Product Focus

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Control of Waste Anesthetic Gases and Vapors

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Laboratory animal technicians, veterinarians, veterinary technicians, researchers, and research support staff are at risk when exposed to waste inhalation anesthetic gases and vapors (WAGs), because WAGs are associated with pregnancy complications, cancer, genetic mutations, liver and kidney damage, psychomotor changes, and immunological effects. Administration of gas for anesthetic purposes releases WAGs, which include both gaseous and volatile liquid agents, into associated and adjacent work areas[1,2-5].

Worker safety regulations originated in 1970 with the implementation of the Occupational Safety and Health Act (OSHAct). The OSHAct set forth two duties for employers:

- Each employer shall furnish to each employee a place of employment, free from recognized hazards that are causing or likely to cause death or serious harm to their employees (the General Duty Clause); and
- Each employer shall comply with occupational safety and health standards under the Act.

The Occupational Safety and Health Administration (OSHA) promulgates safety and health standards with technical advice from the National Institute for Occupational Safety and Health (NIOSH), a branch of the Centers for Disease Control. The OSHA exposure criteria for WAGs are based on levels determined by the administration as not hazardous to workers. OSHA exposure standards are published as Permissible Exposure Limits (PELs). The PEL quantifies the maximum level of exposure for an individual averaged over an eight-hour work day.

NIOSH researches hazardous situations and recommends practices to ensure worker safety. The agency publishes Recommended Exposure Limits (RELs) for chemicals based on a review of toxicological and industrial hygiene data. The RELs do not bear the weight of law; however, they can serve as proof of a recognized hazard in citations under the General Duty Clause.

The American Conference of Government Industrial Hygienists (ACGIH) is a professional society that reviews toxicological data and publishes Threshold Limit Values (TLV) for chemical substances. TLV refers to an exposure level that workers can withstand repeatedly without adverse health effects. TLVs are expressed as a time weighted average (TWA), the concentration for a conventional work day within a forty-hour work week that would not produce adverse effects.

The inhalation anesthetic gases and vapors of concern to laboratory animal workers are diethyl ether, nitrous oxide, and halogenated agents such as halothane, methoxyflurane, and isoflurane. OSHA has set the PEL for ethyl ether at 400 ppm. The NIOSH-REL for halogenated anesthetics is 2 ppm ceiling, not to be exceeded during any part of the working exposure when used alone, and 0.5 ppm when use with nitrous oxide[2,4]. The NIOSH REL for nitrous oxide is 25 ppm during administration[3]. The ACGIH lists halothane as 50 ppm TWA. One can apply the OSHA General Duty Clause for methoxyflurane or isoflurane, as none of the previously

A comparison of fume hoods available. Different models work either by exhaust or recirculating, and have a number of distinguishing characteristics. (Chart compiled by *Lab Animal* staff.)

COMPANY	FUME HOOD LINE	EXHAUST	RECIRCULATED	DISTINGUISHING CHARACTERISTICS
The Baker Company, Sanford, ME 1-800-992-2537	ChemGARD™	yes		stainless steel, sensor alarm
Bosio Metal Specialties, Philadelphia, PA 215-627-0838	custom	made to order	made to order	stainless steel
Harvard Apparatus, Inc., South Natick, MA, 1-800-272-2775	Ductless Portable Filtering Hoods		yes	exhausts no pollutants
Hazard Technologies, Millersville, MD 1-800-852-3698	recirculation		yes	anesthetic formalin filters available
Labconco, Kansas City, MO 1-800-821-5525	Protector®	yes		molded one piece fiberglass liner
	Basic™	yes		
	Paramount™		filtered	organic sensor alarm
	Walk-in	yes	walk-in	
Nuclear Associates, Carle Place, NY 516-741-6360	Preparation and Fume Hood Enclosure Module	yes		radiation protection
Viking Medical, Medford Lakes, NJ 1-800-920-1033	fiberglass hoods	yes	yes: filtered, absorption, combination	fiberglass construction
VWR Scientific, West Chester, PA 1-800-937-5000	Redishp® Supreme Kewaunee®	yes		modified epoxy-resin lining
	Redishp® Supreme Air Walk-in Kewaunee®	yes		modified epoxy-resin lining

mentioned administrative bodies have defined an exposure limit.

Employers should take the following steps to ensure that workers are adequately protected from exposure to WAGs:

- Monitor airborne concentrations of WAGs by personal sampling.
- Implement appropriate engineering controls, work practices, and maintenance procedures.
- Institute a worker education program that describes standard operating procedures for all tasks that may expose workers to WAGs, and informs workers about proper work practices, controls, equipment, and protective gear they should use when working with anesthetic gases and vapors[1-5].
- Implement a periodic medical evaluation program for staff exposed to WAGs at or above the recommended levels.

