

# ***Patient and Provider Safety with the Chemotherapy Infusion Process***

**A continuing education program  
for nurses, pharmacists and  
pharmacy technicians.**

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# Patient and Provider Safety with the Chemotherapy Infusion Process

## EDUCATIONAL OBJECTIVES

Upon completion of this activity, pharmacists, pharmacy technicians, and nurses will be able to:

- Outline the history exposure risk to hazardous drugs.
- Describe the current guidelines surrounding the preparation and administration of chemotherapeutic drugs.
- Differentiate the types of safety equipment used in the preparation and administration of chemotherapeutic drugs.
- List the safety benefits and operational functions of different types of closed IV preparation/administration equipment.

## ACCREDITATION



ProCE, Inc. is accredited by the Accreditation Council for Pharmacy Education as a provider of continuing pharmacy education. ACPE Universal Activity Number 221-000-11-011-H05-P/T has been assigned to this knowledge-based home-study CE activity (initial release date 01-10-11). This program is approved for 1.0 contact hour (0.1 CEU) in states that recognize ACPE providers. The program is provided at no cost to participants. Statements of credit will be issued online upon completion of the program evaluation and the post-test with a score of 70% or higher. No partial credit will be given.



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## DISCLOSURE

It is the policy of ProCE, Inc. to ensure balance, independence, objectivity and scientific rigor in all of its continuing education programs. Faculty must disclose to program participants any significant relationships with companies that manufacture or market products discussed during their presentation. **Steven D'Amato** and **Seth Eisenberg** both report having no relevant affiliations or financial relationships to disclose. A portion of grant funds received by ProCE from Hospira will be used to compensate the faculty for this program.

Please note: The information and views presented in this monograph are those of the faculty through clinical practice and knowledge of the professional literature. Portions of this program may include the use of drugs and/or devices for unlabeled indications. Use of drugs and/or devices outside of labeling should be considered experimental. Participants are advised to consult and verify manufacturer product information, the professional literature and use his/her professional judgment in applying the presented information in patient care activities.

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Seth Eisenberg studied at California State University Northridge and received his nursing degree from the University of Nevada, Las Vegas. He has been practicing in the field of oncology since 1983, which includes 22 years in hematopoietic stem cell transplantation at the Fred Hutchinson Cancer Research Center.

His involvement with the Oncology Nursing Society (ONS) includes helping to form a local chapter, launching one of the first SIGs, and working as co-editor for the Chemotherapy SIG Newsletter. He has served as Coordinator for the Chemotherapy SIG is also the 2008-2009 SIG Council Chairperson. In addition, Seth is a member of the ONCC Test Development Committee.

Seth has presented at ONS Congress, Fall Institute, IBMTR Tandem Conference, and other national conferences. He has published articles in the Oncology Nursing Forum, Critical Care Nurse, and Nursing Clinics of North America. He was a review editor for the NIH booklet "Chemotherapy and You," revised a chapter for the ONS "Chemotherapy Biotherapy Guidelines," and recently accepted a position as a contributing editor for ONS Connect.

He was the Principle Investigator in a nursing research study, and presented his findings at the 2006 Seattle Nursing Research Conference where he received the Best Presenter Award, and at the Western Institute of Nursing Conference in California. He currently has another nursing research study in progress.

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**Authorship**

Seth Eisenberg provided the primary authorship for this monograph. The monograph was developed with content presented by Seth Eisenberg and Steven D'Amato at a continuing education symposium on May 16, 2008 in Philadelphia, PA.

Imagine if the word *chemotherapy* was excised from the oncology lexicon, and in its place we substituted the words *hazardous drugs*. Would that make a difference in how we handled them? Would we, as oncology nurses, pharmacists and technicians, consider changing our practice and taking the necessary precautions to protect ourselves and our working environment?

