedure.

Specific Procedures

Nitrous oxide/oxygen is utilized for procedures where the efficacy of local anesthesia may be reduced and for potentially more painful procedures – these include oral surgery, periodontal therapy, and some endodontic procedures. Its use is routine in many dental offices during extraction of third molars. For these feared and potentially painful procedures, patients actively request sedation. Demand was found in one survey to range from just 2% for routine prophylaxis to up to 68% for periodontal surgery (Table 1).[23]

Table 1. Demand for sedation or anesthesia by procedure

Routine dental cleaning	2%
Extraction	47%
Endodontic therapy	55%
Periodontal therapy	68%

Source: Chanpong B, et al. Anesth Prog. 2005;52(1):3–11.

Other Conditions/Situations

Many conditions can be exacerbated by stress, including the stress of dental treatment. These include cardiovascular conditions such as hypertension, angina and previous myocardial infarction, and cerebrovascular accidents. For these patients, nitrous oxide sedation can be used to alleviate anxiety (stress). Nitrous oxide sedation also minimizes hyperactive gag reflexes in patients. Most asthmatics can safely receive nitrous oxide/oxygen sedation, which can reduce stress (a trigger for asthma). It is contraindicated in severe asthmatics.

Table 2. Indications for nitrous oxide/oxygen sedation

Fear and anxiety
Pain
Special needs
Complicated, potentially painful procedures
Relief of stress
Gag reflex

Relative Contraindications

There are a number of relative contraindications to the use of nitrous oxide, though no known absolute contraindications. If patients are unable to breathe adequately through their noses, insufficient nitrous oxide will be inhaled for sedation. These patients include those with upper respiratory tract infections (such as colds and influenza), blocked sinuses, blocked nasal passages due to allergies, and mouth breathers. Nitrous oxide should not be administered to patients who have received ocular surgery that included introducing a gas bubble in the eye (perfluoropropane or sulfur hexafluoride), as nitrous oxide inhalation can result in the gas bubble expanding and causing eye damage or delaying post-surgical healing.[24] Similarly, patients who have undergone middle ear surgery (tympanic membrane graft) should not receive nitrous oxide sedation. The distending ability of nitrous oxide gas can also be problematic in patients with colostomy bags or bowel obstructions, as well as in patients with blocked eustachian tubes (the tympanic membrane can become distended following inhalation of the gas). Cystic fibrosis patients are relatively contraindicated due to the cystic spaces present that may become distended.

In patients receiving bleomycin sulfate therapy for neoplasms, an increased incidence of pulmonary fibrosis and other lung diseases is found.[25] Pneumoencephalography, pneumothorax, and chronic obstructive pulmonary disease (COPD) are additional relative contraindications to nitrous oxide/oxygen sedation. Pa-

tients with hypoxic drive, whereby their breathing is regulated by the drive to breathe when hypoxia is present as opposed to breathing by normal biophysiological feedback mechanisms, are at slightly increased risk during nitrous oxide sedation.

The mood-altering effects of nitrous oxide may be a contraindication in patients with some mental or psychiatric conditions, patients with drug addictions or recovering from addictions, patients under the influence of drugs or alcohol, and patients self-administering barbiturates. Patients with true phobias, as well as those taking sleep-inducing medication, antidepressants, or psychotropic drugs should be evaluated carefully before nitrous oxide sedation is considered.[26] Nitrous oxide use in pregnant women should be avoided during the first trimester, as if any damage to the fetus occurs, sedation with nitrous oxide could be automatically implicated. Before using nitrous oxide sedation in any pregnant patient, the patient's physician or ob/gyn should be consulted.

