Factors Influencing Oncology Nurses' Use of Hazardous Drug Safe-Handling Precautions

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Purpose/Objectives: To examine relationships among factors affecting nurses' use of hazardous drug (HD) safe-handling precautions, identify factors that promote or interfere with HD precaution use, and determine managers' perspectives on the use of HD safe-handling precautions.

Design: Cross-sectional, mixed methods; mailed survey to nurses who handle chemotherapy and telephone interviews with managers.

Setting: Mailed invitation to oncology centers across the United States.

Sample: 165 nurses who reported handling chemotherapy and 20 managers of nurses handling chemotherapy.

Methods: Instruments measured the use of HD precautions and individual and organizational factors believed to influence precaution use. Data analysis included descriptive statistics and hierarchical regression. Manager interview data were analyzed using content analysis.

Main Research Variables: Chemotherapy exposure knowledge, self-efficacy, perceived barriers, perceived risk, interpersonal influences, and workplace safety climate.

Findings: Nurses were well educated, experienced, and certified in oncology nursing. The majority worked in outpatient settings and administered chemotherapy to an average of 6.8 patients per day. Exposure knowledge, self-efficacy for using personal protective equipment, and perceived risk of harm from HD exposure were high; total precaution use was low. Nurse characteristics did not predict HD precaution use. Fewer barriers, better workplace safety climate, and fewer patients per day were independent predictors of higher HD precaution use. HD handling policies were present, but many did not reflect current recommendations. Few managers formally monitored nurses' HD precaution use.

Conclusions: Circumstances in the workplace interfere with nurses' use of HD precautions.

Implications for Nursing: Interventions should include fostering a positive workplace safety climate, reducing barriers, and providing appropriate nurse-patient ratios.

More than 5.5 million healthcare workers potentially are exposed to hazardous drugs (HDs) in the workplace (Bureau of Labor Statistics, 2010). Although most drugs defined as hazardous are cytotoxic agents used in the treatment of cancer, many drugs used for other indications and in other patient populations are equally unsafe. The Occupational Safety and Health Administration (OSHA) acknowledged that risk and issued recommendations for the safe handling of HDs 25 years ago (OSHA, 1986). The Oncology Nursing Society (ONS) (Polovich, Whitford, & Olsen, 2009) and the American Society of Health System Pharmacists ([ASHP], 2006) maintain published guidelines for HD safe handling. According to the National Institute for Occupational Safety and Health ([NIOSH], 2004), evidence exists that work environments are contaminated with HDs, which increases the potential for exposure of nurses, pharmacists, and other healthcare workers.

Background

The adverse effects of occupational exposure to HDs are well documented in the literature. HD exposure is associated with acute symptoms such as hair loss, abdominal pain, nasal sores, contact dermatitis, allergic reactions, skin injury, and eye injury (Harrison, 2001; Valanis, Vollmer, Labuhn, & Glass, 1993a, 1993b). Nurses working with HDs have experienced adverse reproductive outcomes, including fetal loss, miscarriage, or spontaneous abortions; infertility (Fransman et al., 2007; Martin, 2003; Valanis, Vollmer, Labuhn, & Glass, 1997); preterm births; and learning disabilities in offspring (Martin, 2003). HD exposure of nurses also has been associated with DNA damage (Fuchs et al., 1995; Yoshida, Kosaka, Tomika, & Kumagai,

2006) and chromosomal abnormalities (McDiarmid, Oliver, Roth, Rogers, & Escalante, 2010; Testa et al., 2007). In addition, the occurrence of cancer increases among occupationally exposed individuals (Hansen & Olsen, 1994; Martin, 2003; Skov et al., 1992), which is consistent with the inherent carcinogenic potential of many HDs.

Because exposure to HDs is associated with adverse outcomes, safe-handling precautions are recommended to reduce or eliminate healthcare worker exposure. Those include biologic safety cabinets for HD preparation; two pairs of disposable gloves that have been tested for use with HDs; a disposable gown made of chemical-protective fabric with long sleeves, cuffs, and back closure; a NIOSH-approved respirator to protect against aerosols when needed; an eye and face shield that provides splash protection when needed; administrative controls (e.g. policies and procedures); and careful work practices to reduce opportunities for exposure (NIOSH, 2004; OSHA, 1999).

Given the potentially serious consequences of HD exposure, why nurses have not universally adopted safe-handling precautions is difficult to explain. All studies on use of personal protective equipment (PPE) published since 1986 reported glove and gown use that was lower than current recommendations (Mahon et al., 1994; Martin & Larson, 2003; Nieweg et al., 1994; Stajicj, Barnett, Turner, & Henderson, 1986; Valanis, McNeil, & Driscoll, 1991; Valanis & Shortridge, 1987).

