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RESEARCH ARTICLE

NITROUS OXIDE SEDATION IN PEDIATRIC DENTISTRY: A NEW APPRAISAL

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Abstract

Purpose: The American Academy of Pediatric Dentistry (AAPD) identifies nitrous oxide/oxygen inhalation as a safe and effective procedure to moderate anxiety, produce analgesia, and improve effective communication between a patient and health care provider. The prerequisite to diagnose and treat, as well as the safety of the patient and practitioner, should be measured before using nitrous oxide. By creating this guideline, the AAPD intends to support the dental profession in developing appropriate practices in the use of nitrous oxide/oxygen analgesia/anxiolysis for pediatric patients.

Methods: This guideline is established on an assessment of the present dental and medical literature correlated to nitrous oxide/oxygen analgesia/ anxiolysis in pediatric patients. A MEDLINE examination was directed using the positions nitrous oxide, analgesia, anxiolysis, behavior management, and dental treatment.

Background: Dentists have proficiency in providing anxiety and pain control for their patients. While anxiety and pain can be modified by psychological techniques, in various instances pharmacological approaches are required. Analgesia/anxiolysis is defined as diminution or eradication of pain and anxiety in a conscious patient.

Conclusion: A patient with a non-collaborative profile in the pediatric dental office entails a specific method for effective treatment and for the child's safety. If psychological procedures are unproductive, inhalation conscious sedation should be considered as a worthwhile possibility. Sedation with N₂O-O₂ is mentioned in specific cases when it is supported by behavior control techniques that can deliver more safety and comfort for children during the dental treatment. Specific training in this extent is essential for the professional medical team as well as a profound knowledge of the technique itself so that the country's laws and regulation are realistic without endangering the patient's health.

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Introduction:-

Conscious sedation is a technique in which one or more pharmacological agents are employed to produce a mild depression in the central nervous system, without loss of consciousness so that verbal contact can always be maintained with the patient; this allows for certain dental procedures to be performed.¹

The technique is associated with a great margin of safety. In Odonto pediatrics, the sedative agents generally employed are nitrous oxide (N₂O) and benzodiazepines, amongst other agents with sedative properties. The use of nitrous oxide/oxygen (N₂O) is becoming more frequent for general and pediatric procedures in dental medicine and has become common practice in many countries.

It is also frequently used in general pediatric medicine for procedures ranging from minor surgery to more invasive diagnostic procedures. Nitrous oxide, or protoxide of nitrogen (N₂O), is a colorless gas with a sweetish taste. It has an anxiolytic and sedative effect, and also promotes muscular relaxation and analgesia. N₂O is non-irritant for the respiratory tract, with minimal alveolar concentration and low solubility in tissues. It acts with a quick onset and a rapid recovery, the entire procedure only lasting for a few minutes.^{2,3}

When N₂O is administrated in concentrations ranging between 20% and 50% (along with 80-50% O₂), the patient almost always stays awake, calm and capable of following spoken instructions. However, some patients may suffer episodes of unconsciousness when concentrations of N₂O are higher than 50%.

Sedatives such as N₂O are classified by their route of administration or by their impact on patients' conscience. Accordingly, N₂O-O₂ is an inhalation conscious sedation. Nevertheless, the 2007 Dentists' Guidelines for utilization of general anesthesia published by the American Dental Association (ADA) recommend a more specific classification, qualifying conscious sedation as minimal, moderate or deep and for this purpose N₂O-O₂ is classified as moderate.

The American Academy of Pediatric Dentistry Guidelines consider it a safe and effective basic control technique that allows the reduction of the child's anxiety and promotes improvements in the communication between the Pediatric Dentist and the child. It is described as a "standard technique" for Pediatric Dentistry and as a successful procedure in 90% of adequately selected patients.^{4,9}

This article's main goal is to lay out up-to-date guidelines on the operation of inhalation sedation with nitrous oxygen/ oxygen (N₂O-O₂) for the management of child behavior during a Pediatric Dentistry appointment, highlighting aspects of this procedure which have been recently examined by international institutions such as the Council of European Dentists and the American Academy of Pediatric Dentistry.

Sedation In Pediatric Dentistry

In contrast to adult sedation, in children the procedure has the objective of controlling behavior and achieving complete treatment in a safer and more efficient way. The child's cooperation and the Pediatric Dentist's power of control over the child both vary according to the child's age.

In numerous situations, moderate levels of sedation are required for behavior control of children under 6 years old and patients with developmental delays. However, this need must be assessed before the procedure. Children under six are particularly vulnerable to the effects of sedation. Studies show that a patient may easily lapse into a non-intended deeper level of sedation. For older children, the use of other non-pharmacological techniques may reduce the need of this intervention.^{6,8}

Inhalation conscious sedation with N₂O-O₂ is used to achieve the following objectives: preserve patients' safety and well-being; minimize discomfort and physical pain; control anxiety, minimize psychological trauma and maximize amnesia; increase behavior and movement control so that dental treatment can be completed; provide patients with a safe condition without the need for medical supervision.

