THE UNIVERSITY OF BRITISH COLUMBIA

Exposure Control Plan for Hazardous Drugs

1. Introduction

Purpose & Background

The University of British Columbia (UBC) is committed to providing a safe and healthy workplace by protecting campus occupants from the potential adverse effects from exposure to hazardous drugs in accordance with the British Columbia *Occupational Health and Safety Regulation* (OHSR). Based on the OHSR, an employer is required to develop, implement, and maintain a Hazardous Drugs Exposure Control Plan (ECP) if a risk assessment indicates that an employee is or may be exposed to a hazardous drug.

Chapter 6 of the OHS Regulation lists "Hazardous drugs" as substances with specific requirements. The requirements of the regulations and Best Practices for the Safe Handling of Hazardous Drugs are incorporated in this Exposure Control Plan (ECP).

Hazardous drugs are specific drugs used to treat cancer and other diseases in both people and animals. There are UBC research projects that involve the use of hazardous drugs in either animal models or cell/tissue cultures.

If a worker is or may be occupationally exposed to a hazardous drug, the employer must develop and implement an ECP meeting the requirements of section 5.54 of the regulation. This ECP is applicable to all UBC employees, users of UBC spaces, and students carrying out work with hazardous drugs at UBC and where there is potential for hazardous drug exposure to occur. UBC employees who are using hazardous drugs in a clinical setting (human patients) are required to follow the Hazardous Drug ECP of the health authority with jurisdiction at the site. If none is available, this ECP can be used or contact Safety & Risk Services (SRS) or the UBC Vancouver or Health, Safety & Environment (HSE) for UBC Okanagan.

This ECP focuses on the use of hazardous drugs in research facilities where the drug could be administered in animal subjects. If administration in humans is done by UBC employees, it is normally done in a hospital setting. The health unit specific protocols for working with hazardous drugs are followed in these cases.

Scope

This document is applicable to all UBC faculty, staff, and students who handle or may come in contact with hazardous drugs.

Legal Requirements

Sections 6.43-6.58 of the OHSR outlines the regulatory requirements for hazardous drugs while sections 5.54 - 5.57 of the OHSR outlines the requirements for when an ECP is required and what elements must be included in the ECP. Furthermore, occupational exposure limits can be found in the Table of Exposure Limits for Chemical and Biological Substances within the OHSR. Where respiratory protective equipment is required, Part 8 of the OHSR provides the requirement for personal protective equipment and also references CSA Standard *Z94.4-02, Selection, Use, and Care of Respirators*. Additional requirements may be applicable depending on the nature of the work being performed.

All UBC faculty, staff, and students are expected to understand the legislative requirements and what must be done to protect themselves from hazardous drugs exposure in the workplace.

2. Relevant Sections of the Document

- What is a hazardous drug? Hazardous Drugs – designation
- Health Hazards and Routes of Exposure
- Hazard Identification and Risk Assessment
- Controlling the risk of exposure: substitution, engineering, administrative and personal protective equipment
- What documents and records do I need to keep? Documentation and Record Keeping
- Appendices:
    - Appendix A: Past and Present Hazardous Drugs Used in UBC Animal Units
    - Appendix B: NIOSH List of Hazardous Drugs (2020)
    - Appendix C: Labels and Signs for Hazardous Drugs
    - Appendix D: Job Tasks and Appropriate Controls (examples)
    - Appendix E: Record of Exposure to Hazardous Drugs (template)
    - Appendix F: Roles and Responsibilities

3. Roles and Responsibilities

The roles and responsibilities described in this ECP are in accordance with the BC OHSR and the University Health and Safety Policy - SC1.

The responsibilities of the employer, department manager/supervisor, employee, Safety & Risk Services and Joint Occupational Health & Safety Committee are listed in Appendix F.

4. Hazardous Drugs – designation

The Regulation states that the term hazardous drug means a drug that has one or more of the following characteristics:

- Carcinogenicity
- Teratogenicity
- Genotoxicity
- Reproductive toxicity
- Organ toxicity (at low doses)

A drug is also considered a hazardous drug if it is:

- A new drug that mimics an existing drug with one of the characteristics listed above
- Listed in the NIOSH List of Hazardous Drugs in Healthcare Settings.

For drugs not on the NIOSH list, a health & safety professional can determine whether a drug is considered a hazardous drug by using the following sources of information:

- Drug information sheets provided by the manufacturer (e.g. Safety Data Sheets – SDS)
- Product monographs in Health Canada's Drug Product Database
- Health warnings from government or professional groups
- Drug information from the American Hospital Formulary Service.

For reference, a "drug" is defined by Oxford dictionary as a substance which has a physiological effect when ingested or otherwise introduced to the body.

THE UNIVERSITY OF BRITISH COLUMBIA

5. Routes of Exposure & Health Hazards

Routes of Exposure

At UBC hazardous drugs are used in research involving animals. This type of research is mainly done in animal facilities that have strict access protocols. Where work is done in alternate housing, a site-based risk assessment is required. Alternate housing spaces are areas outside a UBC animal facility where a procedure(s) on an animal is performed and/or animals may be held/housed for less than 24 hours or longer (depending on the approvals).

Researchers and staff working in these facilities can be exposed to hazardous drugs in different ways. The route of exposure (oral, dermal or inhalation) depends on both the form of the drug (solid/liquid) and the task being done (e.g. crushing of pills).

Health Hazards

Patients treated with high doses of antineoplastic agents (a type of hazardous drug) exhibit effects including nausea, rashes, hair loss, liver and kidney damage, hearing loss, cardiac and hematopoietic (blood cell) toxicities. Some of these effects are also prevalent in exposed workers.

Exposure to hazardous drugs has been associated with many adverse health effects, such as an increase in the risk of leukemia and other cancers, a risk of damage to organs or organ systems, and a risk to the ability to successfully conceive and have healthy babies.

The health risk depends on the toxicity of the drugs and how much exposure a worker has to these drugs.

6. Hazard Identification & Risk Assessment

Any research involving handling and/or administration of hazardous drugs for human patients takes place in one of the research hospitals and it will follow the specific health unit guidelines. This ECP does not apply to these cases.

Hazard Identification

Hazard identification is the process by which existing hazards are inventoried in a workplace. Preparation and administration of the hazardous drug can be done inside the animal unit or in a research lab. For the later case the prepared drug (e.g. injectable solution, medicated food/water) is transported to the animal unit for administration.

At each location where, hazardous drugs are stored and handled the facility manager, principal investigator or designated responsible person must develop a written list of every hazardous drug that a worker is or may be exposed to in the workplace. The list is made readily available for reference by workers at each of the workplaces to which the list applies. The list must be amended when new hazardous drugs are introduced and reviewed annually.

Appendix A contains a list of hazardous drugs historically used in the UBC animal units (Point Grey, BC Children Research Institute, Jack Bell Prostate Centre, Centre for Heart Lung Innovation, ICORD, and UBC Okanagan). This list was created based on individual risk assessments done for animal protocols approved at the respective locations and is not an exhaustive list.

Risk Assessment

The degree of risk is dependent on the inherent toxicity of the substance, as well as the extent of exposure. Workers may be exposed *via* inhalation of dusts or aerosols, absorption through the skin, needle stick injuries, and ingestion (e.g. because of ingestion of contaminated food). Compliance with the personal hygiene requirements (sections 5.82 to 5.84 of OHSR) should eliminate ingestion as a source of exposure.

Exposure may occur during preparation, administration and usage of hazardous drugs, handling of body fluids from animals receiving hazardous drugs, handling and disposal of hazardous drugs waste and related trace contaminated material, and transportation of hazardous drugs substances.

Surface contamination is one of the main sources of occupational exposure to hazardous drugs. Due to their chemical stability, residue from hazardous drugs can persist in the workplace and be spread far from their point of origin. Residue can also collect on items that are not directly used for handling hazardous drugs, such as pens, door handles, and elevators buttons. Since surfaces throughout the workplace may be contaminated, there is potential risk of exposure for anyone working in the space.