Table 3. Relative contraindications for nitrous oxide/oxygen sedation

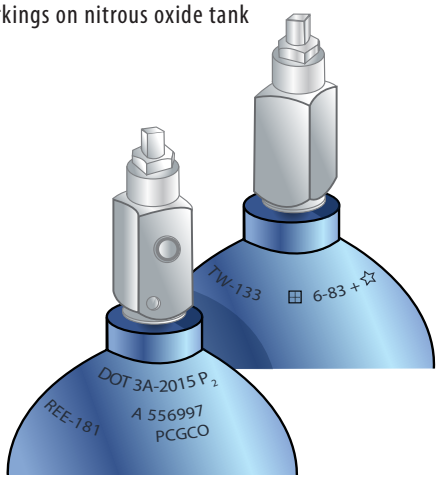
Impediments to adequate breathing
Drug and substance abuse
Mental disorders
Pregnancy
Recent middle ear surgery
Surgical treatment to the ocular area with a gas bubble
Conditions where gas distention is problematic
Use of antidepressants, psychotropic drugs, sleep-inducing medication
Bleomycin sulfate therapy
Severe cardiac conditions
Cystic fibrosis
Unknown or dubious medical history or health status

Physical Properties

Nitrous oxide gas is produced by heating ammonium nitrate crystals to around 250°C, then scrubbing, compressing, and liquefying the gas before placing it in pressurized tanks ready for use. When used, it is present as both a liquid and a gas in the tank and vaporizes at room temperature as it is used. The color of the nitrous oxide tank varies by country – in both the United States and Canada, nitrous oxide tanks are always blue, and the pressure will measure around 750 pounds per square inch (psi) at 70°C (less at lower temperatures), irrespective of the size of the tank or the quantity of nitrous oxide remaining in it. Once there is no liquid phase remaining in the tank, the pressure will start to drop. The shoulder of the nitrous oxide cylinder is marked with information including (but not restricted to) the brand, manufacturer's test date and serial number, inspector's mark, and DOT specification and service pressure.[27] The oxygen tank used during nitrous oxide/oxygen sedation is green in the United States and white in Canada, with other colors used in a number of countries. Unlike nitrous oxide cylinders, as the amount of oxygen in the tank decreases the pressure decreases proportionately.

Figure 2. Mobile units used for nitrous oxide/oxygen sedation

Figure 3. Markings on nitrous oxide tank



Adapted from: Clark MS, Brunick AB. Handbook of nitrous oxide and oxygen sedation. 3rd Edition, Mosby, 2008.

Physiology and Nitrous Oxide

Nitrous oxide possesses a minimum alveolar concentration (MAC) of 104%, making it impossible to induce general anesthesia with nitrous oxide below a concentration of 100% and without hyperbaric conditions. Nitrous oxide sedation appropriately administered is safe for normal, healthy patients and its effects on the cardiovascular and respiratory systems are minimal. Although a mild myocardial depressant, it has a mild central sympathetic stimulatory effect that offsets this and it lacks potency (nitrous oxide sedation in patients with severe cardiac disease may have stronger physiological effects and therefore its use may be contraindicated).

Nitrous oxide has a low blood/gas partition coefficient (0.47), so only minimal amounts dissolve in blood. The fast onset and quick recovery seen with nitrous oxide/oxygen sedation is due to its rapid diffusion and saturation in blood. At a concentration of 50% to 70%, rapid uptake occurs from the alveoli to the pulmonary circulation and simultaneously creates a vacuum in the

lungs that helps to pull more gas into the alveoli. (If nitrous oxide has been used adjunctively with a potent inhalational general anesthetic agent such as sevofluorane, both the nitrous oxide and the anesthetic agent are pulled into the lungs and have a faster onset and quicker recovery.)

Nitrous oxide/oxygen sedation has a fast onset and rapid recovery.

The fast onset and quick recovery associated with nitrous oxide use are a function of concentration gradients. After nitrous oxide sedation is finished, the nitrous oxide is quickly diffused back into the lungs along with oxygen and other gases. Due to this, oxygen exchange into the lungs and circulation is impaired, which can result in 'Diffusion Hypoxia.' For this reason, patients should receive 100% oxygen for three to five minutes following cessation of nitrous oxide administration to prevent any possibility of hypoxia.

