Nitrous Oxide as Labor Analgesia

Clinical Implications for Nurses

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INTRODUCTION

Nitrous oxide (chemical abbreviation N₂O) is a colorless, almost odorless and tasteless gas made for inhalation to provide analgesia during painful procedures. Many Americans are most familiar with it as “laughing gas” used for dental procedures. In the early and mid-20th century, it was used for pain management in labor along with other medications, but fell out of favor by the late 1970s. During the last 5 years in the United States, a growing movement has emerged to return to the use of nitrous oxide as an analgesic during labor (see Box 1 for a case scenario).

In 2010, the American College of Nurse-Midwives published a position statement on nitrous oxide (American College of Nurse-Midwives, 2010), which supports and encourages the promotion of additional labor and analgesic options to those currently available (e.g., lumbar epidurals and intravenous/intramuscular opioids). Because many currently practicing labor and delivery nurses have never been exposed to nitrous oxide self-administration, this article will discuss its historical use, pharmacologic effects on the maternal/fetal dyad, newborn, indications/contraindications, patient self-administration and nursing implications.

HISTORICAL PERSPECTIVE

Nitrous oxide was first synthesized in the 1700s. It was inhaled recreationally for the feeling of euphoria it produced. It was not until the mid-1850s that it began to be used as a dental analgesic in England (King, 2011). In 1881, Klickovich (Poland-Russia) pioneered the study utilizing 80 percent nitrous oxide for laboring women. Nitrous as a labor analgesic had limited use until 1934, when Minnit took the process a step further and introduced the first anesthesia machine for self-administration. Since that time, the use of nitrous oxide as a labor analgesic gained popularity in Great Britain and other European countries. It continues to be utilized by up to 40 percent to 60 percent of laboring women in those countries (Rosen, 2002).

Laboring women in the United States also gained access to nitrous oxide during this time and it became one of the many alternatives for labor pain management from the late 1930s.

Abstract: A new interest in self-administered nitrous oxide for labor analgesia has emerged in recent years in the United States. It has been used widely in Europe for decades, with favorable results. The American College of Nurse-Midwives published a position statement in 2010 supporting the practice of self-administered nitrous oxide as an additional analgesia choice for laboring women. Recent literature on this subject has been directed toward midwives, obstetricians and/or anesthesiologists, with little emphasis for labor and delivery nurses. This article presents highlights of nursing care for women using self-administered nitrous oxide during labor and birth. DOI: 10.1111/j.1751-486X.2012.01763.x

Keywords: labor analgesia | N₂O | nitrous oxide | self-administered nitrous oxide
In the 1940s, regional anesthesia (spinal and caudal blocks) grew in popularity, allowing women to be awake and alert during labor and birth while feeling almost no pain. Regional anesthesia techniques continued to improve during that decade, with continuous spinal and caudal infusions finding favor (Zabriskie, 1943). These advances helped to pave the way for the development of lumbar epidural anesthesia, which proliferated in the 1980s and 1990s, thereby practically eliminating the use of nitrous oxide in the United States.

Epidural anesthesia maintained its popularity because of its effective pain relief. Improvements in infusion techniques, which combined regional anesthetic medications with opioids and employed continuous infusion via pumps, allowed for more consistent pain relief and improved women’s ability to change positions in bed. Despite these improved anesthesia techniques, the potential still exists for adverse effects, including acute hypotensive events after epidural placement, slowed uterine contractions, prolonged second stage of labor, fever and the need for operative vaginal births (Anim-Somuah, Smyth, & Jones, 2011). Historically, the literature upheld evidence that using epidural anesthesia in labor increased the risk of cesarean delivery; however, the most recent Cochrane review of epidural use in labor does not find sufficient statistical support of this association (Anim-Somuah et al.).

For some women, epidural anesthesia may not be a viable option because of preexisting hematologic disorders, spinal injury or malformation, localized infection at the injection site of the proposed epidural or allergy to local anesthetics. Many women want to avoid the interventions that accompany epidural anesthesia, including intravenous access, bladder catheterization, continuous electronic fetal monitoring (CEFM) and confinement to bed.
literature on any of the aspects of use of nitrous oxide for labor analgesia. The review recognized and called for more research to be conducted on safety, efficacy, patient satisfaction, environmental exposure and maternal/fetal effects. Readers should consider the limitations of the available literature and the AHRQ findings and recommendations in their own evaluation of the literature.

