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Personal Protective Equipment Use and Hazardous Drug Spills among Ambulatory Oncology Nurses: Results from a Mailed Survey

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Abstract

Purpose/Objectives—To examine patterns and organizational correlates of personal protective equipment (PPE) use and hazardous drug spills.

Design—Cross-sectional mailed survey.

Setting—Ambulatory practices in California, Georgia, and Michigan.

Sample—252 Oncology Nursing Society members who administer hazardous drugs.

Methods—Bivariate and multivariable regression analyses.

Main Research Variables—Outcomes were PPE use and hazardous drug spills. Covariates included nursing workloads, nurses' practice environments, and barriers to PPE use.

Findings—26% reported a recent drug spill. 90% wore only one pair of chemotherapy-tested gloves. Increased PPE use was significantly associated with nurse participation in practice affairs (β = 0.25, 95% CI 0.10 to 0.41), non-private ownership (β= 0.37, 95% CI 0.10 to 0.64), increased nursing workloads (β = 0.03, 95% CI 0.01 to 0.04), and fewer barriers to PPE use (β = 0.65, 95% CI 0.36 to 0.93). Spills were significantly associated with less favorable manager leadership and support (OR 0.68, 95% CI 0.47 to 0.98), and higher workloads (OR 1.03, 95% CI 1.01 to 1.06).

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Conclusions—Drug spills occur often in ambulatory settings. PPE use remains low and barriers to use persist. Higher workloads are associated with both lower PPE use and more spills.

Implications—Managers should monitor and correct aberrant workloads and assure PPE is available and staff are trained.

Knowledge Translation—1) Workloads are an important factor to consider in reducing hazardous drug exposures. 2) Nurses report substantial barriers to exposure prevention, including absence of equipment and lack of training. 3) Educational interventions are needed to improve use of PPE and reduction in hazardous drug exposures

Keywords

antineoplastic agents; nursing staff; workload; occupational exposure; oncology nursing

An estimated 8 million United States health care workers are potentially exposed to hazardous drugs annually (Connor & McDiarmid, 2006; Randolph, 2012). Oncology nurses prepare and administer substantial volumes of antineoplastic drugs, as roughly 18 million doses are administered to adults in the United States annually (Cherry, Woodwell, & Rechtsteiner, 2007). Urinary and blood metabolites have been detected in nurses who handle these drugs (Connor et al., 2010). Adverse health effects from exposures include acute effects (skin rashes, eye irritation, nausea), as well as long-term adverse reproductive issues (infertility, spontaneous abortions, congenital anomalies), and possibly cancers (National Institute for Occupational Safety and Health (NIOSH), 2004; Occupational Safety and Health Administration, 1999).

Despite over 30 years of efforts to improve personal protective equipment (PPE) use and safe-handling guidelines, recent studies have documented work surface contamination and dermal, eye, and inhalation exposure among oncology nurses who report hazardous drug spills (Friese, Himes-Ferris, Frasier, McCullagh, & Griggs, 2012; Kopp, Schierl, & Nowak, 2013). The National Institute for Occupational Safety and Health (NIOSH) 2004 Alert reported workplace hazardous drug exposure as a persistent problem among health care workers (National Institute for Occupational Safety and Health (NIOSH), 2004). The use of chemotherapy-tested gloves, single-use disposable gowns, respirators/masks, eye protection, and closed-system transfer devices are recommended to protect against unintentional exposures (Valanis, Vollmer, Labuhn, Glass, & Corelle, 1992). However, studies that evaluated nurses' safety handling performances have highlighted frequent barriers to PPE use. Despite increased availability of recommended PPE in workplaces, these devices are not always accepted, appropriate, or accessible to nurses (Boiano, Steege, & Sweeney, 2014b; Martin & Larson, 2003; Polovich & Clark, 2012a).

Both the Oncology Nursing Society and the American Society of Clinical Oncology recommend consistent PPE use to reduce drug spills and subsequent exposure (Jacobson et al., 2009). Yet it is less clear what organizational factors may influence PPE use and drug exposure. A 2012 survey of nurses found that lower workloads, nurse participation in decision making, adequate staffing, and two-nurse order verification were associated with lower odds of skin or eye exposure to hazardous drugs (Friese et al., 2012). Additional

studies have shown that fewer reported barriers to protective equipment use and more frequent performance of safety-promoting behaviors were associated with improved hazardous drug safe-handling precautions (Friese et al., 2014; Polovich & Clark, 2012a). Yet few studies have examined organizational factors and barriers across diverse ambulatory settings. A better understanding of mechanisms by which broader organizational structures and processes protect oncology nurses from potential hazardous drug exposure is necessary to inform interventions.

