Nitrous Oxide For Dental Assistants and Dental Hygienists

1

Course Objectives

Describe the following in relation to the administration and monitoring of nitrous oxide in a dental office:

- The pharmacology of nitrous oxide
- The biochemistry of nitrous oxide
- The anatomy of nitrous oxide administration
- Emergency procedure related to the use of nitrous oxide
- Mechanics of operating a nitrous oxide unit
- Proper disinfection of nitrous oxide equipment

2

Course Objectives

- Demonstrate the proper use of setting up, administering and monitoring of nitrous oxide for a patient in a dental setting.
- Properly document in a patient's chart the administration and monitoring of nitrous oxide and local anesthetics.
- Discuss the role of the dental hygienist and dental assistant in the administration and monitoring of nitrous oxide.

3

Course Objectives

- State the requirements, as specified by the Indiana State Board of Dentistry, for a dental hygienist and dental assistant administering and monitoring nitrous oxide during patient treatment.
- Describe environmental hygiene as it relates to nitrous oxide use.
- Evaluate signs and symptoms of nitrous oxide-oxygen sedation.

4

INDIANA STATE REQUIREMENTS

a) A dental hygienist or dental assistant (as defined in IC 25-14-1-1.5(4)) may administer nitrous oxide under the direct supervision of a licensed dentist if the dental hygienist or dental assistant has:

(1) been employed in a dental practice for at least one (1) year or has graduated from a program accredited by the Commission on Dental Accreditation of the American Dental Association

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INDIANA STATE REQUIREMENTS (cont)

(2) satisfactorily completed a three (3) hour didactic nitrous oxide administration course containing curriculum on pharmacology, biochemistry, anatomy of nitrous oxide administration, emergency procedures, and the mechanics of operating a nitrous unit, accredited by the Commission on Dental Accreditation of the American Dental Association; and

(3) demonstrated clinical competency on at least five (5) patients under the direct supervision of a licensed Indiana dentist whose license is in good standing.

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INDIANA STATE REQUIREMENTS (cont)

(b) The licensed Indiana dentist supervising the clinical competency under subsection (a)(3) shall provide to the dental hygienist or dental assistant a signed affidavit certifying the competency.

(c) Upon receipt of the affidavit provided to a dental hygienist or dental assistant under subsection (b), the provider of an educational program or curriculum described in subsection (a)(2) shall issue a certificate of completion to the dental hygienist or dental assistant. The certificate of completion must be publicly displayed in the dental office of the dental hygienist or dental assistant.

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INDIANA STATE REQUIREMENTS (cont)

d) Before permitting a dental hygienist or dental assistant to administer nitrous oxide, the **supervising dentist shall**:

(1) verify that the dental hygienist or dental assistant has completed the requirements of subsection (a); (2) determine the maximum percent-dosage of nitrous oxide to be administered to the patient; and (3) ensure that any administration or monitoring of nitrous oxide by dental hygienists or dental assistants is done in accordance with relevant guidelines and standards developed by the American Dental Association or the American Academy of Pediatric Dentistry.
SECTION 5. IC 25-13-1-11, AS AMENDED

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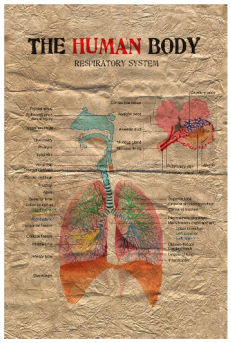
ANATOMY AND PHYSIOLOGY



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OBJECTIVES

- Discuss respiratory system structure and function to include:
  - Inspiration
  - Expiration
  - Minute volume
  - Tidal Volume

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RESPIRATORY SYSTEM FUNCTION

- Exchange Oxygen and Carbon dioxide across pulmonary/capillary membranes
- Performed continuously and with minimal effort
- Driven involuntarily by the medulla oblongata
- Driven voluntarily by the cerebral cortex
- Nitrous oxide uses same pathways

