

Management of Waste Anesthetic Gases *Policy Considerations*

Healthcare providers, particularly anesthesia professionals, operating room personnel, post anesthesia care unit (PACU) nurses, and visitors in the PACU may be exposed to waste anesthetic gases (WAG). Because WAG may lead to adverse health effects in staff and visitors, it is important to limit the venting of WAGs into the healthcare environment. Potential health effects of exposure to waste anesthetic gases are nausea, dizziness, headaches, fatigue, and irritability, as well as sterility, miscarriages, birth defects, cancer, and liver and kidney disease.¹ The environmental effects of waste anesthesia gases is also a concern.

Modern anesthesia workstations in the U.S. incorporate a scavenging system to manage WAGs. Healthcare facilities where general anesthesia is administered are required to ensure that the scavenging system is effective and routinely maintained. According to a 2011 National Institute for Occupational Safety and Health (NIOSH) survey of anesthesia professionals, the use of scavenging systems is nearly universal.² However, variability exists with respect to adherence to other recommended practices and differs among those administering adult or pediatric anesthesia.² The checklist below provides policy considerations for anesthesia providers, facility biomedical engineers, and healthcare facility administrators for limiting WAG exposure. WAG exposure and system leaks can occur in any anesthetizing location where inhaled anesthetic agents and gases (e.g., halogenated agents, nitrous oxide) are used. Operating rooms in hospitals may have more sophisticated vacuum and ventilation systems in place to mitigate the risk of WAG exposure. Anesthesia providers in non-operating room or office-based practices should verify that appropriate safety precautions are in place to limit WAG exposure.

During the development of a WAG policy, anesthesia providers should consult with their facility biomedical engineers and review relevant local, state, and federal law and regulations, accreditor standards, and other professional organization standards, as these may dictate acceptable WAG ranges and the frequency of monitoring hazardous gases and vapors.

Waste Anesthetic Gas Exposure Risk

- Anesthesia Workstation
 - During initial set-up or anesthesia machine check-out procedure.
 - During vaporizer filling or emptying.
 - From leaks in the anesthesia workstation (e.g., from leaks in tubing, seals, gaskets or vaporizers).
 - At the high pressure system between the nitrous oxide (N₂O) cylinder and the yoke assembly or between the anesthetic gas column outlets and the N₂O hose.
 - When the system is flushed or purged using the oxygen flush valve.
- Airway
 - From around the mask.
 - From the endotracheal tube if the cuff is not inflated to a minimal seal or from the laryngeal mask airway if the cuff is not properly placed, inflated or when there is an excessive leak.

- ❑ Waste gas scavenging system
 - Limited air exchange of the operating room or an obstructed venting tube in a passive system.
 - Ineffective or inoperable vacuum system in an active system.
- ❑ Environment
 - Due to ineffective or poor room air exchanges.
 - Exhaled from the patient's airway during emergence, transport and in the PACU.

Engineering and Environmental Controls to Limit WAG Exposure

- ❑ Follow manufacturer's instructions for appropriate use and safety precautions for each type of anesthesia delivery system.
- ❑ Removal of WAGs from the anesthesia circuit can be accomplished by either active (suction applied) or passive scavenging (WAGs proceed passively down corrugated tubing through the room ventilation exhaust grill of the OR).³
 - Active systems are more effective than passive systems at reducing excess WAG concentrations because leaks in the scavenging system do not result in an outward loss of gas.
 - Active systems require a means to protect the patient's airway from the application of suction, or buildup of positive pressure.
 - Passive systems require that the patient be protected from positive pressure buildup only.
- ❑ Maintain the scavenging system to properly collect and remove anesthetic gases.
 - Verify that air exchanges in the operating room are efficient and not blocked by other equipment.
 - Conduct and document scheduled preventative maintenance and inspection of the anesthesia workstation and scavenging system.
 - The scavenging system should be independent of the main facility ventilation system.
 - Do not discharge gases near a facility air intake.
 - Use a properly designed and operating ventilation system to minimize WAG concentrations in the PACU and recovery room areas.
- ❑ When designing operating and non-operating room ventilation, reference regulatory authorities at the federal, state, and local levels, facility accreditors and other organizations, such as the American Institute of Architects (AIA), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), National Fire Protection Association (NFPA), Occupational Safety and Health Administration (OSHA), and National Institute for Occupational Safety and Health (NIOSH).
 - Mitigating WAG is one element that is considered when determining the appropriate air exchange levels within the facility. Other elements include, but are not limited to: the class of operating and procedure rooms; types of procedures to be performed; layout of adjacent spaces (e.g., operating rooms); building ventilation design; and energy efficiency.
 - Determining the appropriate air exchange rate and air sampling frequency and procedure for facility rooms (e.g., operating rooms, procedure rooms, PACU), should be a collaborative process lead by facility engineers and architects.
- ❑ A properly designed and maintained heating, ventilation, and air conditioning (HVAC) system can also contribute to the dilution and removal of WAG not collected by the scavenging system.

