



BC Cancer Agency
CARE & RESEARCH

Module 1

Safe Handling

of

Hazardous Drugs

**Including Recommended
Procedures and Techniques**

Section A

Potential Hazards of Handling Cytotoxic/Hazardous Drugs

Cytotoxic/hazardous drugs used to treat cancer may cause temporary or permanent changes in a patient's health.¹ Temporary adverse effects that patients may experience during or after treatment are well documented - immunosuppression, nausea/vomiting, hair loss, etc. and may be reversible. Cancer treatment regimens that may cause permanent health problems include cardiotoxicity after cumulative doses of doxorubicin and peripheral nerve damage after high doses of vincristine. In therapeutic doses, some cytotoxic drugs can lead to reproductive problems such as decreased fertility, fetal malformations, and spontaneous abortions.^{2,3}

It is not known whether healthcare workers who handle cytotoxic drugs regularly will experience side effects.¹ Reports suggest that acute adverse effects similar to those seen in treated cancer patients may occur in healthcare workers, especially if protective clothing and equipment are not used.⁴⁻⁷ Various studies have demonstrated possible links between occupational exposure to cytotoxic drugs and menstrual dysfunction⁸, infertility⁹, miscarriages and stillbirths³, low birth weights and congenital abnormalities.¹⁰ It should be taken into consideration that these studies were carried out in either the 1980's or based on staff exposure in the 1980's when use of personal protective equipment and safe handling techniques were not well established. These studies do not reflect current work practices but they do provide the evidence to support continued advancements in and adherence to safe handling practices.

All pharmacy staff must receive training for handling hazardous drugs safely, cleaning up spills, and using all equipment and PPE properly.^{6,11-15} There must be established work practices related to both drug manipulation techniques and to general hygiene practices.⁶ Workplace procedures must be developed for using and maintaining all equipment that functions to reduce hazardous drug exposure.^{4,13,14}

Hazardous Drug List

Each facility must develop a hazardous drug list to ensure that healthcare staff working in the facility is made aware of which drugs are hazardous.^{4,5,6,13,14}

NIOSH has published hazardous drug criteria to help facilities evaluate the drugs on their formulary.⁴ The BCCA proposed evaluation criteria for HDs based on NIOSH is:

Hazardous Drugs include those drugs that exhibit one or more of the following characteristics in animals or humans:

1. Carcinogenicity
2. Teratogenicity or other developmental toxicity
3. Reproductive Toxicity
4. Organ Toxicity at low doses
5. Genotoxicity
6. Structure toxicity profiles of new drugs that mimic existing drugs determined hazardous by the above criteria⁴
7. No information available and drug is primarily used as an antineoplastic agent

The facility's hazardous drug list must be posted in all areas where these drugs are received, stored¹⁴, prepared, and administered.¹⁴

Medical Surveillance, Personal Exposure Records, and Work Re-Assignment

Protection from hazardous drug exposure depends on adherence to safety programs established by employers and followed by workers. A comprehensive approach to minimizing worker exposure should be part of a safety and health initiative that includes safe work practices, proper engineering controls, and personal protective equipment (PPE) supported by a medical surveillance program.^{5,16}

Medical surveillance involves collecting and interpreting data to detect changes in the health status of working populations potentially exposed to hazardous substances. Elements of a medical surveillance program are used to establish a baseline of workers' health and then monitor their future health as it relates to their potential exposure to hazardous agents.^{6,17} Employers should encourage healthcare workers who must handle hazardous drugs while performing their work responsibilities to be monitored routinely by their family physician as part of a medical surveillance program.^{5,11,16,18}

Elements of a medical surveillance program as suggested by NIOSH include:

- Reproductive/general health questionnaires completed at the time of hire (baseline) and periodically thereafter
- Lab work including CBC and urinalysis at the time of hire and periodically thereafter
- Physical examination completed at the time of hire and then as needed for any worker whose health questionnaire indicates an abnormal finding
- Follow-up for workers with health changes or a significant exposure or risk of exposure (i.e. substantial skin contact, eye contact, clean-up of a large spill)

There is no information available regarding safe limits for exposure to cytotoxic/hazardous drugs. A record of how much drug each staff member handles may be useful in the future for group studies on the consequences, if any, of handling all hazardous/cytotoxic drugs in the workplace.¹

Worksafe BC Occupational Health and Safety (OHS) Regulation 6.52, states: “the pharmacy department maintains records of all pharmacy workers who prepare or handle hazardous drugs, including the name of the drugs handled and, when practicable, the number of preparations per week. Exposure records must be maintained for the duration of employment plus 10 years, and training records for 3 years from the date that the training occurred. A copy of these records is maintained by the pharmacy professional practice leader/department manager in a permanent ‘Exposure Record’ for each staff member. If they wish, an individual resigning from the department may take a copy of their own ‘Exposure Record’ with them to their future place of employment”.

Acute exposures as a result of a spill, needle-stick or other accident must be immediately reported to the pharmacy professional practice leader/department manager and to Occupational Health and Safety staff.¹⁷ Appropriate documentation must be completed - i.e. an Unusual Occurrence Form, and/or an Accident/Injury Form.^{6,11,12,17}

Employees must be fully informed of the potential for reproductive hazards that may occur if they are exposed to hazardous drugs.^{5,6,14,15,17} It is the responsibility of the employee handling HD's to discuss with their immediate supervisor any desired change in work assignment as a result of their pregnancy, breast-feeding or attempt to reproduce. All attempts should be made by management to re-assign personnel who are pregnant, breastfeeding or planning imminent parenthood to work in another area of the pharmacy in order to avoid working directly with hazardous drugs, if so requested.^{4,6,12-14,17}

Refer to BCCA Systemic Policy V-20 – Employee Health: Management of Risks Related to Cytotoxic Agents at <http://www.bccancer.bc.ca/HPI/ChemotherapyProtocols/Policies.htm>

Section B

Sterile Preparation Room and Anteroom

Warning signs, which are clearly visible and clearly state the identified hazards, must be posted in all areas where cytotoxic drugs are stored or mixed. Storage and preparation areas for cytotoxic drugs must be posted with a list of all cytotoxic drugs present in the workplace”^{6,19}

Biological Safety Cabinets (BSC)

The Biological Safety Cabinet (BSC) is a ventilated containment cabinet which aids in the:

- protection of the operator
- protection of the parenteral admixture
- protection of the environment¹⁸

Worksafe BC Regulations for Biological Safety Cabinets Section 6.53(1)

This OHS Regulation provides information on preparation and administration and states:

“All mixing, preparation and priming of administration sets with a cytotoxic drug must be performed in one centralized area in a specially designated Class II Type B biological safety cabinet that:

- *is exhausted to the outside atmosphere in a manner that prevents recirculation into any work area*
- *has exhaust and ventilation systems that remain in operation for a sufficient period of time to ensure that no contaminants escape from the biological safety cabinet into the workplace*
- *is equipped with a continuous monitoring device to permit confirmation of adequate airflow and cabinet performance”*

In order for the BSC to provide an aseptic environment and protect the operator, paths of airflow must remain clear.¹⁸ Clean air must be able to reach critical sites; contaminated air must be able to escape via the rear grill, not via the work space opening.¹¹ Manipulations must be performed at least 6” in from the front opening and side walls of the BSC.^{1,5,18}

It is important to avoid:¹

- overloading the BSC
- rapid movements inside, or near the front opening of the BSC
- unnecessary movements in and out of the front opening
- activities that disturb or block the air flow

To protect the upper body and face from any splashes or aerosols produced inside the BSC, the glass screen must be kept at the manufacturer's recommended height during hazardous drug preparation.^{5,11,13,20,21} Each individual owner's manual should be consulted for recommended BSC window height (normally eight to ten inches) – cabinets should not be operated with the window in any other position.

- If the window height is used above the recommended level, it could cause intake air velocity to drop too low for proper personnel protection
- If the window height is lowered below the recommended level, it could cause intake air velocity to increase and allow dirty external air to cross onto the work surface and contaminate the product

It is imperative that workers are told and understand that the BSC does not prevent the generation of contamination within the cabinet and that the effectiveness of such cabinets in containing HD contamination depends on operators' use and proper technique.^{5,6,11,18}

Classes of Biological Safety Cabinets

Class I BSC

The Class I BSC provides personnel and environmental protection only. It does not protect the product from microbial contamination because unfiltered room air continually enters the cabinet front to flow across the work surface. Personnel protection is made possible by constant movement of air into the cabinet away from the worker. HEPA filtered air from the cabinet is re-circulated into the room or exhausted to the outside environment. **These cabinets are used where there is a need for containment, but not aseptic product protection and therefore must not be used for sterile hazardous drug preparations.**^{6,11}

Class II BSC

The Class II (Types A1, A2, B1 and B2) BSCs provide personnel, product and environmental protection.^{6,11} The Class II BSC is classified according to the venting of exhaust air and has three key features:

- A front access opening with inward airflow
- HEPA-filtered, vertical airflow within the work area
- HEPA-filtered air exhausted back into the room, back over the work area, or out through a facility exhaust system

Class II Type A cabinets re-circulate 70% of HEPA filtered air down towards the work surface within the BSC and exhaust 30% of HEPA filtered air back into the room or out to a facility exhaust system. There is a possibility that the re-circulated air is contaminated with HD vapours when it is expelled back into the room. Therefore, this type of Class II cabinet must not be used for admixing hazardous drugs.^{4,6,11,18}

Class II Type B cabinets do not re-circulate exhaust air into the room. **A minimum Class II Type B1 BSC must be used for the preparation of cytotoxic (hazardous) drugs.**^{4-6,11,14,18}

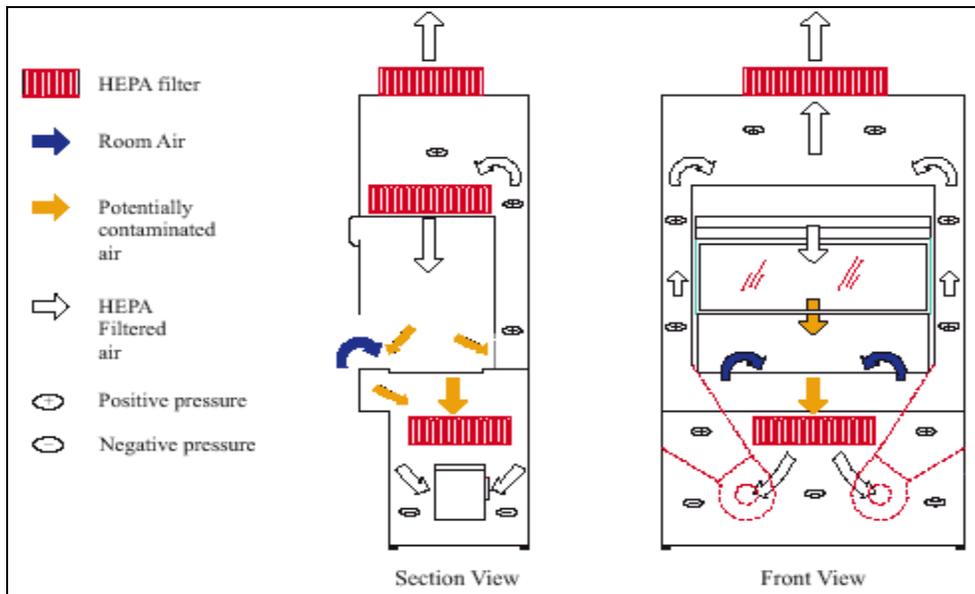
Class II Type B1 BSC

A Class II Type B1 cabinet draws room air in through the front intake grill where it is HEPA-filtered. The air is then drawn to the top of the cabinet; HEPA filtered a second time, and directed towards the work surface. From there it is drawn through the front intake and rear exhaust grills, filtered through a HEPA filter and re-circulated to the work area or exhausted to a facility's external exhaust system through a third HEPA filter. Due to the potential for HD contamination of the cabinet during the cytotoxic preparation process, it is preferable to choose a BSC that does not recirculate air onto the work surface (i.e. Class II B2 or Class III).^{6,15}

The major route for "used" air (60-70%), which may be contaminated with HD particles, to exit the work surface of the BSC is via the rear exhaust grill. This "contaminated" air is HEPA-filtered below the work surface and trough to remove any drug particles and is then expelled from the top of the BSC through a second HEPA filter into an outside duct away from any air intake locations. This prevents recirculation into the work area/room.

