Perioperative management of anesthetic waste exposure

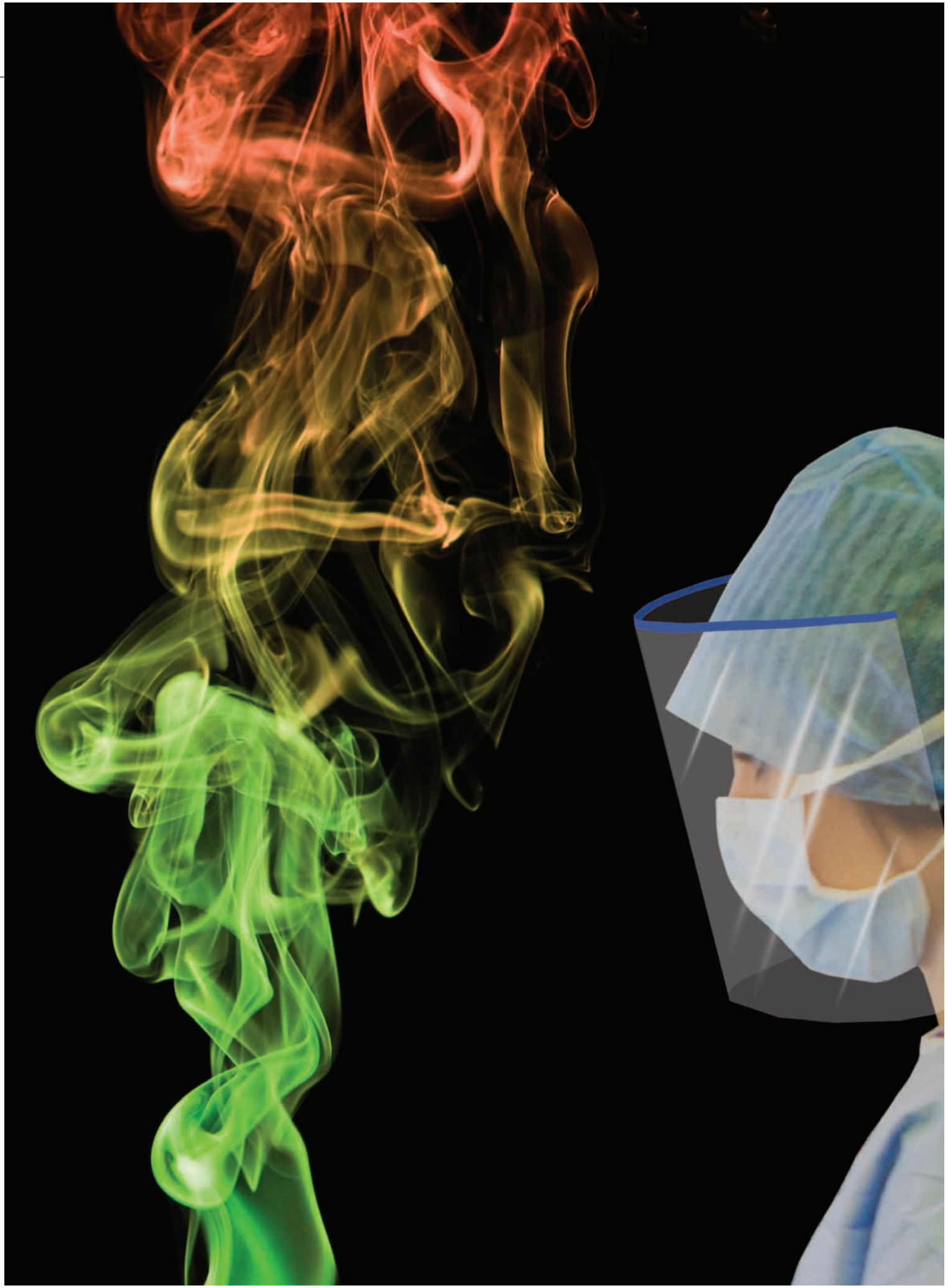
By Sophia Mikos-Schild, EdD, MSN, MAM/HROB, RN, CNOR and Randolph W. Schild, MN, CNOR, RNFA

CE
2.3
ANCC CONTACT HOURS

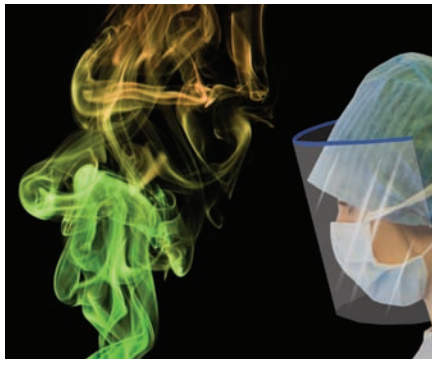
Health consequences of exposure to waste anesthetic gas (WAG) can be minimized by following Occupational Safety and Health Administration (OSHA) guidelines for monitoring as well as internal policies.