Hazardous drugs listed on animal protocols are undergoing a risk assessment as part of the animal protocol approval. The risk assessment considers the following input information about the drugs:

Table 1: Data Considered when a Risk Assessment for an Animal Protocol is Completed at UBC

Input information	Rationale
The physical state of the drug when purchased (solid or liquid)	• To determine the possible route of exposure and type of handling required
The solvent(s) used to prepare the drug	• To determine additional risks due to the solvent • To investigate possible additive effects
The drug's specific toxicity and health hazard	• If published, LD_{50} is listed to indicate the level of acute toxicity • Acute and chronic health hazards are listed to inform the users and to determine appropriate controls • Physical hazards are listed only if significant (*)
Task/procedures involving each drug	• To determine mode(s) of exposure • To determine appropriate controls
Occupational exposure limits	• When available, are listed in order to inform the users • To provide information on possible monitoring and when would be necessary

*This is usually determined by the chemical safety advisor writing or reviewing the assessment

The main routes of exposure to hazardous drugs, associated activities and suggested controls are listed below.

Table 2: Hazardous drugs: Routes of Exposure, Associated Tasks and Controls

Route of exposure	Examples of activities	Suggested controls
Direct dermal contact	• Handling oral (e.g. oral gavage) or topical forms of hazardous drugs • Contact with a leak or spill of hazardous drugs	• Wearing double disposable gloves • Using a closed-system transfer device • Make sure all open skin (open cuts or sores) are covered (e.g. band aids)
Indirect dermal contact	• Handling contaminated bedding (with animal excreta) • Handling or touching contaminated materials, such as equipment, containers, work surfaces, or cages	• Wearing double disposable gloves • Observing a precautionary period for handling animal excreta

Route of exposure	Examples of activities	Suggested controls
Contact with eyes	• Handling liquid forms or solutions of hazardous drugs • Weighing out powders on top loading balances on the open bench	• Wearing eye protection or a face shield • Weighing out powders in a fume hood
Inhalation	• Inhaling aerosols or vapors released when priming a syringe • Inhaling particulate material released when crushing tablets, opening capsules, or weighing powders • Inhaling particulates when dumping contaminated animal bedding	• Performing activities inside a ducted biological safety cabinet or fume hood • Wearing an appropriate respirator (when necessary) • Performing staining activities inside a fume hood • Using cage changing stations for dumping of animal bedding
Percutaneous exposure	• Preparing or administering drugs using a needle • Handling broken glass or overfilling sharps containers • Reusing razor blades, scalpels, or dissection pins	• Using a needless system or safety engineered medical sharp • Use single use sharps and dispose of directly in a dedicated hazardous drugs sharps container
Ingestion	• Eating food that has been contaminated with hazardous drugs • Inhalation of particulates can introduce contaminants in the digestive system as well	• Ensuring all food is stored away from areas where hazardous drugs are handled • Thorough hand washing

It is the responsibility of workplace managers/supervisors to identify hazards and ensure qualified personnel perform risk assessments. SRS and HSE are available to provide guidance in this process and able to advise when sampling is required. All risk assessments must be reviewed and re-evaluated in the following cases:

- There is reason to believe the current assessment is no longer valid
- The scope, circumstances, or nature of the work activity has changed significantly i.e. change in procedure, equipment, and/or physical form of the drug
- The results of any exposure or health monitoring suggest that a review is necessary

7. Exposure Limits

There are no general occupational exposure limits (OEL) for hazardous drugs because it is not possible to determine safe exposure levels. According to the Occupational Health and Safety (OHS) Regulation if a worker is or might be occupationally exposed to a hazardous drug the employer must develop and implement an ECP. If substitution is not practicable, the employer must implement an exposure control plan to maintain workers' exposure **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA).

8. Risk Controls

Once all hazardous drugs have been identified and the risks assessed, the employer must choose appropriate controls. Controls aim to eliminate or minimize exposure to workers. The hierarchy of controls is a systematic approach to control for risks in a workplace from most to least effective.

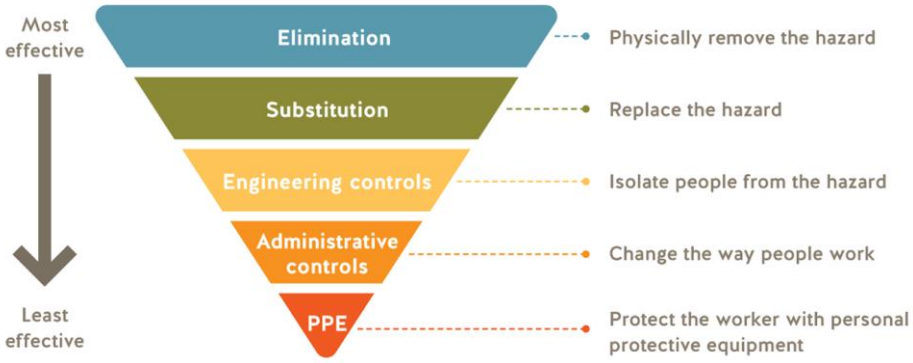

Figure 1: Hierarchy of Controls Diagram (from Controlling risks – WorkSafeBC)

A combination of controls is usually the most effective protection.

8.1 Elimination / Substitution

Elimination is at the top of the hierarchy of controls. The employer must first consider whether it is possible to eliminate the risk of exposure to a hazardous drug.

If elimination is not practicable, the employer must control the risk of exposure using substitution. Examples of substitution include using a less-hazardous drug or a different form of the drug that poses a lower risk of exposure to workers. For example, instead of crushing a pill (exposure by inhalation) to make it easier to swallow, determine if using a liquid form is practicable.

If substitution is not practicable, the employer must keep the risk ALARA through engineering and administrative controls. The engineering controls and administrative controls must be appropriate in relation to the work activity and consistent with the risk assessment for the workplace.

8.2 Engineering

Engineering controls aim to minimize the exposure to hazardous drugs through physical modifications to facilities, equipment and processes. Animal units that have a limited number of engineering controls available must contact SRS or HSE to conduct a risk assessment to determine the most effective exposure control strategy.

8.2.1 Enclosures

Mixing, preparing, or priming an intravenous administration set with a solution containing a hazardous drug listed in **Table 1** of the NIOSH list of Hazardous Drugs must be done in a ventilated enclosure that:

- Meets or exceeds the requirements for a Class II Type B2 biological safety cabinet
- Has exhaust and ventilation system that remain in operation for a period of time sufficient to ensure that no contaminants escape into the workplace
- Is connected to the exhaust ventilation system which must discharge to the outdoors in a manner that prevents contaminants from being recirculated in the workplace or an adjacent workplace
- Is equipped with a continuous monitoring device to permit confirmation of adequate airflow and cabinet performance

Preparation of hazardous drugs listed in **Table 2** of the NIOSH list of Hazardous Drugs must be done in a certified Class II Type B2 biological safety cabinet or in a fume hood.

A type of engineering control specific to working with animals are the ventilated racks and cages. These provide controlled air flow to keep animals separate from other animals and potential exposures. They also ensure

contaminants are not release from the cages into the atmosphere therefore providing protection for the workers as well.

8.2.2 Cage dump stations

Cage dump stations are designed to minimize exposure to workers when contaminated bedding is being disposed of. These stations can employ HEPA filters, active ventilation and/or an enclosed cabinet as means of controlling exposure by inhalation.

8.2.3 Downdraft table

Downdraft tables are engineering controls that use built-in ventilation to extract hazardous particles from the air. They have built-in ventilation that pulls air, odors, vapors, and aerosols down and away from the worker's face. They are used primarily for dissections of formaldehyde-preserved specimens and for capturing dust, vapors, or other contaminants generated during various work activities.

The capture efficiency of a downdraft table can be affected by changing conditions in the room. Keeping the filtration system clean and operating properly is very important.

8.2.4 Restraining equipment

For some procedures (e.g. intravenous injection, blood sampling) restraint devices or equipment are useful adjuncts to the handling, and help ensure that the procedure can be done safely for both the animal and the person. Correct use of such restraint devices will help avoid unnecessary stress or injury to the animal during the procedure and reduce hazardous drugs exposure to the person (e.g. *via* needle poke).

