CASE STUDY

Implementation of a safety program for handling hazardous drugs in a community hospital

FIROUZAN (FRED) MASSOOMI, BILL NEFF, AMY PICK, AND PAULA DANEKAS

Purpose. The implementation of a safety program for handling hazardous drugs in a community hospital is described.

Summary. A committee of representatives of the departments of pharmacy, nursing, human resources, safety, radiology, performance improvement, employee health, and environmental services and members of the hospital administration was formed to formally address the management of hazardous drugs in a community, not-for-profit, adult hospital in Omaha, Nebraska. Published guidelines and regulations were reviewed to determine the hospital's compliance with the handling of hazardous drugs. A knowledge deficit regarding the risk and severity of occupational exposure to hazardous drugs was identified. A formal education plan was immediately implemented providing inservice education to all staff who may come into contact with hazardous drugs. Each drug was electronically tagged in the hospital computer system. The nitrile gloves used in the pharmacy were switched to a brand tested for resistance to chemotherapy drug permeation. The use of personal protective equipment for all health care workers who may come into contact with hazardous drugs was also instituted. Waste stream management was addressed, and a new waste stream was identifed and implemented to address chemicals regulated by the Resource Conservation Recovery Act. Nursing, pharmacy, and housekeeping personnel were extensively educated on the different waste streams and the importance of segregating waste at the point of use. All gloves for housekeeping and laundry service staff were replaced with hazardous-drug-rated nitrile gloves.

Conclusion. A gap analysis allowed a multidisciplinary team to establish a safety program for managing hazardous drugs in a community hospital.

Index terms: Education; Health professions; Hospitals; Protocols; Safety; Team; Toxicity, environmental

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Problem

Occupational exposure to hazardous drugs and chemicals during drug compounding and administration is a real and unpredictable risk.[1-3] Only in the past two decades have guidelines and recommendations been established for the safe handling of hazardous drugs by health care workers. One of the first articles addressing the safe handling of antineoplastics was published in 1981,[4] with subsequent articles further defining the risk of and additional practice standards for handling antineoplastic agents.[5] It was not until 1985 that practitioners were provided guidelines for the safe compounding and administration of hazardous drugs.[6] The American Society of Health-System Pharmacists (ASHP) updated these guidelines in 2006 to provide practitioners with a better understanding of the risks associated with handling toxic agents and the advent of new technologies to minimize occupational exposure.[7]

The Centers for Disease Control and Prevention through the National Institute for Occupational Safety and Health (NIOSH) issued an alert[8] to update the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) technical manual for employers regarding the handling of hazardous drugs.[9] The NIOSH alert contained alarming evidence of the risk associated with handling hazardous drugs and expanded the risk beyond the individuals who compound and administer these products to all individuals (e.g., shipping–receiving staff, housekeeping staff, laundry service staff) who

FIROUZAN (FRED) MASSOOMI, PHARM.D., FASHP, is Pharmacy Operations Coordinator; BILL NEFF, B.S., B.S.PHARM., is Patient Care Pharmacist—Infectious Diseases; AMY PICK, PHARM.D., is Patient Care Pharmacist—Hematology/Oncology; and PAULA DANEKAS, PHARM.D., is Pharmacy Clinical Coordinator, Department of Pharmacy Services, Nebraska Methodist Hospital, Omaha.

Address correspondence to Dr. Massoomi at the Department of Pharmacy Services, Nebraska Methodist Hospital, 8303 Dodge Street, Omaha, NE 68141 (fred.massoomi@nmhs.org).

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may come into contact with these chemicals.[8]

The U.S. Environmental Protection Agency (EPA) published the Resource Conservation Recovery Act (RCRA) in 1976 to address the proper disposal of hazardous chemicals.[10] The list of regulated chemicals included drugs that may be used in hospital pharmacies today. This document addresses the formal disposal of waste associated with the use of certain hazardous drugs.

The aforementioned guidelines and recommendations provide a framework for establishing practice standards for health-system pharmacies; however, ongoing investigations into risk reduction may warrant changes in practice standards. As new information about the safety of hazardous drugs is published, the application of gap analysis may be necessary for existing frameworks.

Nebraska Methodist Hospital (NMH) is a community, not-for-profit, adult hospital in Omaha, Nebraska. It is licensed for 440 beds and has an average daily census of 300. Primary services include oncology, obstetrics, orthopedics, and cardiovascular services. The pharmacy department comprises 21 pharmacist full-time equivalents (FTEs) and 23 supportive pharmacy FTEs. During 2006, the pharmacy department aseptically compounded 2,107 oncology-related hazardous drugs and dispensed 32,621 doses of hazardous drugs (as defined by NIOSH).[8]

The hazardous materials committee of NMH, a subcommittee of the safety committee, was formed in 2004 to formally address the management of hazardous drugs. The committee consisted of representatives of the departments of pharmacy, nursing, human resources, safety, radiology, performance improvement, employee health, and environmental services and members of the hospital administration.