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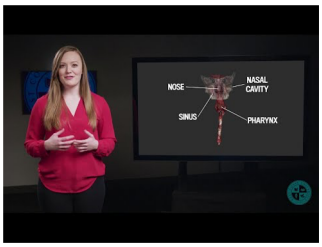
UPPER RESPIRATORY SYSTEM



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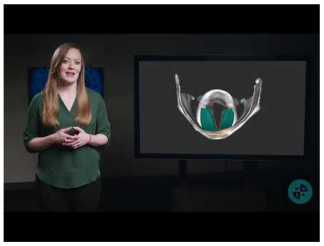
LOWER RESPIRATORY SYSTEM



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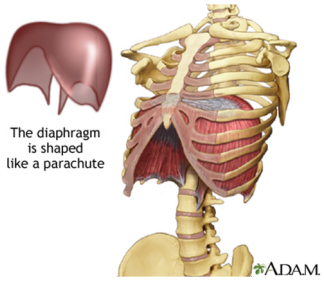

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RESPIRATORY PROCESS- INSPIRATION (INHALATION)

- Negative pressure created by the diaphragm's downward movement creates a vacuum effect pulling air into the lungs
- Inspiration stops when pressure in lungs= atmospheric pressure

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RESPIRATORY PROCESS-EXPIRATION (EXHALATION)

- When pressure becomes equal, pulmonary stretch receptors send an inhibitory signal to inspiratory muscles
- Inspiratory muscles stop contracting
- As chest wall and lungs recoil, expiration occurs
  - This is a passive process

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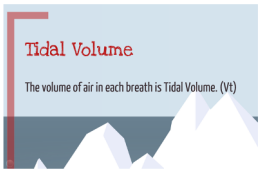
TIDAL VOLUME

- Amount of gas inspired into the lungs
- Varies/ Average adult tidal volume is 500 mL



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MINUTE VOLUME

- Amount of air exhaled in one minute
- Equals the product of tidal volume and number of breaths per minute
  - Average adult respiration rate **12-15 breaths per minute**
  - Average minute volume approximately **6-7 LPM**
  - Start pediatric patients at **4 LPM**

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PRACTICE

- The patient's tidal volume is 500 mL and the respiration is 14 breaths per minute. What is the minute volume?
- 500 ml multiplied by 14 = 7000 ml = 7 Liters

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CALCULATING PERCENTAGES OF GASES

- To determine percentage of nitrous oxide delivered divide the liters per minute of Nitrous by the total liters per minute being delivered (both nitrous oxide and oxygen)
  - For example, if you are delivering 6 lpm total (nitrous oxide(3 lpm) and oxygen (3 lpm)) you would divide 3 by 6 = .50 or 50%

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CALCULATING PERCENTAGES PRACTICE

- You are delivering 7 LPM total nitrous oxide (3 lpm) and oxygen (4 lpm)
  - What is the percentage of nitrous oxide?
    - Divide 3 lpm (nitrous oxide) by 7 lpm (total)= approximately 43%
  - What is the percentage of oxygen?
    - Divide 4 lpm (oxygen) by 7 lpm (total)= approximately 57 %

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PHARMACOLOGY

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OBJECTIVES

- Discuss the pharmacokinetics and pharmacodynamics of nitrous oxide
- Name the 3 factors that affect absorption of nitrous oxide into the bloodstream
- Define minimum alveolar concentration (MAC)

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OBJECTIVES

- Discuss onset and recovery from nitrous oxide
- Define diffusion hypoxias
- List possible adverse effects of occupational exposure
- List safety considerations to reduce occupational exposure

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Uptake and distribution

- Uptake and distribution are affected by:
  - Partial pressure
  - Solubility
  - Partition coefficient

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PARTIAL PRESSURE

- Gases move passively from areas of higher pressure to areas of lower pressure.
- Nitrous oxide has high partial pressure in the lungs, moving easily from the lungs to the bloodstream.