## History

The known dangers of exposure to antineoplastic chemotherapy date back over two and a half decades. In 1978, Donner described the risks to pharmacists working with chemotherapy using the traditional horizontal laminar flow hood which was primarily designed to promote sterility rather than protect against contamination during mixing or reconstitution.<sup>1</sup> The following year, it was shown that the urine of nurses who had been exposed to chemotherapy tested positive using the Ames mutagenicity test.<sup>2</sup> While the test is not specific for chemotherapy, and can produce false positives, it succeeded in demonstrating the unintended absorption of chemotherapy, and opened the door to further examination of contamination within the workplace.

In another study, mutagenic substances were found in the urine of pharmacy personnel who prepared chemotherapy using a traditional horizontal-flow hood, whereas no evidence of contamination was found in staff using a vertical-flow Class II biological safety cabinet (BSC).<sup>3</sup>

Everson stated in 1985, “Because of the wide use of cancer chemotherapy in recent years, the extent of exposure of individuals engaged in the manufacture, preparation, and administration of chemotherapeutic drugs is of considerable concern.”<sup>4</sup> This quote would become a prelude to the information documented in numerous studies over the next 20 years regarding the dangers of exposure to chemotherapy.

## Risks of exposure

Studies have looked at both acute and long-term consequences of exposure to chemotherapy. A summary of these adverse effects are provided in Table 1. Acute effects tend to be less common, less serious in nature, and more generalized. Valanis and colleagues examined several groups of pharmacists, technicians and nurses, and compared them to other hospital workers who were not exposed to these drugs. A statistically significant difference in

symptoms was observed in those workers who had experienced dermal contact with hazardous drugs.<sup>5</sup>

**Table 1. Partial list of known adverse effects from exposure to hazardous drugs.<sup>5</sup>**

Long-term exposure linked to:
Menstrual dysfunction
Infertility
Miscarriages
Stillbirths
Acute exposure linked to:
Lightheadedness
Headache
Dizziness
Nausea and vomiting
Contact dermatitis and eczema
Hair loss
Local skin or mucous membrane reactions
Allergic reaction
Abdominal pain
Nasal sores

Most studies have focused on reproductive consequences of exposure, including infertility<sup>6</sup>, spontaneous abortions<sup>7</sup>, menstrual dysfunction<sup>8</sup>, and the development of birth defects.<sup>9</sup> Some studies have also shown a higher incidence of cancer, secondary malignancies, and chromosomal changes.<sup>10, 11</sup>

It could be argued that the studies are unconvincing, since none were randomized, controlled or blinded. However, it is because of the established dangers of chemotherapy that designing such studies would be uniformly unethical and therefore impossible to conduct. The International Agency for Research on Cancer (IARC), the Occupational Safety and Health Administration (OSHA), American Society of Health-System Pharmacists (ASHP) and the Environmental Protection Agency (EPA) have classified many of these drugs as carcinogenic and/or mutagenic. Therefore, in the absence of such research, we must rely upon the vast amount of information on their mechanism of action and known side effects.

## Guidelines

Arising from concerns about the potential (and yet undiscovered) dangers of inadvertent exposure, ASHP issued a Technical Assistance Bulletin in 1985 summarizing published information on certain classes of drugs used for treating cancer known as hazardous drugs.<sup>12</sup> ASHP began by recommending BSC's which prevent contaminated air from being recirculated into the drug preparation area. This "vertical-flow hood", pulls air away from the working area and routes the exhaust to the outside. Working with OSHA, further recommendations included the use of personal protective equipment (PPE) consisting of gloves, gowns and face shields. These recommendations were soon adopted by the Oncology Nursing Society (ONS).<sup>13</sup> In its 2004 Alert, the National Institute for Occupational Safety and Health (NIOSH) has further defined drugs to be hazardous if they meet any of the following criteria:<sup>14</sup>

- Carcinogenic
- Teratogenic
- Exhibits reproductive toxicity
- Exhibits organ toxicity at low doses
- Genotoxic
- Structure and toxicity profiles that mimic existing drugs determined hazardous by the above criteria

