

Use of Nitrous Oxide in Maternity Care: AWHONN Practice Brief Number 6

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type of practice.

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Recommendation

Nitrous oxide (N₂O) should be a vital component in the provision of quality maternity care, and the bedside labor nurse is the ideal candidate to initiate N₂O use.

Background

- Nitrous oxide is a gaseous mixture of 50% nitrous oxide and 50% oxygen. Until recently in the United States, this gas has primarily been used in the dental industry.
- The mechanism of action of N₂O is not fully understood (Collins, Starr, Bishop, & Baysinger, 2012). It is currently hypothesized that N₂O adheres to proteins within the neuronal membranes, which alters ion flow through the membranes and affects synaptic transmission (Evers, Crowde, & Balser, 2006). Analgesia, anxiolysis, and endogenous opioid release are all results of N₂O use. When the percentage of N₂O is greater than the percentage of oxygen, N₂O is considered a minor anesthetic; at a concentration of 50/50, it has analgesic properties (Baysinger, n.d.).
- In the United States, N₂O was used to some extent during childbirth in the 1950s and 1960s, but it faded from popularity with the advent of regional anesthesia. Countries outside of the United States have used N₂O in labor for approximately a century, with rates that varied from 43% (Canada) to 62% (United Kingdom; Rooks, 2007).

Indications

- Nitrous oxide has many uses in childbirth. While the most obvious is to promote the comfort of the woman in labor, N₂O can be also used during procedures such as external cephalic version; placement of intravenous lines, intracervical balloons, and Foley bulbs for cervical ripening; manual removal of placenta; and laceration repair. The gas can also be inhaled during placement of regional anesthesia (Collins, 2015; Stewart & Collins, 2012).

Pain Management During Labor and Birth

- In a study on the relationship between analgesic effectiveness and patient satisfaction, Richardson, Lopez, Baysinger, Shotwell, and Chestnut (2017) found that women who received N₂O alone were as likely to express satisfaction with anesthesia as those who received neuraxial analgesia, even though they were less likely to report excellent effectiveness. These results suggest that pain relief alone is not the only contributor to satisfaction with the childbirth experience.
- In a 2012 systematic review for the Agency of Healthcare Research and Quality, Likis et al. (2012) noted that use of N₂O provided less effective pain relief during labor and birth than epidural analgesia, but the quality of studies was predominately poor. These investigators also found insufficient evidence to determine the effectiveness of N₂O compared with nonepidural labor pain management methods because studies were predominately poor quality, used heterogenous outcome measures, and had inconsistent findings (Likis et al., 2012).
- Nitrous oxide may be used with other methods of analgesia, including hydrotherapy; movement; massage; therapeutic touch techniques, such as effleurage, acupuncture, acupressure; aromatherapy; and psychoprophylactic methods. Nitrous oxide may be used during placement of regional anesthesia and after if the relief provided by the anesthesia is suboptimal.

Administration

- Specially designated equipment for the administration of N₂O must be used to

ensure concentration ratios of 50% N₂O and 50% oxygen. Unlike dental apparatus, the apparatus approved for obstetric use does not allow the clinician or user to alter the ratio of gases. Another difference is that the dental apparatus delivers a continuous stream of gas whereas the obstetric apparatus delivers gas only on inhalation via a demand valve in the mask or mouthpiece (Collins, 2017).

- Women using N₂O are taught how to use the mask or mouthpiece. Some women continuously inhale through and between uterine contractions while others inhale only periodically.

Safety

- Safety concerns related to the use of N₂O center on the woman, fetus, and members of the health care team. The safety of the short-term use of N₂O during childbirth has been documented (McPherson & Inder, 2017). Long-term implications are less known.
- Nitrous oxide inactivates the core component of vitamin B12, cobalamin. Because B12 is necessary to convert methionine synthase to homocysteine, the absence of cobalamin can result in elevated endogenous homocysteine levels (Rooks, 2011). When used for the duration of labor and birth versus chronic abuse situations, risk is minimal (Sanders, Weimann, & Maze, 2008).
- With appropriate staff training and vigilance to ensure patient compliance, N₂O exposure levels are expected to fall below recommended guidelines (Stewart & Collins, 2012).
- The demand valve in the apparatus ensures that the gas mixture only flows on inhalation. On exhalation, the flow of gas ceases completely. Devices also have scavenging capabilities through which exhaled N₂O is gathered into a scavenger interface connected to the breathing circuit. The exhaled gas is vented to the outside through the facility vacuum system. Some facilities have integrated vacuum systems; birth centers and home birth practices use portable waste receptacles (CAREstream Medical, 2015; Porter Instrument Division, Parker Hannifin, 2018).
- Dosimeter badges that measure the ambient N₂O concentration can be worn by members of the health care team. Acceptable ambient levels of N₂O were set as 25 parts per million (ppm) by the National Institute for Occupational Safety and Health

