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UC Davis
Institutional Animal Care and Use Committee (IACUC)

Title: Inhalation Anesthesia Use Policy

I. Purpose:

To describe methods for safe delivery of inhalant anesthesia to animals, and to ensure adequate anesthesia for animals as well as safety for laboratory personnel.

II. Background:

Inhalation anesthetics (i.e., nitrous oxide, isoflurane, desflurane, sevoflurane) are used for induction and maintenance of general anesthesia. Isoflurane (a halogenated hydrocarbon) is currently the most commonly used inhalation anesthetic on campus. High levels of un-scavenged waste anesthetic gases present a potential for adverse neurological effects or reproductive risk to exposed workers or developmental anomalies in their offspring.[4]

Exposure to volatile anesthetic gases should be minimized through completion of safety training, using the smallest amount of anesthetics necessary, maintaining anesthetic equipment in proper working order, scavenging anesthetic waste gases, and monitoring the potential for worker exposure.

III. Hierarchy of controls

1. **Engineering controls** – Fume hood, properly configured anesthetic chamber, active or passive scavenging system (active preferred), cuffed (if appropriate to species) endotracheal tubes, laryngeal mask airway, anesthetic face mask with diaphragm, snorkel, or using minimum flow levels to reduce potential for exposure. Well-ventilated spaces are essential, but not a substitute for the controls above.
2. **Administrative controls** – Minimizing anesthetic discharge from induction chambers (if appropriate to the species and procedure) training, SOP to check anesthetic vaporizer/circuit/absorbent.
3. **PPE** – Respirator with appropriate filters.

Common Causes of Exposure (**if you can smell vapors, you are being exposed)**:

- Please note that nitrous oxide (N_2O) is odorless and is not absorbed by activated charcoal. Exposure controls for N_2O are similar to other gases with the exception that a commercial filter is needed and the only way to determine exposure levels is through passive dosimetry.[11] Reach out to EH&S or your Department Safety Coordinator for more information.

1. Benchtop delivery of inhalant anesthetic without adequate scavenging.
2. No face mask or poorly fitted face mask.
3. Use of un-cuffed endotracheal tube (ET) or improper inflation of cuffs on ET tubes.
4. Turning on flow meters and inhalants before attaching the breathing system to the animal. Or not turning off the flow meter before removing the mask from the animal (or before opening the induction chamber).
5. Not turning off flow meter and vaporizer when not in use/between animals.

III. Policy:

1. Staff training must be documented in the proper use of the anesthetic delivery and scavenging system they are working with.
2. For questions about training options contact iacuc-training@ucdavis.edu.
3. Anesthetic gas use should be included in OHSS Risk Assessments and employees made aware of the hazards associated with exposure.
4. If you have concerns about exposure levels vs. CalOSHA permissible limits, you can arrange for exposure testing by contacting Safety Services at healthandsafety@ucdavis.edu or (530) 752-1493.
5. We recommend that anyone using inhalation anesthetics complete the Waste Anesthetic Gas (WAG) course.
6. Active scavenging systems are much more effective than passive scavenging systems at lowering exposure potentials and are recommended.

IV. Procedure:

Methods of Isoflurane Anesthesia

1. **Bell Jar or Conical Tube:**

a. A bell jar or other container of known volume with a tightly fitting lid can be used to induce anesthesia or briefly anesthetize animals for short procedures. The container must be in a fume hood. If the use of a bell jar is required outside of a fume hood, an isoflurane exposure test must be performed by EH&S to ensure adequate safety exposure levels.

b. Using a bell jar to deliver inhalant anesthetics involves no calibrated vaporizer, thus the anesthetic concentration within the jar cannot be controlled and a lethal concentration of anesthetics can rapidly accumulate. The animal must be closely monitored at all times while it is in the jar.
c. Volume of isoflurane for different size anesthetic chambers. The following chart shows approximate concentration (left column) of anesthetic achieved based on volume of the chamber and volume of isoflurane in ml added to chamber.

	Anesthetic Chamber Volume (L)				
Desired Concentration of Isoflurane (%)	1	2	3	4	5
1	0.05	0.1	0.15	0.2	0.26
2	0.1	0.2	0.31	0.41	0.51
3	0.15	0.31	0.46	0.61	0.77
4	0.2	0.41	0.61	0.82	1.02
5	0.26	0.51	0.77	1.02	1.28
	Volume of Isoflurane Liquid Required (mL)				

From: "Anesthesia and Analgesia in Laboratory Animals" 2nd edition pg. 86

d. Induction: Soak a cotton ball or gauze with the appropriate amount of isoflurane.
e. Cover the isoflurane-soaked cotton ball or gauze with a mesh platform to prevent the rodent coming into contact with the anesthetic agent, which can cause localized discomfort or irritation to the animal's skin (Figure 1).