Ms. Y has been working in the OR for 6 years and recently transferred to her institution's outpatient surgery center. It's a busy place with four ORs and a cystoscopy room, and she loves the diversity of her new position. Ms. Y admits patients, scrubs, circulates, and helps them recover in the postanesthesia care unit (PACU). Lately, she has been more tired than usual at the end of her workday, and she has heard colleagues complaining of similar symptoms. This led to a discussion about WAG management. Ms. Y wonders if her feelings of lethargy and fatigue are due to the possibility of leaking WAG. She knows that the anesthesia provider checks the machines prior to each case, but she still decides to discuss her concerns with her manager.

Anesthetic agents have been used to save lives and minimize pain when surgical procedures are performed, but they may also lead to health issues for healthcare personnel in the surgical setting. With



more than 27 million surgical procedures performed annually, a vast number of healthcare personnel in ORs, outpatient surgery (OPS) facilities, and PACUs are exposed to WAG on a daily basis.[1] This exposure to WAG can have mild to serious effects, ranging from lethargy and fatigue, to serious health issues, such as spontaneous abortion, congenital abnormality, infertility, premature birth, cancer, and renal and hepatic disease.[2] Although these effects are noted in the literature, there's some controversy regarding their validity due to the flawed nature of some studies, as well as conflicting study results.[3]



OSHA defines WAGs as anesthetic gases and vapors that leak into the room during a medical procedure.

History of anesthesia

In the late 1700s, Joseph Priestley was an early pioneer of anesthesia who encouraged the investigation of using what he called "airs." Others soon followed in his footsteps, such as Humphry Davy in 1795, who experimented with agents such as nitrous oxide, although its first use was limited to research on animals. During the next 100 years, other agents such as chloroform, cyclopropane, fluroxene, and trichloroethylene were developed and used during "painless surgery." Safety issues, such as explosiveness and flammability, were observed early on with anesthetic gases.[4,5]

Nitrous oxide wasn't used in surgical procedures until 1844 and is one of the oldest anesthetic agents. In 1847, although nitrous oxide was more effective than chloroform, chloroform became a more popular choice because it decreased vomiting.[6] It also didn't have the toxic effects on the heart, liver, and kidneys that nitrous oxide did. It was many years before additional agents were used.

In the 1950s, halothane became the agent of choice for most surgeries.[6] It had a decreased risk of flammability and less safety issues and adverse effects than other agents, including less combustibility and decreased frequency of vomiting. However, halothane is no longer used because it causes central nervous system depression, affects the cardiovascular system, and can cause hepatotoxicity—which may progress from "halothane hepatitis" to hepatic failure and death.

As anesthetic agents became safer, potential issues were no longer investigated. The American Society of Anesthesiologists (ASA) Task Force on Trace Anesthetic Gases stated that trace amounts of anesthetic agents haven't been shown to cause health problems and, "there is insufficient evidence to recommend routine monitoring of trace levels of waste anesthetic gases in the OR and PACU."[5]

In the 1980s, many ORs posted signs stating that static may cause explosions due to anesthetics. There were also meters that measured static electricity, and special shoes had to be worn to minimize static. Many female anesthesia providers were fearful of anesthetic agents causing birth defects and spontaneous abortions. These fears may have stemmed from a 1967 study in the Soviet Union that surveyed 308 anesthesia providers who experienced headaches, fatigue, irritability, and spontaneous abortions.[5,6] Recent surveys of 11,500 U.K. medical school graduates indicated that there was no greater incidence or relationship between occupation and infertility, cancer, spontaneous abortion, or other health issues in work sites that had scavenging systems for waste management.[5]

What are WAGs?

OSHA defines WAGs as anesthetic gases and vapors that leak into the room during a medical procedure. Leaks from machines and faulty canisters may be due to the complexity of the anesthesia machine, which has over 700 parts that aren't airtight.[7] OSHA estimates that more than 250,000 healthcare professionals are exposed to these agents and are at risk for developing symptoms, such as nausea, vertigo, headaches, fatigue, and irritability, even with low-level exposure.[7] Although these symptoms can be annoying or an inconvenience, higher levels of exposure can lead to more serious effects such as miscarriages, sterility, birth defects, and cancer, as well as liver and kidney diseases.

