# Policy on Minimizing Occupational Health Hazards Associated with Nitrous Oxide

## Latest Revision

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## Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that exposure to ambient nitrous oxide ($N_2O$) may be an occupational health hazard for dental personnel and encourages practitioners to take all precautions to minimize associated risks.

## Methods

This policy was developed by the Clinical Affairs Committee, adopted in 1987[1], and last revised by the Council on Clinical Affairs in 2018[2]. This update used electronic database and hand searches of articles in the medical and dental literature using the following parameters: terms: *nitrous oxide*, *occupational exposure*, AND *dentistry*; fields: all; limits: within the last 10 years, English. Additionally, recommendations from the National Institute for Occupational Safety and Health (**NIOSH**) were reviewed.[3,4] Expert opinions and best current practices were relied upon when sufficient scientific data were not available.

## Background

Nitrous oxide is an inhalation agent commonly used in dentistry for analgesia/anxiolysis. When used in accordance with recommended techniques and patient selection criteria, $N_2O$/oxygen inhalation exhibits a high degree of efficacy and patient safety in the clinical setting.[5-9] Occupational exposure to ambient $N_2O$ has been studied for decades, yet the effects of ambient $N_2O$ exposure on dental personnel remain uncertain. Early reports, many of which came from animal studies[10] and/or preceded scavenging devices[11] and ventilation systems, implicated chronic occupational exposure of unscavenged $N_2O$ in reproductive effects[10,12,13] (eg, decreased sperm count, spontaneous abortions[14], birth defects[10,15]), liver[14] and kidney damage[10,12,15], and neurologic considerations[10,15] (eg, memory, hearing). In offices using scavenging systems, female dental staff frequently (ie, 3 or more days a week) exposed to $N_2O$ were found to have no elevated risk of spontaneous abortion.[16,17] A paucity of clinical research establishing a causal relationship between chronic exposure of dental personnel to $N_2O$ and health problems continues. A recent systematic review on workplace exposure to volatile anesthetics including $N_2O$ reported evidence is both scarce and inconsistent regarding adverse effects.[18] The dentist's exposure often is noted to be greater than that of the dental assistant.[19-21] Exposure may increase due to patient factors, with a 3-fold increase in ambient $N_2O$ levels noted when patients talked, cried, or held their breath during administration of local anesthesia.[22] Furthermore, as the concentration of administered $N_2O$ increases, so does the ambient $N_2O$ level in the operator's breathing zone.[22]

NIOSH reported in 1977 that primary concerns of chronic $N_2O$ exposure were diminished cognition, performance, audiovisual ability, and dexterity; conclusions on reproductive health were not definitive.[10] That report included a recommended exposure limit (**REL**) to a time-weighted average (**TWA**) of 25 ppm yet noted 25 ppm might not be achievable and was subject to review and revision.[23] Shortly thereafter, NIOSH published a technical report intended to help limit occupational exposure in the dental setting to 50 ppm[24] although the REL remained unchanged[25]. In 1986, the American Conference of Governmental Industrial Hygienists established the threshold limit value (**TLV**) for $N_2O$ exposure at 50 ppm.[25] Unless a state or the federal government adopts a TLV, this level is merely a recommendation.[26] Only the Occupational Health and Safety Administration (**OSHA**) can establish a legal limit for exposure (permissible exposure limit [**PEL**]).[26] Notably, OSHA has not established a PEL for $N_2O$ exposure in the health care setting.[25] The International Labor Organization and World Health Organization also have established a TLV of 50 ppm as TWA and noted that $N_2O$ is not carcinogenic.[27]

The introduction of methods to scavenge $N_2O$ and other control measures has been effective in reducing ambient $N_2O$ in the dental environment.[21,28] System maintenance, scavenging of expired gases, ventilation of the operatory/room air exchange, use of the minimal effective dose, and patient selection[9] and management are important to maintaining the lowest practical levels in the dental environment.[3,4,29] Leaks at system connectors and degradation, cracks, and tears in system components may allow $N_2O$ to enter room air, increasing occupational exposure. Frequent and continual inspection will allow

**ABBREVIATIONS**

**AAPD:** American Academy of Pediatric Dentistry. **$N_2O$:** Nitrous oxide. **NIOSH:** National Institute for Occupational Safety and Health. **PEL:** Permissible exposure limit. **REL:** Recommended exposure limit. **TLV:** Threshold limit value. **TWA:** Time-weighted average.

timely maintenance and replacement of components thereby minimizing environmental exposure.[30] A double-chamber mask delivery system has been shown to be more effective in the removal of waste $N_2O$ than a single-chamber mask with a scavenging cap.[31,32] Use of a well-fitted double-chamber mask with recommended scavenging system flow rate can decrease occupational exposure to $N_2O$.[31,33] Recently, disposable masks and mask/circuits have been developed and marketed for improved infection control, but studies comparing their efficacy in scavenging waste gases are lacking.

