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Anesthetics: safety and best practice while working with small laboratory animals

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Anesthetics

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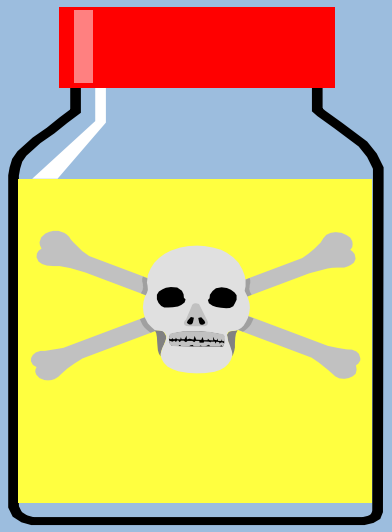
- Inhalation anesthetics: halothane, isoflurane, sevoflurane, desflurane, N2O
  - According to the Swiss drugs regulation isoflurane (as all halogenates) is Catg. B and belongs in a closed cabinet
- Injection anesthetics: ketamine, xylazine, pentobarbital, fentanyl, urethane
  - According to the Swiss drug regulation Catg. B and A and belong in a closed cabinet

Occupational exposure to anesthetic gases: MAK limits (SUVA)



Substance	SWITZERLAND			
	Occupational exposure limit - Time-weighted average for 8 hours		Short-term occupational exposure limit (4 x 15 min/shift)	
	ppm	mg/m³	ppm	mg/m³
Nitrous oxide	100	182	200	364
Halothane	5	40	40	320
Enflurane	10	77	80	616
Isoflurane	10	77	80	616
Sevoflurane	-	-	-	-
Desflurane	-	-	-	-

2% = 20'000 ppm

How we got there and now

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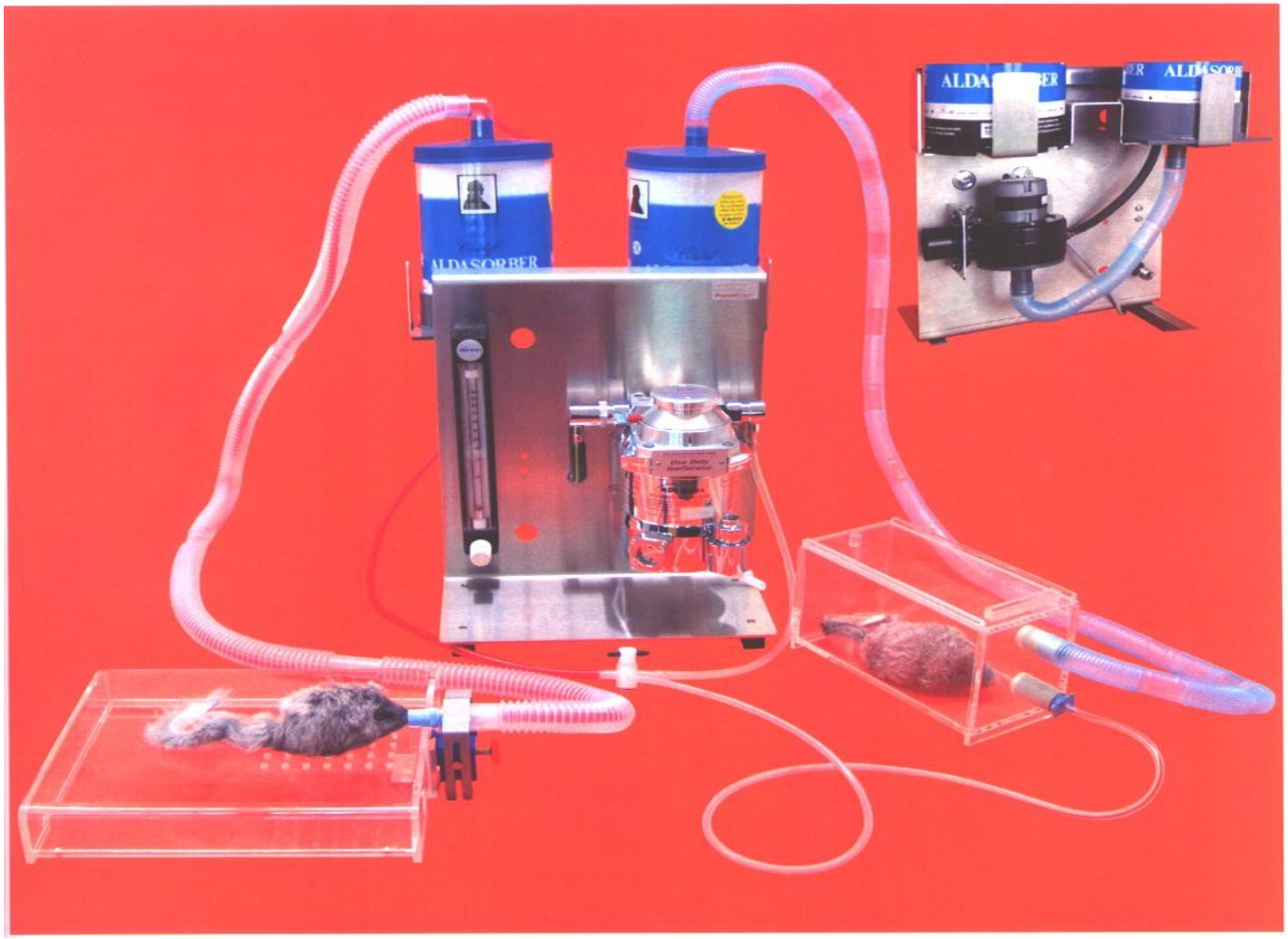
- Once upon a time…
  - Surveys among anesthesia folks (1972 – ASA and NIOSH – 40,044). Main side effects
    - Abortions
    - Birth defects
    - Embryotox, mutagenesis, carcinogenesis and liver disease