A portion (30-40%) of "contaminated" air is drawn through the front intake grill. It combines with air that flows in from the room. This combined air is HEPA filtered below the work surface and then recycled through a second HEPA filter before it recirculates to the work surface. The combined air that flows from the room and from the BSC interior into the front intake grill produces an "air curtain" that prevents particles from entering or leaving via the BSC's front opening. Penetration of this curtain by the arms of the operator, although unavoidable, decreases optimal function of the "air curtain".^{1,12}

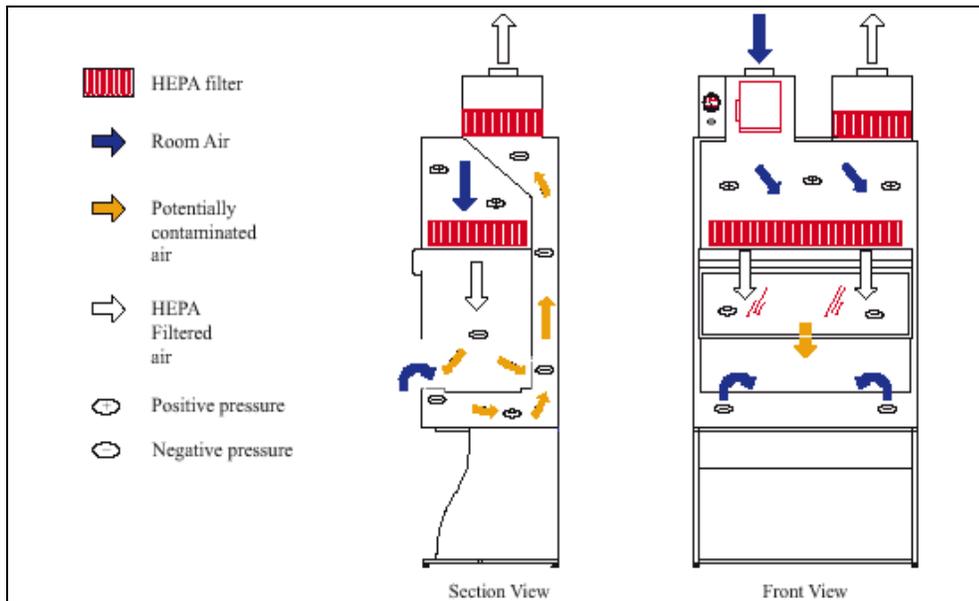
Air flow in a Class II Type B1 Biological Safety Cabinet (BSC)²²



Class II Type B2 BSC

Class II Type B2 cabinets are total exhaust cabinets. All potentially contaminated air from the BSC's work surface is expelled directly to the facility's external exhaust system. Filtered air is not re-circulated to the work surface, or into the work room. Room air enters through the top of the cabinet and passes through a HEPA filter before it flows downwards vertically towards the work surface. Just before the air meets the work surface the now potentially contaminated air splits and is drawn towards the front and rear exhaust grill. Simultaneously, room air enters through the front opening and is pulled down through the front grill. The HEPA filtered air that flows vertically to the work surface along with air that is drawn in from the room through the front intake grill produces an "air curtain" that prevents particles from entering or leaving via the BSC's front opening. 100% of this air is filtered then drawn out to an exhaust vent and HEPA filtered a second time before exhausting to the facility's external exhaust system.

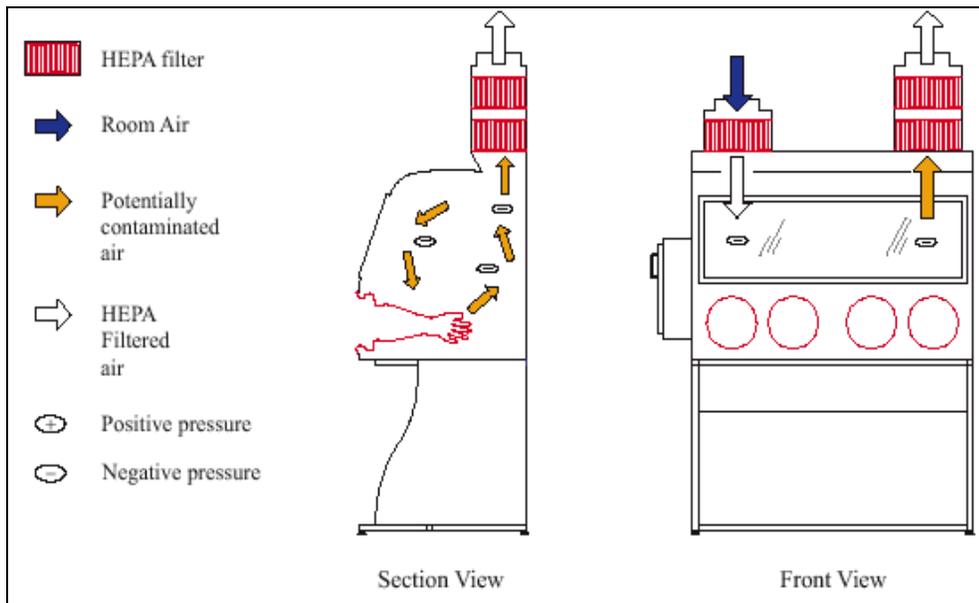
Air flow in a Class II Type B2 Biological Safety Cabinet (BSC)²²



Class III BSC

A Class III cabinet provides the highest level of personnel, product and environmental protection. It has a gas-tight enclosure with a completely sealed viewing window. Work is performed in attached heavy duty long-sleeved gloves. A dunk tank or a double-door air-lock pass-through provides access to the work surface. Room air enters the top of the cabinet and passes through a HEPA filter. Air flow is maintained by a dedicated exhaust system exterior to the cabinet which keeps the cabinet under negative pressure. The used air is double HEPA filtered or passed through a HEPA filter and an air incinerator before exhausting to a facility's external exhaust system. Removal of materials from the cabinet must be through a dunk tank, double door autoclave, or air-lock pass through. Interlock must be used for autoclave and pass through doors to prevent both doors from being open at the same time to maintain a negative pressure environment. The viewing window may be opened for cabinet cleaning and/or decontamination of the interior. This type of cabinet is acceptable for the preparation of cytotoxic/hazardous drugs, but is not a specific requirement of the *OHS Regulation*.

Air flow in a Class III Biological Safety Cabinet (BSC)²²



Location of BSCs

A Class II BSC used for HD preparations must be located away from doorways, traffic corridors, and air conditioning and heating vents.^{5,11,13,15,17,18,21}

Room turbulence will not have an effect on the air flow within a Class III BSC used for HD preparations as it is a totally enclosed cabinet.

HEPA Filters and Airflow

HEPA (High Efficiency Particulate Air) filters must be present in BSCs used in the preparation of hazardous drug IV admixtures.^{1,4-6,15,19} HEPA filters trap approximately 99.9% of particulate matter 0.3 microns in size or greater to provide ultra clean air. Air that flows towards the work surface inside the cabinet and air that is expelled out to the environment first passes through at least one HEPA filter.¹

HEPA-filtered air is not considered sterile; however, the presence of micro-organisms in the filtered air stream is very unlikely. Contamination of a sterile product is most likely due to the introduction of foreign material (i.e. bacteria, particles) from supplies placed into the BSC or from the hands and/or arms of the operator. In addition to compromising the sterility of the drug, particulate matter may act as a carrier for cytotoxic drug particles or aerosols.¹

The top to bottom flow of HEPA-filtered air in a BSC has a number of functions:¹

- sweeps particles and organisms away from the drug to keep it sterile
- keeps contaminated air inside the cabinet to protect the operator and nearby staff
- filters out contaminants before releasing used air into the environment via ducts that open on to the roof of the building

Air flow in the BSC is designed to contain and remove any released HD aerosols and vapours from the working environment when manipulations are performed at least 6" from the front opening.

Note:

- **In horizontal laminar air flow hoods, clean air flows from back to front, sweeping particles and organisms away from the drug but directly towards the operator. This type of ventilation cabinet must not be used for the preparation of hazardous/cytotoxic drugs.**^{1,6,12,13,17}

Ultra Violet Lights

Most biological safety cabinets have a built in ultra violet (UV) light. The UV light is intended to destroy micro-organisms in the air or on exposed surfaces when the BSC blower is turned off. When the cabinet runs continuously, the UV light is not necessary. **The UV light may cause eye damage and must not be turned on when personnel are working in or near the BSC, or in the sterile preparation room.**^{1,20,21,23}

BSC Monitoring

The BSC must be operated continuously with the blower turned on 24 hours a day, seven days a week unless it is being serviced.^{6,11-13,17,18} It must be equipped with a continuous monitoring device to allow confirmation of adequate airflow and cabinet performance.^{6,12,13,18,19}

Lights and gauges located on the front control panel above the viewing window of the BSC should be monitored. Staff working in and around the BSC should be informed of what the values on the gauges read for a properly functioning cabinet. Most BSCs have lights that indicate whether the blower, the internal fluorescent/UV lights and the internal outlet are turned on. As well, there are gauges to indicate airflow and exhaust readings. The values shown on the downflow and exhaust airflow gauges should be monitored on a regular basis. Large fluctuations in values on the gauges can be indicative of a malfunctioning system and must be evaluated immediately. Some Class II Type B BSCs must have a remote or plant air exhaust system for proper operation. These systems are internally interlocked so that the internal blower will not start unless the exhaust flow is within 10% of the required air flow. Should the air flow fall below the 10% limit during operation, the cabinet initiates an audible alarm and visual error messages, de-energizing the internal blower.²⁴

For the safety of the patient and the operator, hazardous drug compounding must not take place when a BSC alarm is sounding or the lights and/or gauges indicate the cabinet is not functioning within the manufacturer's specifications.^{6,21}

Site specific procedures must be created and posted for workers so that when the gauges, lights or alarms indicate that the BSC is not working properly or there is a power interruption, the safety of personnel, the environment and the aseptic condition of the product (if possible) will be maintained.²⁵

Note:

- Most BSC's are wired to the facility's back up generator, so a 'long term' power shutdown would only occur when the unit is unplugged, or as the result of a catastrophic event

Some suggestions for information to be included in site specific BSC malfunction/shutdown procedures:

- Criteria for indications of a BSC malfunction and/or shutdown (i.e. describe how long power has to be off to constitute a problem? What specific values on the BSC gauges indicate a malfunction? What is the significance of BSC alarms?)
- Outline the immediate response of the BSC operator in the event of a malfunction/shutdown (i.e. what to do with the product currently being prepared in the BSC? Other HD currently in the BSC? How to secure the BSC? How to safely exit the BSC? What should other staff members in the area of the BSC do?)
- Site specific contact information - who to contact, under what situation, and the contact number {i.e. facility maintenance personnel, contracted BSC repair technician, nursing (administration interruption), pharmacy manager}
- Contact information should be kept current
- Information regarding a pre-arranged alternative HD IV preparation site/area in the event of a long term shutdown (i.e. Alternative site/area contact information. What and who to bring to the alternate preparation site/area)
- How to prepare the BSC for maintenance/repairs (i.e. BSC decontamination, fan(s) internal/external on/off, placement of plastic covering over the BSC opening, HEPA filter intake)
- Description of BSC decontamination information (i.e. When to perform and how long to purge BSC before and after)
- Description of what PPE must be worn, where, and by whom during a BSC malfunction/shutdown
- Procedures should be posted on or near the BSC

Testing and Certifying Biological Safety Cabinets

Testing and certifying the BSC must be completed by a qualified National Sanitation Foundation (NSF) certified technician when installed. The BSC must be re-certified annually^{6,13,17,19,21} and when the cabinet is altered, repaired or moved.^{11,14,21}

Any service technician or maintenance worker must be informed that the equipment (BSC) may be contaminated with hazardous drugs. Appropriate personal protective equipment must be worn when testing, certifying or servicing the BSC.^{4,12}

If it is necessary to turn off a BSC for testing and certifying or for maintenance, the entire inner cabinet must be decontaminated with an aqueous alkaline detergent solution followed by sterile water for injection and then 70% alcohol.^{4,12,17,18} Once the BSC is decontaminated, the internal blower and the external fan may be turned off. **If the blower and external exhaust fan are both turned off, the work-access opening of the BSC and the HEPA exhaust area must be covered with impermeable plastic and sealed with tape to prevent any remaining HD contamination from inadvertently escaping from the BSC until the maintenance begins. The BSC must be sealed with plastic whenever it is moved or left inoperative for a period of time.^{12,17,23}**

Worksafe BC Guidelines for Biological Safety Cabinet Maintenance Section G30.12

The field (as opposed to factory) certification requirements for biological safety cabinets are listed in Annex F of the NSF standard. The tests that make up these requirements include but are not limited to:

- 1. Down flow velocity profile test*
- 2. Inflow velocity test*
- 3. Airflow smoke patterns*
- 4. HEPA filter leak test*
- 5. Cabinet leak test (required when a cabinet is first installed, if it is relocated, or after maintenance procedures that require removal of the panels)*
- 6. Electrical leakage, ground circuit resistance, and polarity tests*
- 7. Lighting intensity test*
- 8. Vibration test*
- 9. Noise level test*

A cabinet that meets the test criteria should have the following information visibly posted on the cabinet:

- 1. Date of certification*
- 2. Date cabinet should be recertified (stated as no later than a specified date)*
- 3. Number of the certifier's report*
- 4. Name, address, and telephone number of the certifying company*
- 5. Signature of the qualified person who performed the field certification tests*

Replacing HEPA Filters

Only NSF trained bio-safety personnel informed of the hazardous nature of the admixtures prepared in the BSC shall replace HEPA and charcoal (if present) filters.^{4,12,17} HEPA filters will require replacement when they become loaded to the extent that sufficient airflow can no longer be maintained or if they are overtly contaminated by a breach in technique that causes HD to be introduced onto the clean side of the supply HEPA filter.¹² Before replacement of a HEPA filter contaminated with hazardous drug occurs, the NSF technician should be consulted for a mutually acceptable procedure for replacing and subsequently disposing of a contaminated HEPA filter.¹² **Appropriate personal protective equipment must be worn when replacing filters and the contaminated filters must be handled and disposed of as cytotoxic/hazardous waste.**^{5,6}

Cleaning Biological Safety Cabinets

To maintain an aseptic environment and to protect against possible contact with hazardous drug particles, the BSC must be cleaned with aqueous antibacterial solution and disinfected with 70% alcohol²¹ regularly throughout the day.^{1,5,6,13,15} To keep interior surfaces of the BSC as clean as possible, they should be cleaned and disinfected at the start of the work day, after completing each preparation^{6,17}, at the beginning of each work session, and at the end of the day.

