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Occupational Health

Busulfan Safety

Background

Busulfan is a chemotherapy drug classified as an alkylating agent. It works by damaging DNA inside cells, which prevents rapidly dividing cells from reproducing. Busulfan is a drug used to treat leukemia in humans and animals, because cancer cells divide quickly and busulfan has the ability to suppress or destroy bone marrow and blood-forming cells. It is non-volatile, non-flammable and solid and stable at room temperature. In research, busulfan is widely used in laboratory animal models because it selectively suppressed or eliminated bone marrow and reproductive stem cells.

Purpose

This provides requirements for safe use of busulfan in research activities involving live animals, animal tissues, or animal housing environments. It is intended to prevent exposure to personnel, protect animal health, and ensure proper waste handling and regulatory compliance.

Scope

This section applies to:

- All personnel working with busulfan in animal research settings
- Principal Investigators (PIs) conducting studies involving busulfan and animals
- Vivarium, husbandry, veterinary, and case wash staff who may encounter busulfan contaminated materials.

Hazard(s) Identifications

Acute Affects:

- Toxic by inhalation, toxic by ingestion, highly toxic by skin absorption

Chronic Affects:

- Carcinogen, known carcinogen based on sufficient evidence of carcinogenicity from studies in humans.
- Busulfan is classified as a Group 1, carcinogenic to humans, by the International Agency for Research on Cancer (IARC).

Hazard Statements:

- Causes skin irritation
- Causes serious eye irritation
- May cause respiratory irritation
- May cause genetic defects
- May cause cancer
- Suspected of damaging the unborn child
- Toxic if swallowed, in contact with skin or if inhaled

Potential Occupational Exposure

- Personnel working in animal research environments may be exposed to busulfan through contaminated bedding, cages, and animal excretions following administration to rodents. Busulfan is rapidly metabolized and inactivated in rodents, with approximately half metabolized every 3 hours. In humans, busulfan is metabolized into inactive compounds that are primarily excreted in urine, with typically 1% or less of the active drug present in urine. High-dose exposure may result in bone marrow suppression and, in rare cases, pulmonary toxicity.

Precautionary Statements/Prevention:

- Obtain special instructions before use
- Do not handle until all safety precautions have been read and understood
- Wash face, hands, and any exposed skin thoroughly after handling
- Do not eat, drink or smoke when using this product
- Avoid breathing dust/fume/gas/mist/vapors/spray
- Use only outdoors or in a well-ventilated area
- Wear eye/face protection
- Wear protective gloves/protective clothing/eye protection/face protection

First Aid Measures

Eye Contact:

- Immediate medical attention is required. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.

Skin Contact:

- Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Immediate medical attention is required.

Inhalation:

- Remove from exposure, lie down. Remove to fresh air. If not breathing, give artificial respirator. Get medical attention.

Ingestion:

- Call a physician immediately. Clean mouth with water.

Treatment:

- Treat symptomatically

IACUC Review and Animal Use Considerations

- Use of busulfan in live animals must be reviewed and approved by the Institutional Animal Care and Use Committee (IACUC)

- Protocols must include:
    - Route of administration (if applicable)
    - Concentration and volume
    - Frequency and duration of exposure
    - Justification for use of busulfan versus safer alternatives
- Investigators must consider
    - Potential mutagenic and toxic effects on animals
    - Impacts on animal welfare and research outcomes

Animal Housing and Containment

- Animals exposed to busulfan must be identified and managed appropriately to prevent cross-contamination.
- Cages, racks, and transport equipment must be handled as potentially contaminated.
- Busulfan-treated rodents should be housed in clearly labeled filter-top cages. Bedding from treated animals should be collected and bagged after 3 days and disposed of through approved cytotoxic or incineration waste procedures in accordance with institutional requirements.
- Filter-top cages housing busulfan-treated animals should not be connected to ventilated cage systems unless specifically approved by veterinary or environmental health personnel.
- Animal handlers must wear appropriate PPE, including gloves and gowns, and should handle cages inside a certified biosafety cabinet whenever feasible.
- The researchers or his/her technicians are responsible for handling the first cage and bedding change after administration. After the first cage (if no further administration), then vivaria staff can complete further bedding and cage changes.
- Label cages and remove label after decontamination.

Contaminated Materials and Waste Management

All materials that may be contaminated with busulfan must be managed as hazardous chemical waste, including

- Animal bedding
- Carcasses and tissues
- Cages and cage liners
- Sharps and disposable materials

Dispose all waste material in the appropriate cytotoxic waste container. Unused solutions of Busulfan and contaminated solid waste will be disposed of as hazardous cytotoxic material by Environmental Health, Safety and Risk Management (EHSRM)

Use the UC WASTE program at: waste disposal requirements.

Spills

In case of a spill contact EHSRM at x: 2-5528 or UCPD at x-2-5222 during non-business hours.

Disposal using sinks, intentional evaporation and trash cans is against the law.