As additional information became available, these guidelines have been continually updated, raising

both the level of concern and the need for improved safety measures.<sup>14,15</sup>

The NIOSH Alert, published in 2004, has generated increased focus in the area of worker protection.<sup>14</sup> The main purpose of the NIOSH Alert was to heighten the awareness among healthcare workers and their employers about the health risks of working with hazardous drugs. It emphasized that the health risk is influenced by the extent of the exposure and the potency and toxicity of the hazardous drug. The Alert also served to provide extra guidelines for protection of workers and give employers the necessary administrative and engineering controls to maintain a safe workplace.

Most recently, additional recommendations have been made by the United States Pharmacopeia (USP).<sup>16</sup> The revised USP Chapter <797> - Pharmaceutical Compounding – Sterile Products, details specific standards for the preparation and handling of hazardous drugs within the context of all sterile compounds. These standards are enforceable by the Food and Drug Administration (FDA).<sup>17</sup> A summary of the evolution of safety guidelines can be found in Table 2.

## Routes of Exposure

Recent research has focused on precisely how clinicians are being contaminated—with the goal of looking for ways to prevent such exposure.<sup>11, 18</sup> Studies have clearly demonstrated the presence of chemotherapy on the exterior of numerous vials

**Table 2. Safety guidelines timeline.**

Year / Organization	Description
<b>1983 ASHP</b>	Procedures relating to concerns about safe handling of antineoplastic drugs first published, leading to 1985 Technical Assistance Bulletin.
<b>1985 ASHP Technical Assistance Bulletin on Handling: Cytotoxic Drugs in Hospitals</b>	Recommendations regarding type of BSC, and the use of PPE.
<b>1986 OSHA/NIOSH, ONS</b>	Described the equipment and practices designed to prevent exposure.
<b>1990 ASHP</b>	Included new information contained in 1986 OSHA guidelines and additional published documents; wording changed from cytotoxic to hazardous drugs.
<b>2003 ONS</b>	Update to Safe Handling of Chemotherapy Guidelines.
<b>2004 NIOSH Alert</b>	Detailed that workplace and worker contamination continues to occur, despite current guidelines; recommended closed system devices and defined them as: "A drug transfer device that mechanically prohibits the transfer of environmental contaminants into the system and the escape of hazardous drug or vapor concentrations outside the system"; recommended double-gloving and consideration of using closed systems.
<b>2006 ASHP</b>	Includes NIOSH 2004 recommendations; definition and further recommendations for use of closed systems to help reduce contamination and exposure;
<b>2008 USP &lt;797&gt; Safe Handling Revisions</b>	Further recommendations for the use of closed system devices.

from different manufacturers that are shipped to different locations.<sup>19,20,21,22</sup> It is believed that this contamination occurs during the manufacturing process. The consequence of such exterior contamination widens the potential for exposure to include personnel not normally involved with preparation and administration, such as personnel who unpack or restock shelves.

A major potential source for contamination occurs during drug preparation and administration. Aerosolization, vaporization, or leakage during reconstitution and mixing can easily contaminate the immediate area. In addition, contamination can be spread throughout the environment, reaching distant locations such as the bedside or patient chairs either directly or by airborne particles.<sup>23</sup> Contamination can also be found on the outside of IV bags and syringes.<sup>24,25</sup> While direct inhalation of droplets, vapors, or particulates during preparation can occur, studies have yielded inconsistent results, most likely due to the techniques used to capture vapor.<sup>11</sup> However, the significance of hazardous drug vapors in the environment should not be underestimated, particularly during reconstitution or spill cleanup.