Morning Cleaning

A BSC not located in an ISO Class 7 sterile preparation room where the concentration of airborne particles is controlled may have a higher chance of introduction of particulate matter into the interior of the cabinet.

Clean the BSC prior to beginning HD IV admixture preparation:¹³

- **If the BSC is not located in an ISO Class 7 sterile preparation room, all interior surfaces of the BSC require cleaning (except under the working surface) with an aqueous antibacterial solution followed by 70% alcohol in the same manner as the day end cleaning. The BSC must purge for 15 minutes¹³ prior to compounding.**^{6,13}

OR

- **If the BSC is located in an ISO Class 7 SPR (USP 797), only the BSC working surface requires cleaning with an aqueous antibacterial solution followed by 70% alcohol. The BSC must purge for 5 minutes prior to compounding.**⁶

Note:

- Do not use 70% alcohol on the viewing window if it is made of plastic (i.e. Plexiglas[®]) as this may cause permanent fogging. A lint-free towelette moistened with sterile water for irrigation may be used following an aqueous antibacterial solution to remove residue or streaking⁶

Cleaning During the Day

The working surface of the BSC must be cleaned and disinfected throughout the day; otherwise it will become the most contaminated area of the cabinet as HD admixtures are prepared.

The working surface of the cabinet must be wiped with an aqueous antibacterial solution (or WET ONES[®]) followed by 70% alcohol:^{5,15,21}

- **after wiping completed preparations and removing them from the BSC**
- **before leaving the BSC for an extended period of time (i.e. for break)**
- **upon returning to the BSC after an extended period of time**
- **after a minor spill involving the working surface**

At least 30 seconds must be allowed for the alcohol to act before beginning the next admixture preparation.¹⁵

Day End Cleaning/Latex-free Preparations

All interior surfaces of the BSC must be cleaned after preparations within the BSC are completed for the day and prior to compounding ‘latex-free’ preparations.²⁶ The surfaces of the BSC should be cleaned with an aqueous antibacterial solution followed by 70% alcohol. **Proper hand washing procedures must be followed and full personal protective equipment (PPE) must be worn, including a NIOSH approved respirator (e.g. N95) appropriately fit-tested for the operator and safety glasses with side shields^{4,6,12,13} to prevent splashing into the eyes.**

To protect others from potential exposure to hazardous drugs, only personnel participating in the cleaning process shall be present in the sterile preparation room or in the area of the biological safety cabinet.¹⁵ The viewing window is raised and the protective airflow into the cabinet is interrupted, so there is a chance that HD particles may be expelled during cleaning. The presence of others in the room while the BSC is being cleaned may increase the number of particles available to be drawn into and contaminate the interior of the BSC. To ensure others are aware, a sign on the outside of the door to the sterile preparation room must be hung indicating “DO NOT ENTER – Cleaning/Decontaminating the BSC”.

See Module 1 - Appendix 1 – Daily Cleaning of the Biological Safety Cabinet (BSC)

Decontaminating Biological Safety Cabinets

Decontamination is the physical removal of hazardous drug from a non-disposable surface to a disposable surface or the chemical inactivation of hazardous drug from a surface.⁵ The BCCA recommends physical removal because there is no known single non-toxic product available that will deactivate all hazardous drugs. Physical removal is achieved by wiping non-disposable surfaces with disposable towelettes moistened with aqueous alkaline detergent solution. This is followed by wiping with water and then alcohol to re-establish sterility. Alcohol alone will not deactivate or remove HD from a surface and may result in the spreading of HD contamination.^{5,11}

Routine decontamination of the BSC is necessary to maintain an environment as free from contamination as possible and to reduce the potential health risks associated with exposure of healthcare workers preparing and handling hazardous drug(s).

While decontaminating the BSC, proper hand washing procedures must be followed (see page 1-19) **and full personal protective equipment (PPE) must be worn, including a NIOSH approved respirator (e.g. N95) appropriately fit-tested for the operator and safety glasses with side shields^{4,6,12} to prevent splashing into the eyes.** (See page 1-16 for Personal Protective Equipment and Clothing).

To protect others from potential exposure to hazardous drugs, only personnel participating in the decontamination process shall be present in the sterile preparation room or in the area of the biological safety cabinet.¹⁵ The viewing window is raised and the protective airflow into the cabinet is interrupted for an extended period of time, so there is a chance that HD particles may be expelled during decontamination. The presence of others in the room while the BSC is being decontaminated may increase the number of particles available to be drawn into and contaminate the interior of the BSC. To ensure others are aware, a sign on the outside of the door to the sterile preparation room must be hung indicating "DO NOT ENTER – Cleaning/Decontaminating the BSC".

Removable parts of the BSC are decontaminated within the BSC and shall not be removed from the cabinet. When cleaning the trough underneath the work surface tray, personnel must have a firm hold of all cleaning materials so that they are not drawn into the airflow causing damage to the filters.

Decontamination of the BSC must occur once a week^{6,13,17} or:

- **after a spill in the BSC^{6,12,13,17}**
- **after any non-aseptic work has been performed in the BSC (e.g. BSC certification or servicing, non-sterile HD preparation such as oral or topical preparations)⁶**
- **before turning the BSC off for maintenance/certification/servicing^{6,12,13}**
- **before using the BSC, after a power interruption**
 - ✓ **If the BSC has been turned off it should be operated long enough to purge room air from the critical area (at least 30 minutes)⁶ prior to decontamination**

The BSC must purge for at least 30 minutes prior to IV admixture preparation following decontamination.^{6,13}

See Module 1 - Appendix 1 – Decontamination of the Biological Safety Cabinet (BSC)

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI-20: Biological Safety Cabinet (BSC) Decontamination

Section C

General Protective Guidelines

Intravenous admixture products may be exposed to viable (i.e. carry bacteria) and non-viable particles. Particulate may be generated by materials, movement, electrical static and people. People generate approximately 100,000 particles per minute while sitting, 250,000 particles per minute while standing, and 5 million particles per minute while walking. Skin, hair, nails, cosmetics, and/or clothing may be sources of particulate contamination.¹⁵

Workers must follow protective guidelines in order to minimize the release of particles into the preparation environment leading to possible contamination of the final product(s) and to decrease the possibility of personal exposure to hazardous drugs.¹⁵

It is important to recognize that exposure requires direct contact with the drug particles or droplets. Unlike radiation, merely being close to the drugs is not a health threat. This is why most of the protective measures involve maintaining some form of barrier between the worker and the hazardous drug.¹ Contact with hazardous drugs including drug contamination on vial surfaces, receipt of broken vials, compounding and administration of the drug, handling hazardous drug waste, and disposing of contaminated materials may cause surface contamination of the work environment, which may lead to exposure of workers.

The possible routes of exposure to avoid are:^{1,19}

- direct skin contact or puncture¹²
- inhalation of drug powders, sprayed droplets (aerosols^{12,27}) or vapours
- swallowing (ingestion) of drug powders or aerosols
- oral exposure from surface contact (hand to mouth)¹²

Activities which increase the potential for exposure due to splattering, spraying, aerosolization, or skin puncture include but are not limited to:¹⁹

- Withdrawing devices including needles from drug vials
- Transferring drugs from one container to another
- Recapping needles (unsafely)
- Breaking glass ampoules

Activities to avoid due to the possibility of splattering, spraying, aerosolization, skin puncture, or ingestion include but are not limited to:

- Expelling air from a syringe used for HD into the BSC environment contaminating the air
- Expelling HD solution from a syringe into an open waste container
- Removing administration lines from IV bags containing HD
- Priming IV administration lines with HD solution
- Placing gloved hands in or around the mouth or eyes
- Eating, drinking, chewing gum, or applying makeup in or near areas where HDs are handled, received, stored, or administered

Despite all precautions, there may be occasions when drugs penetrate a protective barrier. This could include an accidental skin puncture or when a drug container breaks. It is important to follow established procedures for dealing with accidental HD contact and for cleaning up HD spills. Staff should locate and be familiar with these procedures **before** they are needed to help prevent panic when such an event occurs.¹

See Accidental Exposure to Hazardous Drugs page 1-46

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number V1-10 - Hazardous Drug Spill Control in Pharmacy

Personal Protective Equipment (PPE) and Clothing

There must be procedures and directives available for safe and aseptic handling of hazardous drugs. There must be strict adherence to safe handling procedures and directives.^{6,17} To prevent transfer of cytotoxic drug particles to the outside environment and to assist in the overall cleanliness of the preparation area, healthcare workers must understand the function, use and limitations of personal protective equipment (PPE) and clothing. **Protective equipment and clothing must be provided and used¹⁷ to minimize or prevent unnecessary exposure to hazardous drugs.**^{4,5,11,14,17}

Prior to entering the sterile preparation room/area to compound/prepare sterile and non-sterile hazardous drug medications inside the biological safety cabinet, proper ‘gowning’ of the healthcare worker is required.^{14,15}

See Module 1 - Appendix 1 - Donning of PPE

Scrubs

The recommended use of scrub uniforms made of low-lint cotton or cotton/polyester material reduces the bioburden in the clean room environment¹⁸ and helps to limit the spread of HD contamination. Street clothes should be replaced with fresh scrubs daily when the work assignment will take place in an aseptic drug preparation area.¹⁸ Buttoned lab coats should be worn over scrubs when not inside the sterile preparation area.¹¹ Wearing scrubs outside the facility should be discouraged. Scrubs should be isolated when laundered if contamination is suspected.¹

Footwear

Each facility must be in compliance with Worksafe BC regulations to help reduce preventable injuries due to inappropriate footwear.

Worksafe BC Regulation 8.22 states:

- 1. “A worker’s footwear must be of a design, construction and material appropriate to the protection required.”*
- 2. “To determine appropriate protection, the following factors must be considered; slipping, uneven terrain, abrasion, ankle protection and foot support, crushing potential, temperature extremes, corrosive substances, puncture hazards, electrical shock and any other recognizable hazard.”*

Pharmacy departments should develop a site specific policy determining appropriate footwear protection required in each work area of the pharmacy, taking into consideration the following risks: cytotoxic exposure, puncture hazards, slipping, tripping, spillage of liquids, and any other recognizable hazard.

Shoe Covers

Shoe covers minimize the spread of HD particulate contamination.⁵ **Shoe covers must be put on before the worker steps inside the sterile preparation room and must be removed with gloved hands immediately upon exiting.**^{5,11} **Used shoe covers must be disposed of in the hazardous waste containers and not saved for re-entry into the sterile preparation room.**⁵

Hair Covers

Personnel have been found to be a major source of particulate load in the sterile preparation area.^{15,23} Disposable hair covers (and beard covers if necessary) prevent hair and skin particles from contaminating the BSC and the clean room air. **A disposable hair cover (covering hair and ears completely) must be worn by all personnel working in the BSC and/or present in the sterile preparation room.**^{1,5} The hair cover is donned (and beard cover if necessary) prior to handwashing and gowning. Hair covers should be removed immediately upon leaving the SPR and must be disposed of in hazardous waste containers.^{5,15}

Masks

Surgical masks must be worn when compounding in the BSC.^{6,15} Surgical masks do not provide protection against breathing in HD aerosols^{5,11}; however, they do protect the clean room environment from possible microbial contamination by workers.



Surgical Mask

Respirators

A NIOSH approved respirator must be worn when cleaning up cytotoxic/HD spills outside of the BSC and when decontaminating or cleaning the BSC.^{6,11}

If a NIOSH approved disposable respirator (ie.N95, N100) is used, staff must be fit-tested¹¹ prior to initial use and retested at least every 2 years, when there is a change in the respirator face piece, or when a user's physical condition changes affecting the fit.²⁸ A positive and negative pressure seal check should be performed by the worker before each use of a respirator to determine if the respirator is properly sealed to the face.¹⁹



3M 1860 Respirator Mask (N95)

A NIOSH approved Powered Air Purifying Respirator (PAPR) equipped with a HEPA filter may also be used. It is a mask that covers the entire face and does not require fit-testing. The PAPR may be selected for use if the N95 or N100 respirator does not fit, if the employee has facial hair or a facial shape that interferes with mask-to-face seal, or if the N95 or N100 respirators are unavailable. These respirators must be cleaned according to the manufacturer's recommendations to ensure continued operator protection during future use.