Figure 4. The lungs and alveoli

Considerations and Precautions for Patients and Staff

Patients must complete or, in the case of existing patients, update a detailed medical history prior to receiving care or being considered candidates for nitrous oxide/oxygen sedation. If there is any doubt that the patient is a suitable candidate, use of nitrous oxide/oxygen sedation should be postponed until the patient's physician or specialist has been consulted. It is essential that the patient (or parent or guardian) complete and sign an informed consent form after discussion of the sedation and treatment and before receiving treatment – otherwise, legal ramifications exist. Patients must receive written instructions, and thorough contemporaneous records must be kept.[28] One unit (Accutron) offers an adjunctive device that prints out the flow of gas and percentage of nitrous oxide administered to a patient, which then becomes part of the patient record.

Nitrous oxide abuse by dental healthcare professionals can occur. It is important to monitor the amount of nitrous oxide used for dental treatments – should a discrepancy occur between the actual and expected volume present, abuse should be considered as a possible explanation. Repeated exposure to high levels of nitrous oxide does have negative consequences, including possible teratogenic and reproductive effects. Chronic nitrous oxide exposure results in inactivation of methionine synthease, a Vitamin B-12 dependent enzyme. Neurologic dysfunction, megaloblastic anemia, bone marrow depression and peripheral cytopenia can all occur with repeated or long exposure to nitrous oxide (whether occupational or related to nitrous oxide abuse).

Figure 5. Adjunct print-out device

Scavenging is essential during nitrous oxide/oxygen sedation. It is important that room ventilation and scavenging are adequate to prevent the build-up of nitrous oxide in dental operatories.[29] Nasal hoods contain scavengers that remove exhaled nitrous oxide through a vacuum to the outside world, reducing the possibility of build-up of nitrous oxide in the dental office.

Scavenging is essential during nitrous oxide sedation.

It is unacceptable and substandard care to use a nasal hood that does not include scavenging.

Figure 6. Nasal hoods with scavengers

Handheld monitoring devices can be used to assess the trace levels of nitrous oxide present in the office and the effectiveness of the scavenging.

Figure 7. Handheld monitoring device

Administration of Nitrous Oxide

Either a centralized unit with nitrous oxide/oxygen piped into each operatory or a mobile unit can be used to administer nitrous oxide/oxygen sedation. Modern units have flowmeters that prevent too high a concentration of nitrous oxide being given, by cutting off the flow of nitrous oxide if the ratio of nitrous oxide to oxygen is greater than 70%/30%. The reservoir bag used during sedation provides a reservoir of gas, allows the clinician to monitor a patient's respiration by watching the inflation and deflation of the reservoir bag, and provides an emergency mechanism to supply oxygen. In dental offices, a latex-free nasal hood (or mask) is used to administer the gases. All hoses and connections used as part of the sedation equipment are also latex-free.

Figure 8. Patient in chair with nasal hood in position during sedation

Prior to nitrous oxide sedation, the patient must be screened, an assessment of his or her health and risk made, and vital signs measured to check that they are within normal ranges. In addition, the airway should be evaluated using a stethoscope. The patient should also have been advised not to eat a heavy or fatty meal shortly before nitrous oxide sedation to avoid nausea and reduce any risk of vomiting. To administer sedation, the patient should be seated in the operatory chair, and a moderate percentage of nitrous oxide/oxygen given.

Typically, patients are titrated easily by increasing the amount of nitrous oxide until the desired sedation is achieved. During sedation procedures it is essential that a staff member is in the operatory with the clinician, to be at hand should an emergency occur and to avoid the possibility of the clinician being incorrectly accused of and litigated for inappropriate sexual advances while the patient was sedated and in an altered mental state that could include sexual dreams.

Figure 9. Flowmeter

It is essential if nitrous oxide is administered to pregnant women to ensure an appropriate mix of nitrous oxide and oxygen, as insufficient oxygen can result in spontaneous abortion.