In the years since the OSHA (1986) guidelines, oncology nurses have incorporated the use of gloves for handling HDs in their practice. Some remaining areas of concern include the fact that chemotherapy-designated gloves are not used in all settings, double gloves are used infrequently, some nurses do not wear gloves for all HD-handling activities, and gown use continues to be low (Mahon et al., 1994; Martin & Larson, 2003; Polovich & Martin, 2011).

The use of HD safe-handling precautions has been well documented, but the reasons for using or failing to use those precautions have not. Occupational safety literature has considered organizational factors important to worker safety (Cooper & Phillips, 2004; Gershon et al., 1995, 2000; Gershon, Stone, Bakken, & Larson, 2004); however, that relationship has not been explored in the area of HD handling. Nurses work as employees in hospitals, clinics, or physician practices; therefore, organizational influence is expected to affect precaution use. Most studies have examined nurse's use of HD precautions from the nurses' perspectives, with no studies identified that examined managers' perceptions of HD handling.

The purposes of this study were to examine relationships among factors that are believed to affect nurses' use of HD safe-handling precautions, to identify factors that promote or interfere with HD precaution use, and to determine managers' perspectives on use of safe-handling precautions. Examining the perspectives of both nurses and managers is important to understanding factors that affect HD precaution use.

Theoretical Framework

The Factors Predicting Use of Hazardous Drug Safe-Handling Precautions model guided this study (see Figure 1). That model was adapted from one used to predict the use of hearing protection devices in high-noise work environments (Lusk, Ronis, & Hogan, 1997), which was based on the Health Promotion Model (Pender, Murdaugh, & Parsons, 2006). The proposed model is integrative because it takes into account the interaction between the person and the situations or environments that influence behavior (Peterson & Bredow, 2004).

To summarize the relationships of the model, knowledge of the hazard is related to perceived risk and self-efficacy. Higher self-efficacy for using PPE and positive organizational influences are expected to decrease perceived barriers. Perceived risk, self-efficacy, perceived barriers, organizational influences, and interpersonal influences are expected to impact use of safe-handling precautions. Finally, conflict of interest was added to

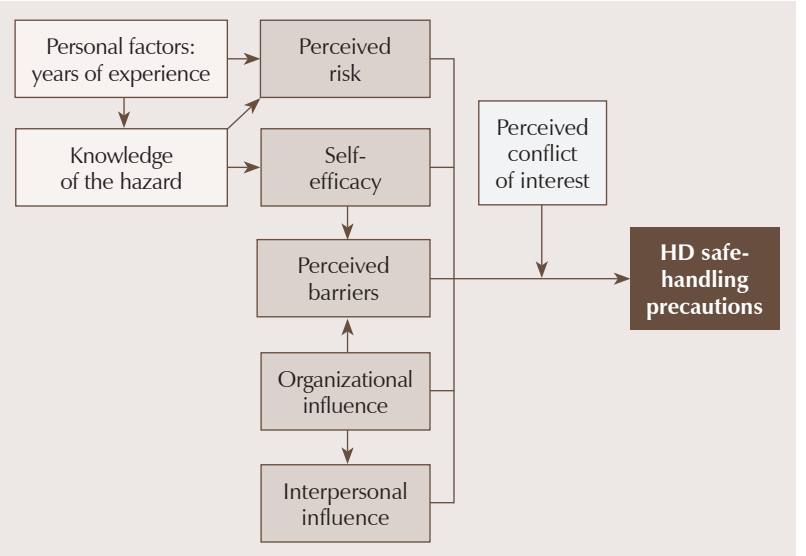

Figure 1. Theoretical Framework: Factors Predicting Use of Hazardous Drug (HD) Safe-Handling Precautions

Note. From "Predictors of Hearing Protection Use for Hispanic and Non-Hispanic White Factory Workers," by D.M. Raymond 3rd, O. Hong, S.L. Lusk, & D.L. Ronis, 2006, *Research and Theory for Nursing Practice: An International Journal, 20,* p. 129. Copyright 2006 by Springer Publishing Company, LLC. Adapted with permission.

the model because with PPE, different from the use of hearing protection, nurses may consider patient needs before their own, which may interfere with the use of safe-handling precautions.

Methods

A cross-sectional, mixed methods design was used with two components. The first was a mailed survey method to reach nurses who currently were involved in handling HDs. The second component was a semi-structured telephone interview to explore managers' perspectives on use of safe-handling precautions in the workplace.