Specific Training Of The Pediatric Dentist

Regarding sedation with N₂O-O₂, a Pediatric Dentist's training routine must include theoretical and practical elements. The Council of European Dentists has recently recommended a two-day theoretical course (10-14 hours) that covers knowledge of anxiety behavior control, technical aspects of different forms of sedation, psychological and biological features of N₂O usage, and basic support for life and emergencies.^{3,5}

In order to complement theory, practical knowledge on educational patterns must be covered. Furthermore, the training must include a supervisor's evaluation of the student's performance in five cases of observation and five cases of treatment. It is important that at the endpoint of any such courses the student becomes eligible to obtain a certificate and understands that practice and experience must be regularly updated.

Patient Selection

The selection of the patient is based on a careful clinical examination and a well-documented medical and dental history elaborated by the Pediatric Dentist. Determination of risk factors and a better understanding of the patient's profile are mandatory.

If a single risk factor is found, an anesthetist must be consulted in order to decide whether the patient can be submitted to the sedative procedure. Patients must be classified according to the American Society of Anesthesiologists (ASA) classifying system as shown in Table 1 Sedation with N₂O-O₂ can be performed in ASA III and ASA IV patients, provided its use is restricted to hospitals and under the supervision of a responsible anesthesiologist.^{2,9}

**Table 1 - American society of anesthesiologists (ASA)
physical status classification evaluation**

| ASA Classification | |
|--------------------|---|
| Class I | No organic, physiological, biochemical or psychiatric alterations |
| Class II | Moderate systemic alterations (diabetes, asthma) |
| Class III | Severe systemic alterations (acute diabetes, psychomotor retardation, severe pulmonary failure) |
| Class IV | Severe alterations that may endanger life (heart failure) |
| Class V | Moribund patient with no chances of surviving a surgery |

Technique of nitrous oxide/oxygen administration

Nitrous oxide/oxygen must be administered only by appropriately licensed individuals, or under the direct supervision thereof, according to state law. The practitioner responsible for the treatment of the patient and/or the administration of analgesic/ anxiolytic agents must be trained in the use of such agents and techniques and appropriate emergency response.

Selection of an appropriately sized nasal hood should be made. A flow rate of 5 to 6 L/min generally is acceptable to most patients. The flow rate can be adjusted after observation of the reservoir bag. The bag should pulsate gently with each breath and should not be either over- or underinflated.^{1,4,9}

Introduction of 100% oxygen for 1 to 2 minutes followed by titration of nitrous oxide in 10% intervals is recommended. During nitrous oxide/ oxygen analgesia/anxiolysis, the concentration of nitrous oxide should not routinely exceed 50%.

Nitrous oxide concentration may be decreased during easier procedures (eg, restorations) and increased during more stimulating ones (eg, extraction, injection of local anesthetic). During treatment, it is important to continue the visual monitoring of the patient's respiratory rate and level of consciousness. The effects of nitrous oxide largely are dependent on psychological reassurance. Therefore, it is important to continue traditional behavior guidance techniques during treatment. Once the nitrous oxide flow is terminated, 100% oxygen should be delivered for 3 to 5 minutes. The patient must return to pretreatment responsiveness before discharge.

Monitoring The response of patients to commands during procedures performed with anxiolysis/analgesia serves as a guide to their level of consciousness. Clinical observation of the patient must be done during any dental procedure.^{3,6,9}

During nitrous oxide/oxygen analgesia/anxiolysis, continual clinical observation of the patient's responsiveness, color, and respiratory rate and rhythm must be performed. Spoken responses provide an indication that the patient is breathing. If any other pharmacologic agent is used in addition to nitrous oxide/oxygen and a local anesthetic, monitoring guidelines for the appropriate level of sedation must be followed.¹⁰



Adverse effects of nitrous oxide/oxygen inhalation

Nitrous oxide/oxygen analgesia/anxiolysis has an excellent safety record. When administered by trained personnel on carefully selected patients with appropriate equipment and technique, nitrous oxide is a safe and effective agent for providing pharmacological guidance of behavior in children.

Acute and chronic adverse effects of nitrous oxide on the patient are rare. Nausea and vomiting are the most common adverse effects, occurring in 0.5% of patients. A higher incidence is noted with longer administration of nitrous oxide/oxygen, fluctuations in nitrous oxide levels, and increased concentrations of nitrous oxide.

Fasting is not required for patients undergoing nitrous oxide analgesia/anxiolysis. The practitioner, however, may recommend that only a light meal be consumed in the 2 hours prior to the administration of nitrous oxide.

