ADVISORY NO. 8.5: ANESTHETIC GAS USE (RESEARCH)

Summary: Many anesthetic gases are used at the University of Cincinnati. Anesthetics of concerns are ether, nitrous oxide, and halogenated agents, i.e. chloroform, enflurane, halothane, isoflurane methoxyflurane, trichloroethylene, and sevoflurane. Use of anesthetic gases requires ventilation (engineering controls) to remove vapors from the workplace. This document describes safe practices for the use of anesthetic gases and engineering controls necessary to protect personnel from exposure to vapors.

Scope: This Advisory applies to all researchers that use anesthetizing and euthanizing gases and vapors.

Reference Regulations: Occupational Safety and Health Administration - Laboratory Safety Standard (29 CFR 1910.1450)
Accreditation Guidelines from 2002 AAALAC Report (Association for Assessment and Accreditation of Laboratory Animal Care, International)
National Institute of Occupational Safety and Health Report no. 77-140.

Definitions:

Chemical Hygiene Plan (CHP) – a written policy, developed and implemented by lab management, which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards associated with use of hazardous chemicals.

Engineering Controls – methods of controlling employee exposures by modifying the source or reducing the quantity of contaminants released into the work environment.

Material Safety Data Sheets (MSDS) – contains the following information: substance identification and synonyms, hazardous components, physical data, fire and explosion data, toxicity data, health effects and first aid, reactivity, storage and disposal procedures, spill and leak procedures, and protective equipment. It also contains a contact number in case of emergency

Peroxides – a class of chemicals that may explode when subjected to heat, light, friction and impact.

Personal Protective Equipment (PPE) – devices worn by the worker to protect against hazards in the environment. Respirators, gloves, and hearing protection are examples.

Responsibility:

Deans, Director, and Department Heads
Ensure that adequate facilities, ventilation, and equipment are provided for the safe use of anesthetic gases.

Coordinate the implementation of recommended remedial action.

Ensure an environment where principal investigators and other personnel are encouraged to follow this Advisory.

Actively support this Advisory within individual units.

Principal Investigators
Implement procedures in accordance with this Advisory

Principal Investigators (cont.)
Ensure that staff is aware of this Advisory, instructed on the details of implementation, and provided with equipment and controls. Maintain documentation as required.

Assign resources to support the implementation of this Advisory.

If there is an accident or injury, follow the Guideline

Laboratory Managers or Senior Research Personnel
Ensure employees are instructed on and follow proper procedures and utilize ventilation and protective equipment provided during their work.

Environmental Health and Safety
Provide training to the Principal Investigator and Laboratory Manager upon request, and maintain records of training.

Provide technical assistance and conduct safety audits. Conduct air monitoring for anesthetic gases to evaluate employee exposure. Monitoring to evaluate work conditions will be conducted initially, upon request, and after an exposure incident.

Institutional Animal Care and Use Committee (IACUC)
Maintain a list of Research Areas that use anesthetic and euthanizing gases. Provide information to Environmental Health and Safety as necessary.

Employees
Comply with this Advisory and any further safety recommendations initiated by the Principal Investigator.

Conduct assigned tasks in a safe manner, wear appropriate personal protective equipment, and only use equipment for which they have been formally trained.

Report to the principal investigator any job related injuries or illnesses, health and safety concerns, and unsafe or unhealthy working conditions.

Review chemical hazard information detailed on MSDSs before beginning work with anesthetic gases.

Procedures:

A. Standard Operating Procedures (SOP)

- Read the MSDS and safety precautions for all anesthetic gases used, and incorporate these precautions into the Chemical Hygiene Plan (CHP) with written Standard Operating Procedures.
- Personnel who use anesthetic gases should be aware of the exposure symptoms associated with handling and use. If a lab worker is experiencing symptoms, the person should seek immediate medical attention. The supervisor must then complete an Injury Report, and contact EH&S to arrange for environmental monitoring.

B. Ventilation

- All personnel using anesthetic gases must use adequate local exhaust ventilation to minimize personal exposure. Recommended ventilation during anesthetizing and euthanizing procedures includes scavenging devices, chemical fume hoods, and

snorkel hoods. Canopy hoods do not work well for this application, due to the distance from the source and the large volume of air required to capture migrating gasses.

