

# Personal Protective Equipment

## Evaluating usage among inpatient and outpatient oncology nurses

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**BACKGROUND:** Chemotherapy agents have long been considered hazardous, and safety for health-care providers when administering these drugs is a primary concern. Personal protective equipment (PPE) is known to decrease exposure to hazardous drugs. Studies report that PPE is underutilized among healthcare providers in inpatient and outpatient settings.

**OBJECTIVES:** The purpose of this study was to examine the use of PPE among inpatient and outpatient nurses while administering hazardous chemotherapy agents.

**METHODS:** This cross-sectional, descriptive study used the Hazardous Drug Handling Questionnaire (HDHQ) to measure nurses' self-reported use of PPE.

**FINDINGS:** Results of the HDHQ indicated that nurses are not using PPE as recommended by hazardous drug administration guidelines. Interventions for proper PPE usage include interprofessional collaboration among oncology nurses, administrators, organizations, and health-care systems to ensure the safety of healthcare providers, patients, and family caregivers.

### KEYWORDS

hazardous agents; safe-handling practices; chemotherapy exposure; drug toxicity

**DRUGS ARE CONSIDERED HAZARDOUS IF STUDIES** in humans or animals indicate that the drugs have the potential to cause cancer, reproductive toxicity, birth defects, or damage to organs at low doses (Couch & West, 2012; U.S. Department of Health and Human Services, 2004). According to the National Institute of Occupational Safety and Health (NIOSH), hazardous drugs typically exhibit one or more of the following characteristics in humans or animals: carcinogenicity, teratogenicity, reproductive toxicity, organ toxicity, and genotoxicity (U.S. Department of Health and Human Services, 2016). Slightly more than half of the drugs meeting the NIOSH criteria for hazardous designation are antineoplastic agents used in the treatment of cancer (U.S. Department of Health and Human Services, 2014).

Administration of chemotherapy has increased in various settings, including free-standing infusion centers; subspecialty physician offices, such as urology and neurology; long-term care facilities; emergency departments; operating rooms; and patients' homes. In addition, the use of antineoplastic agents for nononcologic indications increases the risk and concern for occupational exposure. Therefore, these medications are deemed hazardous materials and can put nurses and other healthcare providers at risk for serious health complications regardless of area of expertise (U.S. Department of Health and Human Services, 2014).

### Chemotherapy Exposure Side Effects

Chemotherapy exposure can potentially harm healthcare providers, particularly nurses, pharmacists, physicians, and ancillary staff (Washington State Department of Labor and Industries, 2015). Negative side effects of exposure to hazardous chemotherapy agents are classified as acute or chronic. According to NIOSH (2019), acute or short-term effects from chemotherapy exposure have been observed in patients treated with antineoplastic agents, as well as in healthcare providers who administered these drugs. Acute effects associated with exposure to antineoplastic agents include skin rashes, allergic reactions, alopecia, nausea and vomiting, and cardiac and hematopoietic toxicities. The Centers for Disease Control and Prevention (CDC) documented numerous studies that identified urine mutagenicity, chromosomal damage, sister chromatid exchange, and DNA damage as biological markers of exposure in healthcare providers exposed

to antineoplastic agents. These biomarkers can potentially lead to long-term adverse effects (NIOSH, 2019). In addition, reproductive issues, such as temporary or permanent infertility and damage to the developing fetuses of pregnant women, were identified by the CDC as potential long-term side effects of chemotherapy exposure (NIOSH, 2018).