Sample and Recruitment

Nurse participants in the study were RNs employed in oncology settings who reported handling chemotherapy (preparation, administration, disposal, or handling contaminated excreta) in the previous year. Manager participants identified themselves as holding a formal position in which part of their responsibility included supervision of nurses who handle chemotherapy.

To include members and nonmembers of ONS, oncology nurses were identified through their places of employment using a national sample frame. A sample size of 159 was determined sufficient to detect a moderate effect size for the mailed survey (power = 0.8, α = 0.05) (Faul, Erdfelder, Lang, & Buchner, 2007). The recruitment goal for the exploratory component was 20 managers.

Participants were selected from a membership mailing list purchased from the Association of Community Cancer Centers. Surveys were mailed to potential RN and manager participants. The Tailored Design Method (Dillman, 2007), which includes multiple contacts with the questionnaire recipient by first class mail, the use of a small incentive, stamped return envelopes, and a respondent-friendly survey, was used to increase the response rate. The response rate was 46% (165 of 359) for nurse participants and 38% (20 of 52) for manager participants.

Instruments

Nurses' use of HD safe-handling precautions, the study outcome, was measured with the **Revised Hazardous Drug Handling Questionnaire** (Martin & Larson, 2003), which was further refined for the current study. The questionnaire was based on the current guidelines for handling of HDs (NIOSH, 2004). Following a pilot study, the instrument was revised so that items measuring the frequency of use of protective equipment were changed from a three-point scale (usually, occasionally, or rarely) to a five-point scale (5 = always, 4 = 76%–99% of the time, 3 = 51%–75%, 2 = 26%–50%, 1 = 1%–25%, and 0 = never) to capture additional variability. Total HD safe-handling precautions is the mean score for five items each from the administration and disposal scales (use of chemotherapy gloves, double gloves, chemotherapy gowns, eye protection, and respirators). Higher scores indicate higher use of safe-handling precautions. The internal consistency reliability for those 10 items was adequate (α = 0.83).

The instruments that measured the predictor variables were the **Chemotherapy Exposure Knowledge scale**, the **Barriers to Using PPE scale**, a **self-efficacy scale**, and **three items about perceived risk**, which were adapted from measures used in studies of dermal chemical exposure in industrial workers (Geer, Curbow, Anna, Lees, & Buckley, 2006; Geer et al., 2007). Content validity (content validity index = 1) was established by three consultants (two with expertise in HD handling and one with expertise in occupational safety and health) using the universal agreement method (Polit, Beck, & Owen, 2007). All were administered twice, two weeks apart, in a pilot study of 20 oncology nurses who handle HDs. The instruments are available from the authors on request.

The 12-item Chemotherapy Exposure Knowledge scale (Geer et al., 2007) measures knowledge about HD exposure. Response options are true, false, and don't know. Correct responses receive a score of 1, and others receive 0. Possible scores range from 0–12, with higher scores indicating higher knowledge. Internal consistency was acceptable (α = 0.7).

The 13-item Barriers to Using PPE scale (Geer et al., 2007) has four response options from strongly disagree to strongly agree. Scores have a possible range of 13–52, and higher scores indicate higher perceived barriers. Test-retest reliability was 0.72 and internal consistency was 0.88.

Perceived risk (Geer et al., 2007) was measured with three items having four response options from strongly disagree to strongly agree. The potential range of scores is 1–4, with higher scores indicating higher perceived risk of harm from HD exposure. Test-retest reliability was 0.78 and internal consistency was 0.72.

The Workplace Safety Climate questionnaire was adapted from the Healthcare Worker Questionnaire developed by Gershon et al. (1995, 2005, 2007) (see Figure 2). Gershon used factor analysis to assess construct validity of the original questionnaire, which measures six organizational dimensions (availability of safety equipment, management support, absence of job hindrances, feedback and training, cleanliness and orderliness, and minimal conflict or good communication). The 21 items have five response options from strongly disagree to strongly agree. The potential range of scores is 21–105, with higher scores indicating

Indicate your level of agreement with these statements regarding safety in your workplace.