Chemotherapy Gowns

Chemotherapy gowns help to minimize healthcare workers' exposure to hazardous drugs by providing a physical barrier to extraneous drug particles generated during the compounding process. **To decrease particulate levels in the area and to decrease the risk of direct skin contact with the drugs, workers must wear non-linting, solution-resistant disposable gowns with tightly-fitting cuffs, a closed front, and tied in the back.**^{1,5,11} **Gowns must be worn for all activities that may result in the worker's direct exposure to hazardous drugs.**^{4,5,11}

Gowns worn in the sterile preparation room and anteroom must be removed for storage or disposal while still in the HD work area. They must not be worn into the general pharmacy to prevent the spread of HD contamination from one area to another.^{1,14}

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI-40 - Chemotherapy Gowns

Chemotherapy Gloves

Disposable chemotherapy gloves help to minimize the risk of occupational exposure to hazardous drugs by providing a physical barrier to extraneous drug particles on surfaces or to those generated during the compounding process. **Two pairs of 'chemotherapy' gloves must be worn while handling all hazardous drugs and hazardous drug waste and must be disposed of as hazardous waste.**^{4,6,11,15,18}

Tiny holes or thinning of the gloves may occur during use. Gloves should be handled gently to avoid tearing or stressing the material.¹ Tweezers should be used to avoid activities which may tear or stress gloves, such as removing multiple vial closures and handling adhesive surfaces of labels or seals. **Both pairs of gloves must be changed every 30 minutes or immediately if a tear, puncture or contamination is known or suspected.**^{4,5,11} **Hands must be washed every time gloves are removed.**^{4,6} When removing a chemotherapy gown, carefully remove the outer pair of gloves first, then the gown and then the inner pair of gloves.

Two pairs of disposable gloves must be worn at all times by all personnel working in the sterile preparation room.¹¹ **Gloves should be powder-free.**^{5,6,11,15} **If powder-free gloves are not available, powdered gloves must be wiped with a towelette moistened with 70% alcohol**^{5,17} **prior to entering the sterile preparation room – alcohol must not be sprayed to remove powder.**

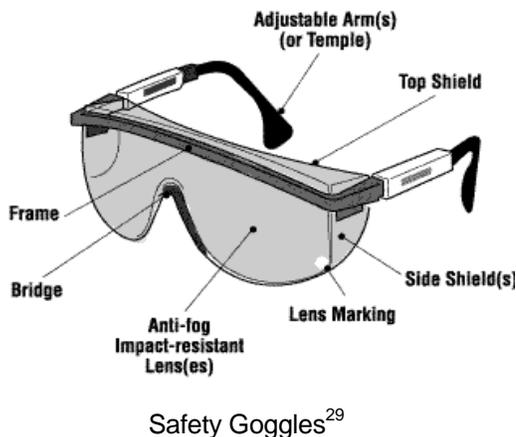
Studies on gloves indicate that many latex and non-latex materials provide effective protection against penetration and permeation by most hazardous drugs.¹¹ Recent concerns with healthcare workers' sensitivity to latex have prompted testing of newer glove materials. Gloves made of nitrile, neoprene and polyurethane which have been successfully tested against a battery of antineoplastic drugs have been found to be suitable chemotherapy gloves.^{4,5,11} **Latex-free 'chemotherapy-approved' gloves must be made available to staff.**¹⁴

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI-30 - Chemotherapy Gloves

Eye Protection

Eye protection is not necessary when preparing cytotoxic drugs in a BSC with the viewing screen down. **Goggles/safety glasses with side shields must be worn when cleaning or decontaminating the BSC or when cleaning up a cytotoxic drug spill outside the BSC.**⁶ Goggles/safety glasses may be washed with aqueous alkaline detergent solution and water for re-use. If HD contamination is suspected, they must be discarded in a cytotoxic waste container.

Contact lenses may absorb aerosolized drug and pose an extra potential hazard in the event of a splash of any hazardous solution into the eye. If possible, glasses should be worn for vision correction while preparing hazardous drug IV admixtures. When glasses are worn for vision correction, safety glasses with side shields must be worn over them while cleaning or decontaminating the BSC and during spill cleanup.



Hand Washing

Proper hand washing with an anti-microbial soap must be performed to prevent microbial contamination of sterile products and to remove any drug particles after handling cytotoxic drugs.¹ **Hands must be washed before donning protective gloves and immediately after removal.**^{1,4,5,11,13} **Remove all jewellery including bracelets, rings and watches before washing hands and arms to prevent material from being trapped around or underneath them.**^{1,18} **Hands must be dried with a clean, non-linting towel.**¹ **Wearing of artificial nails or nail extenders is prohibited while working in the sterile compounding environment.**¹⁵ Healthcare workers who wear artificial nails are more likely to harbour gram negative pathogens on their fingertips than those who have natural nails both before and after hand washing.³⁰ Freshly applied nail polish does not increase the number of bacteria removed from skin under nails, but chipped nail polish may support the growth of large numbers of organisms on finger nails.³⁰ Natural nails should be kept neat and trimmed and free of nail polish.^{15,18,30}

Recommendations for time spent washing hands and arms prior to IV admixture preparation have not been well established. Handwashing guidelines for OR staff recommend washing hands from the elbow to the fingertips for at least 2 – 6 minutes.³⁰ Handwashing prior to the preparation of IV admixture chemotherapy drugs for immuno-compromised patients or prior to cleaning/decontaminating the BSC should be performed for at least 2 - 3 minutes. Antimicrobial scrub brushes are not recommended as they can cause skin irritation and skin damage.¹⁵ Rinse with water running away from the hands towards the elbows. Dry hands and forearms with a clean or sterile non-linting towel or high-speed, cool temperature hand dryer.

Safety Stations

Eyewash stations and emergency showers must be easily accessible^{13,17} and located in a well lit area close to the HD sterile preparation area.⁶ The location of each emergency shower or eyewash station must be identified with a highly visible sign.¹⁴ The sign should be in the form of a symbol that does not require workers to have language skills to understand it.³¹ Staff must be made aware of the location and use of safety stations as part of their initial safety orientation. (See Accidental Exposure to Hazardous Drugs on page 1-46).

Eyewash Stations

Tap water is not recommended for flushing the eyes as pressure damage can occur.^{6,31}

Sink Mounted

To use a sink mounted eyewash station, follow these steps:

1. Push the handle away from you to start the water flow
2. With thumb and forefinger of each hand, hold eye lid(s) open allowing flushing water to bathe eye(s)
3. Move eye(s) up-down-left-right for at least 15 minutes
4. Seek medical advice as soon as possible
5. Note which cytotoxic drug was involved and the quantity of drug that the eye(s) were exposed to
6. Fill out an Accident/Injury form and an Unusual Occurrence Form



Mounted Eyewash Station³²

Hand Held Portable

Alternatives to a sink mounted eyewash station include hand held portable eyewash stations which may consist of an IV bag of 0.9% NaCl solution (normal saline) or an irrigation bottle of water or normal saline with appropriate tubing.^{12,23} The portability means emergency equipment can be placed closer to potential hazards or taken to the contaminated worker. These eyewash stations are ideal quick first response eyewashes.³³



Irrigation Bottle³⁴

Emergency Showers

Emergency showers are designed to flush the user's head and body. They must **not** be used to flush the user's eyes because the high rate or pressure of water flow could possibly damage the eye.³¹

Any part of the body with known or suspected contamination should be rinsed for a minimum of 15 minutes but rinsing time can be up to 60 minutes. The temperature of the water should be one that can be tolerated for the required length of time. Water that is too cold or too hot will inhibit workers from rinsing or showering as long as they should.³¹ A towel and gown should be made available to dry and replace contaminated clothing. Contaminated clothing should be discarded as HD waste or isolated and labelled for laundering according to site directives.



Safety Shower³²

When designing the safety shower area, consideration should be made to allow for proper drainage when the shower is running.

Safety Stations Maintenance

Inspecting and operating (activating) the emergency shower and mounted eyewash station must be performed and documented by an employee weekly.^{31,35} A weekly check will ensure that there is flushing fluid available as well as help clear the supply line of sediments and minimize microbial contamination caused by 'still' or sitting water.

A complete inspection on an annual (yearly) basis is also recommended.³¹

Hand held portable eyewash equipment must be inspected and maintained according to the manufacturer's instructions.³¹ Consideration of expiry dates and shelf life of solution in the portable eyewash station is recommended to avoid bacterial and/or fungal growth.

Section D

Supplies

Wipes/Towelettes

Soap moistened wipes/towelettes (i.e. WET ONES[®]) may be used to physically remove HD particles from the work surface of the BSC, and the outside surfaces of gloves, products, and devices prior to removal from the BSC. Other wipes are commercially available however consideration when choosing these products is recommended due to the possibility of chemical interaction with approved solutions already in use.

Soap-free, lint-free towelettes and gauze are available to be moistened with 70% alcohol, aqueous antibacterial solution or aqueous alkaline detergent solution.

Alcohol Swabs and Solutions

Individually packaged swabs pre-moistened with 70% IPA must be used to disinfect a critical site prior to piercing. Sterile 70% alcohol wetted gauze pads or other particle-generating material must not be used to disinfect the sterile entry points of containers.¹⁵

Bottles of sterile 70% alcohol (isopropyl or ethyl) should be readily available in sterile preparation rooms.⁶ These solutions may be used for disinfecting devices, supplies, and gloves prior to placement into the BSC and for disinfecting surfaces of the BSC following decontamination or cleaning.¹²

Aqueous Cleaning/Decontaminating Solutions

Cleaning solutions should be low residue, non-foaming aqueous antibacterial and/or virucidal solutions compatible with stainless steel. Decontaminating solutions should be low residue, low-foaming aqueous detergent solutions compatible with stainless steel and should have an alkaline pH of 8 – 9.

When selecting cleaning or decontaminating agents, careful consideration should be given to compatibilities, effectiveness, and inappropriate or toxic residues. Diluted solutions should be prepared and stored according to the manufacturer's directions and kept in previously cleaned containers. Partly emptied containers should not be topped up. The solution should be applied to the towelette or gauze in order to avoid contaminating the bulk cleaning solution.⁶

Recommendations for Selection of Devices

Techniques and devices used in the safe and accurate reconstitution and withdrawal of HD in a vial must support minimizing the production/release of HD aerosols and vapours, maintaining the sterility of HDs, and preventing leakage/spillage.^{1,17}

Several devices are marketed for use in compounding hazardous drug preparations. There is no single device which is suitable for all HD IV compounding. The choice of device must be based on minimizing the escape of hazardous drug particulates and limiting the production and release of HD aerosols and vapours into the environment and onto surfaces. Availability of devices and maintaining the safety of the patient and the worker are also important considerations. **Staff must be trained to use the proper technique required with each device utilized in the safe preparation of hazardous drugs.¹¹**

The following criteria may be considered when deciding which devices are most suitable for the preparation of hazardous drugs.

- Venting devices equalize the pressure in a hazardous drug vial, minimizing the possibility of back spray and HD aerosolization
- **Venting devices must have filters^{5,6}**
- Filters should be small enough to remove the intended particulate. If removing glass particles from a solution in an ampoule, a 5 micron filter is recommended. For preventing the release of HD aerosols into the environment a 0.2 micron filter may be used
- Closed system drug transfer devices may be utilized for all HD manipulations to prevent the release of HD aerosols and vapours into the BSC^{4,6}
- **Luer lock fittings must be used for all hazardous drug connections made during manipulation and dispensing^{1,5,13,14}** (except some pediatric doses)
- To minimize exposure of critical sites to micro-organisms, devices should be chosen which will reduce the number of required manipulations needed to compound admixtures

Devices

The above criteria are meant to provide guidance to pharmacy personnel when evaluating which devices will provide safe and aseptic HD IV preparations. The following section contains information illustrating a number of devices currently being used by pharmacies in British Columbia that are preparing hazardous drugs. It would be impractical to describe every device currently being used. The devices available for compounding chemotherapy are constantly changing.

Syringes

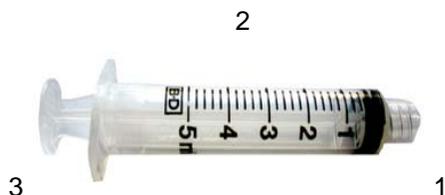
Syringes are made of either glass or plastic. Disposable plastic syringes are frequently used in compounding sterile preparations because they are inexpensive, durable and are in contact with substances only for a short time, which minimizes the potential for incompatibility with the plastic itself.¹⁸

A luer lock disposable syringe is used in the preparation and administration of hazardous drugs to help prevent leakage and accidental separation of connections between devices such as syringes and needles.^{1,5,14,17} Over tightening luer lock connections could cause cracking or breaking of the device(s).

An appropriate size syringe must be selected so it is no more than 75% full when containing the final HD dose.^{1,5,11,13,17} This minimizes the risk of the plunger accidentally separating from the syringe barrel.

There are three main parts of a syringe:

1. the tip/hub
2. the barrel
3. the plunger



The plunger and tip/hub are critical sites (see pg 1-41). Touching the plunger ribs of a multi-use syringe could result in contamination of the interior of the barrel and subsequent contamination of the drug or diluent inside the syringe. **A syringe must not be used more than five times for a single compounding procedure (i.e. reconstitution).**¹¹

Syringe Tip Caps

A luer lock syringe tip cap is used to protect the syringe tip/hub from contamination during storage or transport^{1,5,13,14,17}. It also prevents HD solution from being accidentally ejected since the plunger cannot be pushed in or withdrawn when a luer lock tip cap is in place.¹ A multi-function tip cap may be used on a chemotherapy dispensing pin if the original intermittent stopper cap is discarded. **Care must be taken to avoid touch-contaminating the end of the multi-function tip cap that is luer locked to either the syringe or the chemotherapy dispensing pin (critical site).**^{1,15}

Tip caps may be packaged in multiples where each row of caps is sterile until the paper backing is peeled away. The paper should be peeled away at an angle to expose only one tip cap at a time. Tip caps packaged in a tray are single function with only one connection end (critical site).