Environmental contamination can take place during priming of tubing, purging of air bubbles, connecting and disconnecting infusions from patients, or when changing continuous infusion bags.<sup>26</sup> Nurses can also be exposed through inadvertent ingestion or contamination of food and drink.<sup>27</sup>

Exposure to a hazardous drug following a spill is not only an immediate concern, but contamination can spread to other areas if the drug is not adequately neutralized. Unfortunately, the body of evidence for optimal cleaning of spills is limited, although solutions of sodium hypochlorite with or without detergent have been recommended. Currently, there is only one commercially available product marketed for this purpose and consists of two towelettes: one with sodium hypochlorite and the other with sodium thiosulfate. (Surface Safe™, Hospira)<sup>13, 26, 28</sup> It should be noted that alcohol alone does not inactivate hazardous drugs.

### Preventing Exposure

Since multiple, complex sources of exposure exist, prevention to exposure is equally multifaceted. The International Society of Practicing Pharmacist (ISOPP) has developed a hierarchy for the order of protection. These levels are listed in Table 3. The

elimination or replacement (Level 1) of hazardous drugs is not likely in the short term. Indeed, drugs such as cyclophosphamide—one of the identified “marker” drugs for tracking of contamination—has been in use for the past 50 years and remains a common component of numerous treatment regimens. Therefore, safety measures must focus on levels 2 through 4.

Isolating the hazard begins with unpacking of the potentially contaminated vials. Staff handling these containers must be aware of the potential, and must use proper precautions, including approved chemotherapy gowns and gloves. This is particularly important when a broken vial is unexpectedly encountered. ASHP standards and USP Chapter <797> detail how hazardous drugs should be segregated from other sterile products during storage, as well as the use of negative pressure “clean rooms” to prevent non-hazardous drugs from being contaminated due to proximity during preparation.

### Engineering Controls

Engineering controls refer to devices designed to contain the hazardous drug in a closed environment such as BSCs or compounding aseptic containment isolators (CACI, also known as glove boxes). All BSCs optimally should be 100% vented to outside air through high-efficiency particulate air (HEPA) filtration.

A glove box provides a physical barrier between the pharmacist or technician and the compounding activity. Materials are passed into the main work area through an enclosed pass-through chamber, and accessed through glove ports to perform aseptic manipulations.

**Table 3. ISOPP Hierarchy for the order of protection.**

Level	Safety Measure
1	Elimination, substitution, replacement
2	Isolation of the hazard/source containment
3	Engineering controls/ventilation
3B	Administrative controls/organization methods
4	Personal protective equipment

Biological safety cabinets and glove boxes in particular are expensive investments which can

create a dilemma for small practices. In addition, the inside of these devices require proper decontamination to eliminate a build up of hazardous compounds. Sodium hypochlorite/sodium thiosulfate wipes can be used for decontamination of the inside of BSCs.

The use of luer-lock connections decreases the possibility of inadvertent disconnection. Slip tip syringes should be uniformly avoided. Once tubings have been connected, they should not be disconnected; bags should not be unspiked. Using a primary IV tubing primed with a neutral solution and a secondary tubing for chemotherapy allows for the tubing to be flushed without having to unspike the chemotherapy bag. For continuous infusions, the bag should be held at waist level and removed while inverted inside an approved chemotherapy waste bag to contain any splashing or spillage.

### Closed Systems

An additional and relatively new component to preventing exposure to chemotherapy is the use of Closed System Drug Transfer Devices (CSTDs). NIOSH defines a Closed System as a device that “mechanically prevents the transfer of environmental contaminants into the system and the escape of drug or vapor out of the system.”<sup>14</sup> Even when using a proper BSC or glove box, chemotherapy is released into the immediate area under the hood. Contamination is then spread to the surface of the bag or syringe, in addition to escaping through the front of a BSC. To prevent this, CSTDs prevent the leakage or escape of vapors from vials, syringes and bags during the mixing and administration process. General characteristics of a closed system include:

- Protects integrity of the IV fluid container whether on a syringe for transfer or on the end of an IV set
- Creates a needle-free closed system
- Allows safe transport of prepared syringes
- Upon disconnect, the system seals and closes reducing or eliminating the risk of drips and spills

Several manufacturers are currently offering CSTDs. All of them have at least 2 basic parts: a vial adaptor designed to prevent leakage and trap vapors, and a valve-based component for transferring the drug to a small volume container. This valve can also be placed at the end of a syringe or tubing to prevent dripping or leakage during and after administration,

as the internal valve only operates when it is activated. This has the added advantage of completely preventing a spill should tubing become disconnected from the patient during an infusion, as the valve would close and trigger an immediate occlusion alarm on the infusion pump.

