Nitrous Oxide: Expanding Women’s Options for Pain Management

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Learning Objectives

Participants will learn:
- How nitrous oxide works
- Maternal risks/benefits of nitrous oxide
- Neonatal effects
- Guidelines for safe use

Nitrous Oxide Drug Info

- Colorless, tasteless, non-irritating, slightly sweet odor
- Nonflammable
- Most rapid onset of all the inhalation agents
- Weak anesthetic at high doses
- Anxiolytic and moderate analgesic at low doses
- Administered by inhalation
- Absorbed by diffusion through the lungs
- Eliminated via respiration.
- The elimination half life of nitrous oxide is approximately 5 minutes
- It is excreted essentially unchanged (nonmetabolized) via the lungs, less than 0.004% is actually metabolized in humans

History of Nitrous Oxide

- Nitrous oxide isolated in 1786 by Joseph Priestly
- Use as an anesthetic first by chemist Sir Humphrey Davies (1778-1829)
- 1st use of nitrous for labor analgesia: Russian occupied Poland in 1881 (80%/20%)
- British physician developed equipment for self-administration in 1934
- Used widely for labor in the United States from 1930s until the 1970s

N2O for Labor Analgesia

- Impressive safety record
- Used commonly in numerous countries with high standards for medical care
  - Used by 60% women in UK
  - 50% in Australia
  - Almost 50% in Canada and Finland
  - In the United States
    - Until past 5 years offered by only
      - UCSF
      - Vanderbilt
      - Small rural hospital in Lewiston, ID
    - Currently
      - Growing consumer interest
      - New programs opening up all over US!
Current options for laboring women in the United States considered to be “very helpful”

- Epidural: 81%
- Hydrotherapy: 48%
- Massage/therapeutic touch: 40%
- Opioids: 40%
- Application of heat: 31%
- Position changes: 23%
- Breathing Techniques: 21%

(Declerq, 2006)

Welcome Nitrous Oxide!

How does it work?

- Exact mechanism unknown
- Enters body through inhalation
- Onset is < 60 seconds
- Analgesic effectiveness thought to be related to release of endorphins, dopamine and other natural opioids in brain
- Increases release of prolactin and decreases release of cortisol, reducing hormonal response to stress
- Though not a potent analgesic, it helps women relax, gives them a sense of control and distracts the perception of pain
- Most common estimate of analgesic efficacy suggests that 30% nitrous oxide by mask is equivalent to 10-15 mg morphine
- As the weakest inhaled gas, nitrous oxide is always paired with a stronger agent when used for anesthesia

Efficacy

- Studies that evaluate efficacy are difficult to design
  - Randomized controlled trials that assign patients to a group that offers no analgesia in order to assess the efficacy of a particular technique are not ethical
  - Severe pain is experienced by most women at some point in labor
  - Intensity is highly variable and depends upon
  - Maternal factors
  - Size and presentation of the fetus
  - Whether labor is spontaneous or augmented
  - Rate of cervical dilation during the first stage
  - Parity
  - Psychosocial factors

Research

- Systematic review by Mark Rosen 2002
- Eleven randomized controlled trials were used to determine efficacy
  - Difficult to quantify nitrous oxide’s analgesic effects in labor objectively , despite over 100 years of experience
  - Appears to provide benefit for many laboring women
- 8 controlled and 8 observational studies were reviewed to establish adverse outcomes
  - No effect on progress of labor
  - Nausea and vomiting ranged from 5-36%
  - Hazy memory of labor as high as 37%
  - No differences in oxygen saturation unless given with opioids
  - Neonatal no significant differences in apgars or neonatal survival
- Nonsystematic review of studies on occupational exposure was conducted
  - Exposure levels exceeded recommendations when used in rooms with poor ventilation, using uncavenged nitrous oxide

Risks for mother

- Greatest potential risk aspiration
- LOC have been reported with concentrations 75%-100%
- Rare instances with 50%, if someone else holds mask
- Use in labor
  - Sub anesthetic dose
  - Anxiolytic and analgesic
  - Patient remains awake with protective reflexes intact