(1977) and as 50 ppm by the American Conference of Governmental Industrial Hygienists (New Jersey Department of Health and Human Services, 2004). European standards were set at 100 ppm (European Society of Anaesthesiology Task Force on Use of Nitrous Oxide in Clinical Anaesthetic Practice, 2015).

Benefits/Advantages

- Noninvasive.
- Women retain mobility; bedrest is not required.
- Intravenous access is not required.
- Very rapid onset and elimination: within 2 to 3 inhalations, the woman will begin to feel the effect. Similarly, the gas is eliminated from the lungs quickly within a few breaths (Rooks, 2011).
- Viable option during procedures when regional anesthesia is not in use (e.g., external cephalic version, manual removal of placenta, perineal repair).
- No adverse effect on uterine activity; N₂O will not decrease frequency or intensity of uterine contractions (Rooks, 2011).
- Women may utilize the gas at any stage of labor, including the second stage, without adverse effect on the fetus or neonate (Rooks, 2011).
- The woman controls administration, which contributes to satisfaction with the birth experience.
- Substantial anxiolysis.
- Decreased cost compared to regional anesthesia.

Risks/Disadvantages

- Variable efficacy (Klomp et al., 2012; Likis et al., 2012; Richardson et al., 2017).
- A small percentage of women may experience side effects during use, including nausea and vertigo (Likis et al., 2012).

Contraindications

- Conditions that may create space for the collection of gas, e.g., recent pneumothorax, gastric bypass surgery, and inner ear surgery.
- Known B12 deficiency (other than mild deficiency) because of the relationship between N₂O and cobalamin binding.
- Pernicious anemia.
- Impaired consciousness, whether by injury, medication, or drug or alcohol use because

the modality requires the ability to appropriately use the equipment.

- Functional impairment that limits the use of the extremities (Stewart & Collins, 2012).
- Relative contraindications include methionine synthetase deficiency or reduction (Collins, 2017; Naddoni, Balakundi, & Assainar, 2017).

Education

- Women should be instructed at onset of use that an adequate seal with mouthpiece or face mask is necessary to ensure that the demand valve opens on inhalation. Additionally, for best results, the woman should initiate inhalation at least 30 seconds before the onset of the contraction.
- The family/visitors in the room must be advised that no one may assist the woman or hold the mask for her, and that if anyone other than the woman is found attempting to use the apparatus, the modality or the offending visitor will be removed from the room.
- Staff education to ensure broad understanding of N₂O use is a necessary component of a successful program (Pinyan, Curlee, Keever, & Baldwin, 2017). Periodic refreshers will help ensure consistency of practice and keep staff informed of current evidence.

Implementation of N₂O Programs

- Successful implementation is dependent on the involvement of all key individuals who interact with women in labor, including but not limited to representatives from midwifery, obstetrics, perinatology, nursing, nurse management, anesthesiology, newborn nursery, neonatal intensive care, risk management, biomedical, and facilities departments (Collins et al., 2012; Pinyan et al., 2017).
- It is important to note that use of N₂O does not require initiation by anesthesia personnel. Some institutions may house their N₂O programs under the anesthesia department, while others use ancillary services such as respiratory therapy. Most U.S. institutions use bedside nurse-led initiation on order of maternity care provider similar to the European model (Pinyan et al., 2017), which is within the scope of practice of the bedside nurse. Involvement of team members from other departments (anesthesia, respiratory therapy, etc.) can result in delay if those members are not readily available.
- Recommendations for future research include the effect of N₂O on physiologic birth

process, including length of labor and mode of delivery; long term effects on the neonate, patient, and health care providers; maternal satisfaction; and the effect on rates of breastfeeding initiation and success.



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