The committee initially decided to examine the stricter recommendations of the 1995 OSHA document[9] and RCRA regulations.[10] However, due to the dating of these documents and the advent of updated recommendations, it was agreed that all regulations and guidelines (OSHA, NIOSH, ASHP, and RCRA) should be formally addressed. The committee decided to formally address all risk points associated with handling hazardous drugs, from the point of ordering to disposal.

To assist in assessing gaps in compliance, the committee prepared a spreadsheet to simplify key points of the recommendations and to compare them with NMH's practices. This spreadsheet incorporated all recommendations from each guideline, provided a crosswalk to similar recommendations, and highlighted the differences among the documents. Each committee member was assigned sections of the guidelines to review based on his or her area of expertise (e.g., pharmacy addressed ordering, compounding, and disposal of hazardous drugs). Each practice or process had to be supported by a policy or practice statement to be considered compliant.

Analysis and resolution

Staff education. An important gap identified was a knowledge deficit of the hospital administration, pharmacy, and nursing personnel regarding the risk and severity of occupational exposure to hazardous drugs. This gap was identified as critical and a priority to address. A formal education plan was immediately implemented providing inservice education to all pharmacy staff and nursing staff involved in the preparation and administration of hazardous drugs.

During the education process, concerns were raised regarding the safety of physicians who prescribe and administer these agents, as well as shipping–receiving staff, housekeeping staff, and laundry service staff who may come into contact with these drugs. These departments were subsequently included in the initial critical inservice education programs.

To ensure continual education on the proper handling of hazardous drugs, a section was added to the annual organization review test required to be taken by all employees. In addition, this information is presented to all new employees of NMH during orientation.

Drug formulary assessment. Comparing NMH's formulary to appendix A of the NIOSH alert helped define the magnitude of risk.[8] The NMH formulary contains 89 of the 136 hazardous drugs listed. Each hazardous drug identified on the formulary was electronically tagged in the hospital computer system with the following alert: "Hazardous Drug, contact Pharmacy for questions." The hazard status of all proposed formulary candidates is assessed before inclusion on the formulary. If a new agent is identified as hazardous, the nursing and pharmacy departments will assess the risks and determine what safety measures are needed before it can be used. To date, the Food and Drug Administration does not require hazardous drugs to bear a symbol that designates them as such.

Receipt of hazardous drugs from wholesalers. The NIOSH document describes the possible occupational exposure risk to personnel working in the hospital's receiving areas. These employees may be at risk of exposure if vials were broken during transport. The wholesaler for NMH labels all totes that contain hazardous drugs. However, the wholesaler limits the labeling of totes to hazardous drugs that are classified as chemotherapeutic agents and does not address other nonchemotherapeutic drugs identified by NIOSH as hazardous.[8] The totes have additional packing material to protect the vials from breaking, and the vials are sealed in a zipper-lock bag with a hazardous drug label. When opening

these totes, NMH purchasing personnel don a mask and two pairs of hazardous-drug-rated nitrile gloves to minimize potential exposure to products that may have been damaged in transport.

During this process, we assessed our current nitrile gloves for chemotherapy permeation resistance and found that the manufacturer had not performed any such testing. Consequently, we switched all nitrile-based gloves used for handling hazardous drugs to a brand (Exteem, Cardinal Health, McGaw Park, IL) that had adequate documentation for chemotherapy permeation resistance for hazardous drugs used in NMH.

Hazardous drug storage. At NMH, the area where hazardous drugs were compounded and stored did not have formal signage alerting employees to the potential hazard. New signage was posted in the main room where hazardous drugs are stored and compounded and in the entrance into the pharmacy. Since there is not a universal symbol for hazardous drugs, the symbol for "warning" was incorporated into the signage (Figure 1).

Based on the findings of Connor et al.[11] regarding the positive surface contamination of chemotherapy drug vials, all chemotherapy agents are kept in the wholesaler's original packaging until they are used in the compounding area. Hazardous drugs are stored in plastic storage bins to minimize the risk of drugs falling out and are labeled using tall-man lettering to minimize look-alike, sound-alike errors.

Figure 1. Signage designating areas used to store and compound hazardous drugs.

Compounding. Hazardous drugs are stored and compounded in an International Organization for Standardization class 7 room with a negative-pressure gradient of 0.02 in of water column. Aseptically compounded hazardous drugs are prepared in a Controlled Environment Testing Association-compliant,[12] negative-pressure, containment sterile isolator. The isolator exhausts 100% of the workspace air to the outside.