ABOUT NITROUS OXIDE
Nitrous oxide, comprising two nitrogen atoms and one oxygen atom, is a nonflammable gas that is liquid at room temperature. The mechanism of action is not well-understood, but is thought to be via the stimulation of endogenous endorphin release and, possibly, corticotropins and dopamine release. These biochemical actions create a euphoric effect that makes the patient less aware of pain (Rosen, 2002). When nitrous oxide is administered, without opioids or other central nervous system depressants, it is defined as minimal analgesia by some hospital protocols (Starr, Collins, & Baysinger, 2011).

PHARMACOLOGIC EFFECTS ON WOMEN IN LABOR
Several pharmacologic characteristics make nitrous oxide a well-suited analgesic for laboring women. Nitrous oxide’s rapid onset of action and quick clearance prevents accumulation in maternal or fetal tissues. Most women feel the positive effect of pain relief, decreased anxiety, euphoria and/or a feeling of not caring about the pain within 30 to 60 seconds (Rosen, 2002).

Women using nitrous oxide remain awake and alert, with complete motor and sensory function throughout use. The maternal laryngeal reflex is not inhibited, so aspiration risks are not increased. Nitrous oxide has not been demonstrated to alter uterine activity nor lengthen the first or active phase of labor (Volmanen, Palomäki, & Ahonen, 2011). Su, Wei, Chen, Hu, and Xu (2002), in their study comparing inhaled oxygen to nitrous oxide, found that the nitrous oxide users had a lower cesarean rate as compared to the control group who inhaled oxygen—11 percent versus 19 percent, respectively ($P < 0.05$) and shorter active phase of labor, 153 minutes versus 187 minutes, respectively ($P < 0.05$).

Unlike the ratio of nitrous oxide to oxygen utilized in the 1940s, the currently prescribed fixed concentration of nitrous oxide to oxygen (50 percent to 50 percent) is associated with fewer side effects and prevents maternal desaturation. It can be initiated or discontinued quickly, with clearance from the maternal system within 30 to 60 seconds (Akerman & Dresner, 2009). An advantage of the rapid clearance of nitrous oxide from a woman’s system is the option to change to another form of pain management if she is not satisfied with the nitrous oxide. Some other nonpharmacologic therapies that have been used as an adjunct to nitrous oxide and may potentiate the therapeutic effect include water immersion, psychoprophylaxis, hypnosis and acupressure. Other positive aspects of nitrous oxide use are that laboring women can remain ambulatory and do not require intravenous access nor CEFM.

As with all forms of labor analgesia, there are some limitations to the use of nitrous oxide. Because nitrous oxide has a peak onset of action of 30 to 50 seconds after initiation of inhalation, women may need some initial coaching as to timing of inhalation in relation to uterine activity. While this delayed onset of peak action of the nitrous oxide may be viewed by some as a limitation, it is easily overcome with patient education and practice through the first contractions after initiation.

Pain relief is as individualized as the perception of pain; for some women nitrous oxide will not provide adequate pain relief. Other women may perceive adequate pain relief but the adverse effects of nausea and vomiting (which occur in about 5 percent to 36 percent of women) may be more bothersome than the pain relief is helpful (Rosen, 2002). Nausea and vomiting are common in labor and the birth process, especially near transition, even without medication use (Volmanen et al., 2011). This makes it difficult to ascertain whether any nausea and vomiting experiences are related to the normal labor process or to nitrous oxide administration. Similarly, vertigo, occurring in up to 39 percent of laboring women who receive nitrous oxide, may also outweigh the benefits of its use for some women (Su et al., 2002). Anecdotally, a very small number of women have experienced dysphoria, restlessness and anxiety while using nitrous oxide (Bishop, 2007). When side effects occur, women and their health care providers need to evaluate whether nitrous oxide administration is a viable choice for their labor.
PHARMACOLOGIC EFFECTS ON THE FETUS/NEWBORN

Nitrous oxide crosses the placenta to concentrate in the fetus at about 80 percent of the maternal serum level. Nitrous oxide is quickly eliminated from the newborn as respirations are initiated; thus, it causes neither central nervous system nor respiratory depression in the newborn. Several studies have demonstrated no effect on Apgar scores or neonatal behavioral scores (Rosen, 2002). One study of 1,300 Chinese women using nitrous oxide for labor demonstrated no difference in Apgar scores, incidence of meconium stained fluid or cord blood gas results (Su et al., 2002). No effect on fetal heart rate has been documented in the literature.