- ❑ To minimize the risk of a leak while filling or refilling a vaporizer:
 - Use equipment that minimizes leaks when filling or refilling vaporizers.
 - When possible, fill the vaporizer at either the beginning or end of the operating room schedule so as to minimize exposure to WAG to operating room personnel.
 - If possible, use a local ventilation hood, ventilation cabinet, or a local scavenging device, especially if a vaporizer-specific filling device is not in use.
- ❑ All gases and vapors are scavenged to outside of the building following local standards.
- ❑ Adopt occupational exposure limits (OELs) to limit employee exposure.
- ❑ Preventative Maintenance
 - Maintenance and inspection programs for anesthesia machines should follow recommended manufacturer guidelines to include inspection, cleaning, testing, lubrication, and adjusting of scavenging system components and the anesthesia systems.
 - Damaged or worn parts should be promptly replaced.
 - Documentation of the date, work performed, and individual(s) who serviced equipment.
 - Conduct scheduled inhaled anesthetic and nitrous oxide environmental monitoring to include the nitrous oxide supply line, tank, anesthesia machine and immediate vicinity of the patient's head.
- ❑ Environmental Hazard³
 - Provide current material safety data sheets (MSDS) for all anesthetic gases.
 - Develop and implement a written WAG hazard management program.
 - Check for and remedy high pressure leaks of nitrous oxide cylinders.
 - WAG spills should be cleaned up and controlled by properly trained and equipped personnel.
 - Because of the volatility of liquid anesthetics, rapid removal by suctioning in the OR is the preferred method for cleaning up spills.³
 - Spills of large volumes in poorly ventilated areas or in storage areas should be absorbed using an absorbent material (i.e., a sorbent) designed for clean-up of organic chemicals. "Spill pillows" commonly used in hospital laboratories, vermiculite, and carbon-based sorbents are examples of materials commercially available and regularly used for this purpose.³
 - To minimize exposure to waste liquid anesthetic agents during clean-up and disposal, the following general guidelines are recommended by the manufacturers of liquid anesthetic agents:³
 - Wear appropriate personal protective equipment.
 - Where possible, ventilate area of spill or leak. Appropriate respirators should be worn.
 - Restrict persons not wearing protective equipment from areas of spills or leaks until clean-up is complete.
 - Collect the liquid spilled and the absorbent materials used to contain a spill in a glass or plastic container. Tightly cap and seal the container and remove it from the anesthetizing location. Label the container clearly to indicate its contents.
 - Transfer the sealed containers to the waste disposal company that handles and hauls waste materials.

- Healthcare facilities that own or operate medical waste incinerators may dispose of waste anesthetics by using an appropriate incineration method after verifying that individual incineration operating permits allow burning of anesthetic agents at each site.

Environmental Impact

Facilities, pharmacies, and anesthesia providers work together to select the medications that are needed to provide safe anesthesia services to their patient population. The environmental impact of anesthetic gases continues to be studied. The information below briefly summarizes the environmental impact of WAGs and is not intended to limit the availability of drug choices.

- ❑ Use low flow anesthesia after induction and prior to emergence. Avoid unnecessary high fresh gas flow rates for all inhaled drugs.^{4,5}
- ❑ If appropriate, consider selecting anesthetic gases with lower environmental impact.⁴⁻⁸
 - Research shows that the atmospheric lifetimes, global warming potential, and ozone depleting potential of anesthetic gases leads to a negative impact on climate change.⁵
 - Under comparable and common clinical conditions, desflurane has a greater potential impact on global warming than isoflurane or sevoflurane.^{4,6-8}
 - N₂O is also destructive to the ozone layer and has global warming potential.⁶⁻⁸
 - Propofol has an overall very low impact on greenhouse gas emissions.⁴
- ❑ Techniques such as total intravenous anesthesia and neuraxial or peripheral nerve blocks are least harmful to the climate.^{4,7}
- ❑ Technological advancements continue to improve anesthesia administration while mitigating the environmental impact of WAGs. One example is technology that supports the ability to capture and recycle anesthetic gases.^{9,10} Anesthesia professionals should be aware of new technology and opportunities to implement new innovations into their practice.