Engineering Controls

Three different types of products on the market can control exposure levels to waste inhalation anesthetic gases and vapors. They are laboratory fume hoods, portable or bench top fume capture hoods, and anesthetic unit scavenging systems. Each animal facility should test and maintain these pieces of equipment to effectively protect workers from exposure to WAGs.

Fume Hoods

A laboratory chemical fume hood is specifically designed to protect workers from exposure to hazardous fumes and flammable compounds (table gives a comparison of available models). Any properly used and maintained chemical fume hood will limit exposure to WAGs, provided the anesthesia equipment can fit into it. The fume hood constantly draws air into the hood from the room or other source, and exhausts to the exterior of the building. It is important to monitor adequate face velocity and air flow in the hood using a visible air flow indicator to ensure safe conditions[6].

Animal care workers should use chemical fume hoods when filling anesthetic vaporizers with liquid anesthetic agents and when animals are anesthetized by the gauze saturated nose cone, anesthesia jar, or chamber methods. Diethyl ether is flammable and should only be used in a chemical fume hood.

Many animal facilities use Class II, Type A biological safety cabinets for rodent cage-changing. In most cases, this type of cabinet does not protect workers from exposure to WAGs. This type of cabinet exhausts 30% of the air through the exhaust HEPA filter into the room and recirculates 70% through the supply HEPA back into the cabinet. HEPA filters remove particulate, not volatile compounds. As a result, WAGs can build up in the cabinet, become concentrated by recirculation, and then exhausted into the room. The Class II, Type B3 biological safety cabinet limits worker exposure to WAGs because it is ducted to the building exhaust[7].

Local Exhaust Capture

There are many makes and models of portable hoods, bench top hoods, and fume capture devices[6]. These units are not a substitute for a chemical fume hood, but are suitable when portability is an issue. Some models are designed to connect to the building exhaust system. Check with your safety and facilities officers to make sure the exhaust air is not recirculated, and the building exhaust is not located near a building air intake or entrance. Some models use an activated carbon filter and recirculating fan to remove noxious fumes and return the air to the room. Always verify that the filter material will absorb the WAGs. For example, activated charcoal is

not effective in removing nitrous oxide by absorption[4]. Using portable, filtered, recirculating hoods is not recommended. If you must use one of these units, always contact your safety officer and verify life-expectancy of the filter bed for the specific anesthetic agent in use and test that the unit removes WAGs.

Scavenging Systems

A well-designed scavenging system uses local exhaust ventilation to capture waste anesthetic gas and vapors from the anesthetic breathing circuit, and exhausts to the outside of the building. These systems can reduce the ambient concentrations of WAGs by up to 90%[4]. Such a system consists of a collecting device (scavenging adapter) connected to the pop-off valve or site of overflow on the anesthetic equipment, and a transfer tubing system to remove the WAGs from the room. The system should vent WAGs directly to the outside of the building or connect to the nonrecirculating building exhaust system[2-4]. These systems remove WAGs either passively or actively. An activated carbon canister is one example of passive scavenging. The effectiveness of activated carbon canisters varies with flow rates through the canister and with manufacturers.

An active scavenging system uses a vacuum pump. Some types of equipment scavenge WAGs via a tight fitting mask. The mask delivers anesthetic gas through one tube, and removes exhaled air via a second tube. A series of one-way valves directing the WAGs to an activated carbon canister or vacuum scavenging system control the flow of gas. Most anesthesia equipment manufactured today includes a well-designed efficient scavenging system.

Conclusion

Laboratory animal facilities routinely use inhalation anesthetic gases and volatile anesthetic liquids, and it is prudent to reduce worker exposure to the lowest possible airborne concentration. Three types of products can control exposure levels to WAGs: fume hoods, portable or bench top fume capture hoods, and anesthetic unit scavenging systems. Fume hoods and scavenging systems are the primary choice for controlling WAGs. Although ductless and portable fume capture hoods are not recommended, a properly designed and maintained unit may be used when portability is an issue.

While meeting the NIOSH REL ensures that workers will not experience any adverse effects such as a decrease in mental acuity or manual dexterity, these limits may be difficult to achieve under all circumstances. If the REL is not attainable, maintaining levels below ACGIH-TLVs will minimize the potential health effects. Document any of the chosen methods' effectiveness by monitoring the staffs' personal exposure rate. The role of the regulators is not to eliminate the use of a specific anesthetic agent, but rather to ensure worker safety when using the agent.

References

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