ACCESSIBILITY AND COST

A major barrier to widespread implementation of nitrous oxide use has been difficulty in obtaining the nitrous delivery system. The only U.S. Food and Drug Administration (FDA)-approved nitrous delivery apparatus, Nitronox®, ceased to be manufactured some years ago, which has contributed to the difficulty in nitrous oxide services. Porter Instrument Division of the Hannifin Corporation has recently acquired the Nitronox® device and has plans to begin manufacturing and selling the new equipment in the fall of 2012 (M. Civitello, personal communication, June 26, 2012).

At the time of this writing (spring 2012), use of nitrous oxide for laboring women is believed to be limited to three large medical centers and a handful of smaller hospitals. For the last 30 years, the University of California at San Francisco (UCSF) has been the primary leader to offer nitrous oxide for labor analgesia under the direction of the UCSF Division of Obstetric Anesthesia (Bishop, 2007). In 2011, Vanderbilt University Medical Center (VUMC) began offering nitrous oxide as labor analgesia, the result of a collaborative initiative between the Obstetrics (OB) department, School of Nursing Nurse-Midwifery Practice and OB Anesthesia department (Starr et al., 2011). The University of Washington is the third major medical center that offers nitrous oxide as an option for labor analgesia (J. P. Rooks, personal communication, April 18, 2012).

In the United States, the setup and initiation of nitrous oxide has traditionally been a function of the OB Anesthesia team or the attending midwife/obstetric provider. At UCSF, certified nurse-midwives (CNMs) set up and initiate nitrous oxide and provide ongoing direct supervision. Anesthesia staff members are available for consultation as needed (Bishop, 2007). In Europe, where the vast majority of low-risk births are attended by midwives, it is common for midwives to supervise nitrous oxide initiation and administration. Nitrous oxide, in the form of Entonox® (a packaged premix of nitrous oxide and oxygen used in Europe but not FDA-approved for use in the United States) is commonly used in home births throughout Europe (Akerman & Dresner, 2009).

Several sources discuss nitrous oxide as being relatively inexpensive; however, no exact figures for cost in the United States have been published (Rooks, 2007; Rosen, 2002). The supplies and bedside anesthesia staff time required for anesthesia care at the bedside for nitrous oxide use are less than that required for epidural placement and monitoring, and therefore theoretically less costly. Institutions currently using nitrous oxide as labor analgesia have individual means of charging for anesthesia services and the use of nitrous oxide. There have not been significant issues with obtaining insurance reimbursement for the use of nitrous oxide in this capacity. Determining the cost-effectiveness of nitrous oxide is an area for future research.

NITROUS OXIDE CANDIDATES AND CONTRAINDICATIONS

Nitrous oxide is beneficial not only for labor pain but also for other indications during and following birth. The rapid onset of action of nitrous oxide makes it a valuable analgesic choice for painful procedures such as laceration repair, forceps- or vacuum-assisted vaginal deliveries, uterine exploration, manual removal of the placenta or bedside dilation and curettage (D&C) (Starr et al., 2011). The anxiolytic properties of nitrous oxide deem it useful for such events as starting intravenous lines, starting intravenous lines, starting intravenous lines.
performing pelvic exams and even during epidural anesthesia placement (see Box 2).

Although nitrous oxide may be the appropriate choice for many laboring women, some contraindications do exist. If a woman cannot physically hold her own face mask or is drug- or alcohol-impaired, she is not a candidate for nitrous oxide self-administration. For some women, the side effects may be significant enough to dissuade usage. Hemodynamically unstable patients or those with impaired oxygenation also may not be good candidates for nitrous oxide use. Some institutions have deemed women with Category 3 EFM tracings and selected Category 2 tracings unsuitable candidates (Starr et al., 2011).