8.2.5 Special packaging

Some drugs can be purchased in vials that prevents exposure (by inhalation) to the powdered drug. These vials contain a pre-weighed sterile quantity of the drug and are fitted with a rubber cap that allows a solvent to be introduced in the vial *via* a syringe without the need to open the vial. Once dissolved, the drug does no longer pose an inhalation risk

8.3 Administrative

Administrative controls are modifications or changes to work practices or behaviours in order to reduce the severity or impact of a hazard. The term “worker” is used for staff, professors and students.

8.3.1 Instruction and training

A worker (including students) who works with or may be exposed to a hazardous drug must receive pre-job education and on-the-job instructions and training on the safe handling of the hazardous drugs.

As necessary, personnel will be trained to a level of “demonstrated competency”. While not necessarily an exhaustive list, education and training may include:

- known health risks, including any potential reproductive hazards,
- relevant techniques and procedures for safe handling,
- the correct selection, use, care, maintenance and disposal of personal protective equipment
- procedures to be followed in the event of a spill or uncontrolled release and waste disposal procedures
- procedures for reporting known exposures and suspected health effects.

The training must be re-assessed if there is a change in the hazardous drugs, handling practices, work activities, or information available on the hazardous drug. According to the regulation, training records must be maintained for 3 years from the date that the training occurred.

8.3.2 Labels and signs

Clearly visible signs must be posted in areas where hazardous dugs are stored. Any container, bin or shelf, in or on which a hazardous drug is stored must be correctly and clearly labeled. Some examples of signs and labels for hazardous drugs are included in Appendix C.

8.3.3 Keeping records

For any worker who prepares/administers a hazardous drug, the supervisor or facility manager must keep records for the duration of that worker's employment plus 10 years. The record must include:

- The name of each hazardous drug prepared by the worker
- If practicable, the number of preparations per week
- Each risk assessment prepared that is relevant to the worker's employment or that applies to the worker at any time during the period of the worker's employment
- For each worker who administers a hazardous drug the record must include the mode of administration (parenterally, orally or by topical application).

A sample log template is provided in Appendix E.

8.3.4 Written safe work procedures

Several written work procedures are accompanying this ECP. These are general procedures addressing:

- The receiving, storage, and transport of hazardous drugs
- Hazardous drugs spill clean-up procedure
- Hazardous drugs waste management

Site specific safe work procedures must be developed and implemented by individual units where hazardous drugs are being used. These procedures should address specific tasks done within the unit. Some examples of tasks are listed in Appendix C. The procedures must be readily available for workers to reference.

8.3.5 Protective reassignment

Protective reassignment applies to a worker, who works with or may be exposed to a hazardous drug that is a reproductive toxin when they inform their employer that they are pregnant or intend to conceive a child. Protective reassignment is an administrative control that involves assigning a worker to alternative tasks that reduce the risk of exposure to hazardous drugs. Some examples of protective reassignment include:

- Moving the worker to a different area that does not involve exposure to hazardous drugs
- Assigning the worker to tasks where they won't be exposed to hazardous drugs
- Reducing hours worked in areas where hazardous drugs are handled.

UBC's Occupational & Preventive Health (OPH) unit provides confidential and free programs and services to help protect the health and safety of staff, faculty, and paid students working both on and off-campus, including UBC-Okanagan and hospital sites. Upon enrolment in OPH, the Occupational Health Nurses provide basic pregnancy and reproductive health information to all employees. Employees who are pregnant or planning for pregnancy are encouraged to contact OPH to schedule a consultation with a nurse. Consultations may include a discussion of any

potential biological, chemical, or physical risk factors in the workplace. A referral to the OPH physician for further evaluation may also be recommended.

Please note: OPH operates under the Freedom of Information and Protection of Privacy Act and does not disclose your personal or medical information to anyone without your written consent. To request an appointment with a nurse, please email oph.info@ubc.ca.

8.3.6 Health monitoring

Health monitoring may be required if workers are exposed to hazardous drugs. OPH provides Occupational Health Nurse consultations to employees upon request to discuss personal health and occupational exposure risk to hazardous drugs substances, including post-exposure follow-up. Due to the challenges with health monitoring for hazardous drugs, OPH only provides health monitoring on a case by case basis. If an employee is experiencing ongoing symptoms that might be dues to exposure to hazardous drugs, they are encouraged to book an appointment with OPH.

8.3.7 Emergency procedures

Instructions on what to do in case of emergencies involving hazardous drugs must be included in the safe work procedures developed at worksites. Clearly labeled spill kits must be kept in or near any area in which a hazardous drug is manufactured, received, prepared, administered, stored or transported.

8.4 Personal Protective Equipment (PPE)

PPE is the least effective control option and should only be used in conjunction with other controls (e.g. engineering and administrative) as a means to further reduce an employee's exposure to hazardous drugs.

The specific PPE that is required for each task in the workplace is determined by a risk assessment. Workers should refer to the safe work procedures at their workplace for determining what types of PPE they are required to wear when handling hazardous drugs.

If the PPE is disposable, then once it's been used for hazardous drugs, it must be discarded. Contaminated (e.g. affected by a spill) disposable PPE must be disposed as hazardous drug waste. Non-disposable PPE must be cleaned with soap and water and decontaminated (if biohazards are also used) after each use. Used PPE must not be worn outside of areas where hazardous drugs are manufactured, prepared, administered, or stored.

8.4.1 Protective gloves

Wear gloves whenever there is a risk of accidental dermal exposure to hazardous drugs. For extended exposure to hazardous drugs, double gloving, the use of thicker gloves, and the frequent change of gloves increases their protective power. Protective gloves used for hazardous drugs should:

- Not be powdered, as the powder can become contaminated, fall off the gloves during removal, and lead to further contamination
- Be compatible with cleaning and decontaminating agents used in the workplace
- Be latex free (e.g., neoprene, nitrile, polyurethane)
- Be able to maintain their resistance to permeation by hazardous drugs when disinfected (e.g., with alcohol)

8.4.2 Protective gowns and lab coats

Workers should wear gowns designed for use with hazardous drugs when there is a risk of contact with hazardous drugs or contaminated bodily fluids and waste from treated animals during the precautionary period. Lab coats and

isolation gowns are also protective for working with hazardous drugs. Change the gown or lab coat immediately if contaminated.

8.4.3 Respirators

An approved and fit-tested respirator must be worn when there is a risk of exposure to airborne particulates, aerosols, or vapours from hazardous drugs. These can be generated from solid or liquid forms of hazardous drugs.

The suitability and choice of respirator (half- or full-face respirator) and cartridges (particulate, chemical, etc.) must be part of a risk assessment based on the potential exposure to airborne particulates, aerosols, or vapours from hazardous drugs for each task in the workplace. Contact SRS or HSE for the risk assessment.

Prior to any tight-fitting respirators being used for the first time, employees must successfully pass a respirator fit test to ensure the respirator forms a tight seal around the face and contaminants cannot enter the breathing zone. A respirator fit test will then be required, at minimum, annually thereafter. More information on respirator fit testing and the registration process can be found for UBC Vancouver campus at SRS Respiratory Protection and for UBC Okanagan at HSE Respiratory Protection.

8.4.4 Face and eye protection

Face protection, such as full or partial face shields and goggles, should be made available for use in any situation where there is a risk of splashing, which may occur when handling liquid forms of hazardous drugs or contaminated body fluids and waste. Eye protection must also be used when cleaning up spills.

8.4.5 Footwear and shoe cover

Workers must ensure their footwear is in a condition to provide protection against exposure to hazardous drugs, such as by wearing closed shoes that are made of a material that prevents liquids from soaking through.

Shoe covers are part of contamination control measures but also help reduce exposure by preventing contamination being spread to other areas of the workplace on workers' shoes.