50% nitrous 50% oxygen used in labor is analgesia, not anesthesia

Neonatal effects

- N2O crosses the placenta
- With intermittent inhalation accumulation over time is negligible
- Mother’s lungs constantly eliminate from fetal blood
- Neonate eliminates most within minutes after birth, principally through lungs
- Multiple studies-no significant differences in
  - Incidence of meconium-stained amniotic fluid
  - Blood gas analyses of umbilical cord blood
  - Apgar scores
  - Neonatal survival
- No identified effect on breast-feeding or maternal-newborn bonding
Contraindications
- Cannot hold face mask (anatomic reasons, psychological, cognitive)
- Impaired consciousness or intoxication
- Vitamin B-12 deficiency
  - Nitrous oxide is known to interfere with vitamin B12 and folate metabolism. In patients with these preexisting conditions, nitrous oxide should only be used with full precautionary consideration
- Pneumothorax, bowel obstruction, increased intraocular pressure, recent ear surgery (Nitrous accumulates in CLOSED SPACES)
- Received intravenous opioids in past two hours
- Impaired oxygenation
- Hemodynamically unstable
- Use with caution in patients with URI, allergic rhinitis, severe sinusitis—may cause emesis in part from pressure changes in the middle ear

Benefits
- Extensive record of safe use for the mother and fetus
- Laboring mom remains awake and alert with complete control motor and sensory function
- Eliminated through lungs, rather than liver
- Rapidly cleared from maternal system in 30-60 seconds
- Unlike opioids, does not depress respiration
- Sub anesthetic concentrations have little influence on cardiac output, stroke volume or heart rate
- Does not trigger malignant hyperthermia
- No adverse effects on physiology and progress of labor

Other Benefits
- Routine co-interventions not needed
  - IV
  - Frequent blood pressure monitoring
  - Continuous fetal monitoring
  - Urinary bladder catheterization
- Can be used alone or to supplement other methods
- Can be started or stopped at any point in labor
- Can be made safe for staff
- Inexpensive
- Safe and effective method for pain management in institutions with limited infrastructure or personnel limitations

Monitoring Considerations
- When N2O is delivered at concentrations ≤ 50% as a sole agent, it is defined by the American Society of Anesthesiologists (ASA) as analgesia minimum sedation
- The patient is responsive and airway, ventilation and cardiovascular function remain unaffected
- Assuming these conditions and with intermittent use, continuous pulse oximetry is not required
- If N2O is used in combination with other IV narcotics, this is considered conscious sedation NOT analgesia and should be administered only in the presence of anesthesia with use of continuous pulse oximetry

Side effects
- Pleasure
- Relaxation
- Feeling of warmth
- Dreams
- Detachment
- Dizziness
- Euphoria
- Fatigue
- Hazy memory of events
- Headache
- Dry mouth
- Buzzing in ears
- Nausea, vomiting
- Rarely, pins and needles or numbness
- Side effects more pronounced if inhaling between contractions

Potential Uses in L&D
- Labor pain
  - Experienced providers find N2O is especially effective
    - Toward end of first stage
    - For multipara
    - For pushing stage
- Manual removal of placenta
- Repair of lacerations
- During epidural placement
- While waiting for epidural
- In institutions where epidurals are not available on 24 hour basis
- For IV starts
- Operative delivery
- D&C
Nitronox Blender: available in US from Porter Instrument

2 portable tanks: nitrous oxide and oxygen

Nitronox: Multiple Safety Features

- Single use breathing system
- Pre-set blended 50/50 from 2 separate cylinders
- No ability to adjust dose
- Demand valve opens only when user applies negative pressure by inspiring
- Demand valve eliminates flow when patient not inhaling, minimizing environmental contamination
- Oxygen driven pressure control-automatic N2O shut-off if oxygen tank depletes
- Audible alarm O2 enrichment feature
- Patient administered
- 100% O2 capability
- Built in scavenging interface
Patient Education