When nitrous oxide is utilized in a patient with vitamin $B_{12}$ deficiency, methionine synthase production is inhibited. This enzyme is essential for normal cell activity and when absent, "genetic and protein aberrations" begin to occur and can result in megaloblastic anemia. (Sanders, Weimann, & Maze, 2008). Vitamin $B_{12}$ deficiency is commonly found with malnourishment as a result of reduced intake, chronic alcohol abuse or anorexia nervosa. Some women who consume strict vegan/vegetarian diets may also exhibit $B_{12}$ deficiency. Altered absorption in the gastrointestinal tract, such as with Crohn’s disease and after bariatric surgery, can also cause $B_{12}$ deficiency. If a woman’s $B_{12}$ level is adequate from replacement therapy, nitrous oxide is not contraindicated (Starr et al., 2011).

Absolute contraindications to the administration of nitrous oxide include the presence of a potential space the gas could fill, such as with pneumothorax, intraocular surgery, bowel obstruction or middle ear surgery. Other conditions that contraindicate nitrous oxide usage are increased intracranial pressure, increased intraocular pressure and pulmonary hypertension. For a more complete list see Box 3 (Sanders et al., 2008; Starr et al., 2011).

ADMINISTRATION OF NITROUS OXIDE

Prior to administration of nitrous oxide, the designated anesthesiology/OB health care provider performs a history and physical, and then written informed consent is obtained. As with any mode of labor analgesia or anesthesia, consent will be directed by the individual institution. While some may require a formal written consent to be signed that details risks and benefits of nitrous oxide use, other institutions will require only verbal review of the risks and benefits for consent.

The team member who sets up the nitrous oxide delivery apparatus will be designated in the policies and procedures of the individual institutions. Some institutions will require that only anesthesia personnel set up the apparatus, while others, such as UCSF, dictate that CNMs, as well as anesthesia personnel, may set up the equipment.

The designated team member will set up the portable gas blender (Nitronox® in the United States), which contains a scavenging system. Scavenging allows for the exhaled nitrous

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**BOX 3 PRECAUTIONS AND CONTRAINDICATIONS FOR NITROUS OXIDE USE**

**PRECAUTIONS/RELATIVE CONTRAINDICATIONS**

- Side effects (e.g., nausea, vomiting, dizziness, dysphoria, etc.) are not tolerable
- Current vitamin $B_{12}$ deficiency
- Some Category 2 and Category 3 CEFM tracings
- Hemodynamic instability and/or impaired oxygenation

**CONTRAINDICATIONS**

- Acute drug or alcohol intoxication or impaired consciousness
- Recent history of trauma, pneumothorax, increased intracranial pressure, increased intraocular pressure, intraocular surgery, bowel obstruction, middle ear surgery, emphysema, pulmonary hypertension and others
- Inability to hold own face mask

Sources: Bishop (2007), Starr et al. (2011).
oxide to be collected for disposal rather than released into the ambient air, and this method should reassure personnel in the area that they will not be exposed accidentally to the gas (see Figure 1).

Part of the nitrous initiation patient education includes instructing the laboring woman and her support persons on the techniques of self-administration. Nitrous oxide can only safely be self-administered by the laboring woman; support persons need to be educated that they absolutely cannot assist in the delivery of nitrous oxide by holding the mask up to the laboring woman’s face. An integral safety feature of nitrous oxide use is that when the woman has physiologically reached her limit of nitrous oxide intake, she will no longer be able to hold the mask up to her face for more, thus self-regulating the intake. When someone else is allowed to hold the mask up to her face, the potential risk of losing consciousness increases dramatically.

The woman thus holds her own disposable face mask or mouthpiece and inhales the 50 percent nitrous and 50 percent oxygen mixture. A demand valve allows the gas to be released only when a tight seal is produced with inhalation.