Indications that the desired level of sedation has been achieved include the patient being relaxed, positive, comfortable, less alert, and less anxious or fearful; relaxed limbs and shoulders; and deeper breathing. With an excessive level of sedation, signs and symptoms include irritation, an inability to communicate, lightheadedness, and nausea.

In children, in addition to the medical history used for patients of all ages, the clinician should check for enlarged tonsils and adenoids as well as other anatomical abnormalities that could affect breathing, and ask about middle ear disturbances or abnormalities. The minimum amount and concentration of nitrous oxide should be given to produce the desired effect. Children are more prone to vomit following administration of nitrous oxide and should not be given heavy meals before sedation. Aspiration of any vomit must be avoided. The dose of nitrous oxide

Table 4. Steps in nitrous oxide/oxygen administration

1.	Full medical and dental history
2.	Informed, written consent
3.	Screening and assessment of health status
4.	Measurement of vital signs
5.	Airway evaluation
6.	Patient seated in the operatory chair
7.	Titration of nitrous oxide using a nasal hood with scavenger
8.	Maintenance of desired level of sedation
9.	Use of a pulse oximeter for patients receiving more than 50% nitrous oxide
10.	Administration of pure oxygen for three to five minutes after completion of the procedure and termination of sedation, or longer if necessary until the patient feels completely normal again
11.	Discharge of patient with written instructions

required for sedation in a child does not have a relationship with the weight of the child, and dosing should be in 10% incremental concentrations of nitrous oxide to achieve sedation.

Figure 10. Pulse oximeters

For *all* patients receiving moderate sedation (more than 50% nitrous oxide), the use of a pulse oximeter to measure the concentration of oxygen in the blood is required in accordance with the guidelines of the ASA Practice Guidelines for Non-Anesthesiologists. Following completion of the procedure and upon cessation of nitrous oxide administration, the patient should receive 100% oxygen for three to five minutes or longer if necessary until the patient experiences no abnormal sensations. At that time, the patient can leave the dental office in a relaxed manner, after an experience that was more pleasant than would have been possible without the use of nitrous oxide/oxygen sedation.

Summary

A number of pharmacological agents and techniques are used in dentistry to achieve conscious sedation, enteral sedation, and anesthesia. The most commonly used conscious sedation technique in the dental office is the administration of nitrous oxide/oxygen. Nitrous oxide offers patients the possibility of receiving dental care with a reduced level of fear and anxiety and reduced pain. Demand for nitrous oxide/oxygen sedation continues to increase. It has withstood the test of time; reduces barriers to care for fearful, phobic, and special needs patients; is safe and efficacious; and aids the provision of care by clinicians.

Glossary of Terms

Conscious sedation: A state of anesthesia in which the patient is rendered free of fear and anxiety and is still conscious

Enteral sedation: Sedation given by sublingual, oral, or rectal administration

Flowmeter: An instrument that is used to monitor, measure, or record the rate of flow (discharge) of a gas (or fluid)

Hypoxia: A state in which insufficient oxygen reaches the blood

Informed, written consent: Consent of a patient (or parent or guardian) in writing after explanation and understanding of the procedure (and alternative procedures) for which consent is being obtained

Minimum alveolar concentration (MAC): The alveolar concentration required to render 50% of patients motionless after painful surgical stimulation

Oximeter: A photoelectric instrument used to measure the level of oxygen saturation in the blood

Titration: The incremental dosing of a drug until the desired effect is obtained

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Author Profile

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Dr. Morris Clark is currently Professor of Oral and Maxillofacial Surgery and Director of Anesthesiology at the University of Colorado School of Dentistry. He is a graduate of the University of California San Francisco School of Dentistry and completed his residency in Oral and Maxillofacial Surgery at Columbia University, New York. He has been a member of the Board of the American Dental Society of Anesthesia for the past 15 years, and is a member of the American Society of Oral and Maxillofacial Surgeons, the American Dental Association, the Metropolitan Denver Dental Society in Denver, Colorado, and the International Federation of Dental Anesthesiology Society. Dr. Clark is the author of more than 100 publications and manuscripts and the author of the best-selling textbook on nitrous oxide 'Handbook of Nitrous Oxide and Oxygen Sedation'.