    ETHER, CLOROFORM, TRICHLOROETHYLENE, CYCLOPROPANE, FLUROXENE, **HALOTHANE**, METHOXYFLURANE, **NITROUS OXIDE**

  - No scavenging before 1977 and semi open systems

- Now
  - No real evidence of toxicity of iso, sevo des….
    - Abortion
    - Multiple sclerosis? (Swedish survey)
    - Psychomotor performance impairment
  - Care is recommended: w**aste management program (WAM)**

Anesthesia assembly



Risk areas for exposure 1 and WAG mgt

- Funnel fill systems are unsafe:
  - risk of filling the wrong agent→ risk for the animal
  - ambient air pollution with the halogenate → risk for the personnel
- Key filled systems are safe and very importantly minimize air pollution

Risk areas for exposure 1 and WAG mgt

Risk areas for exposure 2 and WAG mgt

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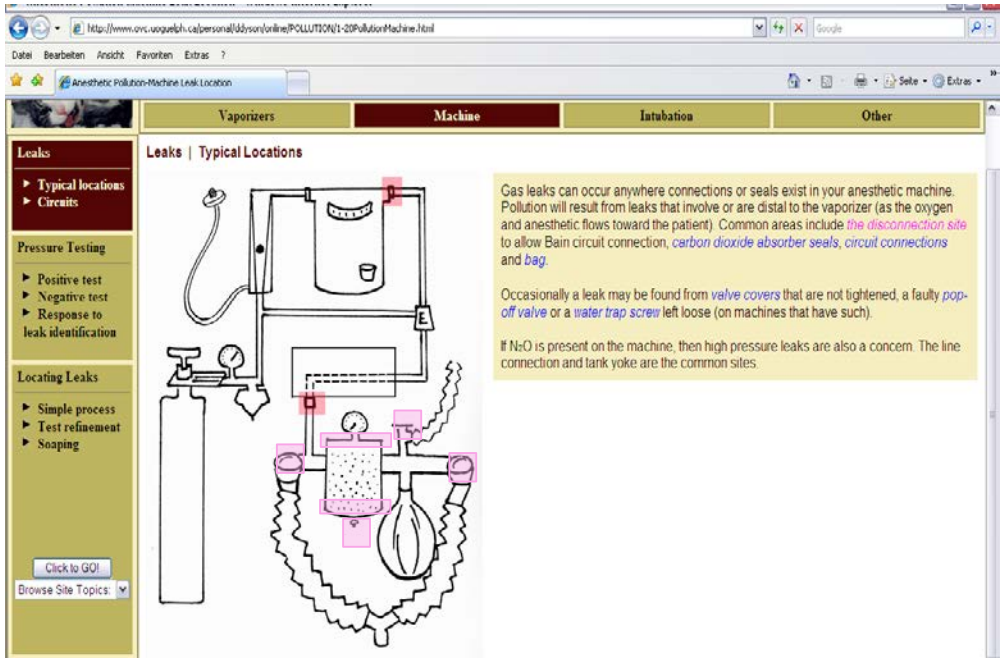
- Leaks
- Disconnections of all kind
- Breathing hoses: tears
- Breathing bag: tears