Tip Cap Tray



Multi-Function Tip Cap



Single Function Tip Cap

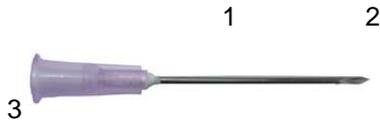
In some cases, tip caps and syringes without luer locks are used. For example, some pediatric HD medications must be dispensed in a slip tip syringe. Therefore, a slip tip syringe cap must be used. The dose should be appropriately packaged to ensure the plunger is not manipulated during transport causing HD solution to be accidentally ejected.

Needles

All parts of a needle are critical sites. Needles must be manipulated by handling their paper over-wrap and/or needle caps. Paper-covered needles must be unwrapped by peeling apart the sides of the package just enough to expose the needle's luer-lock hub. Air flow to the hub must be maintained as the needle is un-wrapped. The needle cap must be left in place until the needle is ready to be used.¹⁸

There are three main parts of a needle:

1. shaft
2. bevel
3. hub



Aluminum-free needles and devices must be used in the preparation or administration of cisplatin, carboplatin or oxaliplatin.³⁶ The aluminum/platin interaction causes a black precipitate to form due to an oxidation-reduction reaction.³⁶ To avoid confusion, the use of aluminum-free devices when preparing all hazardous drug IV admixtures is recommended.

It is important to choose the appropriate needle gauge and length with consideration given to the type of intravenous bag port or vial stopper being punctured, the number of punctures, and the viscosity of the drug being withdrawn or injected. Correct selection of needle gauge and length helps to prevent cytotoxic drug leakage. The larger the needle gauge number, the smaller the needle bore size (i.e. 20G<16G needle).

Safety Engineered Needles (SEN) must not be used in the preparation of hazardous drugs. There is a risk that the HD will spray droplets off of the needle point when the SEN cap is applied.²⁵

Needle Caps

The opening of a needle cap is a critical site. When the needle cap is removed from the needle it should be placed in a needle cap holder with the opening facing up. Alternatively, the open end of the needle cap could rest on an alcohol swab outside of the working area. **Directly placing the open end of the needle cap on the work surface of the BSC must be avoided.**¹⁵

Needle Cap Holders

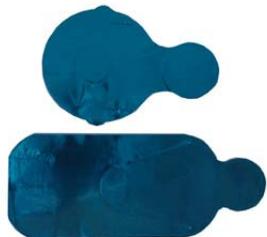
A needle cap holder is a device used to securely house the cap of the needle. It also helps to protect from needle stick injuries by enabling the worker to recap the needle without having to touch the needle cap. It allows for a one-handed recapping of the needle.

If recapping a needle is required, a one-handed 'scoop' method or a needle cap holder should be used. **For worker safety, two-handed recapping of a needle used for HD preparation is never an acceptable practice.**¹⁸

See Module 1 - Appendix 1 - Capping Needles Safely

IV Seals

An IV seal should be affixed to IV bag ports and HD vials that have been accessed during drug preparation prior to their removal from the BSC. The presence of a seal indicates that the port of the IV bag and/or HD vial has been accessed and provides a barrier between the accessed entry and any non-ISO Class 5 environment. Leakage from a poorly punctured entry may not be contained by the foil seal. Vials with foil seals should be handled carefully. The seal self-destructs upon attempted removal and cannot be effectively reapplied providing tamper evident security. They are available in a variety of sizes and colors.³⁹



Dispensing Pins/Universal Spikes

The spike of a dispensing pin or a universal spike is inserted into an administration port of a diluent solution bag to avoid multiple punctures into the medication port of the bag throughout the day. Both ends of these devices are critical sites.

Note:

- The dispensing pin automatically re-seals allowing for syringe detachment without having to reconnect the protective cover between syringes if more than one syringe is required

See Module 1 - Appendix 1 - Withdrawal from an IV Solution Bag Using a Dispensing Pin/Universal Spike

Filters

Filter sizes vary depending on the filtering device used. A **hydrophilic** filter allows solution to pass through and is used to trap particles/contaminants from solution up to a specific size. For example, the use of a 0.45 micron hydrophilic filter will remove microorganisms, particles, precipitates and undissolved powders 0.45 microns in size or larger. Filter devices should be luer locking, compatible with the solution, and hydrophilic to allow the solution to pass through the filter membrane. Filters are available in needle, straw or disc form.

Glass particles¹¹ and/or particulate matter such as coring from a rubber stopper in solutions which can be filtered must be filtered prior to administration. In cases where the particulate matter is not identifiable (i.e. black particulate in a vial that has a grey rubber stopper) the solution should be wasted.

Filter Needles

A filter needle contains a hydrophilic filter. To withdraw the solution, either start with a filter needle and change to a regular needle before expelling the contents or start with a regular needle and change to a filter needle before expelling the contents. **The same filter needle must not be used for both withdrawing and expelling solution.**^{1,18}



Filter Straws

A filter straw contains a hydrophilic filter and has a plastic tubing available in 2" or 4" lengths making it easier to reach the bottom of an ampoule. The tubing reduces the risk of needlestick injury during manipulation of the solution. The filter straw may be used to withdraw solution and then be replaced by a needle if injecting into a container.



Filter Discs

A filter disc is used for filtering withdrawn solution (i.e. from one syringe to another). **A filter disc used for hazardous drugs must be equipped with proximal and distal luer locking connections.**^{5,13,14} Filter discs with slip tip connections are not recommended for use with hazardous drugs as accidental detachment can occur.



Filter Venting Devices

A filter venting device should be used when reconstituting or withdrawing hazardous drug from a vial. Venting without a filtering device may lead to increased release of aerosolized hazardous drug into the work environment. **Techniques employed while using devices must ensure aerosolized drug is not released into the BSC.**¹³ A **hydrophobic** filter repels water not allowing solution to pass through. The use of a hydrophobic filter venting device equalizes the pressure within a chemotherapy vial and prevents the release of aerosolized HD into the work environment. However, these devices may not prevent the release of HD vapours. The airflow in the BSC is designed to contain and remove HD vapours from the working environment.

The choice of a filter venting device depends on the number of punctures to be made. A chemotherapy vent is not recommended for large volume vials which require multiple syringes for reconstitution and withdrawal. Use of a chemotherapy dispensing pin will produce only one puncture in the vial and may be accessed many times.

There are various models of filter venting devices suitable for HD preparation. Chemotherapy dispensing pins and CHEMO VENTS[®] work differently, but they both:

- have at least a 0.2 micron hydrophobic filter
- allow air to enter a vial as solution is withdrawn, trapping air particulates in the hydrophobic filter
- allow air to escape from a vial as solution is injected, trapping HD aerosols in the hydrophobic filter
- equalize the pressure inside the vial

Negative pressure technique is NOT recommended for hazardous drug reconstitution or withdrawal if filter venting devices are available.^{4,6,18} Care must be taken if negative pressure technique is used. Build up of positive pressure within the vial will cause back spray of solution when the needle is removed. Excess negative pressure will result in spillage from the bevel of the needle when it is removed from the vial.⁵

See Module 1 - Appendix 1 – Reconstitution of a Hazardous Drug Vial Using Negative Pressure Technique

See Module 1 - Appendix 1 – Withdrawal from a Hazardous Drug Vial Using Negative Pressure Technique

Chemotherapy Dispensing Pins

The BRAUN CHEMO DISPENSING PIN[®] and the KENDALL CHEMOBLOC[®] are examples of hydrophobic venting devices that have a spike for entry into the vial allowing for reconstitution and multiple withdrawals of the drug with only one puncture. The equalization of pressure during use enables the reconstitution and withdrawal of solution from a vial to be performed with less risk of exposure to aerosolized HDs than with a needle and syringe.

Chemotherapy dispensing pins should not be used for viscous drugs which could plug the filter before the total dose is withdrawn. Chemotherapy dispensing pins or similar devices with spikes should not be used with vials of TAXOL[®] since they can cause the stopper to collapse resulting in loss of the sterile integrity³⁷ and the possible release of hazardous drug.



KENDALL CHEMOBLOC[®]



BRAUN CHEMO DISPENSING PIN[®]

To maintain the sterility of the vial contents when a chemotherapy dispensing pin is attached:

- If more than one vial is required to make up a dose, a new chemotherapy pin should be used for each vial. Spraying of the solution or touch contamination can occur upon removal of the pin
- As soon as possible after disconnecting a syringe from a chemotherapy pin, attach the original intermittent stopper cap or a tip cap to the device to protect its opening (a critical site)
- Whenever the original intermittent stopper cap or tip cap is removed, place it (connecting end up) on a fresh alcohol swab outside the immediate working area so it does not become contaminated
- If the chemotherapy pin becomes plugged, carefully remove it from the vial and discard into the HD sharps container. Re-swab the port and insert a new chemotherapy pin

Note:

- **Chemotherapy dispensing pins must be inspected for cracks prior to use. A cracked chemotherapy dispensing pin must be replaced prior to manipulation of HD solution²⁵**
- **Chemotherapy dispensing pins must be disposed of in a HD sharps waste container²⁵**

See Module 1 - Appendix 1 - Reconstitution of a Hazardous Drug Vial Using a Chemotherapy Dispensing Pin

See Module 1 - Appendix 1 - Withdrawal from a Hazardous Drug Vial Using a Chemotherapy Dispensing Pin

CHEMO-VENT[®]

A CHEMO-VENT[®] is a 0.22 micron hydrophobic single-use venting needle which may be inserted into a vial stopper. A second needle attached to a syringe is required for reconstitution and/or withdrawal of the drug. As solution is added or as drug is withdrawn through the second needle air escapes or enters through the CHEMO-VENT[®] filter. Any air particles or drug aerosols 0.22 microns in size or larger are trapped in the filter. The equalization of pressure while using the CHEMO-VENT[®] enables the manipulation of a vial to be performed with less risk of exposure to aerosolized HDs than with a needle and syringe.



If the CHEMO-VENT[®] becomes wet, equalization of pressure will not occur. A new CHEMO-VENT[®] must be inserted prior to removal of the wet venting device.²³

Multiple withdrawals from a vial that has a CHEMO-VENT[®] inserted may be necessary. **The vial stopper must be disinfected prior to each withdrawal.**¹⁵ To disinfect a vial stopper that has a CHEMO-VENT[®] inserted:

1. Ensure the CHEMO-VENT[®] needle is inserted into the rubber vial closure so that most of the needle shaft is not exposed. Do not touch the vial stopper with the hub of the venting device
2. With the vial in an upright position, swab the rubber vial closure with 70% IPA around the CHEMO-VENT[®]
3. Avoid touching the needle of the CHEMO-VENT[®] with the alcohol swab

See Module 1 - Appendix 1 - Reconstitution of a Hazardous Drug Vial Using a CHEMO-VENT[®]

See Module 1 - Appendix 1 - Withdrawal from a Hazardous Drug Vial Using a CHEMO-VENT[®]

Transfer Devices

Syringe Fluid Dispensing Connectors/Syringe Tip Connectors

A syringe fluid dispensing connector (syringe tip connector) facilitates a safe and efficient solution transfer technique. **Both ends of the individually packaged fluid dispensing connector must have luer lock connections**^{5,13,14} which allow transfer of solution from one syringe to another without leakage.



Solution Sets

Solution sets are available in various models. They are a latex-free closed system infusion set used to transfer parenteral solution either from one container to another container or from a container to a patient. There is a spike for insertion into a container or a buretrol and a luer lock or slip tip connection at the distal end for a needle or other attachment. The set has a drip chamber and a clamp to stop the flow of solution. **Solution set lines attached to IV solution bags for patient administration must be primed with drug-free solution to decrease the risk of accidental hazardous drug exposure.**¹⁹



See Module 1- Appendix 1 - Priming lines in the BSC

Buretols

A buretrol is used to transfer large volumes of solution either from one container to another container or from a container to a patient via gravity. The 150mL volumetric fill chamber is a control tube that allows for exact measuring of solutions to be transferred from one IV admixture bag to a second container without the use of syringes. Above the volumetric fill chamber is a spike for insertion, a clamp, and an air valve. A releasable clamp sits on the tubing just below the fill chamber. An administration port that accepts a solution set spike is distal to the releasable clamp. When the releasable clamp is open, solution may flow from the volumetric fill chamber into the solution set.



A buretrol may be used to measure and add mannitol to a core preparation (high dose cisplatin/mannitol solution). Site specific procedures may be developed with attention to safe handling and aseptic technique.