9. Documentation and Record Keeping

Documentation associated with the Hazardous Drugs Program will need to be maintained and managers/supervisors should be aware of where this documentation can be found. This documentation includes, but is not limited to:

- Exposure control plan (ECP) for hazardous drugs
- UBC Hazardous drugs list
- Hazardous drugs safe work procedures
- Hazardous drugs education and training records (as per section Keeping records)
- First aid records pertaining to hazardous drugs exposures
- Incident/accident investigation reports or near misses pertaining to hazardous drugs exposures
- WorkSafeBC inspection reports, if applicable
- Respirator fit test records

10. Program Review

The hazardous drugs Exposure Control Plan will be reviewed annually and updated as needed by SRS, HSE and in consultation with UBC stakeholders, as applicable.

11. Appendix A: Past and Present Hazardous Drugs Used in UBC Animal Units

Table 1 drugs must be mixed/prepared/primed in a ducted BSC (Class II Type B2). Table 2 drugs must be mixed/prepared/primed in a ducted BSC (Class II Type B2) or a fume hood.

Drug	Health Hazard Information from the Safety Data Sheet	Applicable NIOSH Table
bleomycin	May cause genetic effects, suspected of causing cancer, suspected of damaging fertility or the unborn child.	Table 1
bortezomib	Acute toxicity, Toxic to Reproduction, Suspected of damaging fertility or the unborn child.	Table 1
busulfan	Acute toxicity, may cause cancer.	Table 1
cabergoline	Acute toxicity, may cause harm to breast-fed children.	Table 2
carbamazepine	Acute toxicity, skin sensitizer, reproductive toxicity	Table 2
carboplatin	Respiratory sensitizer, may cause genetic effects, May damage fertility or the unborn child. May cause harm to breast-fed children, acute toxicity	Table 1
chloramphenicol	Suspected of causing cancer, suspected of damaging fertility or the unborn child.	Table 1
cisplatin	Acute toxicity, may cause genetic effects, may cause cancer, may damage fertility or the unborn child.	Table 1
cladribine	Suspected of causing genetic effects, acute toxicity	Table 1
colchicine	Acute toxicity, may cause genetic effects	Table 2
cyclophosphamide	Acute toxicity, may cause genetic effects, may cause cancer, may damage fertility or the unborn child.	Table 1
cyclosporine	May cause cancer, may damage fertility or the unborn child.	Table 1
dasatinib	Suspected of causing cancer, suspected of causing cancer, suspected of damaging fertility or the unborn child.	Table 1
decitabine	Suspected of damaging fertility or the unborn child, suspected of causing genetic effects	Table 1
dexrazoxane	Secondary malignancies observed in patients treated long term with Razoxane (a racemic mixture containing dexrazoxane); Genotoxic *in vitro* and *in vivo*; in laboratory studies, Testicular atrophy observed at or below the human dose	Table 1
diethylstilbestrol	May cause cancer, may damage fertility or the unborn child.	Table 1
docetaxel	Suspected of causing genetic effects, may damage fertility or the unborn child, may cause harm to breast-fed children	Table 1
doxorubicin	May cause genetic effects, may cause cancer, may damage fertility or the unborn child.	Table 1
enzalutamide	May damage fertility or the unborn child.	Table 2
estradiol	May cause cancer, may damage fertility or the unborn child.	Table 2
etoposide	May cause cancer.	Table 1
finasteride	May damage fertility or the unborn child.	Table 2
flutamide	Suspected of causing cancer, suspected of damaging fertility or the unborn child.	Table 2
ganciclovir	May cause genetic effects, suspected of causing cancer, suspected of damaging fertility or the unborn child, may cause harm to breast-fed children.	Table 1

Drug	Health Hazard Information from the Safety Data Sheet	Applicable NIOSH Table
gemcitabine	May cause genetic effects, suspected of causing cancer, suspected of damaging fertility or the unborn child	Table 1
ifosfamide	May cause genetic defects, may cause cancer, may damage fertility and the unborn child	Table 1
imatinib	Suspected of causing cancer, suspected of damaging fertility or the unborn child.	Table 1
irinotecan	May damage fertility and the unborn child	Table 1
isotretinoin	May damage fertility and the unborn child	Table 2
methotrexate	Acute toxicity, may damage fertility and the unborn child	Table 1
mycophenolate mofetil	Suspected of causing genetic defects, may damage fertility or the unborn child.	Table 2
olaparib	Acute toxicity, may damage fertility or the unborn child.	Table 2
oxaliplatin	Skin and respiratory sensitizer, suspected of causing genetic defects, suspected of causing cancer, may damage fertility or the unborn child, may cause harm to breast-fed children.	Table 1
paclitaxel	Skin and respiratory sensitizer, may cause genetic defects, may damage fertility or the unborn child	Table 1
pazopanib	May damage fertility or the unborn child.	Table 2
progesterone	Suspected of causing cancer, may damage fertility or the unborn child, may cause harm to breast-fed children.	Table 2
ribavirin	Suspected of causing genetic defects, may damage the unborn child, suspected of damaging fertility.	Table 2
romidepsin	Acute toxicity, suspected of causing genetic defects.	Table 1
sorafenib	Suspected of causing cancer, may damage fertility or the unborn child, may cause harm to breast-fed children.	Table 2
sunitinib	May damage fertility or the unborn child	Table 2
tacrolimus	Acute toxicity, suspected of damaging fertility or the unborn child.	Table 2
tamoxifen	May cause cancer, may damage fertility or the unborn child.	Table 1
temozolomide	May cause genetic defects, may cause cancer, may damage fertility, may damage the unborn child.	Table 1
temsirolimus	May damage fertility and the unborn child.	Table 1
testosterone	Suspected of causing cancer, may damage fertility or the unborn child.	Table 2
tofacitinib	May damage fertility or the unborn child.	Table 2
trabectedin	Acute toxicity, suspected of causing genetic defects.	Table 1
tretinoin	May damage fertility or the unborn child.	Table 2
valproate/valproic acid	Suspected of damaging fertility or the unborn child.	Table 2
vandetanib	Suspected of damaging fertility or the unborn child.	Table 1
vincristine	Suspected of causing genetic defects, may damage the unborn child.	Table 1

12. Appendix B: NIOSH List of Hazardous Drugs (2020)

Table 1 *Drugs that contain manufacture's special handling information in the package insert and/or meet the NIOSH definition of a hazardous drug and are classified by the NTP as "known to be a human carcinogen," and/or classified by the IARC as "carcinogenic" or "probably carcinogenic." Drugs may have both generic and trade names. AHFS – American Hospital Formulary Service.*

Table 1 drugs must be mixed/prepared/primed in a ducted BSC (Class II Type B2).

Drug	AHFS classification	Supplemental information
trastuzumab emtansine	10:00 antineoplastic agents	Monoclonal antibody conjugated to mertansine (emtasine)
altretamine	10:00 antineoplastic agents	
amsacrine	NA antineoplastic agents	IARC Group 2B
arsenic trioxide	10:00 antineoplastic agents	IARC Group 1 carcinogen
azacitidine	10:00 antineoplastic agents	IARC Group 2A carcinogen
azathioprine	92:44 immunosuppressant	IARC Group 1 carcinogen; NTP "known to be human carcinogen"
belinostat	10:00 antineoplastic agents	May cause teratogenicity and/or embryo-fetal lethality because it is a genotoxic drug and targets actively dividing cells
bendamustine	10:00 antineoplastic agents	Cytotoxic; Developmental toxicity
bleomycin	10:00 antineoplastic agents	IARC Group 2B
bortezomib	10:00 antineoplastic agents	
brentuximab vedotin	10:00 antineoplastic agents	Monoclonal antibody conjugated to vedotin
busulfan	10:00 antineoplastic agents	IARC Group 1 carcinogen
cabazitaxel	10:00 antineoplastic agents	
capecitabine	10:00 antineoplastic agents	Metabolized to 5-fluorouracil
carboplatin	10:00 antineoplastic agents	
carmustine	10:00 antineoplastic agents	IARC Group 2A carcinogen
chlorambucil	10:00 antineoplastic agents	IARC Group 1 carcinogen; NTP "known to be human carcinogen"
chloramphenicol	8:12:08 chloramphenicols	IARC Group 2A carcinogen; NTP "known to be human carcinogen"
cidofovir	8:18:32 nucleoside and nucleotides	
cisplatin	10:00 antineoplastic agents	IARC Group 2A carcinogen
cladribine	10:00 antineoplastic agents	
clofarabine	10:00 antineoplastic agents	
cyclophosphamide	10:00 antineoplastic agents	IARC Group 1 carcinogen; NTP "known to be human carcinogen"
cyclosporine	92:44 immunosuppressive agents	IARC Group 1 carcinogen; NTP "known to be human carcinogen"
cytarabine	10:00 antineoplastic agents	
dacarbazine	10:00 antineoplastic agents	IARC Group 2B
dactinomycin	10:00 antineoplastic agents	
dasatinib	10:00 antineoplastic agents	
daunorubicin	10:00 antineoplastic agents	IARC Group 2B; AKA daunomycin