Studies have also shown that in areas with no ventilation, exposure to WAG might cause genetic damage comparable with smoking 10 to 20 cigarettes per day.[8] The majority of studies examined exposure that exceeded the allowable rate in the United States or Western Europe.[8] Many early studies that involved lab animals were later re-examined and found to have unreliable data and conclusions. Yet, in 2001, a Swedish newspaper reported a study indicating that anesthesia providers were at increased risk for developing multiple sclerosis.[8]

Regulating toxic substances

OSHA sets guidelines for workplace exposure and keeps records of WAG analysis reports for 20 years.[7] Twenty-five states as well as the Virgin Islands and Puerto Rico have adopted their own OSHA-approved plans to minimize risks for employees (see *Professional agencies and WAGs exposure regulations and guidelines*).[7]

In the 1970s, OSHA and the National Institute of Occupational Safety and Health (NIOSH) began to regulate exposure to WAGs and, in 1977, issued recommended exposure limits (RELs) to nitrous oxide and other agents. The air contents of WAGs were limited to 25 parts per million for nitrous oxide, and a maximum of 50 parts per million for 8 hours and 2 parts per million for the other gases over an hour of time.[2,5,9] Other regulated gases include halothane and enflurane. There are no NIOSH RELs for sevoflurane, desflurane, and isoflurane. Scavenging devices are legally required to prevent toxic substances from causing harm to healthcare personnel.

A scavenging system must be available to remove excess anesthetic gases from the OR. The system can be active or passive, as both types are effective methods of protecting the anesthesia provider and the surgical team from anesthetic waste. The systems work differently, but the active system is considered more effective in reducing waste because it doesn't allow for loss of gas if the system leaks.[9]

The active system consists of the exhalation line of the anesthesia machine, which uses the reservoir bag, and a scavenging system connected to the bag that sends the gases out. The exhalation line of the anesthesia machine contains a pressure relief valve, which is connected to a reservoir bag.[2] Under pressure, the reservoir bag captures the excess anesthetic gas and sends it through tubing to a vent intake on the anesthesia column or wall. With negative pressure from suction, it's moved to the outside for venting.

The passive ventilation system brings clean air into the surgical suite and pushes anesthetic wastes outside via circulating or noncirculating air exchanges. These can be as frequent as 21 air exchanges per hour or as few as 10 exchanges per hour.[2] The amount of air exchange depends on the year the procedure room was built, as requirements are based on the regulations that were in place at the time of construction.

Charcoal canisters, which can be used with both active and passive systems, can absorb most of the excess anesthetic waste, although they are expensive and must be changed frequently. Costs and the nonstandardized absorbency of various brands affect the degrees of efficiency, and activated charcoal doesn't absorb nitrous oxide.[7] Canister disposal must also follow manufacturer guidelines and may pose issues for some institutions.[7,9]

Personal protective equipment such as masks, gloves, and goggles, or the use of HEPA filters won't protect a healthcare provider from exposure to

Professional agencies and WAGs exposure regulations and guidelines

Currently, WAG exposure is regulated and guided by a variety of agencies and professional organizations:

- OSHA defines limits in its standards.
- The NIOSH has published information on exposure to WAGs and its effects on healthcare personnel.[7]
- The Joint Commission and Centers for Medicare and Medicaid Services (CMS) require proof of air exchange for surgical suites.[7]
- The American Association of Nurse Anesthetists (AANA) has concluded that pollution is unavoidable when anesthetics are used.[4]
- The ASA provides guidelines for scavenging waste.[5]
- The Association of periOperative Registered Nurses (AORN) doesn't have a position statement regarding education of OR personnel, but supports OSHA guidelines as well as following manufacturer recommendations for performance and safety.[2]

WAGs. These shouldn't be used as substitutes for scavenging systems, charcoal canisters, or good work practices.[7]