Encouraging the woman to inhale slowly and deeply for 30 seconds prior to the onset of the contraction will achieve the most effective results (Rosen, 2002). If the contraction pattern is irregular, inhalation is best timed to begin at the onset of awareness of a contraction. Inhalation continues through the contraction and then the patient removes the mask or mouthpiece and breathes room air between contractions (Akerman & Dresner, 2009). Occasionally, a woman will continue to inhale the nitrous oxide between uterine contractions if she still feels the need (see Figure 2).

Women acclimate very quickly to the self-administration technique. Generally, by the third or fourth contraction of nitrous oxide use, most women will have become adept. The ability to regulate the timing of analgesia adds to a woman’s feeling of control during labor. Women may choose to use it with each contraction throughout labor to obtain optimal relief, while others may inhale for only short period of time. Studies have shown that labor pain, in and of itself, is not the sole predictor of labor experience satisfaction. Although women may have pain, they may still be very satisfied with their labor experience (Rooks, 2011). If a pain-free labor is a woman’s expectation, then nitrous oxide will likely not suffice. If reduced pain is her expectation, then the use of nitrous oxide may prove to be more than adequate. Some laboring women may also find nitrous oxide to be effective for early labor but find that they need an alternative mode of pain relief as labor continues. (Akerman & Dresner, 2009).

Many women may continue to use nitrous oxide throughout the second stage of labor. While some women may actually begin self-administration use at the onset of second stage, others may find it hinders their ability to push effectively. Working closely with patients throughout the second stage to find what works for them is essential. Nursing texts as far back as 1966 (Fitzpatrick, Eastman, & Reeder, 1966) describe that after the birth of the fetal head and body, the woman should breathe only room air while awaiting cord clamping. However, continuous use throughout the birth is reasonable due to the efficient and fast clearance of nitrous oxide from the maternal and newborn systems (Volmanen et al., 2011).

**NURSING IMPLICATIONS FOR PATIENT SAFETY**

Patient safety is a key component of nitrous oxide self-administration. As with any new intervention, nurses must have thorough education and demonstrate competency before providing care for women using nitrous oxide (see Box 4). At VUMC, all nursing staff who care for laboring women are required to view a presentation on nitrous oxide as labor analgesia, which was developed jointly by the CNM and anesthesiologist who led the initiative. Staff are then required to pass a short computerized quiz regarding information from the presentation, so that documentation of core competency with bedside care of the laboring woman using nitrous can be obtained.

Laboring women and their support persons need both initial and repetitive instruction making clear that only laboring
women may administer nitrous oxide to themselves. Support persons must also be cautioned against using the nitrous oxide for personal consumption. If hospital staff note this to be the case, the person needs to be removed from the laboring woman’s room.

Another key aspect for laboring women using nitrous oxide is safety, because of the reality that some women may experience the side effects of unsteadiness or vertigo. A laboring woman and her support person need to understand that she must be assisted from her bed and observed to ensure her safety while moving about the labor room. Women using nitrous oxide while assuming positions such as squatting, sitting on birthing balls, standing in the shower or sitting in the tub, require attentive supervision. Use of adjunctive therapies (hydrotherapy, acupressure, etc.) can be helpful and are practiced in many European settings and some U.S. settings. Nurses need to be attentive to women’s changing needs and desires when using nitrous oxide with any adjunctive therapies.

Nurses must continuously assess the mother and fetus throughout labor and document assessments in accordance with the individual institutional policy. While a patient is using nitrous oxide, vital signs should continue to be taken as required for a laboring woman based on her risk status and stage of labor. If maternal or fetal well-being is thought to be compromised, following hospital guidelines for notification of the OB and/or anesthesia teams and performing the required intrauterine resuscitation nursing interventions (e.g., maternal position change, obtaining IV access, oxygen administration and discontinuing nitrous oxide administration) are recommended (Box 5).