Winged Infusion Sets

To prevent the possibility of any leakage from a port when a hazardous/cytotoxic drug has been injected, the BCCA recommends a maximum of 2 punctures for each port even though one manufacturer's study has shown that the port of an IV solution bag will re-seal itself after 12 punctures with a 19 gauge needle.⁴⁰ If more than two punctures will be necessary, the use of a luer-lock winged infusion set is recommended. It may be used for multiple transfers and withdrawals of solution using one puncture into a container.

Winged infusion sets consist of a stainless steel needle with 'butterfly wings' at one end, a length of tubing and a luer-lock adapter at the other end. A plastic cover must be discarded when removed from the needle.

A safety winged infusion set has a needle cap attachment that slides over the needle when it is removed from the container thereby minimizing the chance of a needlestick injury. Safety winged infusion sets are recommended for use with hazardous drugs whenever possible.



Winged Infusion Set



Safety Winged Infusion Set

See Module 1 - Appendix 1 - Use of a Winged Infusion Set

Closed System Drug Transfer Devices

There are many devices claiming to be closed system drug transfer devices (CSDTD). NIOSH defines a CSDTD as a device that mechanically prohibits the transfer of environmental contaminants into the system and the escape of hazardous drug or vapour concentrations outside the system.⁴

"Consider using devices such as closed-system transfer devices, glove bags, and needleless systems when transferring hazardous drugs from primary packaging (such as vials) to dosing equipment (such as infusion bags, bottles, or pumps). Closed systems limit the potential for generating aerosols and exposing workers to sharps. Evidence documents a decrease in hazardous drug contaminants inside a Class II BSC when a closed-system drug transfer device is used".⁴

A closed-system transfer device is not a substitute for a ventilated cabinet, and should be used only within a ventilated cabinet.¹⁵ Personal protective equipment must be worn and appropriate work practices must be adhered to when using a closed-system transfer device.^{4,13}

Appropriate PPE and work practices are necessary even when using a closed system.⁴

Containers

Ampoules

An ampoule is a small glass container sealed to preserve the sterility of an injectable solution. Ampoules can be used to package drugs that may not be chemically compatible with plastic containers or rubber closures. The upper portion of the ampoule (head) is 'snapped' off creating an open-system.¹¹ Drug contained in an open system container is vulnerable to contamination by particles. **The length of time between opening the ampoule and transferring the solution into a closed-system (i.e. syringe) must be minimized.**¹ Gather and assemble the syringe and needle or filter device prior to opening the ampoule to minimize the length of time the drug is exposed.

Most ampoules are pre-weakened by the manufacturer around the neck. Ampoules often have a painted ring around the neck indicating where the weak point is. A second ring painted higher on the ampoule head indicates the point behind where fingers should be placed to help avoid injury when the ampoule is broken.

The neck of the ampoule is a critical site so it must be wiped with an alcohol swab before breaking and must not be touch-contaminated after being swabbed.^{5,11,15} A new alcohol swab may be wrapped around the neck of the glass ampoule before breaking it to protect the fingers from sharp edges. An ampoule breaker may be used in place of a new alcohol swab. A non-disposable ampoule breaker must be cleaned with soap and water after every use.¹



Glass particles in solutions which can be filtered must be filtered prior to administration.⁴¹ **Solution must not be withdrawn and injected using the same filtration equipment.**^{1,18} If a filter needle was used to withdraw a hazardous drug solution, it must be changed to a regular needle for injection into a solution bag. A 5 micron filter needle or filter straw is recommended for use.

Drug solutions that are oily or too viscous to be filtered should be drawn up using a 20G or smaller needle bore, leaving behind a residual volume of solution in the ampoule. This residual volume should contain any glass particulate that was produced when the ampoule was broken. The residual volume from an ampoule should be withdrawn. The syringe must be tip capped and then discarded in a hazardous drug sharps container. **All parts of an opened ampoule must be discarded in a hazardous drug sharps container.**¹¹

There are three techniques for withdrawal of a hazardous drug from an ampoule using a filter device. Ampoule size, syringe size and operator preference will determine which to use.

See Module 1 - Appendix 1 - Withdrawal of Hazardous Drug Solution from an Ampoule

Vials

A medication vial is either a glass or plastic container with a rubber stopper secured to the top by a ring of aluminium banding. A flip-top cap protects the rubber stopper. There may be traces of hazardous drug trapped between the flip top cap and the rubber stopper. **Removal of the flip top cap must be performed carefully inside the BSC to 'contain' and avoid spreading HD contamination into the sterile preparation room/area.**²⁵



Studies show HD surface contamination exists on commercially available vials of hazardous drugs as delivered from the manufacturer.^{5,42-46} **Vials must be wiped (not sprayed) with 70% alcohol prior to placement inside the BSC.**^{5,23}

Refer Module 1 - to Appendix 2 - BCCA Pharmacy Directive Number III-40-03 – Vials as Delivered to Facility

When piercing vial stoppers with needles, it is important to avoid coring. Coring occurs when the bevel tip and the bevel heel of the needle do not penetrate the port at the same point.¹¹

See Module 1 - Appendix 1 - Preventing Core Formation

The date and time of puncture must be written on reconstituted and partial vials for future reference using ink that will not smudge or wipe off except when entire contents are withdrawn immediately.¹ The product stability may be determined from the BCCA Chemotherapy Preparation and Stability Chart by referring to the manufacturing (puncture) date and time noted on the vial.

Refer to the BCCA Chemotherapy Preparation and Stability Chart at:

<http://www.bccancer.bc.ca/NR/rdonlyres/45C17D6E-7A0A-4A1A-9137-38A1C8F5A28D/28854/ChemoStabilityChart.htm>

Intact glass and plastic vials must be disposed of in a hazardous waste container. Broken glass vials and vials with a chemo vent inserted must be disposed of in a hazardous sharps waste container.

Polyvinyl Chloride (PVC) Bags

Flexible bags made of polyvinyl chloride (PVC) are used for intravenous delivery of hazardous drugs. They are easy to store and eliminate the need for venting when adding or removing solution. Most PVC bags have one injection port which has two diaphragms that must be pierced. There are also one or two administration ports on the bag. Solutions come in volumes ranging from 25mL to 5000mL and may include normal saline (NS), dextrose 5% in water (D5W), and mannitol. PVC bags are packaged in plastic over wraps to limit fluid loss. Bags smaller than 100mL have a stability dating of 15 days out of the over wrap and bags 100mL and larger have a stability dating of 30 days out of the over wrap.⁴⁷

Non-Polyvinyl Chloride (Non-PVC) Bags

Polyvinyl Chloride is a plastic polymer that is hard and brittle at room temperature. A plasticizer (softener) is typically added to increase the flexibility of the polymer. Di(2-ethylhexyl)phthalate (DEHP) is the plasticizer found in most PVC medical devices.

Some drug solutions contain the surfactants Cremaphor EL (paclitaxel) and Polysorbate 80 (docetaxel and etoposide). These surfactants have been shown to cause leaching of the plasticizer DEHP from PVC containers and tubing into the hazardous drug solution.³⁷ The amount of DEHP leached into solution depends on the surfactant concentration, bag size and contact time. It is not known what level of DEHP is 'dangerous' to humans however DEHP is hepatotoxic and exposure should be minimized. **Paclitaxel, docetaxel and etoposide must be prepared in non-PVC containers and administered using non-PVC tubing.**³⁶

Polyolefin bags do not contain PVC. They are biologically inert and non-toxic. Non-PVC bags are available commercially as empty bags or filled with standard IV solutions.

Empty Sterile IV Bags

Empty sterile IV bags may be used with programmable ambulatory infusion devices that require exact volumes of drug and diluent (AIM[®] pump). Commercially available IV bags with inconsistent overfill volumes are not suitable.

Empty sterile IV bags may also be useful as 'waste containers' inside the BSC when contaminated air or excess HD solution needs to be removed from a syringe during HD drug preparation. **The IV bags used for HD solution waste deposit must be disposed of as hazardous waste**^{5,6,11,17}

See Transfer of Hazardous Drug Solution from a Syringe page 1-42

When piercing infusion bag ports with needles, it is important to avoid coring. Coring occurs when the bevel tip and the bevel heel do not penetrate the port at the same point.¹¹

See Module 1 - Appendix 1 - Preventing Core Formation

Evacuated Containers

An evacuated container is a sealed sterile glass IV bottle which has had the air removed creating a vacuum. Standard size bottles are 250mL, 500mL and 1000mL. Sterilization of glass evacuated containers may be achieved through steam sterilization leaving a small amount of normal saline or water in the container. The label will indicate the expiry date and the solution used for steam sterilization.

Evacuated containers may be used when:

- The volume of drug to be added exceeds the capacity of the appropriate solution bag. Solution may be drained into an evacuated container prior to the addition of hazardous drug
- The drug may be more stable in glass than in PVC containers
- The drug is not compatible with plastic and the use of a polyolefin bag is not suitable

Once the drug and solution have been added to an evacuated container for patient administration, the excess vacuum should be aseptically removed using a 0.22 micron hydrophobic venting device.

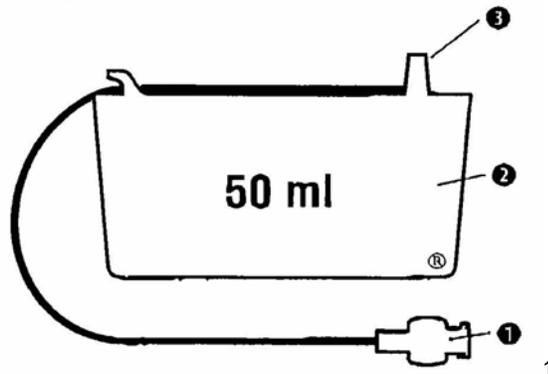
Ambulatory Drug Delivery Infusion Devices

Based on the recommendations of the Institute for Safe Medication Practice (ISMP) Canada, the BC Cancer Agency has revised all treatments with fluorouracil (5FU) continuous infusions to minimize the potential for medication errors. The use of Infusors (fixed-rate elastomeric balloon infusion devices) is one of several recommendations made by the Institute for Safe Medication Practice (ISMP) to increase patient safety. The BCCA has chosen to implement this recommendation and has switched to Infusors for delivery of continuous 5-FU infusions. A fixed flow rate is inherent in the design of the device and programming is not required. The use of a programmable ambulatory pump (i.e. CADD[®], AIM[®]) may still occur in circumstances when an elastomeric infusion device is not deemed appropriate.

CADD[®] Pump and Medication Cassette Reservoir

The CADD[®] ambulatory drug delivery pump is a programmable device that provides measured drug therapy to patients in hospital or outpatient settings. The medication cassette reservoir for the CADD[®] pump is available in 50mL or 100mL volumes and is designed with standard luer lock fittings. A CADD[®] extension set with an anti-siphon valve or a CADD[®] administration set with either an integral or an add-on anti-siphon valve must be used to protect against unregulated gravity infusion that can result from an improperly attached reservoir.

The CADD[®] Pump is indicated for intravenous, intra-arterial, subcutaneous, intraperitoneal use and infusions into epidural space, or subarachnoid space. It may be used for infusion of antibiotics, analgesics, anaesthetics, and antineoplastics.



1. Luer Lock Fitting
2. Medication Bag
3. Pump Attachment

To decrease the risk of exposure to HD, the tubing must be primed with drug-free solution.¹⁴

Note:

- Avoid pressurizing the medication bag (2) inside of the medication cassette reservoir (respect the maximum capacity of the medication bag). Over pressurizing or overfilling may cause the medication bag to rupture.

See Module 1-Appendix 1- CADD[®] Medication Cassette Reservoir Preparation

Elastomeric Infusors

Elastomeric infusors are disposable drug ambulatory infusional devices consisting of an elastomeric reservoir (balloon) inside a hard plastic outer casing (cover) with attached infusion delivery tubing. An elastomeric balloon slowly deflates pushing solution through the tubing at a pre-set flow rate. The pressure on the fluid is generated by the force of the stretched elastomeric balloon.

The restriction of flow in disposable elastomeric infusors is caused by narrow-bore tubing within the flow restrictor. The diameter of this tubing determines the device's flow rate. Flow restrictors may be made of either glass or PVC. Their dimensions should change little with temperature in order to maintain an accurate flow rate. The flow restrictor is always integral to the administration set.

Flow rate is affected by the pressure gradient across the flow restrictor and by fluid viscosity. These factors may vary in clinical settings and significantly affect the accuracy and/or duration of infusional therapy.

Pressure Gradient may be affected by vertical displacement of the device relative to the infusion site (i.e. patient), initial filling volume (i.e. under/overfilling), storage conditions (i.e. refrigeration/freezing), and variations in barometric pressure.⁴⁸

Fluid Viscosity is strongly affected by temperature and somewhat affected by drug concentration.⁴⁸

Disposable elastomeric infusors are available with flow rates ranging from 0.5 – 500mL per hour and running times from 30 minutes to 12 days. Reservoir volumes usually range from 60 – 500mL. Chemotherapy medication is delivered using devices with fixed flow rates ranging from 0.5 – 5mL per hour. The correct elastomeric infusor with the correct infusion rate must be selected when preparing HD medication.