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Chemotherapy gloves are readily accessible in my work area.	❒	❒	❒	❒	❒
2. Chemotherapy gowns are readily available in my work area.	❒	❒	❒	❒	❒
3. The protection of workers from occupational exposure to chemotherapy is a high priority with management where I work.	❒	❒	❒	❒	❒
4. On my unit, all reasonable steps are taken to minimize hazardous job tasks.	❒	❒	❒	❒	❒
5. Employees are encouraged to become involved in safety and health matters.	❒	❒	❒	❒	❒
6. Managers on my unit do their part to ensure employees' protection from occupational exposure to chemotherapy.	❒	❒	❒	❒	❒
7. My job duties do not often interfere with my being able to follow chemotherapy safe-handling precautions.	❒	❒	❒	❒	❒
8. I have enough time in my work to always follow chemotherapy safe-handling precautions.	❒	❒	❒	❒	❒
9. I usually do not have too much to do so that I can follow chemotherapy safe-handling precautions.	❒	❒	❒	❒	❒
10. On my unit, unsafe work practices are corrected by supervisors.	❒	❒	❒	❒	❒
11. My supervisor talks to me about safe work practices.	❒	❒	❒	❒	❒
12. I have had the opportunity to be properly trained to use personal protective equipment so that I can protect myself from chemotherapy exposures.	❒	❒	❒	❒	❒
13. Employees are taught to be aware of and to recognize potential health hazards at work.	❒	❒	❒	❒	❒
14. In my work area, I have access to policies and procedures regarding safety.	❒	❒	❒	❒	❒
15. My work area is kept clean.	❒	❒	❒	❒	❒
16. My work area is not cluttered.	❒	❒	❒	❒	❒
17. My work area is not crowded.	❒	❒	❒	❒	❒
18. There is minimal conflict within my work area.	❒	❒	❒	❒	❒
19. The members of my work area support one another.	❒	❒	❒	❒	❒
20. In my work area, there is open communication between supervisors and staff.	❒	❒	❒	❒	❒
21. In my work area, we are expected to comply with safe-handling policies and procedures.	❒	❒	❒	❒	❒

Figure 2. Workplace Safety Climate Questionnaire

Note. From "Hospital Safety Climate and Its Relationship With Safe Work Practices and Workplace Exposure Incidents," by R.R.M. Gershon, C.D. Karkashian, J.W. Grosch, L.R. Murphy, A. Escamilla-Cejudo, P.A. Flanagan, . . . L. Martin, 2000, *American Journal of Infection Control, 28,* p. 215. Copyright 2000 by Mosby, Inc. Adapted with permission.

a better safety climate. Test-retest reliability was 0.86 and internal consistency was 0.93.

Conflict of interest was measured using six items adapted from the Healthcare Worker Questionnaire (Gershon et al., 1995). The four response options range from strongly agree to strongly disagree for a potential range of 1–4, with higher scores indicating higher conflict of interest. Test-retest reliability was 0.7 and internal consistency was 0.89.

Interpersonal influence in the workplace, the impact of others on PPE use, was measured using an instrument adapted from McCullagh, Lusk, and Ronis (2002). Four items measure a person's beliefs regarding how much coworkers and supervisors think they should use PPE, and three items measure how often other nurses use protective equipment. The potential range of scores is 0–3, with higher scores indicating a more positive view of coworkers' attitudes toward and use of PPE. Test-retest reliability was 0.92 and internal consistency was 0.8.

Self-efficacy (Geer et al., 2007) was measured by six items with four response options ranging from strongly disagree to strongly agree. The potential range of scores is 6–24, with higher score indicating higher self-efficacy. Test-retest reliability was 0.7 and internal consistency was 0.79.

Managers provided additional data through a semi-structured telephone interview with closed- and open-ended questions about chemotherapy policies in their workplace, nurses' use of PPE, education and training for HD handling, barriers to using HD safe-handling precautions by nurses, and the Workplace Safety Climate questionnaire. A written guide was developed to structure the interview and to encourage each participant to provide answers to all questions. A trained research assistant conducted the interviews.

Procedures

Data collection for the study began after obtaining approval from the Georgia State University Institutional Review Board. Members of the Association of Community Cancer Centers identified as nurses were selected from the mailing list from different geographic regions across the country. Surveys were sent with a cover letter describing the importance of the study and a $5 gift

card as an incentive. A preaddressed, stamped envelope was provided for the return of the study instruments. A thank-you and reminder postcard was sent about one week after the original survey. In addition to the paper study instruments, the questionnaire was made available electronically using a secure version of an online survey service. A Web address was sent in the initial mailing with a link to the online survey. Completing and returning the survey instruments constituted consent for the nurse participants. Managers who responded were contacted by a member of the research team to schedule a telephone interview. A consent form was sent to manager participants, which they were directed to keep for their records. Verbal consent was obtained by telephone before the interview, and participation in the interview constituted consent. Interviews were recorded and transcribed verbatim for accuracy.

Data Analysis

Double data entry was performed, data were compared for accuracy, and errors were corrected. Descriptive statistics were used to depict the characteristics of the sample and major study variables. Spearman's correlation coefficient was computed for the relationships among the predictor variables and between the predictors and total precaution use. A significance value of 0.05 was used for all statistical analyses. Hierarchical multiple regression was performed with the significant predictor variables, examining for a significant change in R^2.