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SOLUBILITY

- Highly soluble substances take longer to reach equilibrium
- Insoluble substances reach equilibrium more quickly
- Nitrous oxide is relatively insoluble in the bloodstream
  - Reaches equilibrium within 3- 5 minutes

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PARTITION COEFFICIENT

- Ease with which the a substance passes through membranes to diffuse into and out of the bloodstream and body tissues
- The lower the partition coefficient, the faster the onset and recovery
  - Nitrous Oxide has a low partition coefficient.

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MINIMUM ALVEOLAR CONCENTRATION

- MAC of 1 is the dose required to achieve general anesthesia in 50% of the population
  - Nitrous oxide is the least potent of the inhalational anesthetics
  - Nitrous Oxide MAC is 1.4
    - Cannot be used as a single agent general anesthetic
    - Often used as a carrier gas

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MINIMUM ALVEOLAR CONCENTRATION

- MAC values of .3 - .5 required for levels of sedation used in dentistry
  - 30%-50% nitrous oxide

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ONSET AND RECOVERY

- Once equilibrium is reached, you should begin to notice signs of sedation
- When nitrous is stopped, the partial pressure is higher in the capillaries than in the lungs, the nitrous diffuses from the capillary to the lungs and the patient exhales the nitrous
- 99 % of nitrous oxide leaves the body unchanged

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DIFFUSION HYPOXIA

- Diffusion hypoxia can occur when nitrous oxide diffuses out of the blood and into the lungs
  - This does not occur at the levels of nitrous oxide used in dentistry

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OCCUPATIONAL HAZARDS

- Reproductive difficulties including miscarriage
- Megaloblastic anemia
- Neurological disorders
- Vitamin B-12-dependent enzyme, methionine synthase interference

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SAFETY CONSIDERATIONS

- Maximum exposure limit not determined
  - No scientific evidence for previously published guidelines
- When using nitrous oxide routinely monitor ambient air
  - Time weighted dosimetry
    - Monitors individual exposure to trace gas
    - Allows for continuous monitoring

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REFERENCES

Bassett, Kathy B. (2015). *Local anesthesia for dental professionals.* Pearson Education, Inc.

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PAIN AND ANXIETY MANAGEMENT

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OBJECTIVES

- Define and discuss:
  - Pain
  - Pain Threshold
  - Pain Tolerance
  - Acute vs chronic pain
  - Anxiety
- Discuss strategies for managing pain and anxiety

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PAIN

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PAIN THRESHOLD

- Pain Threshold
  - Level at which a stimulus begins to produce the sensation of pain
  - Often used interchangeably with pain tolerance

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PAIN TOLERANCE

- An individual's reaction to painful stimuli
- Patients with long term (chronic) pain may have intolerance to any type of painful stimuli
- Varies from day to day and person to person
- Factors that affect pain tolerance:
  - Environment, experience, social attitude, gender, and genetics

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ACUTE VS CHRONIC PAIN

- Acute pain
  - Lasts from a few seconds to no more than 6 months
- Chronic Pain
  - Pain that persists for more than 6 months with or without an identifiable cause

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PAIN

- An unpleasant feeling or sensation usually associated with actual or potential tissue damage
- Pain avoidance is a strong innate trait
- Pain can lead to feelings of fear or anxiety which in turn heighten perceptions of pain

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ANXIETY

- Emotional response to a threat or a danger that is not immediately present or is unclear
- Patients may have experienced pain in the past and are afraid they will feel pain again, or may fear pain at the dental office with no history of painful appointments

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MANAGING ANXIETY

- Practitioners may use a combination of pain management, behavioral techniques and pharmaceutical interventions to manage a fearful or anxious patient
  - Should not rely solely on nitrous oxide to manage patient anxiety

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NITROUS OXIDE ROLE IN PAIN AND ANXIETY MANAGEMENT

- Nitrous oxide is a mild analgesic, anesthetic and anxiolytic
  - analgesia- reduction or relief of pain
  - anesthesia- loss of sensation
  - anxiolysis- reduction of anxiety
- Can play an important role in the management of anxiety for individuals who can safely receive it

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Reference

Bassett, Kathy B. (2015). *Local anesthesia for dental professionals.* Pearson Education, Inc.