Diffusion hypoxia can occur as a result of rapid release of nitrous oxide from the blood stream into the alveoli, thereby diluting the concentration of oxygen. This may lead to headache and disorientation and can be avoided by administering 100% oxygen after nitrous oxide has been discontinued.⁵

Pulse Oximetry:

Oximetry refers to the determination of the percentage of oxygen saturation of the circulating arterial blood. Pulse oximetry has been recommended as a standard of care for every general anesthetic. This technique, virtually

unknown in anesthesia 25 year ago, has been so readily adopted now for several reasons. The device provides valuable data regarding blood oxygenation and this information is obtained easily, continuously, and noninvasively.

The pulse oximeter is based upon two physical principles. First, the light absorbance of oxygenated hemoglobin is different from that of reduced hemoglobin at the oximeter's two wavelengths. Second, the absorbances at both wavelengths have a pulsatile (AC) component, which is the result of the fluctuating volume of arterial blood between the source and detector.

Given these two facts and no other physics or physiology, the engineering design of the pulse oximeter is clever but straightforward. Pulse oximetry is a relatively recent advancement in noninvasive monitoring of oxygen saturation of blood and pulse rate of patients under intensive care or during sedation procedures.

No other electronic monitoring device has found widespread use in the operating room more quickly than has the pulse oximeter. It requires no special training or new skills on the part of the user. It can warn of a number of disasters in progress including airway disconnection, loss of oxygen supply, severe increase in venous admixture, or loss of a pulse.

Pulse oximeters deal with the effects tissue and venous blood absorbances in a completely different way. At component, which is attributed to the pulsating arterial blood. The baseline or DC component represents the absorbances of the tissue bed, including venous blood, capillary blood, and nonpulsatile arterial blood.

The pulsatile expansion of the arteriolar bed produces an increase in path length, thereby increasing the absorbance. All pulse oximeters assume that the only pulsatile absorbance between the light source and the photo detector is that of arterial blood.

They use two wavelengths of light: 660 nanometers (red) and 940 nanometers (near infrared). The pulse oximeter first determines the AC component of absorbance at each wavelength and divides this by the corresponding DC component to obtain a "pulse-added" absorbance that is independent of the incident light intensity.

Documentation

Informed consent must be obtained from the parent and documented in the patient's record prior to administration of nitrous oxide/oxygen. The practitioner should provide instructions to the parent regarding pre-treatment dietary precautions, if indicated. In addition, the patient's record should include indication for use of nitrous oxide/oxygen inhalation, nitrous oxide dosage (ie, percent nitrous oxide/oxygen and/or flow rate), duration of the procedure, and post treatment oxygenation procedure.^{1,3,7}

Facilities/personnel/equipment

All newly installed facilities for delivering nitrous oxide/ oxygen must be checked for proper gas delivery and fail-safe function prior to use. Inhalation equipment must have the capacity for delivering 100%, and never less than 30%, oxygen concentration at a flow rate appropriate to the child's size.

Additionally, inhalation equipment must have a fail-safe system that is checked and calibrated regularly according to the practitioner's state laws and regulations. If nitrous oxide/ oxygen delivery equipment capable of delivering more than 70% nitrous oxide and less than 30% oxygen is used, an in- line oxygen analyzer must be used. The equipment must have an appropriate scavenging system.^{2,4,6}

The practitioner who utilizes nitrous oxide/oxygen analgesia/anxiolysis for a pediatric dental patient shall possess appropriate training and skills and have available the proper facilities, personnel, and equipment to manage any reasonably foreseeable emergency.

Training and certification in basic life support are required for all clinical personnel. These individuals should participate in periodic review of the office's emergency protocol, the emergency drug cart, and simulated exercises to assure proper emergency management response. An emergency cart (kit) must be readily accessible.

Emergency equipment must be able to accommodate children of all ages and sizes. It should include equipment to resuscitate a nonbreathing, unconscious patient and provide continuous support until trained emergency personnel

arrive. A positive pressure oxygen delivery system capable of administering >90% oxygen at a 10 L/min flow for at least 60 minutes (650 L, “E” cylinder) must be available.^{4,8}

When a self-inflating bag valve mask device is used for delivering positive pressure oxygen, a 15 L/min flow is recommended. There should be documentation that all emergency equipment and drugs are checked and maintained on a regularly scheduled basis. Where state law mandates equipment and facilities, such statutes should supersede this guideline.³

Occupational safety

In an effort to reduce occupational health hazards associated with nitrous oxide, the AAPD recommends exposure to ambient nitrous oxide be minimized through the use of effective scavenging systems and periodic evaluation and maintenance of the delivery and scavenging systems.

Conflict of interest

None.

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