- Masks



SUPER ACTION: organize your Lab

Disciplined and systematic material inspection

Perform always LEAK TEST!

Risk area for exposure 3 and WAG mgt

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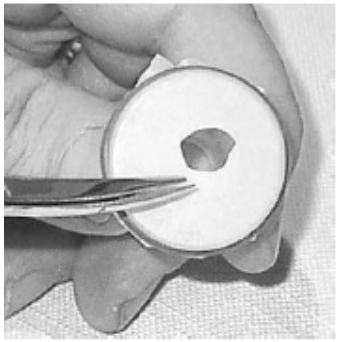
- Induction chamber (opening)

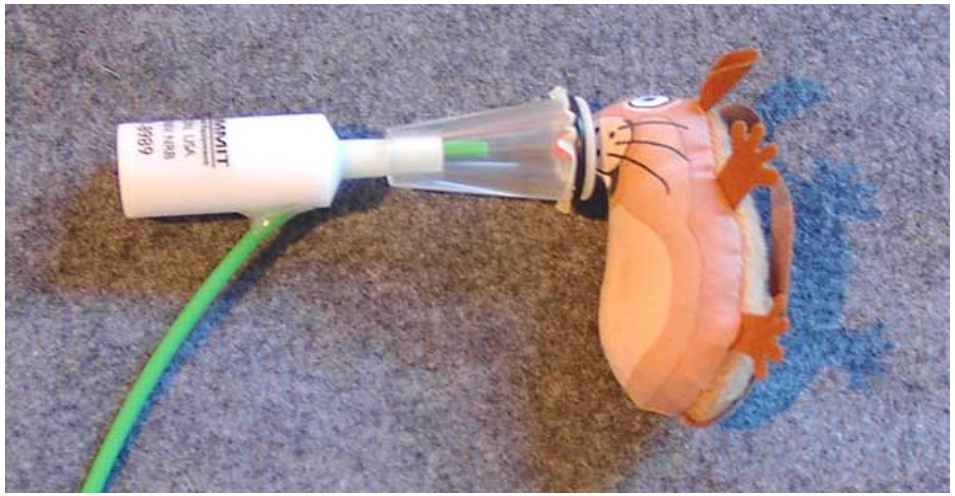
25% - 30% Concentrations (300 000 ppm) at Ambient Room Temperature

Risk area for exposure 4

- Not fitting mask
- Not fitting or deteriorated diaphragm
- No diaphragm
- No scavenging (coaxial)



And WAG mgmt



Risk areas for exposure 5

- RECOVERY AREA
  - Limited risk for rodents

WAG Managment and occupational exposure reduction

- Equipment
  - Tubing with scavenging
  - Fitting masks
  - Proper scavenging equipment
  - Maintenance
- Good practices
  - Use low flows
  - Check for leaks
  - Do not spill
  - Wash out
  - Consider alternative protocols
- Training and awerness
- Monitor ambient concentrations