To determine nurse managers' perspectives on use of safe-handling precautions in the workplace, interview data were analyzed using content analysis. The major categories of interest were derived from the theoretical model for the study and were defined so that words and phrases could be coded to belong to only one category. Content coding was conducted by one team member for consistency.

Findings

Sample

Nurse participants (N = 165) were from geographically diverse settings, with the majority of nurses being Caucasian, women, and middle-aged (range = 23–70 years). Most nurses were very experienced in nursing, oncology nursing, and chemotherapy handling; reported being an ONS member; and were certified in oncology nursing. In addition, most nurses reported practicing in outpatient settings. The average number of patients per day for whom they personally handled chemotherapy was 6.8 (median = 6, SD = 5.2, range = 0–35). Table 1 summarizes the descriptive statistics for characteristics of the participants in the study.

Table 1. Sample Characteristics

	Nurses (N = 165)		Managers (N = 20)	
Characteristic	**$\bar{X}$**	**SD**	**$\bar{X}$**	**SD**
Age (years)	46.4	9.26	48.8	10.2
Experience (years)				
Nursing	21.2	9.25	22.4[a]	11.8
Oncology	15.8	7.59	–	–
Manager role	–	–	9	8.8
Characteristic	**$\bar{X}$**	**Mdn**	**$\bar{X}$**	**Mdn**
Treatment volume				
Patients per nurse per day	6.8	6	–	–
Patients in practice setting	25	18	61	30
Characteristic	**n**	**%**	**n**	**%**
Geographic location				
Midwest	47	29	6	30
Northeast	43	26	6	30
Southeast	40	24	3	15
West	25	15	2	10
Southwest	10	6	3	15
Type of setting				
Outpatient	112	68	12	60
Inpatient	24	15	4	20
Both	27	16	4	20
Missing data	2	1	–	–
Type of facility				
Community hospital	56	34	10	50
Physician office	46	28	2	10
Community teaching hospital	36	22	6	30
Public, government hospital, or other	18	11	–	–
Academic health center	7	4	2	10
Missing data	2	1	–	–

[a] One manager was a non-nurse.
Mdn—median

Most managers (N = 20) were Caucasian, women, and middle-aged (range = 30–70 years). One manager was a radiation therapist and all others were nurses. They held titles of manager, director, or supervisor, and two identified themselves as clinical nurse specialists with management responsibilities. Managers generally were experienced in their role (1–29 years), had up to 49 years of nursing experience, and were responsible for 10–300 employees ($\bar{X}$ = 55.6, SD = 63.2, median = 44.5). Most managers worked in outpatient settings (n = 16, 80%), where 2–450 patients received chemotherapy per day ($\bar{X}$ = 61, SD = 108.5, median = 30). One manager was responsible for multiple practice sites.

Theoretical Predictors

Table 2 displays the descriptive statistics for the theoretical concepts. Nurses generally were knowledgeable about chemotherapy exposure. The item most often answered incorrectly (63 of 160 nurses, 39%) was

"Surgical masks provide respiratory protection from chemotherapy aerosols" (correct answer: false). Two items were answered incorrectly by 25 of 162 participants (15%): "Chemotherapy cannot be absorbed from contaminated surfaces" (false), and "Alcohol sanitizer removes chemotherapy residue from hands" (false).

Nurses reported high self-efficacy for using PPE and moderate barriers to using PPE for HD handling. The barrier items with the highest scores were related to PPE being uncomfortable to wear, making nurses feel too hot, and interfering with job duties, as well as coworkers not using PPE.

On average, nurses perceived a high risk of harm from HD exposure. Nurses generally reported a low conflict of interest between the need to protect themselves and care for patients while handling chemotherapy. Based on the interpersonal scales, nurses perceived that coworkers valued and used HD precautions when handling chemotherapy. Nurses also reported that their employing organization's commitment to safety was high.

Nurses' Use of Safe-Handling Precautions

Use of chemotherapy-designated gloves was high for all HD handling activities except for handling contaminated excreta (see Table 3). Gown use was low for all handling activities. Double gloves, eye protection, and respiratory protection rarely were used by nurses in the current sample. Overall precaution use was highest for HD preparation ($\bar{X}$ = 2.7, SD = 0.76) and lowest for handling HD contaminated excreta ($\bar{X}$ = 1.6, SD = 1.3).