Drug	AHFS classification	Supplemental information
decitabine	10:00 antineoplastic agents	
dexrazoxane	92:56 protective agents	Secondary malignancies observed in patients treated long term with Razoxane (a racemic mixture containing dexrazoxane); Genotoxic *in vitro* and *in vivo*; in laboratory studies, Testicular atrophy observed at or below the human dose
diethylstilbestrol	NA	IARC Group 1 carcinogen; NTP "known to be human carcinogen"
docetaxel	10:00 antineoplastic agents	
doxorubicin	10:00 antineoplastic agents	IARC Group 2A carcinogen
enfortumab vedotin	10:00 antineoplastic agents	Monoclonal antibody conjugated to vedotin; Cytotoxic; Developmental toxicity
epirubicin	10:00 antineoplastic agents	
estramustine	10:00 antineoplastic agents	
estrogen/ progesterone combinations	68:12 contraceptives	IARC Group 1 carcinogen; NTP "known to be human carcinogen"
estrogens, conjugated	68:12 contraceptives	NTP "known to be human carcinogen"; Black Box warning for endometrial cancer and cardiovascular risks; Long-term use in women and laboratory studies increases frequency of several cancers
estrogens, esterified	68:12 contraceptives	NTP "known to be human carcinogen"; Black Box warning for endometrial cancer and cardiovascular risks
etoposide	10:00 antineoplastic agents	IARC Group 1 carcinogen
everolimus	10:00 antineoplastic agents	
floxuridine	10:00 antineoplastic agents	
fludarabine	10:00 antineoplastic agents	
fluorouracil	10:00 antineoplastic agents	
ganciclovir	8:18:32 nucleosides nucleotides	
gemcitabine	10:00 antineoplastic agents	
gemtuzumab ozogamicin	10:00 antineoplastic agents	Monoclonal antibody conjugated to ozogamicin; Cytotoxic; Developmental toxicity
hydroxyurea	10:00 antineoplastic agents	Special warning on handling bottles and capsules
idarubicin	10:00 antineoplastic agents	
ifosfamide	10:00 antineoplastic agents	
imatinib	10:00 antineoplastic agents	
inotuzumab ozogamicin	10:00 antineoplastic agents	Monoclonal antibody conjugated to ozogamicin; Cytotoxic; Developmental toxicity
irinotecan	10:00 antineoplastic agents	
ixazomib	10:00 antineoplastic agents	Male and female patients of childbearing potential must use effective contraceptive measures during and for 3 months following treatment
ixabepilone	10:00 antineoplastic agents	

Drug	AHFS classification	Supplemental information
lenalidomide	92:20 biologic response modulators	Analog of thalidomide; FDA Black box warnings for limb abnormalities; in laboratory studies, caused thalidomide-type limb defects in monkey offspring
lomustine	10:00 antineoplastic agents	IARC Group 2A carcinogen
mechlorethamine	10:00 antineoplastic agents	
melphalan	10:00 antineoplastic agents	IARC Group 1 carcinogen; NTP “known to be human carcinogen”
mercaptopurine	10:00 antineoplastic agents	
methotrexate	10:00 antineoplastic agents	
mitomycin	10:00 antineoplastic agents	IARC Group 2B
mitotane	10:00 antineoplastic agents	
mitoxantrone	10:00 antineoplastic agents	IARC Group 2B
nelarabine	10:00 antineoplastic agents	
omacetaxin	10:00 antineoplastic agents	
oxaliplatin	10:00 antineoplastic agents	
paclitaxel	10:00 antineoplastic agents	
panobinostat	10:00 antineoplastic agents	Special warnings on contraception for females while taking and one month post- treatment
pemetrexed	10:00 antineoplastic agents	
pentostatin	10:00 antineoplastic agents	
polatuzumab vedotin	10:00 antineoplastic agents	Monoclonal antibody conjugated to vedotin; Cytotoxic; Developmental toxicity
pomalidomide	10:00 antineoplastic agents	Analog of thalidomide; Females of reproductive potential must use 2 forms of contraception or continuously abstain from heterosexual sex during and for 4 weeks after stopping treatment
pralatrexate	10:00 antineoplastic agents	
procarbazine	10:00 antineoplastic agents	IARC Group 2A carcinogen
romidepsin	10:00 antineoplastic agents	
streptozocin	10:00 antineoplastic agents	IARC Group 2B
tamoxifen	10:00 antineoplastic agents; 68.16.12 estrogen agonist-antagonist	IARC Group 1 carcinogen; NTP “known to be human carcinogen”
temozolomide	10:00 antineoplastic agents	
temsirolimus	10:00 antineoplastic agents	
teniposide	10:00 antineoplastic agents	IARC Group 2A carcinogen
thalidomide	92:20 biologic response modulators	
thioguanine	10:00 antineoplastic agents	
thiotepa	10:00 antineoplastic agents	IARC Group 1 carcinogen; NTP “known to be human carcinogen”
topotecan	10:00 antineoplastic agents	
trabectedin	10:00 antineoplastic agents	Cytotoxic; Genotoxic

Drug	AHFS classification	Supplemental information
trastuzumab deruxtecan	10:00 antineoplastic agents	Monoclonal antibody conjugated to deruxtecan; Cytotoxic
trifluridine	10:00 antineoplastic agents	Embryo-fetal lethality and embryo-fetal toxicity at doses lower than or similar to exposures at the recommended human dose
uracil mustard	NA	IARC Group 2B
valganciclovir	8:18:32 nucleosides and nucleotides	
valrubicin	10:00 antineoplastic agents	
vandetanib	10:00 antineoplastic agents	
vinblastine	10:00 antineoplastic agents	
vincristine	10:00 antineoplastic agents	
vinorelbine	10:00 antineoplastic agents	
vorinostat	10:00 antineoplastic agents	Adverse embryo-fetal effects at less than the recommended human dose

Table 2 *Drugs that meet the NIOSH definition of a hazardous drug but are not drugs that have manufacture's special handling information or are classified by the NTP as "known to be a human carcinogen," or classified by the IARC as "carcinogenic" or "probably carcinogenic". (some also may have adverse development and/or reproductive effects). Drugs may have both generic and trade names. AHFS – American Hospital Formulary Service*

Table 2 drugs must be mixed/prepared/primed in a ducted BSC (Class II Type B2) or a fume hood.