### Chemotherapy Guidelines

A study by Goodman et al. (1946), one of the first studies on chemotherapy agents, identified concerns related to the handling of hazardous drugs. Despite these concerns, it took about 40 years to develop specific recommendations for chemotherapy preparation and administration. In 1985, the American Society of Health-System Pharmacists (ASHP) recommended safe-handling practices for hazardous drug administration, and the Occupational Health and Safety Administration (OSHA) developed one of the first sets of guidelines for hazardous drugs in 1986 (American Society of Hospital Pharmacists, 1985; U.S. Department of Labor Occupational Safety and Health Administration, 1986). The guidelines were adopted by the U.S. Department of Health and Human Services, ASHP, and OSHA in 1986 (ASHP, 2006; U.S. Department of Health and Human Services, 2004). Although these organizations have provided recommendations and guidelines for safe-handling practices, tremendous discrepancies in compliance exist among healthcare providers, pharmacists, nurses, administrators, and organizations. A major contributing factor to inconsistent safety practices is the nonpunitive nature of the guidelines. Safety measures are often relegated to each organization's own policies and procedures. No governing body mandates proper safety measures for chemotherapy administration.

In 2019, the U.S. Pharmacopeial Convention (USP) will initiate the first mandated safety measures for the safe handling of hazardous agents. These hazardous drug standards will be enforced by the U.S. Food and Drug Administration (FDA) and, worldwide, have been adopted in more than 140 countries (USP, n.d., 2016). Chapter 800, with an expected implementation date of December 2019, outlines chemotherapy safety principles and regulates the proper handling of hazardous drugs across all healthcare settings (USP, n.d., 2016). USP <800> ensures safe handling of hazardous drugs from the manufacturer's delivery of the chemotherapy agents to the organization, during the preparation and storage of agents at pharmacies, while using closed-system devices, when transporting compounded medications within the organization, and during administration and waste disposal on specific units at various organization levels, as well as provides recommendations for the surveillance of healthcare providers administering hazardous drugs. Upon its expected implementation in December 2019, the USP <800> requirements will significantly influence chemotherapy safe-handling practices for all healthcare providers and organizations (USP, 2016).

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**“Consistent and proper use of PPE can eliminate short- and long-term side effects related to chemotherapy exposure.”**

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### Personal Protective Equipment

Various oversight and professional organizations have published guidelines and recommendations that stress the importance of wearing PPE. PPE should be worn before, during, and after the preparation and administration of hazardous agents. The Oncology Nursing Society ([ONS], 2016) advocates for the continued use of PPE to include chemotherapy-designated gowns and gloves, particularly double gloving and using a respirator mask when appropriate. Masks should be worn when there is a chance of inhalation exposure. In addition, goggles or eye protection should be worn in situations when a splash can occur, such as the operating room, administration of chemotherapy into the peritoneal cavity, and cleaning of a chemotherapy spill (ONS, 2016).

In addition, the concept of reusable gowns or reused gowns has also been an area of concern and discussion. In some settings, when multiple patients are seen during a short period of time, a chemotherapy-designated gown can be worn, removed, and worn again by the same healthcare provider. The primary reasons for reusing chemotherapy gowns are cost and availability. Organizations with limited financial resources may not have an abundance of chemotherapy-designated gowns. A study by Eisenberg (2015) acknowledged that gowns, gloves, and other safety equipment are not reimbursed by the Centers for Medicare and Medicaid Services; instead, the equipment costs are absorbed into oncology service budgets. Therefore, affordability can be a potential barrier for the proper use of PPE among healthcare providers, administrators, and organizations.

### Methods

#### Study Design, Sample, and Procedures

A nonrandomized convenience sample of volunteer inpatient and outpatient oncology nurses from a large medical center were invited to complete the Hazardous Drug Handling Questionnaire

(HDHQ). The study included adult oncology RNs and advanced practice nurses who administer chemotherapy. The organization required each of the nurses to have a minimum of one year experience in oncology and a valid ONS chemotherapy card. In addition, eligible participants had to attend the organization's internal three-day oncology course, which consists of an overview of solid and liquid tumors, bone marrow transplantations, chemotherapy administration, and safety measures.

The HDHQ instrument, which is based on updated evidence-based safe-handling recommendations, was developed by Martin and Larson (2003) and later revised by Polovich and Martin (2011) and Callahan et al. (2016). Permission was obtained and granted to use the questionnaire. The nine-page questionnaire required approximately 15–20 minutes to complete. A total of 170 questionnaires were distributed. The convenience sample included 27 inpatient nurses and 67 outpatient nurses. Ninety-four inpatient nurses and one outpatient nurse completed the questionnaire for a 55% response rate.