OSHA recommendations to reduce exposure

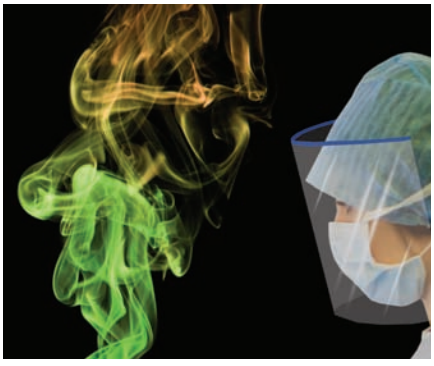
OSHA recommends six practices to minimize the risk of OR personnel's exposure to WAGs. When performed correctly, these practices can reduce exposure; if not followed, the levels of gases can increase.[9]

Practice 1: Check anesthesia equipment. The anesthesia equipment must be examined each day before the first case, as well as given an "abbreviated check" for subsequent procedures. The FDA's Anesthesia Apparatus Checkout Recommendations provide guidelines for inspecting and testing equipment including checking cylinders, flow meters, alarms, valves, breathing systems, oxygen monitor calibration, and other manufacturer recommendations, as well as checking for leaks and switches.[9]

Practice 2: Facemask fittings. The facemask must be fitted to minimize agent leaks. During induction, the anesthesia provider and circulating nurse can be exposed to the agent if the mask doesn't fit the patient properly due to reduced pliability, cuff leaks, a bad seal, or improper use of straps. It's important to have several sizes of masks available so anesthesia providers can find a proper fit.

Practice 3: Follow manufacturers' recommendations for spill prevention. Staff members are required to follow the manufacturer recommendation guidelines on filling the vaporizers to prevent spills. They must be efficient and attentive to cleaning between patients and must check whether the anesthesia personnel turned off the vaporizer at the end of the case.

Practice 4: Proper cuff pressure. Laryngeal mask airways (LMAs), endotracheal tubes (ETTs), and other devices need to be inflated to proper cuff pressure. In addition, the devices need to be inserted properly and remain in position during the procedure. Checking the cuff for inflation will help maintain proper position.



The anesthesia provider as well as management groups in the OR, OPS facility, and PACU are responsible for containing pollution from waste gases.

Practice 5: Cleaning spills. Spills need to be cleaned up according to manufacturer guidelines. Small spills may evaporate before proper cleaning measures can be initiated, while large spills require special handling as recommended by the manufacturer. Trained personnel should know these procedures as they will be filling the vaporizers with special "key-fill spouts."[5,7] The anesthesia provider and assistant should also be familiar with the materials safety data sheet (MSDS) to help contain spills and reduce exposure.

Practice 6: Flushing the system. Regulators suggest that the anesthesia provider administer nonanesthetic agents prior to extubation so the scavenging system can remove "washed-out" anesthetic gases. The flushing of the breathing system shouldn't be vented into the room.[7]

Hazard training and monitoring

OSHA's Occupational Safety and Health Standards Hazard Communication (29 CRF 1910.1200) is mandated to ensure hazards are evaluated and the information regarding current and possible hazardous substances is provided to both employers and employees.[2,7] Personnel should receive education regarding potential exposure hazards, preemployment health assessments, and how to report occupational health-related problems.

The anesthesia provider as well as management groups in the OR, OPS facility, and PACU are responsible for containing the pollution of waste gases. Policies and procedures must be in place to monitor anesthetic waste concentration by sampling, measuring, and reporting regularly to administration.[9] Records of air exchanges for surgery should be maintained and the hospital engineering department may monitor measurements of air exchange. Most facilities monitor exchange rates every hour and use alarms to indicate improper exchanges or problems with the scavenging system.

Recommended work practices for an optimal environment in the OR and PACU

Practice	Staff responsibility	Comment
Check apparatus prior to first case	Anesthesia provider Anesthesia assistant	Check complete anesthesia checklist as recommended by OSHA
Subsequent check of apparatus before each case	Anesthesia provider Anesthesia assistant	Check abbreviated checklist as recommended by OSHA
Properly fitted face masks	Anesthesia provider	Have varied sizes available and use the strap to hold it in place
LMAs, ETTs, and other airway devices should be pliable and positioned properly	Anesthesia provider	Cuff should be inflated adequately so that wastes can't escape
Vaporizers filled in a well-ventilated area and minimize spillage	Anesthesia provider or trained assistant	Use key-fill spout to pour anesthetic into vaporizer to minimize spills
Clean spills promptly	Anesthesia provider or trained assistant	Clean spills using the MSDS and manufacturer guidelines, OSHA standards, and AANA guidelines
Wash out anesthetic gases prior to extubation of patient	Anesthesia provider	Flushed or washed out gases can be removed by scavenging system and decrease the amount of gases in the patient's body
Identify sources of waste/leakage and begin corrective action	Anesthesia provider, anesthesia assistant, OR personnel, biomedical/engineering, or outside contractors	Everyone is responsible to maintain a safe environment. Biomedical/engineering or contractors should be available to correct and repair the machine.
Monitoring WAGs	Contractors, biomedical, and management staff need to cooperate in wearing of badges in procedure rooms and PACU	Sampling, measuring, and data reporting completed at regular intervals per policy and as recommended by OSHA

Adapted from Waste anesthetic gases. United States Department of Labor, Occupational Safety & Health Administration. http://www.osha.gov/SLTC/wasteanestheticgases/index.html.