Elastomeric infusor medication labels must have information which includes the intended rate of administration in millilitres per hour (mL/hour).⁴⁹



Note:

- The elastomeric reservoir must be checked prior to filling the infusor. A twisted reservoir could rupture during filling.
- Injecting too vigorously when filling the infusor with HD and/or diluent creates turbulence in the solution; this may create bubbles. Small bubbles in the balloon itself will not cause problems; they will gradually dissipate. Air in the tubing, while not a danger to the patient, may stop the flow of solution through the tubing, preventing drug from reaching the patient.

See Module 1 - Appendix 1 – Infusor Preparation

Section E

Operational Standards

Operational standards must be adhered to when preparing sterile HD admixtures.^{6,17}

Sterile Preparation Room/Area

- **Eating, drinking, smoking, chewing gum, storing food, or applying/wearing cosmetics¹ in the vicinity of the BSC, in the sterile preparation room and in the anteroom are strictly prohibited^{6,13-15,17}**
- **Personnel with rashes, severe sunburn, weeping sores, conjunctivitis, cold sores, active respiratory infection and cosmetics are prohibited from preparing IV admixtures^{6,15}**

Personal Protective Equipment

- **Appropriate PPE must be donned prior to entering the sterile preparation room and/or working in the BSC^{4,5,11,14,17} (see Module 1 Appendix 1 Donning of PPE)**
- **Gloves should be powder-free.^{5,6,11,15} If powder-free gloves are not available, powdered gloves must be wiped with a towelette moistened with 70% alcohol^{12,17} prior to entering the sterile preparation room – alcohol must not be sprayed to remove powder**
- **Both pairs of gloves must be inspected for visible defects^{4,5,11}**
- **Gloves must be disinfected with 70% alcohol before performing any aseptic compounding activity⁵**
- **Tweezers may be used to handle sticky surfaces of foil seals and to remove multiple or sharp vial caps to protect gloves from tearing and potential contamination¹**
- **Gloves used for chemotherapy preparation must be changed at least every 30 minutes or sooner if torn or if contamination is suspected or known^{4,5,11}**
- **Upon exiting the BSC, outer gloves must either be thoroughly wiped^{1,23} with a soap-moistened towelette or removed^{1,4,5,11,23}**

See Module 1 - Appendix 1 – Donning of PPE

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI-30: Chemotherapy Gloves

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI-40: Chemotherapy Gowns

Biological Safety Cabinet

- **If the BSC is located in an ISO Class 7 SPR, the BSC working surface must be cleaned with an aqueous antibacterial solution followed by 70% alcohol. The BSC must purge for 5 minutes prior to compounding⁶**
OR
- **If the BSC is not located in an ISO Class 7 SPR, all interior surfaces of the BSC must be cleaned (except under the working surface) with an aqueous antibacterial solution followed by 70% alcohol in the same manner as the day end cleaning. The BSC must purge for 15 minutes prior to compounding⁶**
- **The UV light may cause eye damage and must not be turned on when personnel are working in the SPR^{20,21,23}**
- **To decrease activities that may disturb air flow and/or generate particles, all necessary materials to complete the procedure must be taken into the BSC before entering. Do not take unnecessary items into the BSC since airflow is disrupted in an overcrowded BSC^{1,5,13}**
- **Minimize rapid arm movements that disrupt the air barrier²¹**
- **An unobstructed airflow path must be maintained around supplies and equipment in the BSC^{1,11,15}**
- **The front intake grill and the rear exhaust route must remain clear^{1,5,11,13,21}**
- **The viewing window must be kept at the manufacturer's recommended level during HD preparation^{5,11,13,20,21}**
- **Manipulations must be performed at least 6" in from the front opening and side walls of the BSC^{5,13,18,23}**
- **The wearing of artificial nails or extenders is prohibited while working in the biological safety cabinet. Natural nails shall be kept neat and trimmed^{15,18,30}**

See Module 1 - Appendix 1 – Daily Cleaning of the Biological Safety Cabinet (BSC)

See Module 1 - Appendix 1 – Decontamination of the Biological Safety Cabinet (BSC)

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI-20: Biological Safety Cabinet (BSC) Decontamination

General Procedures

- Vials must be wiped with 70% alcohol to remove HD contamination prior to placing inside the BSC^{5,23}
- Whenever possible without compromising critical sites, outer wrapping should be removed from sterile supplies before placing inside the BSC¹⁵
- Prior to placing inside the BSC, outer wrapping of supplies must be wiped or sprayed with 70% alcohol away from the viewing window to avoid disruption of airflow^{1,5,15,21}
- Paper coverings must be peeled away from needle hubs (critical sites)¹
- Gloves must be wiped or sprayed with 70% alcohol away from the viewing window each time prior to entering the BSC^{1,5,15} when gloves have touched surfaces outside of the BSC
- Ports and vial stoppers must be swabbed with 70% IPA and the alcohol must be allowed to dry just prior to accessing¹
- A new alcohol swab must be used for every port and vial stopper¹⁵
- The date and time of puncture/reconstitution must be written on vials for future reference¹ (except when all HD solution is removed)
- Critical sites must be protected as soon as possible after they are exposed and must not be touch contaminated^{1,15}
- A sharps container must be used for disposal of all sharp objects including needles, chemotherapy dispensing pins, CHEMO VENTS^{®5,6,11,13,17}
- Syringes must not be overfilled with hazardous drug (in most cases, syringes should not be more than 75% full, although some preparations require accurate volume measurements that necessitate the use of a smaller volume syringe)^{1,5,11,13,17}
- The volume of prepared drug in a syringe must not be 'topped up' once it has left the BSC – it must be transferred to a new syringe then topped up inside the BSC¹
- When reconstituting hazardous drugs, always ensure that the drug is completely dissolved and particle free before withdrawing a dose or storing for future use.¹³
- Negative pressure technique is NOT recommended for hazardous drug withdrawal if filter venting devices are available^{4,18}
- Aseptic technique must always be adhered to when preparing sterile hazardous drug admixtures^{1,5,6,11,15,17}

Removing Products from the BSC

- **IV solution bag ports that have been accessed must be swabbed with 70% IPA¹⁷**
- **Once the alcohol dries, IV solution bag ports should be covered with a foil seal**
- **Surfaces of final preparation(s) must be wiped with a soap-moistened towelette before removal from the BSC^{1,5}**
- **To remove a vial of HD from the BSC:**
 - ✓ **the port must be swabbed with 70% IPA¹⁷ and should be covered with a foil seal**
 - ✓ **the puncture date and time must be written on vials¹**
 - ✓ **the vial must be wiped with a soap-moistened towelette¹**
 - ✓ **the vial must be placed in a zip lock bag upon removal from the BSC¹**
- **All non-sharp waste generated during compounding must be placed inside a zip lock bag in the BSC for later disposal^{5,6}**
- **Zip lock bags used for contaminated waste must be sealed and wiped with a soap-moistened towelette inside the BSC before removal from the cabinet^{1,4,6}**

Exiting the Sterile Preparation Room/Area

- **Outer gloves must be discarded in a cytotoxic waste container prior to exiting the sterile preparation room/area – outer gloves must NOT be worn outside the sterile preparation room/area once compounding in the BSC has occurred¹**
- **PPE must be removed upon exiting the sterile preparation room/area^{6,12,14,15}**
- **Removal of chemotherapy gowns for storage or disposal must be done with care to avoid spreading HD contamination to other non-contaminated garments**
- **Used shoe covers, mask, hair cover, beard cover (if applicable) and inner gloves must be discarded in a cytotoxic waste container¹¹**
- **Hands must be washed with soap and water after removing gloves^{1,4,5,11,13}**
- **A lab coat must be donned over scrubs upon exiting the sterile preparation area/anteroom¹**

Aseptic/Protective Routines

Critical Sites

Critical sites are surfaces or openings which may come in contact with sterile drug or surfaces which will be punctured that are at risk of direct contact with air, moisture, or touch contamination. **Critical sites must be protected as much as possible and must not be touch-contaminated.^{1,15} While working in the BSC, a path of clean air flow to critical sites must be maintained at all times.¹ Sterile parts of supplies or devices must not contact the working surface of the BSC.¹ Protection of critical sites by precluding physical contact and airborne contamination must be given the highest priority in sterile compounding practice.^{1,15,18}**

Capping Needles Safely

Needles are a critical site and therefore must be covered when not being used for injection or withdrawal.¹⁸ The needle must be capped to reduce aerosol production and prevent splashes from the needle tip prior to manipulation of a drug-filled syringe.¹

There are different methods available for the safe capping of needles. Device availability and operator preference will determine which method is used.

In the event of a needle stick injury, see Accidental Exposure to Hazardous Drugs: Accidental Injection/Skin Puncture on page 1-47

See Module 1 - Appendix 1 - Capping Needles Safely

Swabbing

The rubber closure on a vial or the port on an IV admixture bag must be swabbed with 70% IPA just prior to penetration. At least 10 seconds must be allowed for the 70% IPA to dry (act) before manipulations begin.¹⁵ Swabbing is necessary for disinfection and the physical removal of particulates. The correct swabbing technique is to make several firm strokes in the same direction.¹⁸ A new swab must be used for each surface.^{15,18}

Prior to removal from the BSC, the rubber closure of a vial or the port of an IV admixture bag must be swabbed with 70% IPA.¹⁷

Safe Handling Aseptic Techniques

Transfer of Hazardous Drug Solution from a Syringe

If too much hazardous drug solution has been drawn into a syringe, care must be taken to minimize aerosol and vapour production, and to contain hazardous drug solution while removing the excess.^{12,17} Excess drug may be injected back into the original drug vial, an empty sterile vial, or an empty viaflex bag.^{12,17} Another option is to transfer the calculated hazardous drug volume to a fresh syringe via a syringe fluid dispensing connector. The excess drug may be left in the original syringe, capped and discarded into the sharps container or labelled for later use. Placing excess drug in any type of open container, even while working in the BSC, is inappropriate.

To remove a volume of drug from a syringe which has been placed outside of the BSC, the syringe must be wiped or sprayed away from the viewing window with 70% alcohol prior to placement inside the BSC. **The required volume must be transferred from the original syringe to a new syringe using a transfer device.**¹ If excess drug remains in the original syringe, the labelled syringe may be recapped and saved or discarded into the sharps container.

Drug must NOT be added to a hazardous drug-filled syringe once it has been placed outside the BSC.¹ The hazardous drug must be transferred to a new syringe using a transfer device and then topped up to the correct final volume inside the BSC.

Note:

- **Any amount of excess drug must NOT be ejected into the needle cover, sharps container, or any other open container¹² as this could cause HD aerosolization, vaporization or contamination**

Removal of Bubbles/Air from a Syringe

The presence of bubbles/air in a syringe may prevent accurate measurement of solution. **Bubbles and air must be removed carefully in a manner that prevents the release of HD solution and minimizes the production of HD aerosols in the BSC.**^{12,17}

See Module 1 - Appendix 1 - Removal of Bubbles/Air from a Hazardous Drug Syringe

Attaching and Priming IV Tubing

Priming an IV set with hazardous drug solution in an uncontrolled environment must be avoided.⁵ One recommendation is to attach and prime the appropriate IV set to the final container in the BSC or before adding drug.^{4,5} **To minimize exposure to HD, the administration tubing/line must be primed with HD-free solution.**^{4,12,17}

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number III-50-01 - Priming Lines Standards

Withdrawal of Excess Solution from an IV Solution Bag

To prevent solution bags from becoming too full for safe administration after the addition of cytotoxic drug(s), it is sometimes necessary to withdraw solution from the intact bag before adding the drug(s). Maximum solution volumes for cytotoxic drugs contained in IV solution bags should be established at each facility with consideration given to the type of bag and the fill capacity. This may be supplied by the manufacturer.

There are many acceptable methods for ensuring that IV solution bags are not overfilled during HD preparation. Each facility should train pharmacy staff to perform a method that is aseptic, accurate, and consistent.

See Module 1 - Appendix 1 – Withdrawal of Excess Solution from an IV Solution Bag

Section F

Clean Up and Waste Disposal

Biological Safety Cabinet Waste Cleanup

Procedures for cleaning, decontaminating and disposing of waste from the BSC are intended to safely remove and prevent the transfer of HD particles from contaminated surfaces to areas where personnel may accidentally come into contact with them.

The entire aseptic preparation area must be kept as clean as possible to ensure that prepared products remain free from possible microbial and HD contamination.^{6,15} To facilitate overall cleanliness in the vicinity of the BSC, the stainless steel trolley(s), counters and other surrounding surfaces should be cleaned regularly.

Waste generated throughout the cleaning or decontamination procedures should be collected in suitable zip lock bags, sealed and wiped inside the BSC, and then removed.⁶

See Module 1 - Appendix 1 - Daily Cleaning of the Biological Safety Cabinet (BSC)

See Module 1 - Appendix 1 - Decontamination of the Biological Safety Cabinet (BSC)

See Module 1 - Appendix 1 - Clean Up and Waste Disposal in the BSC

Refer to Module 1 - Appendix 2 – BCCA Pharmacy Directive Number VI-20: Biological Safety Cabinet (BSC) Decontamination

Hazardous Waste Disposal

Hazardous drug waste containers must be available in all areas where hazardous drugs are received, stored, prepared and administered.¹¹⁻¹⁴

All disposable items that may have come in contact with hazardous drugs during receipt, storage, preparation or administration must be treated as hazardous waste including PPE.^{1,5,6,11,17} **Hazardous waste must be separated from general waste and disposed of properly in hazardous waste containers with lids according to CSHP (Canadian Society of Hospital Pharmacists) standards and relevant Federal and Provincial regulations.**^{11,13} **The hazardous container must be distinctly different from other types of waste containers**^{6,11,13,17} (i.e. bright yellow coloring).