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Patient Assessment

Indications/Contraindications/Emergency Procedures

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OBJECTIVES

- List and discuss the elements of patient assessment for nitrous oxide administration
- Discuss indications for nitrous oxide - oxygen sedation
- Identify contraindications to nitrous oxide -oxygen sedation
- Discuss the effects of nitrous-oxide on:
  - Cardiovascular system
  - Central Nervous System
  - Other body systems

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OBJECTIVES

- Discuss nitrous oxide safety profile
- Discuss adverse reactions

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Medical History Assessment

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ASSESSMENT

- Thorough medical history is obtained and fitness to undergo dental procedure is determined.
- Pre and post op: record blood pressure, pulse and respiration (at minimum)
  - Comparing pre-op and post-op vital signs helps gauge level of recovery.

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Classification	Description
ASA 1	Healthy patients
ASA 2	Mild to moderate systemic disease caused by the surgical condition or by other pathological processes, and medically well controlled
ASA 3	Severe disease process which limits activity but is not incapacitating
ASA 4	Severe incapacitating disease process that is a constant threat to life
ASA 5	Moribund patient not expected to survive 24 hours with or without an operation
ASA 6	Declared brain-dead patient whose organs are being removed for donor purposes

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Indications

- Sedation- great for those with high levels of anxiety
- Analgesia-mild analgesic effect
- Anesthetic effect
- Calms gag reflex

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Cardiovascular System Effects

- Nitrous oxide has no effect on the heart's contractility, output, stroke volume, rate, or rhythm
- Blood flow to major organs not affected
- Has a positive effect on myocardial ischemia
- Dilates peripheral vessels, decreasing the workload on the heart
- Cardiac patients less likely to have adverse reactions during treatment

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Central Nervous System Effects

- Nitrous oxide produces a decreased sensory perception
- Reduces the patient's ability to react to pain
- Effect on memory and mood are variable depending on concentration
- Distorts spatial orientation- may feel heavy or light and floating
- Sleepiness

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OTHER BODY SYSTEMS

- Nitrous oxide expands in air spaces in the body resulting in pressure increases in the GI system
  - Avoid in cases of intestinal obstruction until resolved
  - Nausea is a common side effect
- Causes pressure in the middle ear
  - Can cause significant damage if middle ear disturbances are present or recent ear, nose or throat infection causing blockage of eustachian tube

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OTHER BODY SYSTEMS

- Ophthalmic
  - If recent ophthalmic surgery, a gas bubble may have been placed in the eye
  - Nitrous oxide could cause this to expand causing a pressure increase potentially causing:
    - Pain
    - Decreased vision or blindness

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OTHER BODY SYSTEMS

- No known effects on the following systems (when used at typical dental sedation levels):
  - Hematopoeitic
  - Endocrine
  - Hepatic

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OTHER BODY SYSTEMS

- Pregnancy
  - Category C
  - Known teratogenic and fetal toxic effects
  - Caution advised/ Medical consult

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Absolute Contraindications to Nitrous Oxide

- Advanced hypoxic driven COPD
- Active respiratory infection
- First trimester of pregnancy
- Latex allergy (if nitrous unit or mask contains latex)

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Absolute Contraindications to Nitrous Oxide

- Intraocular gas injection within 8-12 weeks
- Recent tympanic membrane grafting
- Any treatment involving the injection of gases into any body cavity

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RELATIVE CONTRAINDICATIONS

- Certain mental/psychological disorders
- Claustrophobia
- Contact Lenses
- Current CNS depressant use

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RELATIVE CONTRAINDICATIONS

- Cystic Fibrosis
- Dry air- induced asthma
- Individuals susceptible to vitamin B12 deficiency
- Latex sensitivity

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RELATIVE CONTRAINDICATIONS

- Currently taking bleomycin
  - Chemotherapy drug
  - Sometimes used to treat malignant pleural effusion by injection into pleural lung space
- Middle ear problems
- Post-traumatic stress disorders
- Pregnancy