The first CSTD product on the market was the Phaseal<sup>®</sup> system by Carmel Pharma. (Table 4) This system consists of multiple components for different vial sizes, an injector which uses a shielded needle to provide an internal connection, and an adaptor which is connected to luer-lock devices. Because the connection is made internally, the valve does not provide a patent path for the drug until the internal valve is opened by inserting the end into a specially designed connector. The injector is then rotated and pushed into place, much like a key is inserted into a lock. The connector is required since the injector is not a standard luer device. To prevent vapors from escaping a vial during reconstitution, the vial adaptors feature an external balloon-like expansion chamber designed to trap vapors that escape due to pressure equalization during the injection of diluent or air.<sup>29</sup>






B-Braun’s OnGuard<sup>™</sup> contained medication system uses a similar proprietary internal connection, and in place of an expansion chamber, uses a hydrophobic 0.2 micron grade membrane for trapping vapors.<sup>30</sup> (Table 4)

Hospira’s closed system product line consists of three fundamental components: the Genie<sup>®</sup> vial adaptor, the Spiros<sup>™</sup> closed luer device, and the LifeShield<sup>®</sup> Clave<sup>®</sup> one-piece closed needle-free connector. The Genie<sup>™</sup> uses an internal balloon which inflates within the vial. The Spiros<sup>™</sup> valve also has an internal chamber designed to prevent fluid from escaping until it is firmly connected to a female luer device. The Spiros<sup>™</sup> valve is a standard passive-system, luer-lock device.<sup>31</sup> (Table 4)

Each of these products have their own inherent strengths and weaknesses, and an impartial head-to-head test has yet to be conducted. When comparing CSTDs, the following should always be considered:

- Compliance
- Customization of the application
- Cost
- Passive fail safe design
- Ease of use
- Prevention of spiking and unspiking bags by nursing

**Table 4. Closed system drug transfer devices.**<sup>29,30,31</sup>

<b>Hospira</b>		
	<b>Spiros™</b>	<ul style="list-style-type: none"> <li>▪ Needle-free</li> <li>▪ Luer-lock and rotating luer compatible</li> <li>▪ Custom-built sets</li> <li>▪ Closed connectors</li> </ul>
	<b>LifeShield® Clave®</b>	
	<b>Genie™</b>	
<b>OnGuard™ Contained Medication System (B Braun/Teva)</b>		
		<ul style="list-style-type: none"> <li>▪ Clicking mechanism when locked in place</li> <li>▪ 0.2 micron membrane for trapping gas</li> </ul>
<b>Phaseal® System (Carmel Pharma)</b>		
		<ul style="list-style-type: none"> <li>▪ External balloon-like expansion chamber to contain aerosols and vapors</li> <li>▪ Double membrane system</li> <li>▪ Luer-lock adaptor</li> </ul>

NIOSH also recommends that as passive fail-safe systems, CSTDs, have safety features that:

- Tell the user whether or not the safety feature is activated
- Cannot be deactivated and remains protective until disposal
- Can perform reliably
- Is easy to use and practical (e.g. compliance)
- Is safe and effective for patient care
- Has been validated with solid- and lipid-based drugs

**Administrative Controls**

Administrative controls should also be considered while implementing engineering controls. Policies need to mandate best workflow practices and delineate access to restricted areas where hazardous drugs are prepared. Employee training programs, with validation, should be instituted along with annual competency testing as technique in drug preparation has a direct influence on contamination—particularly when CSTDs are used. Compliance with institution policies and national guidelines should be well documented.

