# Handling Hazardous Chemotherapeutic Agents:

## Effective Strategies for Risk Containment

# Managing Occupational Risk: Systems and Equipment

Steven L. D'Amato, RPh, BCOP
Maine Center for Cancer Medicine
Scarborough, Maine

# Introduction

- Exposure to cytotoxic drugs has been recognized as a potential health hazard to workers since the 1970s
- No long-term adverse effects of occupational exposure have been conclusively demonstrated – but the risk has been deemed serious enough to warrant guidelines
- OSHA (Occupational Safety and Health Administration) and NIOSH (National Institute for Occupational Safety and Health) have published guidelines for the protection of healthcare workers who work with hazardous agents
- Compliance with guidelines is a documented issue

# Outline

- Factors that affect worker exposure to hazardous agents
- Various systems and approaches used to reduce exposure to hazardous agents
  - Personal protective equipment (PPE)
  - Work-practice controls
  - Engineering controls
  - Closed-system devices
  - Waste management

# What Are Hazardous Drugs?

- The term was first used by the ASHP in 1990 and is currently used by OSHA and NIOSH
- NIOSH Hazardous Drug Alert released in September 2004
- NIOSH considers a drug hazardous if it exhibits 1 or more of the following 6 characteristics:
  - Carcinogenicity
  - Teratogenicity
  - Reproductive toxicity
  - Organ toxicity at low doses
  - Genotoxicity
  - Structure and toxicity profiles of new drugs that mimic existing drugs determined hazardous by the above criteria

# Factors That Affect Worker Exposure

- Drug handling circumstances (preparation, administration, shipping and receiving, disposal)
- Amount of drug prepared
- Frequency and duration of drug handling
- Potential for absorption
- Use of ventilated cabinets or isolators
- PPE
- Closed-system drug preparation and delivery
- Work practices

# Summary of Recommendations

- Assess the hazards in the workplace
  - Working environment, equipment, types of drugs, physical layout, spill response, waste disposal, decontamination
- Handle drugs safely
  - Program for safe handling, policies and procedures, work practices related to drug manipulation and general hygiene
- Use and maintain equipment properly
  - **Develop workplace procedures for using and maintaining all equipment that functions to reduce exposure**

# How to Manage Hazardous Drug Exposure

- Eliminate the source (not an option—no substitutes)
- PPE
- Work practice controls
- Ventilated biological safety cabinet (BSC) or isolator unit (engineering controls)
- Closed-system drug preparation and delivery
- Administrative controls

# Personal Protective Equipment (PPE)

- Protects the worker from absorption or inhalation of hazardous drugs
  - Gloves
    - Double gloves, latex-free, powder-free
  - Gowns
    - Chemoprotective, disposable, back closure, cuffs
  - Respirator/mask
    - Aerosols and spill clean-up
  - Eye protection: when splashing is likely

# Work-Practice Controls

- Goal is to reduce worker exposure
  - When reconstituting drugs, use of negative pressure technique
  - Luer lock syringes and connections
  - Needleless systems
  - Safety needles and catheters
  - Spiking IV containers before adding hazardous drugs
  - Avoiding unspiking IV containers
  - Closed-system drug preparation and delivery

# Work-Practice Controls (*cont'd*)

- Receiving and storage of hazardous drugs
  - Spills are the greatest risk
  - Employees opening and unpacking should wear PPE
  - Store hazardous drugs separately from other drugs
  - Gloves should be worn when transporting vials or syringes to the work area
  - Store and transport hazardous drugs in closed containers
  - Make sure storage area has adequate ventilation

# Engineering Controls

- Equipment designed to contain a hazardous substance
- Ventilated biological safety cabinets (BSCs) or isolator glovebox exhausted 100% to the outside
- Designed to protect workers by containing aerosols generated during the preparation process
- Negative-pressure clean rooms
- Closed-system drug preparation and delivery devices

# SterilchemGARD III Advance Class II, Type A2 Biological Safety Cabinet

$10,000

# ChemoShield® Glovebox

$17,000

# How Gloveboxes Work

- Provide physical barrier between operator and compounding activity
- Materials are passed into the main working chamber through an enclosed pass-through chamber, and accessed through glove ports to perform aseptic manipulations
- Provide better than ISO Class 5 conditions under negative pressure
- Alternative to clean room

# Glovebox vs. Clean Room

- Less space
- Lower startup costs
- Lower operating costs
- Better working conditions?
- Greater sterility assurance
- Effect on productivity?

# Surface Contamination of Antineoplastic Drugs

- 6 sites studied in the US and Canada
- Sampling locations:
  - BSCs, countertops, floors in and adjacent to preparation areas, tabletops, chairs, and floors in treatment areas
- Agents sampled
  - Cyclophosphamide, ifosfamide, fluorouracil

Conner TH, et al. *Am J Health-Syst Pharm.* 1999 56:1427-1432.

# Surface Contamination Results of the 6 Center Studies

- Measurable amounts of the antineoplastic agents were detected in 75% of the pharmacy samples and 65% of the administration samples
- The pharmacy area at the site with the highest number of preparations had considerably more drug contamination
- Contamination was also observed in areas adjacent to the work areas

Conner TH, et al. *Am J Health-Syst Pharm.* 1999 56:1427-1432.