Trained biomedical personnel or hired company technicians can monitor for WAGs in the environment (see *Recommended work practices for an optimal environment in the OR and PACU*). Management policies should determine if personnel should wear sampling badges and when air waste samples should be taken. Monitoring should be performed at 6-month intervals or quarterly as recommended and required by hospital policy or ASA guidelines.[2,5]

Personnel trained in leak detection can help identify the sources of leaks, but management is responsible for maintaining an efficient scavenging system. Regularly scheduled maintenance can ensure equipment is functioning properly for removing waste from the breathing circuits as well as proper venting function.

Reducing WAGs in the PACU

Patients are a source of WAGs in the PACU, especially those who have undergone general anesthesia; those intubated may have a larger concentration of anesthetic gases than those who were extubated prior to arriving in the PACU. Reducing WAGs in the OR or OPS facility by flushing with oxygen on completion of the anesthetic agent ensures that the patient in the PACU has fewer episodes of exhaling WAG immediately postprocedure.[7]

Proper air exchanges can also help minimize WAG. OSHA recommends a minimum of six air exchanges per hour with a minimum of two air changes of outdoor air per hour to dilute the gases.[9] Monitoring WAG levels in the breathing zone at the patient's head should be done periodically, especially peak WAG levels. This is crucial, as multiple recovering patients in one area can increase the amount of waste exposure unless the agent has been flushed with oxygen prior to completing the case. Proper maintenance of the ventilation system improves the air quality and promotes safety for PACU nurses.

Conclusion

Although trace amounts of WAGs in the perioperative area can't be completely eliminated, proper operating equipment, vigilant monitoring, safe practices, and adherence to OSHA recommendations can minimize their presence. Management, anesthesia providers, perioperative nurses, and other staff members have the necessary tools to ensure a healthy environment for patients and staff in the OR. **OR**

REFERENCES

1. *The Importance of Maintaining Normothermia.* Eden Prairie, MN: Arizant Healthcare; 2009.

2. Smith FD. Management of exposure to waste anesthetic gases. *AORN J.* 2010;91(4):482-494.

3. Morgan G, Mikhail M, Murray, M. *Clinical Anesthesiology*. 4th ed. New York, NY: Lange Medical Books/McGraw-Hill; 2005.

4. Barberio JC, Bolt JD, Austin PN, Craig WJ. Pollution of ambient air by volatile anesthetics: a comparison of 4 anesthetic management techniques. *AANA J.* 2006;74(2):121-125.

5. American Society of Anesthesiologists.*Waste Anesthetic Gases: Information for Management in Anesthetizing Areas and the Postanesthesia Care Unit (PACU).* https://ecommerce.asahq.org/p-138-waste-anesthetic-gases-information-for-management-in-anesthetizing-areas-and-the-postanesthesia-care-unit-pacu.aspx

6. McPhee IM. The history of anesthesia: the long struggle to create pain-killers. http://isaacmmcphee.suite101.com/the-history-of-anesthesia-a43518.

7. Waste anesthetic gases. United States Department of Labor, Occupational Safety & Health Administration. http://www.osha.gov/SLTC/wasteanestheticgases/index.html.

8. Nilsson R, Bjordal C, Andersson M, et al. Health risks and occupational exposure to volatile anesthetics—a review with a systematic approach. *J Clin Nurs.* 2005;14(2):173-186.

9. Anesthetic gases: guidelines for workplace exposures. United States Department of Labor, Occupational Safety & Health Administration. http://www.osha.gov/dts/osta/anestheticgases/index.html.

Sophia Mikos-Schild is a nurse educator at St. Mary and Elizabeth Medical Center in Chicago, Ill. Randolph W. Schild is an online faculty member for Chamberlain University.

The authors have disclosed that they have no financial relationships related to this article.

DOI-10.1097/01.ORN.0000415632.48555.e8