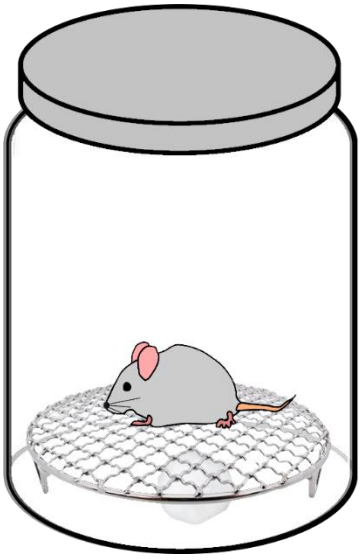

Figure 1:
Jar with known volume and tight-fitting lid.

Wire mesh floor to keep the animal from coming into contact with the isoflurane.

Cotton ball with known volume of isoflurane.

f. Place one animal at a time in the container and close the lid.

g. Observe the animal closely for cessation of voluntary movement, loss of righting reflex, and slowed breathing. **Use caution, animals can be easily overdosed.**
h. Remove animal from the Bell Jar, check the mucous membrane color, respiration, and withdrawal relaxes.
i. The procedure can begin when the animals' respirations and mucous membrane color are normal, but the withdrawal reflex is absent.
j. A conical tube (15 ml or 50 ml) can be used for short duration anesthesia (i.e. <5 min or for terminal blood collection/perfusion) after induction as described in the following steps.
    i. Place a cotton ball or gauze soaked with isoflurane (0.5-1 ml) at the end of a conical tube so that there is no direct contact with the animal.
    ii. After induction place the animal's nose in the opening of the conical tube. Do not put the entire face in the tube, there should be space for air to move around the animal's face. (see picture below)

2. Anesthesia Vaporizer Use:

a. Isoflurane must be administered with a properly serviced vaporizer when used as an anesthetic agent for surgery. See the IACUC Policy on Anesthesia Machine/Vaporizer Service and Verification Guidelines for more information.
b. Personnel must be trained in the proper use of anesthetic machines and vaporizers prior to operation. Contact iacuc-training@ucdavis.edu for more information.
c. Anesthetic gas must be scavenged properly.

3. Waste Gas Scavenging Systems:

Anesthetic machines must have an effective mechanism of waste gas scavenging. Scavenging systems may be active or passive and could include the use of an absorber.

a. Charcoal canisters (e.g., Breath Fresh, f/air, Enviro-Pure, VaporGuard, Clean Air Filter) may be used to absorb halogenated waste gases, but **not** nitrous oxide. Manufacturer's guidelines must be followed, and usage must be documented on the side of the canister either indicating the hours used or weight of the canister

as described in the Anesthesia Machine/Vaporizer Calibration and Maintenance Guidelines.

b. If utilizing passive scavenging, before using the anesthesia machine, verify an activated charcoal waste gas scavenging canister is connected to the system. **It is also essential to ensure the same measurement (weight or time) is used as the previous user.**
    i. Remove the canister from the system.
    ii. Shake the canister briefly to evenly redistribute contents.
    iii. **If using WEIGHT**: weigh the canister and record the date and weight on the canister.
    iv. Reattach canister to the hose or chamber.
    v. Ensure the canister is sitting upright with the holes on the bottom unobstructed (place in holder suspended off the tabletop).
    vi. **If using TIME:** record the time used on the side of the canister at the end of the procedure.
    vii. There should be a scavenging system on the induction chamber and the breathing circuit. Both must have either WEIGHT or TIME recorded on the side.
    viii. Once a canister has reached the maximum time or weight per the manufacturer recommendations, it can be disposed of in a regular trash receptacle or based on manufacturer recommendation.

Table 1. Manufacturer's recommendations:

Canister	Maximum Hours of Use	Maximum Weight Gain
Breath Fresh	12-15 hours	50 grams
f/air	12-15 hours	50 grams
Enviro-Pure	N/A	100-120 grams
VaporGuard	N/A	50 grams
VetOne Clean Air Filter	12-15 hours	50 grams

Charcoal canisters: Manufacturer's guidelines must be followed (see Table 1) and usage must be documented on the side of the canister either indicating the hours used or weight of the canister (pre and post use)

c. CO_2 absorbers (e.g., Soda lime, Baralyme, Amsorb Plus) should be changed regularly. CO_2 absorbers react with water; the pH change when saturated with CO_2 will activate a change in the ethylene violet dye indicator contained in these absorbers. These indicators can change back to white-grey if enough time is allowed, but this does not indicate the absorbers are still functional. Therefore,

the absorbers must be changed as soon as a color change is noted. Lime based absorbers must be disposed of as chemical waste. Amsorb Plus can be disposed of in the regular trash. Contact Safety Services for details on chemical waste disposal.

d. Fume hood: Open drop anesthesia techniques must be conducted in a fume hood that has been tested and certified by Facilities Management.

V. References:

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9. Masselink, T., Hardinger, J., Bowman-Dalley, C. et al. Certified Registered Nurse Anesthetists' occupational exposure to inhalational anesthetic agents: a survey of anesthetic gas safety. BMC Anesthesiol 22, 375 (2022). https://doi.org/10.1186/s12871-022-01896-y
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