Not all nurses participated in all aspects of HD handling. Most nurses reported that they administered (n = 164, 99%) and disposed of HDs (n = 154, 93%), but only 120 (73%) handled HD-contaminated excreta and 32 (19%) prepared HDs. To have a sufficient sample size for hypothesis testing, the main outcome variable, total HD safe-handling precautions, was measured using the 10 items for administration and disposal. Total HD safe-handling precaution use was 1.9 (SD = 1.1, range 0–5).

Relationships Among Predictor Variables and Use of Precautions

The relationships among the theoretical predictors and nurses' use of HD precautions were evaluated using bivariate correlations. Because of the non-normal variable distributions, Spearman rank correlation coefficients (r_s) were calculated (see Table 4). Knowledge of HD exposure was not associated with any other theoretical variable. Higher HD precaution use was associated with all other theoretical variables in the expected direction. Better workplace safety climate was associated with higher self-efficacy, fewer barriers, higher perceived risk, lower conflict of interest, and more positive interpersonal influences. No significant relationships existed between total HD precaution use and nurse characteristics, including education level (r_s = 0.14), age (r_s = 0.06), years of nursing experience (r_s = 0.03), years of oncology experience (r_s = 0.06), or years of chemotherapy experience (r_s = 0.08).

Factors Associated With Nurses' Use of Hazardous Drug Safe-Handling Precautions

Safe-handling precaution use was significantly different based on practice setting, with lower precaution use in private physician offices. Individual and organizational characteristics did not differ significantly between participants working in private physician offices and other types of practice settings; however, nurses in physician offices personally handled chemotherapy for an average of 10.7 (SD = 6) patients per day compared to 5.3 (SD = 3.9) patients per day

Table 2. Descriptive Statistics for Theoretical Predictor Variables

Variable	$\bar{X}$	SD	Range		Meaning
			Observed	Possible	
Chemotherapy exposure knowledge	10.9	1.07	7–12	0–12	Higher scores indicate higher knowledge.
Self-efficacy for using personal protective equipment	20.8	2.96	12–24	6–24	Higher scores indicate higher self-efficacy.
Perceived barriers	21.94	6.5	13–40	13–52	Higher scores indicate higher perceived barriers.
Perceived risk	3.14	0.58	1.6–4	0–4	Higher scores indicate higher perceived risk of harm.
Interpersonal influence	2.21	0.44	0.5–3	0–3	Higher scores indicate a more positive view of coworkers attitudes.
Conflict of interest	1.83	0.62	1–3.5	1–4	Higher scores indicate higher conflict.
Workplace safety climate	88.39	12.03	60–105	21–105	Higher scores indicate a better safety climate.

Table 3. Nurses' Frequency of Use of Safe-Handling Precautions During Various Activities

Precaution	Preparation (N = 32)		Administration (N = 164)		Disposal (N = 154)		Handling Excreta (N = 120)	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Biologic safety cabinet	4.8	0.87	–	–	–	–	–	–
Gloves	4.6	1.2	4	1.7	3.8	1.9	2.9	2.3
Double gloves	1	1.7	1.2	1.9	1.1	1.8	1.3	1.8
Gowns	3.5	1.9	3	2.2	2.9	2.2	1.9	2.1
Eye protection	1.5	2	1.3	1.7	1	1.6	1.2	1.8
Respirator	0.58	1.1	0.61	1.1	0.59	1.2	0.67	1.4
Overall	2.7	0.76	2	1.1	1.9	1.2	1.6	1.3

Note. Response options were 0 = never, 1 = 1%–25%, 2 = 26%–50%, 3 = 51%–75%, 4 = 76%–99%, and 5 = always.

in other types of facilities. Analysis of variance and post hoc testing demonstrated that the mean number of patients per day was significantly higher in private physician office settings, $F(5, 152) = 11.8$, $p < 0.01$. Because a relationship existed between a higher number of patients per day per nurse ($r_s = –0.28$, $p < 0.001$) and lower total HD precaution use, that variable was considered a covariate in further analysis.

Using hierarchical regression analysis, the significant predictors of higher total HD precaution use were a fewer number of patients per day for whom nurses personally administered chemotherapy, fewer barriers to PPE use, and better workplace safety climate, $R^2 = 0.29$, $F(2, 155) = 24.6$, $p < 0.001$. That finding explained 29% of the variance in the final model (see Table 5).

Managers' Perceptions of Nurses' Use of Safe-Handling Precautions

All managers reported having written policies regarding HD safe-handling precautions in their workplace settings. They described those policies as addressing the qualifications for chemotherapy handling, required PPE, procedures for transporting chemotherapy, disposal of HD waste, and handling HD spills.