**Personal Protective Equipment**

Oncology nurses, pharmacists and technicians are undoubtedly more familiar with PPE than any of the afore-mentioned engineering controls. The use of non-permeable gowns and chemotherapy-resistant gloves has been advocated for the past two decades for drug preparation, administration, disposal, and spill cleanup.<sup>26</sup> NIOSH added double-gloving in 2004 due to the high potential for self-contamination of the skin during the removal of contaminated gloves. The following is a list of specific recommendations

- Chemotherapy-resistant gloves
  - Effectiveness influenced by material, thickness and wear-time
  - Nitrile (latex-free rubber), Latex, Polyurethane, Neoprene
  - Long cuffs and powder-free
- Gown
  - Low-permeability fabric such as polyethylene or vinyl
  - Solid front with back closure
  - Elastic or knit cuffs
- Eye protection (if risk of splashing during administration)
- Closed-toe shoes

## Compliance with Personal Protective Equipment

As early as 1980, the use of gloves and other types of protection were “recommended” due to the toxic local dermatologic effects, and the known carcinogenic dangers of some agents.<sup>32</sup> A 1982 survey of 547 nurses demonstrated a higher trend of symptoms for those nurses who were exposed to chemotherapy, although a precise cause and effect analysis was difficult to perform.<sup>33</sup> It is not always possible to cite a direct cause and effect. For example, headaches or nausea can be due to a variety of sources.

Not surprisingly, this voluntary “recommendation” did not result in a high degree of compliance. As stated earlier, the major risk from exposure to hazardous drugs are long-term rather than acute. There are some effects that do not arise until later in life. This lack of immediately evident symptoms may have contributed to the on-going mistaken belief that utilizing protective measures was unnecessary. Indeed, a study by Labuhn and colleagues reported that 59% of the nurses who administered chemotherapy did not wear gowns and gloves.<sup>34</sup> While this is an improvement over a 1985 survey which reported only 18.6% of the nurses always wore gloves (and 0% a disposable gown), Labuhn’s study demonstrated the need for improvement.<sup>35</sup>

In 2001, a survey by Ben Ami showed that despite receiving education regarding the risks of hazardous drugs, 67% of those surveyed did not believe the drugs could be absorbed into the bloodstream, and only half admitted to wearing gloves.<sup>27</sup> Martin and Larson, in their 2003 survey of 500 office and ambulatory clinic nurses, found that only 53% wore gowns during preparation and 31% during administration.<sup>36</sup>

Most recently the ONS Chemotherapy Special Interest Group (SIG) performed a practice survey in 2008 and received 668 responses from nurses in various workplace settings. Ninety-four percent wore gloves for administration and 93% for disposal of hazardous drugs. But when asked about gowns, the figures dropped to 51% and 45%, respectively. While these numbers again show improvement from 2003, compliance with gowns is still relatively poor.<sup>37</sup>

There are many other reasons for low compliance with PPE. Some nurses are still not convinced of the potential dangers of chemotherapy—despite the

body of evidence. Others find PPE cumbersome, and still others may not use gowns and gloves if they are not readily available.<sup>27</sup> Gowns that are stored in a location away from the work area, or gloves that are stocked in only one size can contribute to low compliance. The fact that PPE compliance is still not 100% underscores the need for engineering controls, particularly the use of CTSDs.

## Disposal and Waste

Disposal of hazardous drugs requires the same diligence used in their preparation and administration. In addition, the EPA has specific regulations for how these drugs are handled. Used or partially used containers cannot be mixed with regular trash. It is worth noting that the EPA’s RCRA (Resource Conservation and Recovery Act) list has not been updated since 1976, and several dozen new hazardous drugs have come to market. However, a large number of drugs included in this list (e.g. cyclophosphamide, arsenic trioxide, and melphalan) are still in use today. Therefore, appropriate waste disposal methods should be practiced.