Drug	AHFS classification	Supplemental information
abacavir	8:18.08.20 nucleoside and reverse transcriptase inhibitors	Malignant tumors observed in male and female mice and rats; Genotoxic in vivo micronucleus test.
abiraterone	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Women who are pregnant or women who may be pregnant should not handle without protection (e.g., gloves)
acitretin	88:04 vitamin A	Only met the NIOSH criteria as a developmental and/or reproductive hazard
afatinib	10:00 antineoplastic agents	Special warnings on contraception for females while taking and two weeks post- treatment
aflibercept	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Embryotoxic and teratogenic in rabbits at exposure levels lower than human exposures at the recommended dose, with increased incidences of external, visceral, and skeletal fetal malformations
alefacept	84:92 skin and mucous membrane agents, miscellaneous	Increased frequency of malignancies observed in treated patients
alitretinoin	84:92 skin and mucous membrane agents, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard
ambrisentan	24:12:92 vasodilating agents, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard

Drug	AHFS classification	Supplemental information
anastrozole	68.16.04 antiestrogens; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
apomorphine	28:36.20.08 Nonergot-derivative dopamine receptor agonists	Genotoxic in several in vitro assays
axitinib	10:00 antineoplastic agents	Teratogenic, embryotoxic and fetotoxic in mice at exposures lower than human exposures
bexarotene	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
bicalutamide	10:00 antineoplastic agents	
blinatumomab	10:00 antineoplastic agents	Organ Toxicity at Low Dose - Neurotoxicity
bosentan	24:12:92 vasodilating agents, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard
bosutinib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
cabergoline	28:36:20:04 ergot-derivative dopamine receptor agonists	Only met the NIOSH criteria as a developmental and/or reproductive hazard
cabozantinib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Embryo lethal in rats at exposures below the recommended human dose
carbamazepine	28:12:92 anticonvulsants, miscellaneous	Black Box warning for aplastic anemia; Congenital malformations in offspring of mothers who took drug; Rapid transplacental passage
carfilzomib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Special warnings on contraception while taking and two weeks post-treatment
ceritinib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity
cetrorelix	92:40 gonadotropin-releasing hormone antagonists	Only met the NIOSH criteria as a developmental and/or reproductive hazard
choriogonadotropin	68:18 gonadotropins	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity
clobazam	28:12.08 benzodiazapines	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity; Reproductive toxicity-male; Reproductive toxicity-female
clomiphene	68:16:12 estrogen agonist-antagonists	Only met the NIOSH criteria as a developmental and/or reproductive hazard
clonazepam	28:12:08 benzodiapines	Only met the NIOSH criteria as a developmental and/or reproductive hazard
cobimetinib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity; Reproductive toxicity-male; Reproductive toxicity-female
colchicine	92:16 antigout agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
crizotinib	10:00 antineoplastic agents	

Drug	AHFS classification	Supplemental information
dabrafenib	10:00 antineoplastic agents	Special warnings on contraception for females while taking and two weeks post-treatment
deferiprone	64:00 Heavy metal antagonists	Genotoxic *in vitro* and *in vivo*
degarelix	68:18.04 antigonadropins; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
dihydroergotamine	12:16.00 sympatholytic (andrenergic blocking) agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity
dinoprostone	76:00 oxytocics	Only met the NIOSH criteria as a developmental and/or reproductive hazard
divalproex	28:12:92 anticonvulsants, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Black box warning on embryo-fetal death or severe birth defects; Recommend effective contraception for females during therapy and for seven months after treatment; Present in semen; No sperm donation during and three months post-treatment
dronedarone	24:04:04 antiarrythmics	Only met the NIOSH criteria as a developmental and/or reproductive hazard
dutasteride	92:08 5-alpha reductase inhibitors	Only met the NIOSH criteria as a developmental and/or reproductive hazard
entecavir	8:18:32 nucleosides and nucleotides	
enzalutamide	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Embryo-fetal toxicity in mice at exposures that were lower than in patients receiving the recommended dose
ergonovine/methylergonovine	76:00 oxytocics	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity – third trimester
eribulin	10:00 antineoplastic agents	
erlotinib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
eslicarbazepine	28:12:92 anticonvulsants, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard
estradiol	68:16:04 estrogens	Black Box warning for malignant neoplasms; Increased risk of endometrial cancer, breast cancer, and ovarian cancer; in laboratory studies, increased frequency of carcinomas of the breast, uterus, cervix, vagina, testis, and liver; Present in breast milk
estropipate	68:16:04 estrogens	Black Box warning for endometrial carcinoma in postmenopausal women and use during pregnancy
exemestane	68.16.04 Antiestrogens; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
exenatide	68:20.06 incretin mimetics	Carcinogenicity; Developmental toxicity
finasteride	92:08 5-alpha reductase	Only met the NIOSH criteria as a developmental and/or reproductive hazard
fingolimod	92:20 biologic response modifiers	In laboratory studies, increased malformations and embryo-fetal deaths at less than the RHD; Malignant lymphomas observed in male and female mice

Drug	AHFS classification	Supplemental information
fluconazole	8:18.08 azoles	Only met the NIOSH criteria as a developmental and/or reproductive hazard
fluoxymesterone	68:08 androgens	Tumors in mice and rats and possibly humans
flutamide	10:00 antineoplastic agents	Indicated only for men
fosphenytoin	28:12.12 hydantoins	Metabolized to phenytoin
fulvestrant	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
ganirelix	92:40 gonadotropin- releasing hormone antagonists	Only met the NIOSH criteria as a developmental and/or reproductive hazard
gonadotropin, chorionic	68:18 gonadotropins	Only met the NIOSH criteria as a developmental and/or reproductive hazard
goserelin	68:16.08 gonadotropins; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
histrelin	68:16.08 gonadotropins; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Can cause fetal harm when administered to a pregnant patient with the possibility of spontaneous abortion
icatibant	92:32 complement inhibitors	Only met the NIOSH criteria as a developmental and/or reproductive hazard
isotretinoin	84:92.00 misc. skin and mucous membrane agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity
ivabradine	24:04.90 misc. cardiac agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity
leflunomide	92:36 disease-modifying antirheumatic agents	Teratogenic in laboratory studies at 1/10 HD; Marked postnatal survival at 1/100 HD; Severe liver injury reported in patients; Carcinogenicity observed at doses below HD
lenvatinib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity
letrozole	68.16.04 Antiestrogens; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
leuprolide	68:16.08 gonadotropins; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
liraglutide recombinant	68:20.06 incretin mimetics	Black Box warning for thyroid C-cell tumors, with supporting evidence in laboratory studies; In laboratory studies, teratogenic at or below the MRHD
lomitapide	24:06:92 antilipemic agents, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard
macitentan	48:48 vasodilating agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
medroxy progesterone acetate	68:32 progestins	Only met the NIOSH criteria as a developmental and/or reproductive hazard; IARC Group 2B
megestrol	10:00 antineoplastic agents	Nursing should be discontinued if megestrol is required; Women at risk of pregnancy should avoid exposure

Drug	AHFS classification	Supplemental information
menotropins	68:18 gonadotropins	Only met the NIOSH criteria as a developmental and/or reproductive hazard
methimazole	68:36:08 antithyroid agents	Appears in human breast milk
methyltestosterone	68:08 androgens	Only met the NIOSH criteria as a developmental and/or reproductive hazard
mifepristone	76:00 oxytocics	Only met the NIOSH criteria as a developmental and/or reproductive hazard
miltefosine	8:30.92 misc. antiprotozoals	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity; Reproductive toxicity – male; Reproductive toxicity – female
mipomersen	24:06:92 antilipemic agents, miscellaneous	Black box warning of hepatotoxicity
misoprostol	56:28.28 prostaglandins	Only met the NIOSH criteria as a developmental and/or reproductive hazard
mycophenolate mofetil	92:44 immunosuppressive agents	Black Box warning for embryo fetal toxicity, malignancies and serious infections; Increased risk of first- trimester pregnancy loss and increased risk of congenital malformations; Special warning: tablets should not be crushed and capsules should not be opened or crushed. Avoid inhalation or direct contact with skin or mucous membranes of the powder contained in capsules and oral suspension (before or after constitution). If such contact occurs, wash thoroughly with soap and water; rinse eyes with plain water.
mycophenolic acid	92:44 immunosuppressive agents	Black Box warning for embryo fetal toxicity, malignancies and serious infections; Increased risk of first- trimester pregnancy loss and increased risk of congenital malformations; Black Box warning for lymphomas and other malignancies; genotoxic *in vitro* and *in vivo*
nafarelin	68:18 gonadotropins	Only met the NIOSH criteria as a developmental and/or reproductive hazard
nevirapine	8:18.08.16 nonnucleoside reverse transcriptase inhibitors	In laboratory studies, hepatocellular adenomas and carcinomas at doses lower than human dose
nilotinib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
olaparib	10:00 antineoplastic agents	Genotoxicity; Developmental toxicity
ospemifene	68:16:12 estrogen agonist-antagonists	Black box warning on increased risk of endometrial cancer in certain populations; Risk of adverse outcomes during pregnancy and labor
oxcarbazepine	28:12:92 anticonvulsants, miscellaneous	Tumors observed in laboratory studies at 1/10 MRHD
oxytocin	76:00 oxytocics	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity – third trimester
palifermin	84:16 cell stimulants and proliferants	Potential for stimulation of tumor growth
pamidronate	92:24 bone resorption inhibitors	Only met the NIOSH criteria as a developmental and/or reproductive hazard
paroxetine	28:16:04:20 selective serotonin uptake inhibitors	Only met the NIOSH criteria as a developmental and/or reproductive hazard

