Review Article

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NITROUS OXIDE INHALATION SEDATION IN PEDIATRIC DENTISTRY: A REVIEW

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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 pediatric 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.

Key words: Conscious Sedation, Inhalation Sedation, Nitrous Oxide, Oxygen, Pediatric Dentistry, Uncooperative child.

INTRODUCTION:

Providing comprehensive oral care to young patients is a unique challenge. Child behavior can never become an alibi for a sub-standard work in the mouth. However, in spite of all its technical and materialistic advances, behaviour science still seems to provide limited options for its uncooperative young children. Guidance of children's behaviour in dentistry has been limited to an art rather than a science. It is no wonder that today there are more and more dentists are afraid of children than children afraid of dentists, Henceforth pharmacological intervention becomes an important alternative for the dentist to adopt and manage dental anxiety, stress and fear related to dental procedure and avoid unpleasant and unproductive confrontation with the child [1].

Pharmacological management may divided into three categories, conscious sedation, deep sedation, and general anaesthesia, but due to increased risks and costs associated with deep sedation and general anaesthesia, conscious sedation has emerged as a preferable technique, it is a minimally to moderately depressed level of consciousness that retains the patient's ability to independently and continuously maintain

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an airway and respond appropriately to physical stimulation and verbal command. This level of sedation may be accomplished by inhalation, oral and parenteral administration of a single sedative drug or by combining sedative agents. Sedative agents often include nitrous oxide-oxygen, narcotics, benzodiazepines, chloral hydrate, barbiturates as well as antihistamines. [2]

According to Shapira*et* al [3], the ideal paediatric dental sedative should possess a number of qualities, including safety, minimum respiratory depression, adequate sedation, minimal patient movement, early onset of drug action, and adequate working time. Inhalation sedation should be the first choice for dental patient who are unable to tolerate fear and stress of dental treatment. Nitrous oxide is delivered with oxygen as a titrated dose via a nasal mask. It is cost effective alternative to general anesthesia. [4] Inhaled nitrous oxide also produces anxiolytic and mild analgesic effects. [5] The present review article discusses the nitrous oxide inhalation conscious sedation in paediatric dentistry.

Definition Of Conscious Sedation:

- "Conscious sedation is a minimally to moderately depressed level of consciousness that retains the patient's ability to independently and continuously maintain an airway and respond appropriately to physical stimulation and verbal command"[2]
- "A technique in which the use of a drug or drugs produces a state of depression of the central nervous system enabling treatment to be carried out, but during which verbal contact with the patient is maintained throughout the period of sedation. The drugs and techniques used to provide conscious sedation for dental treatment should carry a margin of safety wide enough to render loss of consciousness unlikely**".** [4]
- "A medically controlled state of depressed consciousness that allows the protective reflexes to be maintained; retains the patient's ability to maintain a patent airway independently and continuously; and permits an appropriate response by the patient to physical stimulation or verbal command, e.g., 'Open your eyes'." [6]

Inhalation Sedation with Nitrous Oxide:

Drugs used for pediatric inhalation sedation includes Nitrous oxide and Oxygen gas.

NITROUS OXIDE

Nitrous oxide is the only inhalation agent currently in routine use of conscious sedation in dental practice. It was discovered by Joseph Priestly in 1772 and first used as an anesthetic agent for dental exodontia by Horace Wells in 1844. Nitrous oxide has been used as the basic

constituent of gaseous anesthesia for the subsequent 160 years, demonstrating its acceptability and usefulness. Nitrous oxide is a colorless, faintly sweet smelling gas with a specific gravity of 1.53. It is stored in light blue cylinders in liquid form at a pressure of 750 pounds per square inch (43.5 bar). [7]

Nitrous oxide is a gas with anxiolytic and sedative effects combined with varying degree of analgesia and muscle relaxation. Recent research suggests that both GABA a and NMDA-receptors are affected by nitrous oxide [8,9]. Nitrous oxide when administrated to patients for inhalation must be given in a mixture with oxygen (30% or more) to safeguard the patient's oxygen supply. Nitrous oxide is non-irritant to the respiratory tract, has a low tissue solubility, and a minimum alveolar concentration (MAC) value of more than one atmosphere. Therefore nitrous oxide has a rapid onset, a fast recovery (both within minutes) and is a poor anesthetic. [6]

OXYGEN

Oxygen is not a sedating agent, however, inhalation sedation agents is always delivered in an oxygen-rich mixture containing a minimum of 30% oxygen by volume. Oxygen is stored as a gas in black cylinders with white shoulders, at an initial pressure of 2000 pounds per square inch (137 bar). Because it is a gas under pressure, the gauge on the inhalational sedation machine will give an accurate representation of the amount of oxygen contained in the cylinder. The oxygen supply used for inhalation sedation should be separate from, and additional to, the supply kept for use in the management of emergencies. Oxygen will sustain and enhance combustion and therefore no naked flames should be allowed in an area where oxygen is being used. [7]

Inhalation Sedation Apparatus

Indication of Nitrous Oxide Sedation:

- Most patients requiring sedation are those with a simple, genuine fear or phobia of dental treatment.
- Children can present particular problem & often require very careful handling
- Patients with mild systemic disorders such as controlled hypertension, angina which may be exacerbated by the stress of dental treatment represent a medical indication.