Although all managers reported having written policies that addressed PPE use in their organization, not all policies reflected current guidelines. Five of 20 (25%) organizations did not require staff to wear gowns during HD handling. One manager stated that gown use was not required by OSHA guidelines, when in fact gowns have been recommended by OSHA since 1986. Two aspects of HD handling were not always addressed in policy: acute exposure management and medical surveillance for HD handlers. Sixteen (80%) organizations had policies describing acute exposure management and only nine (45%) addressed health monitoring of personnel who handle HDs. Policies developed by multidisciplinary committees included all recommended elements. In addition, policies addressed exposure management and health monitoring in organizations where safety officers and employee health professionals were included in policy development and review.

Most managers (n = 16, 80%) reported having orientation programs for chemotherapy handling that consisted of classroom education and supervised practice with a preceptor. Twelve managers (60%) reported using a skill checklist during orientation that included HD precautions. Five of 20 (25%) practice settings had a formal mechanism in place for ongoing monitoring of nurses' compliance with safe-handling policies, 10 (50%) reported using informal "spot checks" to monitor nurses' use of HD precautions, and 5 (25%) sites had nothing in place to monitor nurses' safe-handling precaution use.

When managers were asked why the nurses they supervised might not wear gowns or gloves for HD handling, three reported that their employees had good compliance with PPE in their setting. Managers cited several reasons for nurses not wearing PPE, including gowns not provided by employer (n = 5, 25%), too busy or rushed (n = 5, 25%), gowns uncomfortable or cumbersome (n = 4, 20%), lack of concern for exposure (n = 4, 20%), urgent patient situations (n = 3, 15%), lack of knowledge (n = 3, 15%), poor fitting gloves (n = 1, 5%), concern about cost containment (n = 1, 5%), patients' objections (n = 1, 5%), and precautions being "too extreme" (n = 1, 5%).

Managers scored 67–104 ($\bar{X} = 92.7$, SD = 8.6, potential score = 21–105; $\alpha = 0.92$) on the Workplace Safety Climate questionnaire. Managers' average score was slightly higher than nurses, but both indicated a positive workplace safety climate.

Discussion

Overall, in this sample of nurses who were knowledgeable about HD use, were experienced in handling chemotherapy, were confident in how to use safe-handling precautions, and perceived HD exposure to be a risk to their health, use of HD safe-handling precautions was low. Every HD handling activity represents an opportunity for exposure, and when precautions are not used, the likelihood of exposure increases.

Individual nurse characteristics were not associated with HD safe-handling precaution use, whereas organizational characteristics were. That finding has

Table 4. Relationships Among Nurses' Use of Hazardous Drug (HD) Safe-Handling Precautions and Theoretical Predictor Variables

Variable	Knowledge	Self-Efficacy	Barriers	Risk	Conflict of Interest	Interpersonal Influences	Workplace Safety Climate
Self-efficacy	0.03						
Barriers	–0.04	–0.62**					
Risk	0.13	0.24**	–0.38**				
Conflict of interest	0.07	–0.52**	0.68**	–0.29**			
Interpersonal influences	–0.08	0.43**	–0.51**	0.13*	–0.36**		
Workplace safety climate	0.07	0.67**	–0.65**	0.19**	–0.58**	0.4**	
Total HD precaution use	0.13	0.4**	–0.48**	0.21*	–0.36**	0.24**	0.43**

* $p < 0.05$; ** $p < 0.01$ (one-tailed)

important implications because factors in the workplace environment seem to be the most salient concepts affecting safe-handling practices, but rarely have been considered in studies about HD safe handling. An unexpected finding was that a higher number of patients per day per nurse was associated with lower use of HD precautions.

Several authors (Geer et al., 2006; Mahon et al., 1994; Valanis et al., 1991; Valanis & Shortridge, 1987) have reported that workers cite time pressure or lack of time as a barrier to PPE use across occupational settings. Based on the findings in this study, that assessment seems to be accurate. The number of chemotherapy recipients assigned to a nurse in a day, an objective measure of workload, interfered with HD precaution use. Lack of time also was cited by managers as a reason why nurses may not use PPE.

Implications for Education and Practice

Based on the study findings, the safety climate in an organization has an impact on the routine activities of nurses. That indicates a need for a different focus for efforts to improve nurses' HD precaution use. Current strategies to improve HD precaution use have stressed education to increase exposure knowledge. Although education is a necessary component for precaution use, circumstances in the workplace that interfere with precaution use must be considered if HD safe handling is to improve. Education and training in safe practice is considered an important aspect of a positive safety climate. Hospitals and clinics must provide HD safe-handling education and training not only to increase knowledge, but to demonstrate organizational support for precaution use and worker safety.