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RELATIVE CONTRAINDICATIONS

- Recovering/Recovered Alcoholic
- Substance Abuse
- Use of Colostomy bags
- Bowel obstruction

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SAFETY PROFILE

- Lowest complication rate of all current sedation and analgesia techniques
- No known allergies to Nitrous
- No deaths reported in dental offices when appropriate protocols are followed and equipment and machines are functioning properly.
- Most common adverse reactions due to excessive dosing

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Adverse Reactions

- Signs of excessive concentration:
  - Dizziness
  - Increasingly rigid movements
  - Unresponsiveness
  - Sweating
  - Nausea and vomiting (primary, although rare)

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EMERGENCY PROCEDURES

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OBJECTIVES

- Outline and discuss the steps to respond to an emergency for a conscious and unconscious patient according to the P>A>B>C>D model

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ICE (IN CASE OF EMERGENCY)

- Stop administration of nitrous oxide
  - May keep oxygen only running
- Assess patient symptoms and follow normal emergency protocols

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P-A-B-C-D
POSITION/AIRWAY/BREATHING/CIRCULATION/
DEFINITIVE CARE

- Position
  - Unconscious- supine
  - Conscious- based on patient comfort
- Airway
  - Assess and maintain airway

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P-A-B-C-D
POSITION/AIRWAY/BREATHING/CIRCULATION/
DEFINITIVE CARE

- Breathing
  - Unconscious-assess and provide rescue breaths as necessary
  - Conscious- leave oxygen on
- Circulation
  - Assess and provide CPR if necessary

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P-A-B-C-D
POSITION/AIRWAY/BREATHING/CIRCULATION/
DEFINITIVE CARE

- Definitive Care
  - Respond to the emergency as symptoms indicate
  - If patient does not regain consciousness/ recover sufficiently activate EMS system.

73

REFERENCES

Bassett, Kathy B. (2015). *Local anesthesia for dental professionals.* Pearson Education, Inc.

Malamed, S. (2018). *Handbook of local anesthesia.* Elsevier Health Sciences.

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NITROUS OXIDE ADMINISTRATION

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OBJECTIVES

- List equipment necessary for administration of nitrous oxide
- Discuss the function of each component of the nitrous oxide delivery system
- Discuss safety features of nitrous oxide equipment
- Discuss safe storage for oxygen and nitrous oxide tanks

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OBJECTIVES

- Disinfection and sterilization of nitrous oxide/oxygen delivery equipment
- Detail the steps in administration, monitoring and recovery from nitrous oxide/oxygen sedation
- Discuss proper titration of nitrous oxide
- List the components of proper documentation

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EQUIPMENT

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NITROUS OXIDE TANKS

- Painted Blue in the United States
- 95% liquid
- 5% vapor
- 750 psi when full
- Maintains constant pressure until all liquid has evaporated
- Difficult to determine residual volume- always have an extra tank on hand

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OXYGEN TANKS

- Painted green in the United States
- Contain 100% gas or vapor
- Approximately 2200 psi when full
- Gauge accurately reflects quantity used
- Oxygen tanks are changed more frequently

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Central Supply Delivery System

- Large tanks of nitrous are stored centrally
  - Separate from the treatment rooms
  - Transported from storage system to treatment rooms through copper tubing (required)
  - Includes shutoff valves and pressure relief valves that reduce the psi down to atmospheric pressure
  - Needs to be inspected annually

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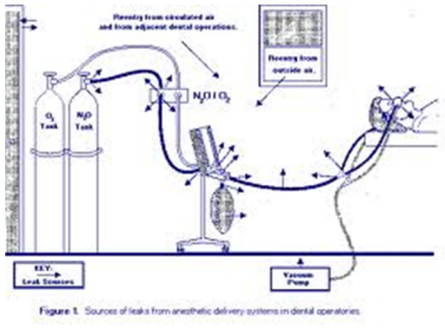

Figure 1. Sources of leaks from anesthetic delivery systems in dental operatories.