### Data Analysis

Frequency and descriptive statistics were computed on the demographic data. Independent t tests were performed to describe the usage of PPE during the different phases of chemotherapy administration. Usage of PPE was computed for the full sample (N = 94), as well as for the inpatient and outpatient nurses. Analyses of variance (ANOVAs) were used to determine any differences in behaviors in PPE practice between the inpatient and outpatient nurses. The participants' ages ranged from 24 to 63 years, with a mean age of 38 years. The majority of respondents self-identified as non-Hispanic, and most reported a Bachelor of Science in Nursing degree as their highest level of education. Full demographic statistics are reported in Table 1.

### Results

The results of this study indicate the specific use of PPE among inpatient and outpatient nurses. Behaviors were examined during three phases: (a) administration of chemotherapy, (b) disposal of chemotherapy, and (c) handling of the excreta of patients postchemotherapy administration (see Table 2). No significant differences between the use of PPE were indicated.

Phase one involved examining the use of closed-system devices, which are used to decrease inhalation and dermal exposure during the priming and administration of hazardous chemotherapy agents. Although most organizations require the pharmacy department to prime the chemotherapy, nurses are responsible for priming chemotherapy at some institutions. Therefore, nurses need to be knowledgeable of the proper use of closed-system devices. In this study, closed-system devices were used most of the time (69%), which correlates with most hospital policies requiring the use of closed-system devices to be initiated in the pharmacy department. In addition, the results indicate that

**TABLE 1.**  
SAMPLE CHARACTERISTICS BY SETTING

CHARACTERISTIC	INPATIENT (N = 27)	OUTPATIENT (N = 67)
	$\bar{x}$	$\bar{x}$
Age (years)	30	42
Experience (years)	5	15
CHARACTERISTIC	n	n
<b>Gender</b>		
Female	25	60
Male	2	6
Missing data	–	1
<b>Race</b>		
White	19	46
Hispanic or Latino	2	2
Asian	2	2
Black	1	1
Other or more than one	2	5
Missing data	1	11
<b>Education</b>		
High school diploma	–	6
Associate degree	–	3
Bachelor's degree	21	46
Master's degree	4	7
Doctorate	–	2
Missing data	2	3
<b>Certification</b>		
Not certified	16	27
OCN®	6	24
AOCN®	1	1
AOCNS®	1	1
Nurse practitioner	–	1
Other	2	2
Missing data	1	11

**TABLE 2.**  
USE OF PPE DURING CHEMOTHERAPY  
ADMINISTRATION PHASES BY GROUP

PHASE <sup>a</sup>	INPATIENT		OUTPATIENT		t
	$\bar{X}$	SD	$\bar{X}$	SD	
1 (N = 92)	27.19	5.76	25.78	5.19	1.152
2 (N = 92)	21.07	4.71	18.38	5.48	2.241
3 (N = 91)	16.88	7.32	16.47	6.22	-0.269

<sup>a</sup>p > 0.05 for all phases.  
PPE—personal protective equipment

chemotherapy-designated gloves and gowns and double gloves were used by inpatient and outpatient nurses most of the time. However, eye protection and respirator masks were identified as being used the least during the first phase of chemotherapy administration (see Table 3).

In phase two, the use of chemotherapy-designated gloves, double gloves, other gloves, chemotherapy-designated gowns, reusable gowns, eye protection, and respirator masks was examined. When disposing of hazardous chemotherapy agents, nurses self-reported their highest use of disposable gloves. Similar to phase one, the lowest use of PPE during phase two was wearing eye protection (see Table 4).

In the third phase, the largest use of PPE among inpatient and outpatient nurses was disposable gloves. Consistent with the results in phases one and two, phase three also indicated that the lowest use of PPE was eye protection (see Table 5).

During the chemotherapy administration phase, a difference between inpatient and outpatient nurses was identified in two areas: the use of reusable gowns and the use of respirator masks.