All disposable HD non-sharp materials must be disposed of in 4 mil thick plastic bags which are placed inside a rigid HD waste container or carton so that all waste is essentially ‘double-bagged’.^{11,13} **The HD waste containers should be puncture proof, have a lid that seals securely and be labelled with an appropriate cytotoxic/hazardous warning. The warning label must identify the contents as cytotoxic/hazardous so that individuals transporting the waste are alerted to the need for special handling.**^{6,11-13} **The container must not be overfilled and the contents of the bag must not be pushed down to make more room due to the risk of HD exposure.**¹³ **When the bag is almost full, it should be sealed and the lid of the container or carton must be securely closed. Two pairs of gloves must be worn when disposing of hazardous waste.**⁴⁻⁶

All needles/sharps used for the preparation and administration of hazardous drug admixtures must be placed in a puncture-proof^{6,11,13} **hazardous drug sharps container for disposal without being crushed or clipped.**^{12,17} **Chemotherapy dispensing pins and CHEMO VENTS® must also be disposed of in a hazardous drug sharps container. This container must be sealed when three-quarters full or at the indicated maximum fill line.**¹¹

While awaiting removal from the facility for disposal, hazardous waste must be stored in a secure area in covered and labelled containers.¹¹ **The handling of hazardous waste once it leaves the pharmacy is directed by the facility.**

Section G

Safe Handling of Oral, Topical, Pre-Packaged and Hormonal Hazardous Drug Dosage Forms

According to the NIOSH Alert, all drugs listed on the Hazardous Drug List must be handled according to hazardous drug safe handling guidelines. **Oral, topical, pre-packaged, and hormonal hazardous drug dosage forms must be handled in a manner that prevents skin contact, minimizes the liberation of powdered or aerosolized HD into the air and cross contamination with other drugs.**⁶ **The dosage form and/or packaging that a hazardous drug comes in from the manufacturer, any manipulation of the dosage form, or any change in the packaging will determine the handling precautions that are to be followed to minimize possible HD exposure.**

Tablets, Capsules and Oral Solutions

- Hazardous drug tablets and capsules packaged in pre-packaged blister strips from the manufacturer may be prepared without donning chemotherapy gloves or a gown⁵⁰
- **Two pairs of chemotherapy gloves must be worn when handling coated, loose (removed from original packaging) hazardous drug tablets and capsules in a designated area of the pharmacy dispensary or in a minimum Class I BSC. Gloves must be discarded as HD waste⁵**
- **Dedicated “chemotherapy” counting trays and spatulas must be used to count HD tablets and capsules that are not blister/strip packaged by the manufacturer^{5,6}**
- “Chemotherapy” dedicated counting tray(s), spatula(s) and countertops should be wiped after each use with 70% alcohol then cleaned using aqueous alkaline detergent solution^{5,6,17} with the gauze disposed of as hazardous waste
- **Hands must be washed thoroughly after removing chemotherapy gloves^{5,6,11,17}**
- **Automated counting machines must not be used to count hazardous drug tablets and capsules^{5,6,17}**
- All activities likely to result in particle generation, for example, weighing or mixing powder, crushing tablets/capsules, or filling capsules, should be performed in a minimum Class I Biological Safety Cabinet in a negative pressure room to minimize the risk of spreading HD ‘dust’ throughout the rest of the pharmacy^{5,6}
- Counting of non-coated tablets/capsules that may have HD powder residue on them or compounding/pouring of HD oral solutions should be performed in a minimum Class I Biological Safety Cabinet^{6,12,17}
- **A BSC used for both parenteral and non-sterile HD preparation must be decontaminated after non-sterile HD preparation and then purged for a minimum of 30 minutes prior to use for preparation of parenteral HD products⁶**

Topicals

- **Two pairs of chemotherapy gloves must be worn when handling hazardous drug topical preparations that have been removed from the original packaging⁵**
- Hazardous drug topical preparations that have been removed from the original packaging may be handled without donning a chemotherapy gown
- Compounding of topical products, especially activities likely to result in particle generation, should be performed in a minimum Class I Biological Safety Cabinet
- **A BSC used for both parenteral and non-sterile HD preparation must be decontaminated after non-sterile HD preparation and then purged for a minimum of 30 minutes prior to use for preparation of parenteral HD products⁶**

Pre-filled Syringes

- HD injections packaged in pre-filled syringes from the manufacturer may be handled without donning chemotherapy gloves or a gown

Refer to Module 1 - Appendix 2 – BCCA Pharmacy Directive Number VI-30: Chemotherapy Gloves

Refer to Module 1 - Appendix 2 – BCCA Pharmacy Directive Number VI-40: Chemotherapy Gowns

Section H

Hazardous Drug Spills

To minimize the exposure of staff and patients to hazardous drugs, spills must be managed appropriately, according to established policies and procedures. Spill kit stations must be located in all areas where exposures may occur.^{5,6,11,14,18} These areas include hazardous drug mixing areas, hazardous drug dispensing areas, hazardous drug storage areas and hazardous drug receiving areas.

New employees must be advised of hazardous drug spill control procedures¹⁴ and be required to demonstrate competency in spill handling.⁵ Training and competency assessments should be documented annually.⁶

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI-10 – Hazardous Drug Spill Control in Pharmacy

Accidental Exposure to Hazardous Drugs

Healthcare workers must be made aware of the management of accidental exposure to hazardous drugs.¹⁴

Any accidental HD exposure must be reported to the professional practice leader/department manager and to the Occupational Health and Safety Staff.¹⁷ The exposure must be documented on the personal employee exposure record.¹⁴ The employee should inform their family doctor or general practitioner of the hazardous drug exposure. **Appropriate documentation must be completed¹⁷ (i.e. Accident/Injury form and/or an Unusual Occurrence form).**

Inhalation

Exposure through inhalation is greatest when particles of aerosolized or vaporized hazardous drug are released into the environment while injecting into a vial or parenteral solution, and when expelling air from a hazardous drug filled syringe. Studies have shown that some hazardous drugs tested may evaporate from solid to gaseous forms under normal working conditions.²⁷ Safe handling techniques and the proper use of a Class II Type B BSC will reduce possible inhalation exposure. Respirator masks are necessary to prevent inhalation exposure to HD aerosols when cleaning and decontaminating the BSC and when cleaning up a hazardous drug spill.

Ingestion

Exposure through ingestion may occur when hazardous drug particles or droplets enter the body through the mouth. This may occur when food, gum, cigarettes, beverages, or anything that may be ingested has become contaminated with a hazardous agent, and placed in the mouth. **Staff must not take food, gum, drinks, cigarettes, or personal medication into an area where hazardous drugs are prepared.**^{4,14}

In the event that inhalation or ingestion occurs, no management or treatment is required unless unusual symptoms occur.

1. Monitor for possible symptoms
2. Report any unusual symptoms to your professional practice leader/department manager and your family physician

Absorption/Skin Contact

Absorption into the body may occur when the skin comes in contact with hazardous drug through aerosolization, sprays or spills or when the skin touches a contaminated surface. The amount of absorption depends on the length of time the skin is exposed, the thickness of the skin, the amount of drug on the skin, and the drug involved. It is important to wear two pairs of chemotherapy gloves any time hazardous drug exposure is possible. It is critical to always wear two pairs of gloves and protective clothing during parenteral hazardous drug preparation and administration. The use of proper aseptic techniques and available PPE and devices will help reduce accidental exposure.

In the event of absorption/skin contact:

1. Immediately remove gloves and/or contaminated clothing
2. Cleanse the affected skin immediately with soap and warm running water – use shower if appropriate
3. Wash thoroughly with soap and water
4. Rinse again with warm running water for at least fifteen minutes
5. Check to see if there is an antidote available for the hazardous drug

In the event of accidental eye contact:

1. CALL FOR HELP
2. Remove gloves
3. Immediately proceed to the eyewash station and flush open eyes with copious amounts of warm water for at least fifteen minutes (or use bottled eyewash solution)
4. Hold eye(s) open with thumb and finger and look directly into the water stream – move eye(s) around to wash all around
5. Do NOT rub eye(s)
6. Do NOT use tap water as pressure damage may occur
7. Report immediately to a physician

Accidental Injection/Skin Puncture

Accidental injection of a hazardous drug may occur if a contaminated needle or broken glass punctures the skin. Punctures can occur during capping and uncapping needles and during needle insertion and withdrawal. To avoid punctures always proceed slowly and cautiously during these procedures.

In the event of accidental injection/skin puncture:

1. Remove gloves
2. Rinse the area with warm running water and allow the wound to bleed freely to flush out any drug. Do **not** squeeze the puncture area¹⁴
3. Wash the area thoroughly with soap and water and rinse with warm running water for at least fifteen minutes
4. The HD and approximately how much was injected should be noted
5. The Supervisor must be informed of an accidental injection/skin puncture immediately
6. Contact the Occupational Health Nurse as soon as possible.

See BCCA Systemic Policy Number: V-20 Employee Health: Management of Risks Related to Cytotoxic Agents at <http://www.bccancer.bc.ca/HPI/ChemotherapyProtocols/Policies.htm>

Section I

Receiving

Receipt and Storage of Hazardous Drugs

Safe handling procedures must be followed to prevent breakage of hazardous drug containers, to minimize exposure to hazardous drugs, and to contain spills when receiving and storing hazardous drugs within the pharmacy.⁵

Personnel handling (receiving and storing) hazardous drugs must be aware of precautions and follow special handling procedures.^{4,5}

- Two pairs of non-sterile gloves must be worn when packing and unpacking boxes containing hazardous drugs^{4-6,11,15,18}
- The outside of cartons must be examined for possible damage prior to opening^{5,6,11}
- Containers, shelves and bins used for storage must be properly labelled^{5,11,14,18}
- Barriers and other design features on bins and shelves must be present to contain accidental leakage and reduce the chance of drugs falling to the floor^{5,11,18}
- Hazardous drugs must be stored separately from other inventory in a manner that prevents HD contamination and personnel exposure.^{4-6,11,13,15,18} Many HDs have sufficient vapour pressures that allow volatilization at room temperature, therefore should be stored within a contained negative pressure room with sufficient general exhaust ventilation, at least 12 air exchanges per hour to dilute and remove any airborne contaminants^{4-6,15}
- To prevent errors from occurring, medication that can be easily mistaken for another (sounds alike, looks alike, similar labelling) must be separated in all areas of the pharmacy^{5,6,11,18}
- Hazardous drugs should be stored at or below eye-level
- Hazardous drugs requiring refrigeration must be unpacked and refrigerated immediately upon receipt¹⁸
- Hazardous drugs in the refrigerator must be stored in individual leak and break-proof bins separately from non-hazardous drugs¹²
- Access to areas where hazardous drugs are stored must be limited to authorized personnel¹²

Receipt of a Damaged Shipment

Policies and procedures must be in place for handling damaged cartons of hazardous drugs.⁵ This may include returning the damaged carton to the distributor after proper containment and re-packaging of the carton.

When a damaged carton containing HD is received and is going to be opened, the receiver must don full PPE including a respirator mask and safety goggles to handle the package and to investigate the contents for damage as there may be no ventilation protection in the receiving area.^{1,5} Opening of a damaged carton may be performed inside a ventilated cabinet (minimum Class I) while wearing PPE.

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI -10 - Hazardous Drug Spill Control in Pharmacy

Packaging and Transportation of Hazardous Drugs

Hazardous drugs must be packaged and transported in a manner which minimizes the risk of exposure to HD due to a spill or breakage during transit.^{4-6,11,13,15,17,18}

Hazardous drugs should be packaged in a labelled, sealed, leak-proof container^{5,6,11,17,18}. Some considerations when determining hazardous drug packaging for transport include:

- package hazardous drugs separately from non-hazardous drugs
- protect from light where required
- protect from breakage during transit
- contain any leakage if contents break or rupture
- use child-proof packaging for tablet containers (if appropriate)
- label appropriately with auxiliary instructions
- use methods for cooling drugs which require refrigeration (cold packs, dry ice)

Reusable packaging should be designated for HD transport only⁶ and must be decontaminated and re-used as per site-specific policies. Disposable HD packaging materials should be discarded as hazardous waste.

Site specific procedures for transporting hazardous drugs should be developed and maintained. Pharmacy staff involved in transporting HDs must be properly trained to adhere to site specific HD transport procedures. The method of transporting hazardous drugs must not produce stress on the contents or packaging. **Pneumatic tubes or other mechanical transport systems must not be used**^{6,11-13,17,18} **for hazardous drug transport.**

Non-pharmacy personnel transporting and receiving hazardous drugs should be aware of HD spill procedures. Spill kits should either accompany hazardous drug packages during transport or be easily accessible.^{5,6,11,18}

Refer to Module 1 - Appendix 2 - BCCA Pharmacy Directive Number VI -10 - Hazardous Drug Spill Control in Pharmacy

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