The role of staff nurses in documenting patients’ nitrous oxide use is similar to that of documenting any analgesic method used during labor. It should include time of initiation, patient’s response and any side effects or complications. End time is also noted with indication for termination of use (i.e., no longer desired, patient request to discontinue due to side effects, desire to change to an alternate medical pain management technique, etc.). As with all nursing documentation, notes should reflect the story of labor analgesia efficacy.
As with any inhaled medical gas, there is concern over environmental dispersion of nitrous oxide waste. For that reason, the current FDA-approved nitrous delivery apparatus contains a scavenging system that enables exhaled nitrous oxide to be collected and safely deposited in a waste receptacle system. Although medical use of nitrous oxide composes less than 1 percent of environmental emissions of nitrous oxide, it is a potent greenhouse gas. With scavenging systems, up to 70 percent of exhaled medical nitrous oxide can be collected (Volmanen et al., 2011). Significant environmental sources of nitrous oxide are power stations, motor sports, agriculture (through fertilizers and dairy farms) and manufacturing of acids and nylons (Scottish Environment Protection Agency, n.d.-a, n.d.-b).

Another safety issue of nitrous oxide, as with other available analgesics, is its association with abuse. When the Nitronox® blender is not in use, it is recommended that it be kept in a secured area, in similar fashion to how opioids are stored. Staff abuse of nitrous oxide should be regarded in the same light as staff abuse of any other medication and addressed according to institutional policy.

Some nurses have voiced concern over their role in nitrous oxide administration, citing concerns about scope of practice. Most Nurse Practice Acts do not provide for a registered nurse to administer anesthetic gases. However, in the case of nitrous oxide use as labor analgesia, the registered nurse is not administering the nitrous oxide; it is the woman who administers it to herself. The nurse’s role is to reinforce education provided per the anesthesia and/or OB team; perform and document appropriate nursing assessments, patient relief and side effects response and, lastly, to guard patient physical safety. In the initiation of a nitrous oxide service, it would be prudent for the nursing management to contact their state board of nursing.

**CONCLUSION**

Nitrous oxide’s pharmacologic makeup and minimal maternal and fetal side make it an appropriate alternative for labor analgesia for many women. With the reintroduction of self-administered nitrous oxide into U.S. hospitals, a working knowledge of safe and evidence-based nursing care of the laboring woman

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**IMPLICATIONS FOR STAFF SAFETY**

Some concerns have arisen among labor and delivery staff regarding their physical safety, environmental safety and medico-legal issues related to nitrous oxide use. Common questions include: “What is the impact on my fertility?”, “Isn’t nitrous abuse by staff/visitors going to be a problem?” and “Is my RN license jeopardized if I participate in nitrous oxide administration?”

The existing U.S. data regarding the relationship to fertility and nitrous oxide exposure are derived largely from the dental profession, where nitrous is administered at higher concentrations (70 percent to 80 percent) and where there is more concentrated exposure because providers are working in close proximity to patients’ exhalations. Slight increases in infertility, spontaneous abortions and preterm labor were demonstrated in dental hygienists in the United States in studies conducted in the 1990s (Volmanen et al., 2011). No U.S. studies have examined workplace exposure on labor and delivery units, which use lower concentrations of nitrous oxide and where scavenging systems are used. In addition to these differences of administration, modern labor and delivery units provide better ventilatory systems to further decrease the ambient levels of nitrous oxide. Per the U.S. Occupational Safety and Health Administration (OSHA, n.d.), exposure limit is 25 to 50 parts per million (ppm), whereas the European limit is generally set at 100 ppm (American College of Nurse-Midwives, 2010). OSHA is currently developing safety requirements for exposure by medical personnel (OSHA). Animal data suggest that exposure below these levels is not supportive of reproductive risk; levels > 500 ppm have been noted as a baseline to cause toxicity (Sanders et al., 2008).

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**CONCLUSION**

Nitrous oxide’s pharmacologic makeup and minimal maternal and fetal side make it an appropriate alternative for labor analgesia for many women. With the reintroduction of self-administered nitrous oxide into U.S. hospitals, a working knowledge of safe and evidence-based nursing care of the laboring woman
using nitrous oxide is essential. An understanding of the history of nitrous oxide use, as well as how the current practices have evolved, will assist labor and delivery nurses to optimize the benefits of self-administration of nitrous oxide. Either alone or in combination with nonpharmacologic pain management therapies, nitrous oxide offers laboring women a feasible alternative to existing modalities. Educating women about analgesic options and including them in the decision-making process empowers them and ultimately leads to satisfying birth experiences.