Drug	AHFS classification	Supplemental information
pasireotide	68:29:04 somatostatin agonists	Only met the NIOSH criteria as a developmental and/or reproductive hazard
pazopanib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
peginesatide	20:16 hematopoetic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
pentetate calcium trisodium	NA	Only met the NIOSH criteria as a developmental and/or reproductive hazard
phenoxybenzamine	12:16:04:04 non-selective alpha-andrenergic blocking agents	IARC Group 2B
phenytoin	28:12.12 hydantoins	IARC Group 2B
pipobroman	NA	
plerixafor	20:16 hematopoietic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
ponatinib	10:00 antineoplastic agents	
progesterone	68:32 progestins	IARC Group 2B
progestins	68:12 contraceptives	
propylthiouracil	68:36.08 antithyroid agents	IARC Group2B
raloxifene	68:16:12 estrogen agonists-antagonists	Abortion and developmental abnormalities seen at low doses in laboratory studies; Evidence of tumors at low doses in laboratory studies
rasagiline	28:36 antiparkinsonian agents	
regorafenib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Black box warning on severe and sometimes fatal hepatotoxicity; Total loss of pregnancy at doses lower that recommended human dose
ribavirin	8:18:32 nucleosides and Teratogenic and embryotoxic nucleotides	Only met the NIOSH criteria as a developmental and/or reproductive hazard
riociguat	48:48 vasodilating agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
sirolimus	92:44 immunosuppressive agents	AKA rapamycin; Increased risk of lymphomas and other malignancies; Embryotoxic and fetotoxic at 0.2 HD
sonidegib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity; Reproductive toxicity – female
sorafenib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
spironolactone	24:32.20 mineralocorticoid receptor antagonists	Black box warning for tumorigenicity in laboratory studies
sunitinib	10:00 antineoplastic agents	
tacrolimus	92:44 immunosuppressive agents	Increased risk of lymphomas and other malignancies; Reproductive effects seen in laboratory studies below the MRHD; Excreted in breast milk

Drug	AHFS classification	Supplemental information
temazepam	28:24:08 benzodiazepines	Only met the NIOSH criteria as a developmental and/or reproductive hazard
teriflunomide	92:20 immunomodulatory agents	Black box warning on severe hepatotoxicity and teratogenicity including major birth defects
testosterone	68:08 androgens	Only met the NIOSH criteria as a developmental and/or reproductive hazard
tofacitinib	92:36 disease modifying antirheumatic drugs	Black box warning for lymphoma and other malignancies
topiramate	28:12.92 anticonvulsants, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard
toremifene	68.16.12 estrogen agonist-antagonist; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
trametinib	10:00 antineoplastic agents	Embryotoxic and abortifacient at doses less than recommended human dose
tretinoin	84:16 cell stimulants and proliferants	Only met the NIOSH criteria as a developmental and/or reproductive hazard
triptorelin	68:18.08 gonadotropins; 10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
ulipristal	68:12 contraceptives	Only met the NIOSH criteria as a developmental and/or reproductive hazard
urofollitropin	68:18.00 gonadotropins	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Developmental toxicity
valproate/valproic acid	28:12:92 anticonvulsants, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard
vemurafenib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard
vigabatrin	28:12:92 anticonvulsants, miscellaneous	Only met the NIOSH criteria as a developmental and/or reproductive hazard
vismodegib	10:00 antineoplastic agents	Only met the NIOSH criteria as a developmental and/or reproductive hazard; Black box warning on embryo-fetal death or severe birth defects; Recommend effective contraception for females during therapy and for seven months after treatment; present in semen; No sperm donation during and three months post-treatment
voriconazole	8:14.08 azoles	Only met the NIOSH criteria as a developmental and/or reproductive hazard
warfarin	20:12.04.08 coumarin derivatives	Only met the NIOSH criteria as a developmental and/or reproductive hazard
zidovudine	8:18:08 antiretroviral agents	IARC Group 2B
ziprasidone	28:16:08:04 atypical	Only met the NIOSH criteria as a developmental and/or reproductive hazard
zoledronic acid	92:24 bone resorption inhibitors	Only met the NIOSH criteria as a developmental and/or reproductive hazard
zonisamide	28:12:92 anticonvulsants,	Only met the NIOSH criteria as a developmental and/or reproductive hazard

13. Appendix C: Labels and Signs for Hazardous Drugs

The signs and label above are examples of possible label that can be used on containers of hazardous drug medication or to label area where these drugs are used. The examples are taken from the "Safe Work Practices for Handling Hazardous Drugs" document published by Work Safe BC.

14. Appendix D: Job Tasks and Appropriate Controls

Work Activity	Control Methods	Personal Protective Equipment (PPE)	Comments
Receiving and storage of hazardous drugs	• Restricted access area • Negative pressure with respect to surrounding rooms • Storage shelves with fall guards • Follow the Receiving, Storage and Transport of Hazardous Drugs SWP	• Recommended gloves for use with hazardous drugs • Gowns / lab coats • An approved and fit-tested respirator (if handling damaged packages containing hazardous drugs)	Surface contamination of containers and packaging is a potential source of exposure for workers as they unpack and store incoming shipments of hazardous drugs. The document Receiving, Storage and Transport of Hazardous Drugs can be consulted for more details on the topic for Point Grey campus.
Transport of hazardous drugs	• Transport hazardous drugs in leak proof containers with outer surfaces cleaned • Use appropriate secondary containment (e.g. closed bag, closed secondary container) • Follow the Receiving, Storage and Transport of Hazardous Drugs SWP	• Recommended gloves for use with hazardous drugs; no gloves should be worn in public hallways • Gowns / lab coats	Workers who transport hazardous drugs throughout a facility may be exposed if they come in contact with contaminated surfaces or a hazardous drugs leak or spill.
Hazardous drugs preparation	• Drug preparation (table 1 drugs) is done inside a BSC Type II B2. Where a BSC Type II B2 is not available consult SRS or HSE to determine the appropriate controls. • Drug preparation (table 2 drugs) is done inside a fume hood • Safety engineered needles are used to reduce the risk of percutaneous exposure • Furniture and equipment are made of materials that are easily cleaned and decontaminated (i.e. stainless steel) • Follow recommended procedures for handling waste and/or cleaning spills	• Recommended gloves for use with hazardous drugs • Gowns / lab coats • Shoe covers (optional) • Eye and, if needed, face protection • An approved and fit-tested respirator (when determined by a risk assessment to be necessary)	Workers who prepare (compound, dilute, mix, etc.) hazardous drugs can be exposed