- Patient with neuromuscular disorders such as spasticity, Parkinsonism & involuntary movement conditions often wishes to cooperate but physically cannot.
- Dentally related problems such as gagging & trismus, persistent fainting & moderately difficult or prolonged surgery. [7]

Contraindication Of Nitrous Oxide Sedation:

- Moderate/severe learning disability: Inability to tolerate the nasal mask and cooperate with nasal breathing
- Severe anxiety: Inability to tolerate the nasal mask and cooperate with nasal breathing
- Chronic obstructive pulmonary disease: Theoretical risk of respiratory failure when exposed to high concentrations of oxygen
- Nasal obstruction: For example, nasal polyps, deviated nasal septum
- Patients treated with bleomycin (chemotherapy agent): Patients predisposed to respiratory failure when exposed to high concentrations of oxygen
- Patients who have had recent retinal surgery: Risk of raised pressure within the eye and damage to sight
- First trimester of pregnancy: Teratogenicity [10]

Patient Assessment:

A useful means of estimating fitness for sedation is to use the classification system introduced by the American society of anesthesiologists (ASA). In this system, patients are allocated to specific grades according to their medical status and operation (or sedation) risk. The classification uses six grades as follows:

ASA 1: fit and healthy

ASA 2: mild systemic disease (for example, well controlled hypertension, diabetes, epilepsy, asthma)

ASA 3: severe systemic disease which limits lifestyle, but not incapacitating (for example, poorly controlled epilepsy diabetes or asthma)

ASA 4: incapacitating systemic disease which is a constant threat to life

ASA 5: life-threatening systemic disease, death likely within 48 hours

ASA 6: A declared brain dead patient whose organs is being removed for donor purposes. [6,11,]

Preoperative Fasting:

The ASA guidelines for minimum fasting periods for infants and children

*Clear fluids: = 2 hours

Clear liquids include, but are not limited to; water, fruit juices without pulp, carbonated beverages, clear tea and black

coffee. The volume of liquid ingested is less important than the type of liquid ingested.

Breast milk: = 4 hours

Nonhuman milk, infant formula = 6 hours

*Solids, Light meal = 6 hours

"The recommendations for solid food were reportedly made with insufficient published data. A typical light meal includes toast and clear fluids. Fried and Fatty foods may prolong gastric emptying. The amount and type of foods must be considered. [12]

Technique:

The nose piece should be introduced with instructions to breathe nasally. The minimal finger pressure under the lower lips to produce an oral seal and gentle tapping of the nose-piece can be helpful to encourage nasal breathing in the young child.

After stabilization of the nose-piece and delivery of 100% oxygen for 3 to 5 minutes the N_2O level should be increased to 30-50 % and administered for 3 to 5 minutes for the introduction period. While administrating the nitrous oxide, the dentist should talk gently to the child to promote relaxation and reinforce cooperative behavior. Asking older children and adults if they feel tingling sensation in the finger and in the toes are appropriate for verification of early signs of central nervous system (CNS) effects. An indication of such CNS effect would be minimal or continual movements of the finger and toes in the young child. Concentrations of nitrous in excess of 50% are usually contraindicated for dental office sedation. When the dental injection is completed, the nitrous oxide level should be reduced to 30 to 35% for a maintenance dose during the dental treatment; alternatively, 100% oxygen may be administrated when the nitrous oxide is only needed for behaviour management related to the dental injection.

Upon termination of nitrous oxide administration, inhalation of 100% oxygen not less than 3 to 5 minutes is recommended. This allows rapid diffuse of nitrous oxide from the venous blood into the alveolus while maintaining oxygenation, enabling the patient to return without incident to pretreatment activities. Inadequate oxygenation may produce such postoperative side effects as nausea, light headedness or dizziness, all of which can be reversed with the continued oxygen administration. Nitrous oxide should be considered an adjunct to aid in management of minimal anxiety in the child capable of cooperating in the dental chair. [13]

Child with Inhalation Sedation Unit

Summary of 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 operating 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

MONITORING:

A dentist, or at the dentist's direction, an appropriately trained individual, must remain in the operatory during active dental treatment to monitor the patient continuously until the patient meets the criteria for discharge to the recovery area. The appropriately trained individual must be familiar with monitoring techniques and equipment. Monitoring must include:

• **Oxygenation:**

– Color of mucosa, skin or blood must be evaluated continually.