Barriers to using PPE, workplace safety climate, and number of patients per day are three specific organizational factors that are related to and have an impact on the use of HD safe-handling precautions. Interventions must address specific factors.

A barrier to HD precaution use is the availability of PPE. Nurses cannot use PPE unless it is provided, and that is an employer's responsibility (NIOSH, 2004). OSHA has the authority to cite and fine organizations that fail to provide appropriate safety equipment to its employees (OSHA, 2004). Adequate supplies of PPE must be provided and use must be encouraged (DeJoy, Murphy, & Gershon, 1995; DeJoy, Searcy, Murphy, & Gershon, 2000; Moore et al., 2005). The current findings and those of studies in other populations demonstrate the influence of positive feedback and reinforcement for safe practices (Dejoy, Gershon, & Schaffer, 2004; Grosch, Gershon, Murphy, & DeJoy, 1999; Moore et al., 2005). Nurses must not be sent actual or implied messages to limit PPE use, which is negative reinforcement.

In the current study, nurses working in physician private practice settings cared for the highest number of patients per day—twice that of nurses working in other settings. Patient assignment is a workplace characteristic over which nurses have little control. Managers must carefully consider workload, not only for safe patient care, but also to reduce interference with nurses' use of HD

Table 5. Summary of Hierarchical Regression Analysis for Factors Predicting Use of Safe-Handling Precautions

Predictor	B	SE	β	t	p
Step 1 ($R^2 = 0.06$)					0.002
Constant	2.29	0.14	–	16.5	< 0.001
Patients per day	–0.05	0.02	–0.24	–3.09	0.002
Step 2 ($\Delta R^2 = 0.23$)					< 0.001
Constant	1.2	0.96	–	1.26	0.209
Patients per day	–0.03	0.02	–0.16	–2.23	0.027
Barriers	–0.05	0.02	–0.28	–3.06	0.003
Workplace safety climate	0.02	0.01	0.25	2.8	0.006

N = 159
SE—standard error

safe-handling precautions. Decreasing nurses' workload may create a conflict for organizations because staffing ratios have an economic impact. Nurses caring for patients receiving chemotherapy should not be too busy to take time to protect themselves from HD exposure. A study demonstrated a relationship between nurse workload and chemotherapy exposure (Friese, Himes-Ferris, Frasier, McCullagh, & Griggs, 2011), thus providing evidence for the influence of nurse-patient ratio on nurse safety.

Implications for Research

Additional research is needed to determine other factors that are relevant to HD precaution use because some factors in the model did not predict safe HD handling. Continued model development using path analysis and structural equation modeling may refine the relationships among the predictors.

Fewer barriers to using HD precautions were a strong predictor of safe-handling precautions; therefore, future research should address ways to reduce barriers. The findings from managers require confirmation in a larger sample. The impact of positive reinforcement for HD safe-handling precaution use by supervisors, systematic ways of monitoring precaution use in day-to-day practice, and validating acuity systems that include chemotherapy complexity in determining patient assignments would be useful.

Finally, HD precaution use other than gloves is lower than current recommendations; therefore, evaluation of the occurrence of exposure and its biologic effects is essential. To date, no registry of data exists connecting nurses' exposure history and health outcomes, making the adverse health effects from HD exposure less likely to be recognized and documented. That differs from other health threats such as exposure to hepatitis B, tuberculosis, and radiation, for which nurses are monitored regularly in the workplace. Without data on exposure to HDs, its full impact may not be realized.

Limitations

The study findings must be considered in the context of some limitations. The nurse sample size was adequate to power the study; however, the sample may not be representative of all nurses handling chemotherapy. ONS members made up 86% of participants, but only an estimated 50% of oncology nurses belong to ONS (A. Stengel, ONS Membership Services, personal communication, December 3, 2007). Oncology certified nurses (OCN®s) may have responded differently than non-OCN nurses; however, access to ONS resources might be expected to bias nurses to better precaution use. Men were underrepresented (2% versus 4% in ONS membership at the time of the study). The number of managers was small, but adequate for the exploratory aspect of this study. In addition, all previously published studies of PPE use have employed self-report measures; therefore, the accuracy of self-report data must be considered a potential limitation.

Conclusions

The current study adds to the body of literature regarding oncology nurses' use of HD safe-handling precautions by moving beyond a descriptive design to a correlational design and including aspects of the organization role in HD safe handling, representing advancement in the understanding of this phenomenon. Nurses often have been held entirely responsible for their own practice, including the use of HD safe-handling precautions. The current findings emphasize the influence that organizations have on nurses' adoption of self-protective behavior, clearly demonstrating that safe practice is a shared responsibility between employers and nurses.

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