REFERENCES


Post-Test Questions

Instructions: To receive contact hours for this learning activity, please complete the online post-test and participant feedback form at http://JournalsCNE.awhonn.org.

1. Nitrous oxide gas is:
   a. commonly known as “laughing gas”
   b. highly flammable
   c. often bitter tasting to many patients

2. Possible side effects for women using nitrous oxide for labor analgesia include:
   a. headache
   b. loose stools
   c. nausea and vomiting

3. Nitrous oxide for labor analgesia is most commonly used at which concentration ratio?
   a. 40 percent nitrous, 60 percent oxygen
   b. 50 percent nitrous, 50 percent oxygen
   c. 60 percent nitrous, 40 percent oxygen

4. All of the following patients are appropriate candidates for nitrous oxide analgesia except the woman:
   a. in labor who had butorphanol (Stadol) 3 hours ago and now needs a 3rd laceration repair
   b. in labor with multiple sclerosis who has very limited grasp ability
   c. undergoing manual removal of her placenta following a spontaneous vaginal birth

5. Before administration of nitrous oxide analgesia to a laboring woman, which of the following procedures is required?
   a. Blood level for drugs and alcohol (toxicology screen)
   b. Blood level to rule out B₁₂ deficiency
   c. History and physical

6. For nitrous oxide to be most efficacious, a laboring woman should be encouraged to begin inhaling the nitrous oxide:
   a. at the beginning of the contraction
   b. thirty seconds prior to the start of the contraction
   c. two minutes prior to the start of the contraction

7. A nurse can be confident the patient education has been effective when the laboring woman states:
   a. “I am concerned the nitrous oxide can keep my baby from taking his first breath.”
   b. “If I can’t hold my mask while pushing, it’s OK for my partner to hold it for me.”
   c. “I understand that the relief provided by the use of nitrous oxide is different from the type of relief provided by an epidural.”

8. Patient safety while nitrous oxide is in use includes the nurse doing what?
   a. Making sure the support person knows how to hold the face mask with a tight seal.
   b. Observing and assisting the patient getting out of bed and moving about her room.
   c. Teaching the patient that birthing balls, hydrotherapy and squatting are contraindicated.

9. According to the authors, nitrous oxide:
   a. does not cross the placenta
   b. has an 80 percent clearance rate through the maternal/fetal circulation
   c. has been demonstrated in several studies to have no negative effect on either Apgar scores or neonatal behavioral scores

10. Nitrous oxide may be a beneficial analgesia choice for laboring women who:
    a. are not candidates for lumbar epidural analgesia because of spinal malformations or hematological disorders
    b. have altered absorption or insufficient dietary intake of B₁₂ resulting in B₁₂ deficiency
    c. have recently undergone intraocular surgery, bowel obstruction or middle ear surgery

11. Staff safety from exposure to nitrous oxide can be optimized by all of the following except:
    a. having well-ventilated labor and delivery rooms
    b. using a scavenging system that collects exhaled nitrous oxide for disposal
    c. verifying greater than 100 ppm of nitrous oxide present in the ambient air

12. Which is the most accurate statement regarding the perception of pain relief by laboring women using nitrous oxide? They:
    a. have less pain than women who have epidural anesthesia for labor pain
    b. usually have more pain than women who use no pharmacological pain interventions
    c. generally will be satisfied with their labor experience

13. A woman arrives at the hospital with her cervix dilated to 7 cm and progresses rapidly to complete dilation. She had desired an unmedicated labor and birth, but is now screaming that she needs something for pain. In relation to this situation and pain relief, which is a true statement?
    a. An epidural placement would be the best mode of pain relief at this point.
    b. It is too late in labor for her to use nitrous oxide.
    c. She is a candidate for nitrous oxide use at this point.

14. An important function of the RN role in nitrous oxide administration is to:
    a. check nitrous oxide equipment and setup of blender
    b. obtain informed consent from the patient
    c. reinforce patient education of self-administration techniques

15. Which of the following is a contributing factor to the resurgence of nitrous oxide use in labor?
    a. A growing demand by women and providers for more interventions during labor.
    b. Epidural anesthesia causing a statistically significant increase in the cesarean rate.
    c. Women’s desire to have more options for pain management in labor and birth.