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Questions

1. Joseph Priestly and Sir Humphrey Davy are credited with discovering _____ and realizing its potential use for _____.
   a. carbon dioxide; anesthesia
   b. nitrous oxide; anesthesia
   c. carbon monoxide; sedation
   d. none of the above

2. Dr. Horace Wells is recognized as the father of anesthesia.
   a. True
   b. False

3. Techniques available to reduce fear and anxiety include _____.
   a. behavioral techniques and communication
   b. acupuncture and acupressure
   c. distraction
   d. all of the above

4. Nitrous oxide/oxygen sedation _____ .
   a. can be used for special needs patients
   b. reduces anxiety and fear in adults and children
   c. is given prior to potentially painful procedures
   d. all of the above

5. Nitrous oxide is the most common inhalation anesthetic used in dentistry.
   a. True
   b. False

6. Patient demand for sedation for periodontal surgery and some endodontic procedures has been found to be _____ and _____, respectively.
   a. 48%; 55%
   b. 65%; 58%
   c. 68%; 55%
   d. 70%; 55%

7. Nitrous oxide should not be administered to patients who have received ocular surgery that included introducing a gas bubble in the eye (perfluoropropane or sulfur hexafluoride), as nitrous oxide inhalation can result in _____.
   a. the gas bubble expanding and causing eye damage or delaying postsurgical healing
   b. the gas bubble contracting and causing scarring as a result of tension
   c. the gas in the bubble will dissipate causing eye damage
   d. any of the above

8. Asthma is usually a contraindication for the use of nitrous oxide/oxygen sedation.
   a. True
   b. False

9. The distending ability of nitrous oxide gas can be problematic in patients with _____.
   a. colostomy bags or bowel obstructions
   b. blocked eustachian tubes or a tympanic membrane graft
   c. cystic fibrosis
   d. all of the above

10. Nitrous oxide tanks are always _____ in the United States and Canada.
    a. green
    b. blue
    c. white
    d. yellow

11. As the amount of nitrous oxide in the nitrous oxide tank decreases, the pressure decreases proportionately.
    a. True
    b. False

12. Nitrous oxide possesses a minimum alveolar concentration of 104%, making it _____.
    a. impossible to induce general anesthesia with nitrous oxide below a concentration of 100% and without hyperbaric conditions
    b. possible to induce general anesthesia with nitrous oxide below a concentration of 100%
    c. impossible to induce general anesthesia with nitrous oxide above a concentration of 100%
    d. none of the above

13. The fast onset and quick recovery seen with nitrous oxide/oxygen sedation is due to its _____.
    a. rapid diffusion and dilution in blood
    b. rapid diffusion and saturation in blood
    c. slow diffusion and saturation in blood
    d. none of the above

14. Patients should receive 100% oxygen for three to five minutes following cessation of nitrous oxide administration, to prevent the possibility of hypoxia.
    a. True
    b. False

15. Should a discrepancy occur between the actual and expected volume of nitrous oxide present in the tank following treatments, _____.
    a. this is of no concern
    b. abuse should be considered as a possible reason
    c. it should be assumed the patient inhaled more than you thought
    d. all of the above

16. Scavenging is essential during nitrous oxide/oxygen sedation.
    a. True
    b. False

17. It is essential that the patient (or parent or guardian) complete and sign an informed consent form after discussion of the sedation and treatment and before receiving treatment.
    a. True
    b. False

18. Handheld monitoring devices can be used to assess _____ and _____.
    a. the trace levels of nitrous oxide present in the office; the effectiveness of sedation
    b. the levels of carbon dioxide present in the office; the effectiveness of the nitrous oxide scavenging
    c. the trace levels of nitrous oxide present in the office; the effectiveness of the scavenging
    d. none of the above