Personnel who aseptically compound chemotherapy drugs must don the required personal protective equipment (PPE) outlined by NIOSH[4] and the *United States Pharmacopeia* (*USP*).[13] This includes hair bonnet, shoe covers, a polyethylene gown, facemask, and double gloves with hazardous-drug-rated nitrile gloves.

The isolator is prepared for compounding by decontamination and disinfection. Personnel who decontaminate the isolator must first don the required PPE. Currently, there is no single method that effectively inactivates all possible chemotherapeutic agents.[14,15] However, we use a product that inactivates a majority of agents with a 2% hypochlorite detergent towelette followed by a thiosulfate benzyl alcohol towelette. The hypochlorite solution has been shown to inactivate azathioprine, bleomycin, daunorubicin, etoposide, fluorouracil, mitomycin, vinblastine, and vincristine.[16] The thiosulfate is used to neutralize the hypochlorite solution and inactivate cyclophosphamide, melphalan, ifosfamide, and methotrexate. Alcohol has not been shown to effectively inactivate residual hazardous drug spray and spills[14]; however, it is the last step in preparing the workspace per *USP* chapter 797. All materials used for the decontamination process are handled and disposed of as hazardous drug waste. Once the compounding personnel and isolator are ready, a chemoprotective compounding mat is placed on the compounding space.

Historically, the sterile compounding of hazardous drugs incorporated the highly inaccurate practice of balancing negative and positive pressures within syringes and vials. This process has been shown to lead to the spraying of hazardous drugs onto the workspace.[17] Since 2002, NMH has used a closed-system drug transfer device for compounding chemotherapy drugs to minimize the exposure spray due to overpressurized vials and establish employee consistency with compounding practices.[18,19]

Before the addition of the hazardous drug to the compounded sterile product, each i.v. bag is prespiked with an appropriate i.v. set or inline filter and primed with the contents of the i.v. bag in a horizontal laminar-airflow hood. The primed product is then placed into the isolator for compounding. Once the final product is double-checked in the isolator by a pharmacist, the product is wiped, labeled, and bagged for delivery. Nurses do not prime i.v. lines for any hazardous drugs on the patient care units. The use of an isolator or a closed-system transfer device does not exempt the use of PPE.

Drug delivery. To minimize the risk of spills, compounded hazardous drugs are placed in a 0.003-mm zipper-lock bag, which is clearly labeled as containing a hazardous drug. These bags were developed and are manufactured for our hospital by a local vendor. Each dose of hazardous drug is hand delivered to the nurse or physician who will administer the product to the patient. These products are prohibited from being

delivered via the pneumatic tube system due to concerns over accidental spills and spill management.

Drug administration. The nurses who administer injectable hazardous drugs must be certified by the Oncology Nursing Society certification program to prevent occupational environmental and visitor exposures. Before the administration of a hazardous drug, the nurse places a chemoprotective compounding mat at the site of administration and then dons PPE. The nurse connects the preprimed drug to the infusion pump via a closed-system transfer device. Once therapy is completed, the nurse places all tubing and disposables used for administration back into the labeled zipper-lock bag that was used for delivery. This bag is then placed in the appropriate waste stream.

Waste stream management. EPA requires some hazardous drug waste to be classified as EPA-regulated hazardous waste and further subclassified under the RCRA (Appendix A).[10] Of note, each state may have different regulations for the proper disposal of said waste. Drugs listed as hazardous by federal EPA regulations are listed on one of three lists: P list, U list, and chemical characteristic. P-listed items are considered acutely toxic; both the drug and the container that held the drug are considered hazardous and must be disposed of in an RCRA-approved container. U-listed items are considered toxic. Chemical characteristic items are pharmaceuticals that cause waste to become ignitable, corrosive, reactive, or toxic. They are further defined as ignitable (an aqueous solution containing 24% alcohol or more by volume with a flash point of <140 °F), corrosive (an aqueous solution with a pH of ≤2 or ≥12.5), reactive (waste with properties that are normally unstable and readily undergo violent changes without detonating; that react violently with water; or when mixed with water generates toxic gases, vapors, or fumes in a quantity sufficient enough to cause human and environmental harm), or toxic (primarily heavy metals that may be above maximum concentration or regulatory levels). Under the characteristic waste definitions, the primary ingredient may not be the listed drug as defined by the RCRA regulations; it may be a diluent or a preservative.[10]

RCRA-rated waste should never be combined with chemotherapy compounding waste. In practice, non-EPA-regulated chemotherapy waste is often placed in yellow waste containers. The EPA-regulated waste stream NMH implemented incorporates the use of RCRA-approved containers that are black. This waste must have a manifest documenting the date and weight of the waste. Although NMH designates its waste streams as red, yellow, and black, none of the recommendations or standards defines a color for chemotherapy and EPA-regulated waste.