C. Usage of Ether

- Ether must be used in a laboratory fume hood. Ether has properties that make it more dangerous to use than other anesthetics: extreme flammability, high vapor pressure, low flash point, peroxide formation, and its classification as a mutagen by NIOSH.

[General ether information]

- Use of ether requires adequate exhaust ventilation, approved flammable liquid storage cabinets, and diligent lab safety procedures. Precautions include close tracking and dating of ether supplies, since this substance will form peroxides over time.
- If animals are euthanized with ether the carcasses must be left in an open container within the laboratory fume hood for 30 minutes to allow the ether to evaporate, before they are bagged and placed within a carcass cooler.
- Environmental Health and Safety strongly recommends the substitution of ether with less volatile anesthetics. Possible anesthetic substitutes include: Halothane, Enflurane, Isoflurane, methoxyflurane, and sevoflurane.

D. Storage of Ether

- Ether must be stored in National Fire Protection Association (NFPA) approved flammable liquid storage cabinets or in rooms meeting OSHA flammable liquid storage requirements. Oxidizers, acids, and other incompatible chemicals are prohibited from being stored in these areas. Sources of ignition, such as surgical cauterizers, must not be permitted in or near work and storage areas.
- Store ether in airtight containers in a dark, cool and dry area. DO NOT permit sources of heat, friction, grinding, or impact near storage areas. Due to peroxide formation, contract Environmental Health and Safety at 556-4968 for disposal of ether over one year old or nearing the manufacturers shelf life.
- Ether-exposed carcasses must be stored in freezers and refrigerators made for the storage of flammable material. These units will have a factory identification plate indicating flammable liquids storage.

E. Gas Anesthetics

- All gas anesthetics must be used with appropriate waste gas scavenging systems.
- Inhalation anesthesia is superior to most injectable forms of anesthesia in safety and efficacy. It is easy to adjust the anesthetic depth. Because the anesthetics are eliminated from the blood by exhalation, with less reliance on drug metabolism to remove the drug from the body, there is less chance for drug-induced toxicity. Inhalation anesthetics are always administered to effect. The disadvantages to inhalant anesthesia are the complexity and cost of the equipment needed to administer the anesthesia, and the potential hazards to personnel. All inhalant drugs are volatile liquids. Volatile anesthetics such as halothane, methoxyflurane, and nitrous oxide have been reported to pose a risk to personnel who are chronically exposed to the agents. Risks include hepatotoxoicity, renal insufficiency and decreased reproductive parameters. Mutagenicity has been reported but teratogenic

effects have been variable, and in vivo carcinogenicity has not been demonstrated. Behavioral modifications have been reported at subanesthetic concentrations. The agents should not be stored in animal rooms because the vapors are either flammable or toxic to inhale over extended periods of time. In particular, ether must be stored in a proper cabinet for flammable materials.

Inhalant Agents

Drug	Toxicity	Comments
Ether	Liver	Flammable and can become explosive with prolonged storage. Ether must be used according to appropriate safety guidelines.
Chloroform	Carcinogen	A hazardous agent (carcinogenic) and cannot be used as an anesthetic agent at UC.
Methoxyflurane		
Halothane		
Isoflurane	Reproductive hazard	
Enflurane	None	
Nitrous Oxide	Hepatotoxic	
Carbon Dioxide (CO_2)	Cerebral anoxia	Poses minimal hazard to personnel and can be used in laboratories or animal room.

- The most complicated aspect of using inhalant anesthesia is the delivery system. A more complete discussion of anesthetic delivery system is available here.