Clinical Practice

- ❑ Anesthesia Machine Safety Check
 - Regular/daily checks of the anesthesia workstation, which includes verification that both an active and passive scavenger systems are connected correctly. An active system should be connected to an appropriate amount of vacuum.
 - [Recommendations for Pre-Anesthesia Checkout Procedures](#) (2008) Sub Committee of ASA Committee on Equipment and Facilities
 - [New Guidelines Available for Pre-Anesthesia Checkout](#) Anesthesia Patient Safety Foundation
- ❑ Monitoring
 - Monitor inspired and expired inhaled anesthetic agents.
 - Monitor that the scavenging system vacuum is adequate for the flow rate in an active system.
 - Monitor that the evacuation tubing is not obstructed in a passive system.
- ❑ Airway Management
 - Select and use appropriately sized, fitted and positioned face masks.
 - Do not turn on halogenated agents or nitrous oxide unless you have a tight mask fit.

- Verify minimum leak of endotracheal tube, laryngeal mask airway or other airway device cuff.
- ❑ Anesthesia
 - If appropriate, minimize use of inhaled anesthetic agents and/or nitrous oxide by using intravenous or regional anesthetic techniques.
 - If appropriate, utilize low fresh gas flow during the maintenance phase of the anesthetic when using a halogenated agent and/or nitrous oxide.
 - Do not allow inspiratory pressures to exceed the minimal leak of a laryngeal mask airway or an endotracheal tube
 - Turn off inhaled anesthetic agent vaporizer and/or nitrous oxide for airway device insertion or anytime the anesthesia breathing circuit is disconnected from the airway device.
 - To decrease the amount of inhaled halogenated agent and/or nitrous oxide from the breathing circuit, increase the flow of oxygen and/or use the oxygen flush valve with the adjustable pressure limiting (APL) valve in the fully open position with the breathing circuit connected to the airway device or occluded distally.¹¹
 - Place mask on patient after extubation in order to vent residual halogenated agents and/or nitrous oxide to the scavenging system.

Communication and Training

- ❑ Conduct initial and ongoing technology education.¹²
- ❑ Conduct role-specific orientation and training.
- ❑ Educate clinicians and staff on documentation requirements.
- ❑ Provide updates, ongoing competency review and new equipment/process education.

Other Resources

- ❑ [The Anesthesia Gas Machine 2016](#)
 - Developed and maintained by Michael P. Dosch, PhD, CRNA and Darin Tharp, MS, CRNA
- ❑ Occupational Safety and Health Administration (OSHA)
 - [Waste Anesthetic Gases](#)
 - [Anesthetic Gases: Guidelines for Workplace Exposures](#)
 - OSHA Technical Manual (OTM) Section VI: Chapter 1 [Hospital Investigations: Health Hazards](#)
 - [OSHA Hospital eTool](#) focuses on hazards and controls found in the hospital setting, describes standard requirements, and recommends safe work practices.
 - See [Surgical Suite](#) for Waste Anesthetic Gases
- ❑ National Institute for Occupational Safety and Health (NIOSH)
 - [Waste Anesthetic Gases—Occupational Hazards in Hospitals](#), Publication Number 2007-151 (Sept 2007)
 - [Control of Nitrous Oxide in Dental Operatories](#), Publication Number 96-107 (1996)
 - [NIOSH Warns: Nitrous Oxide Continues to Threaten Health Care Workers](#) (June 1994)
 - [Controlling Exposures to Nitrous Oxide During Anesthetic Administration](#), Publication Number 94-100 (1994)

- [Guidelines for Protecting the Safety and Health of Health Care Workers](#), Publication Number 88-119 (Sept 1988)
- [Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors](#), Publication No. 77-140 (March 1977)
- ❑ American Society of Anesthesiologists
 - [Greening the Operating Room and Perioperative Arena: Environmental Sustainability for Anesthesia Practice](#)
- ❑ American Dental Association
 - [Nitrous Oxide Use in Dental Offices](#)

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