Nursing, pharmacy, and housekeeping personnel were extensively educated on the different waste streams and the importance of segregating the waste at the point of use. To assist the pharmacy and nursing staff, a poster listing the RCRA-regulated waste is posted in the areas where hazardous drugs are compounded and on the patient care units. In addition to the posters, NMH contracted to have yellow 0.003-mm zipper-lock bags for the disposal of waste in yellow waste streams and black 0.003-mm zipper-lock bags for RCRA-controlled waste made to assist nursing. The color of the bag designates which waste stream bucket to use. This has generated more RCRA-rated waste than expected. It is important to make sure the right waste stream is used, since RCRA-rated waste can be 10 times more expensive to remove from a campus than nonregulated waste.

Environmental services. Using gap analysis, we found that housekeeping staff who worked in areas where hazardous drugs were administered were not wearing PPE beyond standard vinyl gloves. All gloves for housekeeping were replaced with the same hazardous-drug-rated-nitrile gloves used in the pharmacy, since it is impossible to predict when a housekeeper could be exposed to a hazardous drug. In addition, the housekeeping staff is now required to don the same mask and polyethylene gown used by pharmacy for compounding when performing daily cleaning of rooms in which hazardous drugs are administered. Due to the inability of housekeeping or any other hospital staff to determine if a patient is receiving hazardous drugs, NMH established a door placard to alert all hospital personnel of hazardous drug administration.

Staff exposure to patients receiving hazardous drugs was another concern. NIOSH has clearly indicated that body fluids (sweat, emesis) from patients receiving hazardous drugs may contaminate the linen associated with the care of the patient for 48–72 hours postadministration. Interestingly, this is not a new finding, and related guidelines were first published in 1992.[21] NMH contracted to have a yellow linen bag manufactured to assist with the segregation of contaminated linen from normal linen. The vendor for laundry services was educated on the recommendations and the laundry segregation process. Laundry service personnel don the same polyethylene gown and hazardous-drug-rated nitrile gloves when handling the linen of patients receiving hazardous drugs.

Estimated costs. Implementation of a safety program involves incremental costs. However, the cost associated with protecting health care workers from exposure to hazardous chemicals is incalculable. The cost associated with protecting health care workers should be included within the budgeting process, as it is with radiology departments using personal dosimeters and lead aprons.

Appendix B itemizes the cost associated with implementing the NMH safety program for managing hazardous drugs. Costs are based on 2007 pricing and can be used as an estimate for other facilities.

Future projects. Gaps that still need to be formally addressed at NMH include medical surveillance of personnel in direct contact with hazardous drugs (pharmacy and nursing), oral hazardous drugs not administered on the oncology units, all hazardous drugs listed in the NIOSH alert, accurate management of chemotherapy trace-waste and RCRA-regulated pharmaceutical and biohazardous waste with an automated waste segregation system, and nonhospital-based clinics where hazardous drugs are compounded and administered.

Conclusion

A gap analysis allowed a multidisciplinary team to establish a safety program for managing hazardous drugs in a community hospital.

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Appendix A—Pharmaceutical wastes regulated by the Resource Conservation Recovery Act and corresponding Environmental Protection Agency code[20]

Code	Regulated Agent
P-Listed	
P012	Arsenic trioxide
P042	Epinephrine (exempt)
P075	Nicotine
P081	Nitroglycerin (exempt)
P204	Physostigmine
P188	Physostigmine salisylate
P001	Warfarin >0.3%
U-Listed	
U034	Chloral hydrate
U035	Chlorambucil
U044	Cloroform
U058	Cyclophosphamide
U059	Daunomycin
U075	Dichlorodifluoromethane
U089	Diethylstilbestrol
U122	Formaldehyde
U129	Lindane
U150	Melphalan
U151	Mercury
U010	Mitomycin C
U182	Paraldehyde
U188	Phenol
U200	Reserpine
U201	Resorcinol
U202	Saccharine
U205	Selenium
U206	Streptozocin
U237	Uracil mustard
U248	Warfarin <0.3%

Appendix B—Costs associated with implementing safety program for managing hazardous drugs at Nebraska Methodist Hospital[a]

Estimated cost per use for personal protection equipment, $3.17

- Hair cover, $0.09 each
- Mask, $0.13 each
- Polyethylene gown, $0.72 each
- Chemotherapy-rated nitrile gloves (two pairs), $2.00
- Shoe covers (one pair), $0.23

Estimated cost for compounding, $19.73

- PhaSeal device, ~$16.00 per dose (total cost based on number of vials that are reconstituted per dose)
- Surface Safe decontamination, $2.86
- Chemo-mat per dose, $0.87

Estimated cost of waste management

- RCRA-approved 8-gal containers, $12.41 each
- RCRA-regulated waste removal, $42.03 per pound

[a]RCRA = Resource Conservation Recovery Act.