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Personal Protection and Occupational Health

Engineering Controls and Preparation Procedures

- The preparation of busulfan, including reconstitution, weighing, and dilution, must be performed in a certified chemical fume hood or biological safety cabinet (BSC). Work surfaces should be protected using absorbent pads or other approved disposable liners to contain contamination and facilitate cleanup.

Cytotoxic-Resistant Glove Requirements

- Cytotoxic-resistant gloves used for handling busulfan must comply with ASTM D6978 standards for chemotherapy drug permeation resistance and must be powder-free.
- Recommended glove materials include nitrile, neoprene, polyurethane, or other chemotherapy-rated glove materials compatible with cytotoxic drug handling. Vinyl gloves must not be used.
- Double gloving is recommended when preparing, administering, or handling busulfan-contaminated materials. Outer gloves must be changed immediately if torn, punctured, or visibly contaminated.
- Gloves must be removed carefully to avoid skin contamination and disposed of as cytotoxic waste following use.

Required Personal Protective Equipment (PPE)

- The following personal protective equipment must be worn/used in the room or when handling animals:
    - Lab coat/coveralls
    - Shoe covers/booties
    - Double nitrile gloves or compatible cytotoxic-resistant gloves
    - Eye protection
- Personal protection equipment must be discarded or decontaminated at the end of the project.

Hands, arms, and face must be thoroughly washed upon leaving the room.

Personnel working with busulfan must be included in the hazard assessments (e.g. LHAT/OHSS)

Vivarium Coordination and Communication

Investigators must notify vivarium and animal care staff when:

- Busulfan is used in animal procedures
- Animals or materials may be contaminated

Clear communication must include:

- Handling precautions
- PPE requirements
- Waste disposal procedures

Cages or materials must be labeled or otherwise identified as containing busulfan contamination where applicable.

Reproductive Health Considerations

Busulfan is a potential reproductive hazard classified as a Category 2 reproductive toxicity.

Personnel who are pregnant should not be exposed to or handle this cytotoxic in any form.

Personnel who are pregnant, planning pregnancy, or have concerns about reproductive risks should contact Occupational Health for confidential guidance and risk assessment.

Decontamination and Facility Controls

Work surfaces, equipment, and transport items must be decontaminated using approved busulfan methods.

Do not transport contaminated materials between laboratory and animal areas without:

- Secondary containment
- Prior decontamination where feasible

Prevent the spread of contamination to shared spaces.

Training Requirements

Personnel must complete:

- Laboratory safety / Hazard communication training
- Any applicable **Chemical Hygiene or Hazardous Materials training**
- Task-specific training on:
    - Busulfan handling
    - Animal-related exposure risks
    - Waste management procedures

Alternatives and Risk Minimization

Investigators are expected to evaluate and use safer alternatives to busulfan whenever feasible.

Use of busulfan must be justified in the IACUC protocol or applicable risk assessment when safer alternatives are not suitable.

When busulfan is used:

- Use the lowest effective concentration
- Minimize quantities prepared and handled
- Limit the number of personnel exposed

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Reporting Exposure Incidents

Any exposure incident— such as contact of busulfan with eyes, nose, mouth, skin contamination, needlestick and/or sharps exposure – must be **immediately reported** to:

- Your PI or laboratory supervisor
- UCR Biosafety Officer (BSO) and EHSRM at (951) 827-5528.
- Occupational Health ehsocchealth@ucr.edu
- You may contact the UCI Medical Center Infectious Disease Fellow on call at (714) 456-6011 for immediate counseling and guidance. UCR Maintains an agreement with the UCI Center of Occupational and Environmental Health (COEH) Clinic, which serves as our Occupational Health provider and reviews UCR's Animal Occupational Health Program.

Undergraduate Student Employees report your injury to your supervisor (or go to Employee Injuries).

For life-threatening injuries, call 911 immediately.

For all other types, seek Medical Treatment at UCR's preferred Occupational Clinic. Visit the Medical Treatment Facilities webpage to learn more about where to seek medical treatment.

Citations

"Busulfan." *Safety Data Sheet*, Thermo Fisher Scientific, revision no. 4, 21 Dec. 2025, Cat. No. J61348, CAS No. 55-98-1.

Easty, Anthony C., et al. "Safe Handling of Cytotoxics: Guideline Recommendations." *Current Oncology*, vol. 22, no. 1, 2015, pp. e27–e37. *PubMed Central*, doi:10.3747/co.21.2151

National Center for Biotechnology Information. *NCBI Bookshelf*. U.S. National Library of Medicine, https://www.ncbi.nlm.nih.gov/sites/books/NBK555986/.

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Acknowledgement of Working with Busulfan

By signing below, I confirm that I have reviewed and understood the requirements for working with busulfan, I agree to comply with all outlined responsibilities, including:

- Following safe laboratory practices and use of appropriate PPE
- Applying proper first aid and decontamination procedures in the event of an exposure
- Promptly reporting any exposures, incidents, or safety concerns to my supervisor, Biosafety Officer, and Occupational Health

Name (Print)	Identification*	Signature	Date	Supervisor / Principal Investigator

*Identification: Provide your UCR Student ID, Employee ID, UCR NetID, UCR Email, or Date of Birth.