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PORTABLE SYSTEMS

- Can be moved from room to room
- Use smaller tanks
- Best to use when sedation is used infrequently
- Contain less gas and do not last as long as the tanks used in the central delivery system

85

PIN INDEX SAFETY SYSTEM

- Used in portable units
- Each tank has its own pattern of holes in the valve stem
- Does not allow for accidental switching of the tanks
  - Switching tanks is a safety hazard- too much nitrous oxide can cause hypoxia

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FLOW METER

- Indicates the amount of gas being delivered to patient
- There is an on/off knob that allows the gas to flow through the tubing and into the mask
- Two additional knobs regulate the flow of nitrous-oxide and oxygen
- There is a fail-safe mechanism that does not allow oxygen to be turned completely off

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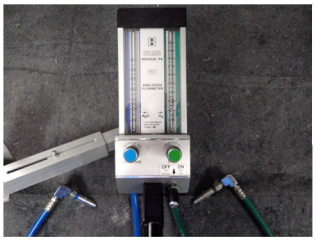
FLOW METER



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RESERVOIR BAG

- Located beneath the flow meter
- Holds a portion of the gases that are available to be delivered into the flowmeter system
- If the bag is overinflated, reduce the flow
- If the bag is underinflated, increase the flow

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CONDUCTION TUBING

- Attaches the equipment to the tubing that goes to the nasal hood
- Corrugated to prevent kinking or stratification of gases
- Make sure nothing is on top of this during treatment
  - Could block flow of gas and damage tubing
- Should be soaked and washed after each use

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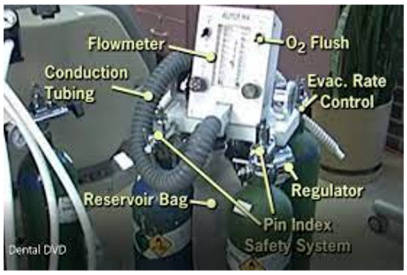

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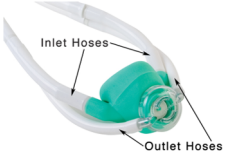
NASAL HOOD

- Breathing apparatus that sits over the patient's nose
- Must fit snugly to prevent leakage
- Come in both disposable and sterilizable
  - Tubing from nasal hood connects to conduction tubing
    - Should also be soaked and washed after each use

92

SCAVENGING SYSTEM

- Important safety system to reduce occupational exposure to nitrous oxide
- Consists of two hoses attached to the nasal hood
  - One hose (inlet hose) delivers gas to patient
  - One hose (outlet hose) evacuates gas being exhaled by the patient



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SAFETY CHECKLIST FOR EQUIPMENT

- Visually inspect all connections and tubing before beginning administration
  - Replace worn or torn tubing or reservoir bags
  - Perform leak testing every 3 months by using a soap solution to check for leaks at pressure connections

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SAFETY CHECKLIST

- Check regulators on central supply systems
- Check diameter index safety system for proper functioning
- Check that alarm systems are functioning
- Check pin index safety system on portable units

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SAFETY CHECKLIST

- Gas Cylinders should be safely stored
  - Upright at least twenty feet from combustible material
  - Dry well ventilated area
  - Temperature should not exceed 125 degrees F
- Do not use oil or grease to lubricate valves
  - Fire hazard
- Open valves slowly

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Administration Step 1

- Patient assessment
  - Thorough medical history
  - Knowledge of contraindications
- Informed Consent- written and verbal instructors to patient and/or parent/ guardian
  - Little to no food in the two hours prior to administration- light meals only

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Administration Step 2

- Assemble Armamentarium
- Ensure adequate functioning
- Check oxygen and Nitrous-oxide levels:
  Should be enough to last length of procedure
- Initiate the flow of oxygen at 6 Liters of oxygen
- Position the nasal hood snugly over the patient's nose

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Step 2 (continued)

- Observe the reservoir bag
  - Should expand and contract with each breath
  - If underinflated increase the liters per minute
    - Patient may feel as though they are suffocating
  - If over inflated decrease the liters per minute