19. Modern units for nitrous oxide/oxygen sedation have flowmeters that cut off the flow of nitrous oxide if the ratio of nitrous oxide to oxygen is greater than _____.
    a. 30%/70%
    b. 55%/45%
    c. 70%/30%
    d. none of the above

20. Prior to nitrous oxide sedation, the airway should be evaluated using a stethoscope.
    a. True
    b. False

21. Typically, patients are titrated easily by increasing the amount of nitrous oxide until the desired sedation is achieved.
    a. True
    b. False

22. During sedation procedures it is essential that a staff member is in the operatory with the clinician to _____.
    a. be at hand should an emergency occur
    b. be at hand to provide sedation in case the clinician is called away
    c. avoid the possibility of the clinician being incorrectly accused of inappropriate sexual advances
    d. a and c

23. The dose of nitrous oxide required for sedation in a child has a relationship with the weight of the child.
    a. True
    b. False

24. Indications that the desired level of sedation has been achieved include the patient _____.
    a. being relaxed, positive, comfortable
    b. having relaxed limbs and shoulders
    c. breathing more deeply
    d. all of the above

25. It is essential if nitrous oxide is administered to pregnant women to ensure an appropriate mix of nitrous oxide and oxygen, as insufficient oxygen can result in _____.
    a. morning sickness
    b. spontaneous abortion
    c. delayed labor
    d. all of the above

26. For all patients receiving more than 50% nitrous oxide, the use of a pulse oximeter to measure the concentration of oxygen in the blood is required in accordance with the guidelines of the ASA Practice Guidelines for Sedation and Analgesia by Non-Anesthesiologists.
    a. True
    b. False

27. With an excessive level of nitrous oxide sedation, signs and symptoms include _____.
    a. nausea
    b. lightheadedness and an inability to communicate
    c. irritation
    d. all of the above

28. In children, nitrous oxide dosing should be in 10% incremental concentrations to achieve sedation.
    a. True
    b. False

29. Minimum alveolar concentration (MAC) refers to the alveolar concentration _____.
    a. required to render 30% of patients motionless after painful surgical stimulation
    b. required to render 50% of patients motionless after painful surgical stimulation
    c. required to reach a concentration of 50% in the alveoli
    d. none of the above

30. Demand for nitrous oxide/oxygen sedation continues to increase.
    a. True
    b. False

ANSWER SHEET

Back to the Future: An Update on Nitrous Oxide/Oxygen Sedation

Name: Title: Specialty:

Address: E-mail:

City: State: ZIP: Country:

Telephone: Home ( ) Office ( )

Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 4 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp.

Educational Objectives

1. Know and describe the indications for nitrous oxide/oxygen conscious sedation
2. Know and describe the contraindications for nitrous oxide/oxygen conscious sedation.
3. Discuss the considerations and precautions for patients and staff associated with nitrous oxide use
4 Understand the physiology and method of administration of nitrous oxide, including any safety requirements.

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?	Objective #1:	Yes	No	Objective #3:	Yes	No	
	Objective #2:	Yes	No	Objective #4:	Yes	No	
2. To what extent were the course objectives accomplished overall?	5	4	3	2	1	0	
3. Please rate your personal mastery of the course objectives.	5	4	3	2	1	0	
4. How would you rate the objectives and educational methods?	5	4	3	2	1	0	
5. How do you rate the author's grasp of the topic?	5	4	3	2	1	0	
6. Please rate the instructor's effectiveness.	5	4	3	2	1	0	
7. Was the overall administration of the course effective?	5	4	3	2	1	0	
8. Do you feel that the references were adequate?		Yes		No			
9. Would you participate in a similar program on a different topic?		Yes		No			

10. If any of the continuing education questions were unclear or ambiguous, please list them.

_____

11. Was there any subject matter you found confusing? Please describe.

_____

_____

12. What additional continuing dental education topics would you like to see?

_____

_____

Mail completed answer sheet to

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A Division of PennWell Corp.
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3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

AGD Code 153

PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

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