In case of spill
- Cover with sand
- Leave the room
- Close the door
- Call the fire brigade

Scavenging Systems

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- **Poor warning properties of anesthetic gases will provide no indication if scavenging is not occurring**

- Waste gas is contained and than released to the outside atmosphere

- Scavenging systems
  - Active Systems
    - Building Exhaust Ventilation : dilution principle
    - Localized Exhaust System
    - Fume Hood
  - Passive Systems
    - Outside line
    - Absorbers

Active systems

- Apply negative pressure to procedure area not just exhaust.
- Exhaust directly to the outside
  - Elephant Drop
  - Slot Exhaust
  - Downdraft Table

Active systems

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- Fume Hoods
  - Apply negative pressure to procedure area not just exhaust.
    - Placement of entire gas mixing and delivery system inside fume hood is ideal
    - Require high degree of attention and maintenance
    - Hazardous chemicals could exhaust back into room

Scavenging Systems

- **Passive systems**
  - ABSORBERS Filtering Gases
    - Activated Charcoal + Adsorbent Material
    - Can only be used with systems that actively move gas (e.g., from pressurized tanks or a vacuum system); systems cannot use gravity
    - Absorb ALL halogenates
    - **DO NOT ABSORB N2O!!!!**
- Use in upright position
  - f/air canister should be suspended so that bottom ports are not covered
- Canisters with exhaust ports on the top work better than those with exhaust ports on the bottom

Scavenging Systems

- **Passive systems**
  - Management of Canisters
    - Routinely check for leaks
    - Documentation
      - Starting weight of canister
      - Date of first use and subsequent use dates
      - Weight of canister before each use – discard canister when gain reaches manufacturer's limit OR 25% of Original Canister Weight
      - Expiration date of canister
    - Tedious
- **Therefore, use must be limited to situations where other means of scavenging are not practicable.**

> 1400g

= EXHAUSTED

No labelling of weighing

< 1400g

= ABSORBING

Correct labelling:

Date

Weight

Signature

ALDABOSRBER:

- Filters only halogenates (isoflurane, sevoflurane)
- Efficient up to 1400 g (1220 g when new!)
- NOT EFFICIENT for absorbing N2O!!!

Action: ***please weigh and label your absorber AFTER EACH USE*** *to avoid ambient air pollution with the halogenate → risk for the personnel*

Do not use N2O as driving gas

Fazit Nitrous oxide

- PRO:
  - II gas effect
  - Analgesia
  - CV inert
- CONTRA
  - High MAC= high concentration
  - Hypoxia
  - Bloating
  - MUTAGENIC
  - TERATOGENIC
    - > 50 ppm TWA FOR 8 HOUR DAY

No clinical /scientific benefits for rodent anesthesia

Use ONLY if scavenging to outside (better active)

Injection anesthetics

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- Use vs abuse
- Small vs large animals
- Single dose vs CRI

- Urethane
  - Long term terminal anesthesia in rodents and rabbits
  - Mutagen (Lewis, 2004) and as a group 2B carcinogen by the International Agency for Research on Cancer (IARC).
    - suppresses bone marrow, readily crosses the placenta, induces fetal tumor formation (in utero), and initiates preneoplastic changes in the skin (Field and Lang 1988).
  - Absorbed through the skin & mucosae
  - Mandatory to implement a program for eliminating or sufficiently reducing exposure potential to all staff involved
    - standard operating procedures (SOPs), administrative controls, personal protective equipment (PPE), work methods, engineering controls, and waste disposal procedures

Conclusions

- Be informed
- If unsecure ask
  - OHS official F. Achermann, Anesthesia official A Bergadano
- If family wish or pregnant or breast feeding risk is very low but speak up and have a tailorized risk analysis done
- Beware of other risks
  - Cyanometacrylate
  - Allergens

- Be smart, be compliant