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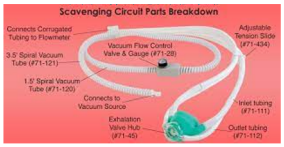
Step 2 (Continued)

- While delivering 100% oxygen, check scavenging system for proper functioning
  - Follow manufacturer directions



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Step 3 Induction and Monitoring

- Pre-induction
  - Deliver 100 % oxygen for 2 minutes
- Induction
  - Start nitrous oxide at 10% for one minute
  - 20% nitrous oxide for one minute
  - 25% nitrous oxide for one minute
  - Titrate up 5% each minute until desired sedation level achieved (not higher than 70%)

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LEVELS OF SEDATION

- General anesthesia
  - Drug induced loss of consciousness
- Deep sedation
  - Drug induced state of depressed consciousness accompanied by partial or complete loss of protective reflexes

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LEVELS OF SEDATION

- Moderate sedation
  - A depression of consciousness during which patients can respond purposefully to verbal commands
- Minimal sedation- Nitrous oxide should produce minimal sedation of the patient
  - Minimally depressed level of consciousness
  - Patient is able to maintain airway independently
  - Responds normally to tactile stimulation and verbal commands

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Initial Induction Signs

- Vital signs should remain within normal limits
- Eye and swallow reflex unaffected
- Verbal communication maintained

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Signs of Sedation

- Feeling of warmth
- Sense of relaxation
- Feeling of heaviness of the extremities
- Tingling extremities

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Signs of Oversedation

- Uncontrolled laughter
- Sweating
- Nausea
- Dilated pupils
- Agitated combative behavior
- Lethargy, closing mouth frequently
- Hard stare
- Dysphoria
- Inability to follow commands
- Hallucinations
  - Can be of a sexual nature

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STEP 4 RECOVERY

- Discontinue the flow of Nitrous-Oxide
- Administer 100% oxygen for 3-5 minutes
- Confirm that vital signs have returned to baseline
- The patient should sit in the chair for a few minutes to avoid the risk of hypotension
- Once patient is feeling alert and oriented patient may leave

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STEP 5 DOCUMENTATION

- Document the following (at minimum):
  - Pre and post operative vital signs
  - Initial tidal volume
  - Lpm of nitrous oxide and Lpm of oxygen
  - Duration of sedation
  - Post sedation issues, adverse reactions and comments

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DISINFECTION

110

STERILIZABLE COMPONENTS

- All components that can be sterilized in a steam autoclave should be sterilized after each patient
  - Sterilizable components vary by manufacturer- check manufacturer recommendations
- Disposable items should not be reprocessed for re-use: ONE TIME USE ONLY

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DISINFECTION/STERILIZATION OF HOSES

- If hoses are sterilizable (according to manufacturer directions)
  - Wash off any chemicals before preparing to sterilize
  - Wash inside and out with warm soapy water
  - Can use ultrasonic or instrument washer
  - Make sure hoses are dry inside and out before wrapping
  - Don't allow to touch the walls of the sterilizer
  - Don't' use dry heat or chemical sterilization
  - Don't use cold sterile

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DISINFECTION OF HOSES

- For hoses that are not sterilizable per manufacturer directions:
  - Wipe down, then wash with warm soapy water at the interval suggested by manufacturer

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DISINFECTION OF MASKS

- Disposable masks
  - Discard after each use
- Sterilizable masks
  - Remove any visible debris
  - Dry before wrapping and placing in autoclave
  - Visually inspect for cracks or breaks before reusing. Discard if not intact
  - Discard after approximately 250 cycles

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DISINFECTION OF FLOWMETER

- Flat screen flowmeter- Barrier or wipe
- Analog flowmeter- (knobs, switches, dials etc)
  - Place a bag over the whole flowmeter/ no effective way to properly and completely disinfect

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REFERENCES

Bassett, Kathy B. (2015). *Local anesthesia for dental professionals.* Pearson Education, Inc.

Crosstex/Accutron User's manual. (2020). *Infection control suggestions for nitrous oxide/oxygen delivery systems.*

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