A significant difference between the groups was indicated in the use of reusable gowns ( $F = 5.059, p < 0.05$ ). A cross tabulation determined that 93% of inpatient nurses never reused gowns compared to 72% of outpatient nurses. Differences were also indicated in the use of respirator masks among inpatient and outpatient nurses ( $F = 17.695, p > 0.01$ ). The cross tabulation indicated that 37% of inpatient nurses always use a respirator mask compared to less than 1% of outpatient nurses.

During the disposal phase of chemotherapy administration, a significant difference was indicated between inpatient and outpatient nurses' use of respirator masks ( $F = 30.064, p < 0.01$ ). A cross tabulation determined that 33% of inpatient nurses always used respirator masks compared to 4% of outpatient nurses. In phase three, PPE use while handling excreta postchemotherapy administration, no difference was identified in any of the areas between the inpatient and outpatient nurses.

**Discussion**

The results of the study contribute to the body of knowledge that inpatient and outpatient nurses are not using PPE to their best advantage. Although the study findings suggest that consistent and appropriate use of PPE does not meet the standards of best practice guidelines, the data collected reflect similar outcomes identified in previous studies (Martin & Larson, 2003; Polovich & Martin, 2011). When properly worn, PPE can reduce exposure to hazardous drugs. According to this study's results, consistent and proper use of PPE can eliminate short- and long-term side effects related to chemotherapy exposure. Despite interventions, PPE continues to be a challenge for nurses and healthcare organizations (Martin & Larson, 2003; Polovich & Martin, 2011).

In a descriptive, cross-sectional study, Callahan et al. (2016) administered the HDHQ to 115 nurses working on a high-volume hazardous drug unit. The authors of the study stated that, despite increased knowledge related to safe-handling practices like

**TABLE 3.**  
FREQUENCY OF PPE USE DURING CHEMOTHERAPY ADMINISTRATION (N = 94)

TIME FRAME (%)	CTD	CD GLOVES	OTHER GLOVES	DOUBLE GLOVES	CD GOWNS	OTHER GOWNS	REUSABLE GOWNS	EYE PROTECTION	RESPIRATOR MASKS
Never	3	2	82	29	17	92	73	72	42
1-25	3	1	1	11	6	1	18	15	23
26-50	4	2	8	8	5	1	3	3	5
51-75	1	3	3	5	9	-	-	1	4
76-99	18	9	-	12	13	-	-	2	5
Always	65	77	-	29	44	-	-	1	15

CD—chemotherapy-designated; CTD—closed transfer device; PPE—personal protective equipment

**TABLE 4.**  
FREQUENCY OF PPE USE DURING CHEMOTHERAPY DISPOSAL (N = 94)

TIME FRAME (%)	CD GLOVES	OTHER GLOVES	DOUBLE GLOVES	CD GOWNS	OTHER GOWNS	REUSABLE GOWNS	EYE PROTECTION	RESPIRATOR MASKS
Never	2	80	40	21	87	78	70	46
1–25	–	11	11	14	6	14	15	19
26–50	4	3	7	16	1	2	3	10
51–75	5	–	4	5	–	–	1	3
76–99	13	–	13	9	–	–	1	4
Always	70	–	19	29	–	–	4	12

CD—chemotherapy-designated; PPE—personal protective equipment

PPE, behaviors fell below the recommended standards. Barriers to execute the proper use of PPE and conflicts of interest were identified as possible causes of the decreasing engagement of safe-handling practices.

The results of this study indicated that double gloving, a standard of care in chemotherapy administration, is not uniformly practiced, as has been in the case in previous studies. He, Mendelsohn-Victor, McCullagh, and Friese (2017) reported that in a study of 252 nurses, only 90% wore one pair of chemotherapy-tested gloves. According to Polovich and Martin (2011), double gloving is not a common practice. In a study by Hennessy (2016), double gloving was identified as the most difficult practice to change for many nurses; however, double gloving has been recommended as best practice by NIOSH and ONS for years.