- Pre-treatment evaluation: Vital signs including blood pressure, heart rate, oxygen saturation, fetal heart monitoring
- Inform of potential side effects and reasonable expectations
  > Pain will not be eliminated
  > May feel dizzy or nauseous etc.
- Instruct patient on self-administration
  > Placement of mask to form seal
  > Begin inhalation 30 seconds before contraction (if regular) or the moment the contraction is felt (if irregular)
  > Requires careful attention/anticipation to contraction timing
  > Take slow deep breaths and concentrate on breathing
  > Caregiver at side to coach
  > Remove mask in between contractions and breathe room air normally

Pain Management Options

- For some women, N₂O will not provide adequate pain relief
- Some women may not like the way it makes them feel
- Some woman will find it useful in early labor, but prefer something stronger as labor progresses
- Nitrous can be quickly initiated and discontinued, transitioning to use of other methods, such as IV narcotics or an epidural
- If nitrous oxide is discontinued, may safely receive dose of narcotics 15 minutes later

Maternal Satisfaction Broken Down

- 50% of laboring women love it
- 30% feel it helped a little
- 20% don’t care for it at all!

Candidates for Use

- In labor, any stage
- No time is too early or late!
Nursing Care Considerations

- Required order by licensed OB provider
- Labor assessments and interventions are performed according to facilities practice guidelines and the woman’s risk status and stage of labor, not based on concurrent use of N\textsubscript{2}O
- Equipment check and proper set up
- Documentation generally includes
  > Time of initiation
  > Patient’s response
  > Side effects or complications
  > Time of termination
  > Reason for terminating

Nitrous Abuse

- Potential for recreational use by staff or visitors
- Recommended that the nitronox blender be kept in a secure location when not in use
- Abuse would be addressed according to institutional policy

Other Concerns

- Dental literature-possible effect on human reproduction (high levels of unscavenged gas, small unventilated spaces) including impaired fertility, miscarriages
- Dose is critical determinant
- Occupational exposure standard (OES) limit to 25ppm/8 hour time in US, 100ppm in UK
- Risk is essentially eliminated with adequate ventilation and scavenging
- Safe Practices
  > Good ventilation
  > Scavenging equipment
  > Exposure can be measured with nitrous-sensitive badges
  > Hospital must establish safe practice

Environmental Concerns

- Concern about N\textsubscript{2}O’s contribution to the overall climate-heating effects of “greenhouse gases”
- In 2013, nitrous oxide (N\textsubscript{2}O) accounted for about 5% of all U.S. greenhouse gas emissions
- Medical use is a very small part of the greenhouse gas problem

Possible Barriers to Implementation

- Concerns about state regulations on “anesthetizing locations”
- No billing code-currently not reimbursable
- Anesthesia department : ? fear of competition and financial loss-maintaining the epidural “mono-culture”
- Concerns over nursing scope of practice
- General resistance to change
- System inertia
Nursing Scope of Practice

- Most state’s Nurse Practice Acts do not provide for an RN to administer anesthetic gases
- In the case of nitrous oxide used as labor analgesia, the patient self-administers (much like an epidural PCA)
- Depending on institution may be anesthesia-initiated or nurse-initiated
- The nurse’s role is to
  > Provide and reinforce education (dependent on your institution’s guidelines)
  > Perform and document appropriate assessments and interventions
  > Guard patient safety

Conclusion

- Women need access to a range of options for pain relief in labor
- Nitrous oxide is a safe and reasonable option for child-bearing women
- Educating women about their analgesic options and including them in the decision making process is empowering and ultimately leads to a more satisfying birth experience

Staff Education

- Staff must be trained and demonstrate competence in use
- Ongoing education required

Bibliography

- UCSF Standardized Procedure for the Administration of Nitrous Oxide in Labor by Nurse Midwives. 2009

Thank you!