Establishing a balance of gas flows entering and exiting the delivery system is important for effectiveness and decreasing ambient levels. If the flow of inhalation gases overinflates the breathing bag, excessive leakage from the mask can occur.[4] Allowing the bag to expand and collapse with each breath ensures proper delivery of gases. Likewise, the rate of suction of the exhaled gases needs to be sufficient to allow removal of gases from the system but maintain the desired clinical effects. NIOSH has recommended that the exhaust ventilation of $N_2O$ from the patient's mask be maintained at an air flow rate of 45 liters per minute and vented outside the building away from fresh air intakes.[4] However, scavenging at this rate has been shown to reduce the level of psychosedation achieved with $N_2O$ inhalation.[34]

Additional steps can be taken to lower the ambient $N_2O$ levels. Ambient concentration will change with increased room air turnover and percentage of fresh air intake. One hundred percent clean outdoor air has been recommended for dental operatory ventilation.[3] Well-separated supply and exhaust vents allow good mixing and prevent short-circuiting.[3] Use of supplemental measures, such as high-volume dental suction placed in proximity to the mouth[22,35] and administration of 100% oxygen following termination of $N_2O$ flow[36], has been shown to reduce ambient $N_2O$ levels significantly. Measuring levels of $N_2O$ in the dental operatory can be helpful in determining the type and extent of remediation necessary to decrease occupational exposure.

Patient selection is an important consideration in reducing ambient $N_2O$ levels.[9,29] Patients who are unwilling or unable to tolerate the nasal hood and those with medical conditions (eg, obstructive respiratory diseases, emotional disturbances, drug dependencies) that contraindicate the use of $N_2O$ are candidates for other behavior guidance techniques.[9,29] In the dental environment, patient behaviors such as talking, crying, and moving have been shown to result in significant increases in baseline ambient $N_2O$ levels despite the use of the mask-type scavenging systems.[22,37] Titration of $N_2O$ concentration levels in relation to procedure difficulty can help lower levels of ambient $N_2O$. $N_2O$ can be discontinued once adequate anesthesia is achieved[38], or decreased levels can be maintained during easier procedures and increased for stimulating procedures[39].

## Policy statement

The AAPD encourages dentists and dental auxiliaries to maintain the lowest practical levels of $N_2O$ in the dental environment. The AAPD also encourages practitioners to weigh the risks and benefits of using $N_2O$ when treating pediatric patients. Adherence to the following safety practices can help minimize occupational exposure to $N_2O$.

- Educate dental personnel on minimizing occupational exposure to and potential abuse of nitrous oxide.
- Use scavenging systems that remove $N_2O$ during patient's exhalation.
- Ensure that exhaust systems adequately vent scavenged air and gases to the outside of the building and away from fresh air intake vents.
- Use, where possible, clean outdoor air for dental operatory ventilation.
- Monitor ambient $N_2O$ levels in dental operatories in accordance with local and state regulations.
- Implement a plan for careful, regular inspection and maintenance of the nitrous oxide/oxygen delivery equipment according to manufacturer's recommendations.
- Carefully consider patient selection criteria (eg, tolerance of nasal hood, ability to breathe from the nose, cooperative potential, recent illnesses, indications, contraindications) prior to administering $N_2O$.
- Select a properly-fitted double-chambered mask size for each patient.
- During administration, visually monitor the patient and titrate the flow/percentage to the minimal effective dose of $N_2O$.
- Encourage patients to minimize talking, moving, and mouth breathing during $N_2O$ administration.
- Use high volume dental suction when possible during $N_2O$ administration.
- Use a rubber dam or isolation devices with suction evacuator when possible during operative treatment.
- Administer 100% oxygen to the patient for at least 5 minutes after terminating $N_2O$ flow to replace the $N_2O$ in the gas delivery system.

The AAPD encourages an interprofessional approach between dental team members who are pregnant or trying to conceive and their physicians regarding the effects of $N_2O$ on reproductive health to assure comfort and safety with the administration of nitrous oxide/oxygen analgesia/anxiolysis.

The AAPD encourages research on the efficacy of newer-style (eg, disposable mask, disposable mask/circuit) nasal hoods in scavenging waste gases. Furthermore, because of the paucity of literature on health effects of occupational $N_2O$ exposure in the dental setting with modern delivery, scavenging, ventilation, and monitoring systems, the AAPD encourages additional studies and periodic review of the occupational exposure recommendations by NIOSH.

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