## Employers’ Responsibilities

National guidelines should be reviewed on a regular basis. Each healthcare facility, regardless of whether it is a single physician office, an ambulatory clinic, a community-based hospital, or a large Comprehensive Cancer Center, should have detailed policies and procedures based on the current national guidelines. While each workplace may have different needs, employers are required by OSHA to provide the necessary equipment to protect workers from hazardous exposure. Nurses who do not have access to proper equipment (e.g., gowns or gloves) should discuss this with their employer and advocate for their own safety—particularly in light of the known dangers associated with hazardous drugs.

Areas within the pharmacy where hazardous drugs are prepared should be limited to pharmacy personnel to reduce the potential for exposure. All staff working with hazardous drugs should be properly trained, including the use of all equipment (e.g., closed systems). Annual competency testing should be performed, with an emphasis on meticulous workplace practices, as even the best designed equipment will fail if not used properly. In addition, education should be given to non-nursing/pharmacy personnel who may come in contact with a hazardous drug spill, such as housekeeping or maintenance personnel.

Since compliance is an integral part of preventing exposure, nurses should be directly involved with the selection and testing of safety devices. Again, proper education in the use of these devices is crucial for their success.

Monitoring of staff should be performed to assess for compliance with policies. Employers should also provide employees with the necessary controls to minimize exposure to hazardous agents.

### **Summary**

The antineoplastic chemotherapy agents used for treating cancer patients are indeed hazardous drugs. The known risks of exposure to these drugs has been well documented, and can include acute, long-term, and reproductive complications. It is important for nurses to not only understand these risks, but to also have the requisite safety equipment available to prevent exposure. Nurses must be aware of new guidelines and new safety devices that are available. Above all, education remains the cornerstone for providing a safe environment when preparing or administering highly toxic chemicals.

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### Post-Test

- Which drug preparation cabinet (hood) provides greater protection to a person preparing a mutagenic substance?
  - Horizontal-flow hood
  - Vertical-flow Class II biological safety cabinet
  - Both provide equal safety
  - Neither provides safety
- Which of the following statements is **false** regarding an acute effect from exposure to chemotherapy?
  - Acute effects tend to be more common
  - Acute effects tend to be less serious in nature
  - Acute effects tend to be more generalized
  - All of the above statements are true
- Which of the following adverse effects is generally not linked to long-term exposure to hazardous drugs?
  - Hair loss
  - Menstrual dysfunction
  - Infertility
  - Miscarriages
- According to NIOSH, a drug is considered hazardous if it meets which of the following criteria?
  - Carcinogenic
  - Teratogenic
  - Genotoxic
  - Any of the above
- It is safe to assume that intact vials that contain antineoplastic agents received from the manufacturer are not contaminated with drug on the outside surface.
  - True
  - False
- Which of the following is **NOT** a general characteristic of closed system drug transfer device?
  - It protects integrity of IV fluid container
  - It creates a needle-free closed system
  - The device improves the shelf-life of most drug products
  - The device seals and closes upon disconnect
- All of the following should be considered when comparing closed system transfer devices.
  - Compliance
  - Customization of application
  - Cost
  - Ease of use
  - All of the above
- NIOSH recommends that closed system transfer devices have all of the following safety features except:
  - Cannot be deactivated and remains protective until disposal
  - Devices work only with lipid-based drugs
  - Tell the user whether or not the safety feature is activated
  - Can perform reliably
- Which of the following is not an acceptable piece of personal protective equipment?
  - Chemotherapy-resistant gloves
  - Eye protection
  - Cloth gown
  - Closed-toe shoes
- Which of the following sites is exempt from having policies and procedures based on current national guidelines?
  - Single physician office
  - Ambulatory clinic
  - Community-based hospital
  - Comprehensive cancer center
  - None of the above are exempt



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