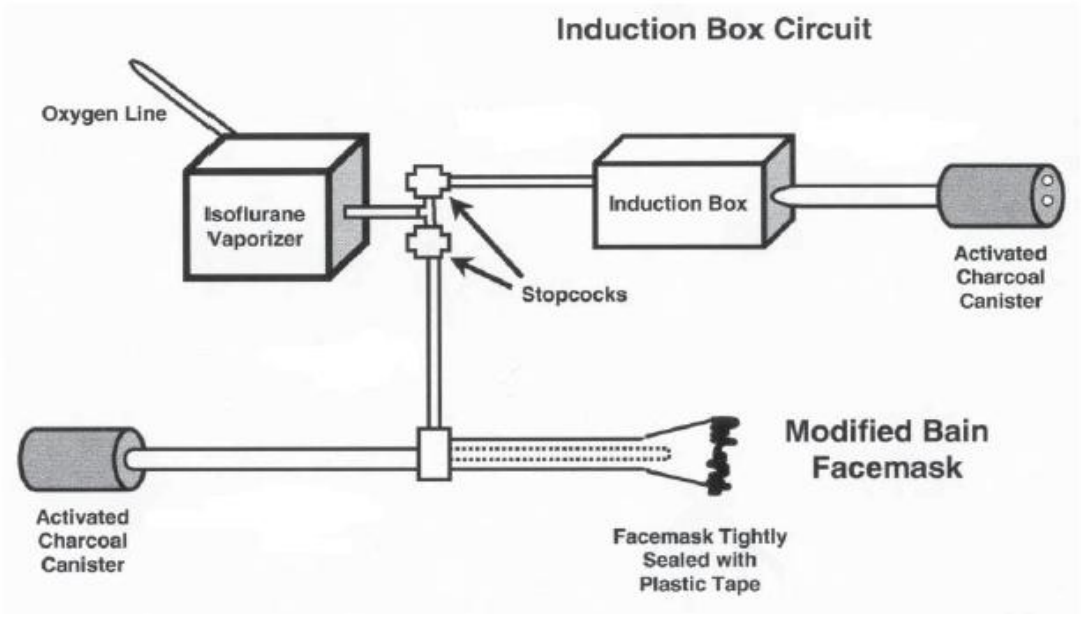
Drop System

The drop system is the most basic type of anesthetic delivery system. It involves the application of the anesthetic gas to an absorbent material that is then placed in the bottom of an anesthetic chamber or nose cone device.

Problems with a drop system and how to deal with them

- Significant waste gas is produced. To minimize waste:
  - Perform anesthesia in a fume hood or other well-ventilated area.
  - Use a chamber with a tight-fitting cover
  - Use a chamber with the smallest diameter mouth possible
  - Keep the lid on except when the animal is being placed into or removed from the chamber
  - Add anesthetic to the absorbent material only a fume hood.

Anesthetic Machine



Resource: Contemporary Topics American Association for Laboratory Animal Science, Vol 42, No. 2, March 2003.

The EH&S recommended method of delivering an inhalant anesthetic is with an anesthetic machine. These machines precisely mix the gas with air or oxygen and can be easily adjusted. Machines can vary in construction and design. Anesthetic machines typically require more training to learn to operate.

The University of Cincinnati Office of Environmental Health and Safety recommends that exposure to all volatile anesthetic gases be kept to as low as reasonably achievable. Recent research assessments report that the levels of waste isoflurane that occur in high-throughput laboratory operations exceed the NIOSH recommended occupational exposure levels of 2 ppm. If you need an exposure evaluation contact the EH&S office at 556-4968.

- Anesthesia machines must have a waste gas scavenging system equipped with an activated charcoal canister. In addition, the canister exhaust should be captured in a laboratory fume hood. For information on calibration of anesthesia machines access the following website:

  http://medcenter.uc.edu/lams/documents/Anesthesia_Machine_and_F-Air_Canister_Maintenance_Guidelines.pdf

Related Documents: Federal OSHA Fact Sheet No. 91-38 (Waste Anesthetic Gases)

OSHA 1910.106 Flammable Liquid Storage

NFPA 45 Fire Protection for Laboratories Using Chemicals

NFPA 30 Flammable and Combustible Liquids Code

Technical Support: Environmental Health and Safety (556-4968) will provide technical support for the proper use and storage of anesthetic gases. EH&S will conduct evaluations of engineering systems used to control exposures to anesthetic gases and conduct personal exposure for laboratory workers.

Laboratory Animal Medicine will provide information on suitable substitutes for ether upon request (558-5171).