This study identified that chemotherapy-designated gowns were only worn 47% of the time during chemotherapy administration, 31% during the disposal of chemotherapy, and 25% during the

handling of excreta of patients being administered chemotherapy. Martin and Larson (2003) reported that nurses wore gloves more than 50% of the time and that 53% usually wear gloves. In addition, a study by Polovich and Martin (2011) showed that appropriate use of chemotherapy-designated gowns was reported by 62% of nurses preparing hazardous chemotherapy drugs and by 52% of nurses administering chemotherapy to patients. The outpatient nurses in the Polovich and Martin (2011) study reported limited availability of appropriate gowns and acknowledged that a focus on quality patient care hindered the use of PPE.

#### Limitations

This study used a small, homogeneous sample of nurses from a single institution. In addition, the nine-page HDHQ was administered via pen and paper and took approximately 15–20 minutes to complete; therefore, the length of the questionnaire may have deterred some participants from completing the survey.

**TABLE 5.**  
FREQUENCY OF PPE USE WHILE HANDLING EXCRETA POST-CHEMOTHERAPY ADMINISTRATION (N = 94)

TIME FRAME (%)	CD GLOVES	CD GOWNS	OTHER GOWNS	REUSABLE GOWNS	EYE PROTECTION	RESPIRATOR MASKS
Never	39	34	82	89	58	49
1–25	10	12	11	4	26	27
26–50	22	21	1	1	1	2
51–75	4	2	–	–	3	3
76–99	3	2	–	–	6	2
Always	16	23	–	–	–	11

CD—chemotherapy-designated; PPE—personal protective equipment

### Implications for Practice

Proper use of PPE is an opportunity to protect the health and well-being of healthcare providers and patients while delivering important medication. Based on the results of this study, the risk of exposure to hazardous chemotherapy drugs does not appear to be a sufficient impetus for nurses to engage in self-protection mechanisms, which would guard them against the potential toxicity of the drugs being provided to the patient.

The results of this study emphasize the importance of educating nurses on self-protection early in their training and continuing PPE education during staff orientations and annual competencies. Education and training on the proper use of PPE can reduce healthcare providers' risk of exposure to hazardous drugs. Ensuring that nurses understand when to use and when to wear PPE during all phases of chemotherapy administration can protect the healthcare providers administering hazardous drugs and the patients receiving the therapy.

As additional strategies to increase the use of PPE emerge, the organization has updated its educational materials and has hired two clinical educators to review proper use of PPE with staff. The outpatient nurse manager has increased the availability of chemotherapy-designated gowns. In addition, an organization-wide interprofessional team that includes members from pharmacy, nursing, leadership, occupational medicine, housekeeping, and distribution has been developed to meet the necessary requirements from USP <800> for chemotherapy safe-handling. Following the implementation of USP <800>, studies of PPE usage can determine if a positive shift in compliance has occurred among healthcare providers.

### Conclusion

Chemotherapy agents and regimens involve the use of hazardous materials with the potential to cause acute and chronic side effects in patients and the healthcare providers who administer them. Proper use of PPE is a safe-handling best practice, including using chemotherapy-designated gowns, double gloving chemotherapy-tested gloves, and using respirator masks when appropriate. Although the use of PPE in the delivery of hazardous chemotherapy agents has made major advancements, specific guidelines, written recommendations, and the first mandated standards will formally regulate the use of PPE among healthcare providers. This evolution of safe-handling practices protects nurses and other healthcare providers while delivering evidence-based and safe care to patients. Enforcement of safe-handling guidelines requires educating nurses on the full extent of PPE use and creating an interprofessional collaboration of nurses, administrators, organizations, and, in some cases, healthcare systems to ensure the safety of healthcare providers, patients, and family caregivers.

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### IMPLICATIONS FOR PRACTICE

- Educate nurses on the importance of personal protective equipment (PPE) for the safety of healthcare providers, patients, and family caregivers.
- Prepare for the implementation of Chapter 800 (USP <800>) by following evidence-based standards for chemotherapy administration.
- Develop mechanisms of action for self-monitoring proper use of PPE in various practice settings.

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