Work Activity	Control Methods	Personal Protective Equipment (PPE)	Comments
Hazardous drugs administration	• Treatment of animals should be done in an area kept under neutral or negative air pressure; based on a risk assessment engineering controls could be required (e.g. fume hood, BSC) • Safety engineered needles are recommended to reduce the risk of percutaneous exposure • Use disposable, absorbent pads to capture any possible spills • Use bandages over areas where a topical medication has been applied • Follow recommended procedures for handling waste and/or cleaning spills	• Recommended gloves for use with hazardous drugs • Gowns / lab coats • Eye and, if needed, face protection	Administration of hazardous drugs can take many forms (i.e. IV, inhalation, injections, oral, or topical) and workers can be exposed by using equipment that may leak or spill, by directly handling medication, by exposure to body fluids, etc.
Housing of animals treated with hazardous drugs	• Whenever available animals should be housed in microisolator type cages during the treatment with hazardous drugs and the precautionary period (the period for which the animal excretes the drug or metabolites of the drug)	• Respirators are needed to enter rooms where animals are housed in open air cages (contact SRS or HSE for an assessment)	A risk assessment will help establish appropriate controls based on the unit specific details.
Non-invasive monitoring of animals treated with hazardous drugs (during the precautionary period) **Cage/bed changing**	• Removal of animal from the cage should be done, when possible, in an enclosure.	• Recommended gloves for use with hazardous drugs • Gown or lab coat • Respirators could be needed when enclosures are not available (contact SRS or HSE for an assessment)	Non-invasive monitoring tasks include observing the animal without direct contact as well as procedures requiring physically handling the animal (i.e. weighing, injection site evaluation, cage changing and imaging).
Invasive monitoring of animals treated with hazardous drugs (during the precautionary period)	• Procedures should be done in an enclosure • Use disposable, absorbent pads to capture any possible spills • Use safety engineered needles and disposable syringes when necessary • Follow recommended procedures for handling waste and/or cleaning spills	• Recommended gloves for use with hazardous drugs • Disposable gown • Eye protection • Respirators could be needed when enclosures are not available (contact SRS or HSE for an assessment)	Invasive monitoring tasks involve direct contact with bodily fluids (i.e. surgery, IV treatment)

Work Activity	Control Methods	Personal Protective Equipment (PPE)	Comments
Bed changing and cage cleaning	• Identify animals who have received hazardous drugs (name of drug and day/time of administration on cage) • The use of pressure washers for cleaning purposes is prohibited • The use of other spraying devices that could aerosolize contaminants has to be approved (contact SRS or HSE for a risk assessment) • Cleaning of contaminated cages (during the precautionary time) should be done inside an enclosure or a cage dump station. • Contaminated waste should be disposed of according to UBC's waste management procedures on Vancouver Campus or Okanagan Campus.	• Heavy duty cleaning gloves (re-usable) on top of disposable gloves • Gown / lab coat • Eye protection • Respirators could be needed when task happens during the precautionary period and cannot be completed in an enclosure (contact SRS or HSE for an assessment).	Cleaning cages or changing bedding of animals receiving hazardous drugs exposes the worker to contaminated residues resulted from the animals excreting the drug or metabolites.
Waste disposal	• Adequate, leak-proof waste disposal containers, including sharps and solids containers are available and labelled as "hazardous drugs waste" • Procedures for disposal of contaminated waste are in place • Contaminated bedding is disposed of according to the procedure • Animal carcasses are disposed of as biohazardous waste	• Recommended gloves for use with hazardous drugs • Gown / lab coat	Workers can be exposed to hazardous drugs *via* contact with contaminated waste and/or waste containers. The document Hazardous Drugs – Waste Management can be consulted for more details on handling the waste on Point Grey campus.
Spill response	• Supply of spill kits are available in area where hazardous drugs are handled • Regular training on emergency spill procedures is provided	• Heavy duty cleaning gloves on top of disposable gloves • Disposable gown / lab coat • Eye and face protection • An approved and fit-tested respirator	While responding to a spill, workers can be exposed to a leak, spill, or can inhale aerosols, vapours or particulates released. The document Hazardous Drugs Spill Clean-up can be consulted for more details on responding to spills on Point Grey campus.

15. Appendix E: Record of Exposure to Hazardous Drugs

All workers (staff, professors, students) who prepare or administer hazardous drugs are required to document their daily exposure as per WorkSafe BC regulation and UBC Hazardous Drugs Exposure Control Plan (HD_ECP).

The UBC Hazardous Exposure Control Plan applies to all UBC workers who are preparing and/or administering hazardous drugs. In addition to the HD_ECP risk assessments are written for other specific situations in which hazardous drugs are used (e.g. animal protocol, alternate housing) – specify these risk assessments in the space provided in the table.

Worker's name_____ Time interval (first – last date**, column 3)_____

	1	2	3	4	5	6
No.	Hazardous drug name	Task (P or A) *	Date or date interval **	No. of "P" or "A" *per* day or time interval	Mode of administration (if applicable) ***	Applicable risk assessment (title and date)

* use "P" for preparations and "A" for administration

** for date use format day/month/year, for interval use a max of 7 days

*** Specify: injection, orally, topically or other

16. Appendix F: Roles and Responsibilities

Employer Responsibilities

- Ensure employees are protected from exposure to hazardous drugs in the workplace by considering the hierarchy of controls (e.g. in order of elimination, substitution, engineering, administrative, and personal protective equipment (PPE))
- Provide adequate washing facilities to ensure good hygiene principles are being practiced
- Ensure resources are made available for hazardous drugs monitoring, when required
- Ensure employees are provided with the necessary materials, tools, and equipment to minimize hazardous drugs exposure
- Ensure employees who are exposed to hazardous drugs participate in health monitoring, when required

Safety & Risk Services and Health, Safety & Environment Responsibilities (on behalf of the employer)

- Ensure a Hazardous Drugs ECP has been developed, implemented, and maintained to ensure hazardous drugs exposure levels are as low as reasonably achievable (ALARA) as per the BC OHSR
- Assist in the implementation of this hazardous drugs ECP through training and consultation
- Provide education on hazardous drugs exposure including how to recognize early health signs and symptoms
- Assist with hazardous drugs risk identifications and assessments, as requested
- Advise when air monitoring for hazardous drugs is required
- Perform risk assessments to determine respirator requirements
- Conduct respirator fit testing sessions for tight-fitting respirators
- Investigate hazardous drugs-related concerns and recommend the appropriate corrective actions
- Collaborate with Occupational & Preventive Health (OPH) when there is potential for workers to be exposed to hazardous levels of hazardous drugs that would warrant health monitoring
- Act as a resource to UBC Faculties and Departments on hazardous drugs-related inquiries

Facility Manager/Supervisor Responsibilities

A facility manager or supervisor can also have responsibilities as an employee (see section below)

- Attend education and training sessions provided by the employer
- Identify occupations, areas, or tasks where the potential for exposure to hazardous drugs exists
- Ensure employees (staff, students) are educated and trained on working with hazardous drugs and demonstrate an adequate level of competency
- Ensure employees can identify health signs and symptoms associated with hazardous drugs exposure
- Ensure the hierarchy of controls are considered and implemented accordingly
- Ensure qualified personnel, as defined in section 1.1 of the OHSR, develop and provide site-specific safe work procedures for tasks where hazardous drugs are handled. Ensure employees are familiar with and follow the procedures
- Provide employees with adequate supervision to ensure sustained implementation of work practices as needed to eliminate or minimize exposure to hazardous drugs
- Ensure hazardous drugs exposure incidents are investigated appropriately and the results are posted at the workplace

- Ensure employees follow safe work procedures for handling, storing, and maintaining equipment, tools, and materials
- Maintain a hazardous drugs list for the workplace (e.g. animal unit, lab)
- Where applicable, ensure ongoing participation of employees in the UBC Respirator Protection Program which includes the requirement of annual fit testing
- Ensure employees who are exposed to hazardous drugs participate in health monitoring, where needed

Employee Responsibilities

An employee can also have responsibilities as a supervisor (see section above)

- Follow the Hazardous drugs ECP, risk assessments and safe work procedures
- Attend education and training sessions provided by the employer and/or facility manager/supervisor
- Understand the hazards of working with hazardous drugs and the health signs and symptoms related to exposure
- Adhere to the hierarchy of controls for hazardous drugs
- Ensure all equipment, tools, and materials needed to control against hazardous drugs exposure are in good working condition and used appropriately
- Where applicable, ensure respirators are being used, cared for, and maintained properly and annual fit testing is taking place
- Report unsafe hazardous drug exposure conditions to the supervisor
- Report incidents/accidents to UBC's Centralized Accident/Incident Reporting System (CAIRS)
- Participate in incident/accident investigations, where required

Joint Occupational Health & Safety Committee Responsibilities

- Consult with the employer and employees on topics related to hazardous drugs
- Provide recommendations on the improvement of the health and safety of employees that are participating in the UBC hazardous drugs ECP
- Participate in incident investigations relating to hazardous drugs exposures