# Surface Safe®

- Two-step applicator kit for BSC decontamination
- **Step 1** – for cleaning contaminated surfaces
  - 5.5” x 10” towelette containing 2% (W/W) specially formulated sodium hypochlorite soap solution
- **Step 2** – neutralizing solution for Step 1
  - 5.5” x 10” towelette containing 1% (W/W) sodium thiosulfate solution and 0.9% (W/W) benzyl alcohol

Cost: Approximately $1.89 per application

# Closed-System Devices for Drug Preparation and Delivery

- NIOSH definition
  - Mechanically prevent the transfer of environmental contaminants into the system and the escape of drug or vapor out of the system

NIOSH Publication No. 2004-165: September 2004.

# Closed-System Preparation and Delivery Products

- Eliminate or minimize caregiver and patient exposure to potentially hazardous agents
- Examples include:
  - PhaSeal®
  - OnGuard™ Contained Medication System
  - ICU Medical Oncology Products

# Closed-System Characteristics

- 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 with hazardous medications
- Upon disconnect, the system seals and closes the system, reducing or eliminating the risk of drips and spills

# Closed-System Considerations

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

# Passive Fail-Safe Systems

- The device is needleless
- The safety feature is an integral part of the device
- The device works **passively** (eg, it requires no activation by the user)
- If user activation is necessary, the safety feature can be engaged with a single-handed technique and allows the worker's hands to remain behind the exposed sharp (if present)

NIOSH ALERT 1999 Publication 2000-108.

# Key Features of Passive Fail-Safe Systems

- The user can easily tell whether the safety feature is activated
- The safety feature cannot be deactivated and remains protective through disposal
- The device performs reliably
- The device is easy to use and practical (eg, compliance)
- The device is safe and effective for patient care
- Validated with solid and lipid-based drugs

NIOSH ALERT 1999 Publication 2000-108.

# PhaSeal System Components

- Protector
- Injector
- Connector
- Infusion Adapter
- Assembly Fixture

# OnGuard™ Contained Medication System

# ICU Genie™

# ICU Spiros™

# ICU Administration Set With Clave® and Spiros™

# Administrative Controls

- Policies and procedures
- Workflow and access to restricted areas
- Employee training program with validation
- Annual competency evaluation
- Documentation

# USEPA Resource Conservation and Recovery Act (RCRA)

- Defines hazardous waste federally in the US
- Listed on 1 of 2 lists
  - U-list (toxic, ignitable, reactive, corrosive)
  - P-list (acutely hazardous)
- RCRA list includes:
  - Chlorambucil, cyclophosphamide, daunorubicin, uracil mustard, arsenic trioxide, DES, streptozocin, melphalan, and mitomycin
- RCRA list has not been updated since 1976
  - More than 100 new chemotherapeutic entities have been approved since then

# Hazardous Drugs vs. Hazardous Waste: Where OSHA & EPA Meet

## OSHA HAZARDOUS DRUGS

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

Examples:
- Chemotherapy agents
- Endocrine disruptors

## EPA TOXIC HAZARDOUS DRUG EXAMPLES

- Arsenic trioxide
- Cyclophosphamide
- Mitomycin
- Melphalan

## EPA IGNITABLE HAZARDOUS DRUG EXAMPLES

- Paclitaxel
- Valrubicin
- Etoposide

## EPA HAZARDOUS WASTE

P&U Listed Examples:
- Epinephrine base
- Warfarin
- Nicotine

Characteristic Examples:
- Formulations containing ≥24% alcohol
- Formulations containing heavy metals
- Strong acids & bases

© 2008 PharmEcology Associates, LLC

# Chemotherapy Waste

- Disposal protocols for chemotherapy waste
  - Empty vials, syringes, IVs, tubing, gowns, gloves
  - Treated as infectious medical waste
- Empty for U-listed waste means all contents that can be removed through normal means
- If container is not empty, it should be placed into a Hazardous Waste Container
- Different disposal facilities used for Regulated Medical Waste and RCRA designated waste

# Common Pharmaceutical Waste Stream Management

| Type of Waste Container | Color Code | Contents | Treatment Method |
|---|---|---|---|
| Red bag (non-pathology) | Red | Biohazardous (RMW) + Rx | Autoclave/ Landfill |
| Red sharps/ needlebox | Red | Biohazardous; needles, etc. + Rx | Autoclave/ Landfill |
| Trace chemo Rx | Yellow or White | Bulk & trace chemo, needles, tubing | RMW Incineration |
| Sewer | | Unused IVs, tablets, etc. | Wastewater treatment plant |
| Municipal Trash | | Unused ointments, etc. | Landfill |

© 2008 PharmEcology Associates, LLC

# Employer's Responsibility

- Guidelines should be reviewed on a regular basis
- Policies and procedures should be developed based on the latest guidelines
- All staff working with hazardous drugs need to be properly trained
- Monitoring staff compliance to established guidelines
- Provide employees with the necessary controls to minimize exposure to hazardous agents

# Summary

- Risks of occupational exposure to hazardous drugs have been established
- New **guidelines** have been established to help guide practices to develop components of a safe handling plan
- Following the current guidelines can reduce employees' exposure to hazardous drugs
- Passive fail-safe systems should be used
- Incorporating a closed-system with passive fail-safe characteristics benefits both the caregiver and patient in preventing exposure to hazardous agents
- Education of clinical and administrative staff is important to develop effective policies and procedures