– Oxygen saturation by pulse oximetry may be clinically useful and should be considered.

• **Ventilation:**

– The dentist and/or appropriately trained individual must observe chest excursions continually.

– The dentist and/or appropriately trained individual must verify respirations continually.

• **Circulation:**

– Blood pressure and heart rate should be evaluated pre-operatively, post-operatively and intra-operatively as necessary (unless the patient is unable to tolerate such monitoring).

Documentation: An appropriate sedative record must be maintained, including the names of all drugs administered, including local anesthetics, dosages, and monitored physiological. [14]

PULSE OXIMETRY

Pulse oximetry has revolutionized modern monitoring procedures. It is a non-invasive method of measuring arterial oxygen saturation using a sensor probe, placed on the patient's finger or ear-lobe, which has a red light source to detect the relative difference in the absorption of light between saturated and desaturated hemoglobin during arterial pulsation. Adequate oxygenation of the tissues occurs above 95%, whereas oxygen saturations lower than this are considered being hypoxaemic. Under normal circumstances, a child's oxygen saturation (SaO2) is 97–100%. The probe is sensitive to patient movement, relative hypothermia, ambient light and abnormal haemoglobinaemias, which means that false readings can occur. Indeed, the role of carbon dioxide monitoring (capnography), as an adjunct to pulse oximetry and alert clinical observation, is under increasing scrutiny. [15]

Recovery and Discharge:

Once dental treatment is complete, the patient enters the recovery phase. The patient may be recovered in the dental operatory or a separate recovery area. The sedation dental nurse monitors the patient during this period. The dentist is responsible to assess if the patient is fit for discharge and 'should only be allowed to leave when they have returned to a normal level of responsiveness and orientation for age and mental status'

Once the patient is fit for discharge the medical observations should be recorded for a final time and if these are satisfactory then the cannula can be removed. Care must be taken with this as although not sharp it has been intimately in contact with the patient's blood. The nurse will often escort the patient back to the surgery or recovery room and reinforce postoperative instructions both verbally and in writing. At this stage the patient and the escort are free to leave. [16]

CRITERIA FOR DISCHARGE

Criteria	Fit for Discharge	Unfit for Discharge
Speech	Comprehensible	Slurred, unintelligible
Response to questioning	Rational	Nonsensical
Orientation	Aware of surroundings	Patient unaware of where they are or why they are
Ability to walk	Stands and able to walk Unaided	Unsteady on feet and require support to walk [16]

CARE OF YOUR CHILD AFTER SEDATION

Today your child had dental treatment under conscious sedation.

He/she received the following medicine(s) for sedation:

☐ Chloral hydrate ☐ Meperidine (Demerol) ☐ Hydroxyzine (Vistaril)
☐ Diazepam (Valium) ☐ Midazolam ☐ Other_____

Children repond to sedation in their own way, but the following guidelines will help you know what to expect at home:

GOING HOME

1. Your child will not be able to walk well, so we suggest that you carry your child or use a wheel-chair to transport your child to the car.
2. Young children must be restrained in a car safety seat and older children must be restrained with a seat belt during transportation.

ACTIVITY

1. Your child may take a long nap. He/she may sleep from 3 to 8 hours and may be drowsy and irritable for up to 24 hours after sedation. When your child is asleep, you should be able to awaken him/her easily.
2. Your child may be unsteady when walking or crawling and will need support to protect him/her from injury. An ADULT must be with the child at all times until the child has returned to his/her usual state of alertness and coordination.
3. Your child should not perform any potentially dangerous activities, such as riding a bike, playing outside, handling sharp objects, working with tools, or climbing stairs until he/she is back to his/her usual alertness and coordination for at least 1 hour.
4. We advise you to keep your child home from school or daycare after treatment and possibly the next day if your child is still drowsy or unable to walk well. Your child should return to his/her usual state of alertness and coordination within 24 hours.

EATING AND DRINKING INSTRUCTIONS

Begin by giving clear liquids such as clear juices, water, gelatin, Popsicles, or broth. If your child does not vomit after 30 minutes, you may continue with solid foods.

REASONS TO CALL THE DOCTOR

1. You are unable to arouse your child.
2. Your child is unable to eat or drink.
3. Your child experiences excessive vomiting or pain.
4. Your child develops a rash.

FOR THESE OR ANY OTHER CONCERNS about your child's sedation, please contact our office at_____.

CONCLUSION:

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.

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