Nurse reports of hazardous drug spills provide insights into the context of understanding high-risk adverse events. We used a cross-sectional multi-state survey of oncology nurses to identify associations between organizational factors and reported barriers and two key outcomes: PPE use and self-reported drug spills. The results will inform policymakers, clinical administrators, and clinicians on how to improve PPE use and reduce potential exposures and potential harm to healthcare workers,

Methods

In 2014, members of the Oncology Nursing Society who resided in Michigan, Georgia, or California (n=654) and held part- or full-time employment status in ambulatory oncology settings were invited to respond to a mailed survey. Using Dillman's total design method to maximize response rates (Dillman, Smyth, & Christian, 2008), we personalized cover letters, provided $40 up-front cash incentives, and sent up to three monthly reminders to non-responders. Participants completed a mailed questionnaire from February through September 2014.

The questionnaire included items relating to the two outcomes of PPE use and hazardous drug spills, key covariates of organizational structure, perceived barriers to PPE use, and personal and practice factors. Measures were selected due to their congruence with Donabedian's Quality of Care Model (Donabedian, 2005) and extant frameworks that examine PPE use by workers (McCullagh, Ronis, & Lusk, 2010).

The study examined two primary outcomes: self-reported PPE use and hazardous drug spills within the last six months. The Revised Hazardous Drug Handling Questionnaire measures frequency of using PPE when preparing or administering hazardous drugs (Martin & Larson, 2003; Polovich & Clark, 2012b). This scale measures use of chemotherapy-tested gloves, double gloving technique, single-use disposable gowns, eye protection, respirators/masks, and closed-system transfer devices on a 6-point Likert Scale (0 = *never*, 5 = *always*). The PPE outcome was derived from a mean score of the six items. The second outcome - reported hazardous drug spills – was treated as a binary outcome; nurses were asked if they had experienced a spill, drop or leak of hazardous drugs greater than 5 mLs within the last six months (*yes* or *no*).

The Safety Organizing Scale measures collective behaviors performed by employees in high-reliability organizations (e.g., nuclear power plants) to mitigate high-stakes operational failures (Vogus & Sutcliffe, 2007). The 9-item scale measures the present safety performance and modifiable actions of clinicians. Items are scored on a 7-point Likert scale

ranging from *not at all* (1) to *a very great extent* (7) that safety behaviors are performed at the workplace. This scale has demonstrated high internal reliability and validity (Vogus & Sutcliffe, 2007; Wilson, 2013).

Nursing practice environments are features of workplaces that enable nurses to deliver high-quality care (Lake & Friese, 2006). Environments were measured using the Practice Environment Scale of the Nursing Work Index (PES-NWI), as revised for ambulatory oncology settings. The revised PES-NWI items reflect the presence of six key work features: collegial nurse-physician relations; participation in practice affairs; managers' ability, leadership and support; staffing and resource adequacy; supportive relations with medical assistants, and; foundations for quality care. A total of 23 items are scored on a 5-point Likert scale, ranging from *strongly disagree* (1) to *strongly agree* (5). Higher scores reflect more positive environments. Each sub-scale was derived from item means. Sub-scales have documented validity and reliability in prior studies (Cronbach alphas for internal consistency ranged from 0.80–0.90) (Shang, Friese, Wu, & Aiken, 2013).

Nurses' reported barriers to wearing PPE were measured from 13 items in Geer's Dermal Exposure Survey (Geer, Curbow, Anna, Lees, & Buckley, 2006). Nurses scored items on a 5-point Likert scale from *strongly disagree* (1) to *strongly agree* (5); the mean across all 13 items was used in analyses. In addition, nurses reported their average workloads (average number of patients cared for during the last shift), oncology practice ownership (privately owned vs. other), and demographics (years of nursing experiences, oncology certification, education level).

Statistical analyses were performed with SAS 9.4. Relationships between the two outcome variables and dependent variables were explored with bivariate analyses, including independent-sample *t*-tests and chi-square tests. Based on the distribution of the outcomes, linear regression models were used to estimate PPE use, with generalized estimating equations specified to account for clustering of nurses within practices. To examine factors associated with hazardous drug spills, multivariable logistic regression models were estimated with generalized estimating equations. To achieve parsimonious models, backward selection procedures removed variables that did not reach significance at $p < .30$. Final models retained main effect covariates that reached significance at $p < .05$. Interaction terms between barriers to PPE and organizational factors were also tested (Knol & VanderWeele, 2012).

Results

In total, 467 nurses completed surveys (70.5% response). Participant information is shown in Table 1. Most participants were female (97%), 43 years or older (79%) with at least 6 years of oncology experience (75%), and worked in outpatient oncology settings (96%). Nurses worked in 132 oncology facilities in California (63% of total), Michigan (21%) and Georgia (16%), with a range of 1 to 12 nurses employed per facility. Slightly more nurses worked in public, non-profit, or government-owned practices (57%) than privately-owned practices (43%). When asked the average direct care workload during nurses' last work shift, 72% of respondents reported providing care to five to nine patients. The final analytical sample

(n=252) excluded 23 respondents who did not meet study criteria, and 192 nurses whose routine work did not include preparing or administering hazardous drugs. We did not observe significant differences among study variables between the analytic sample and excluded participants.

The sample mean (SD) for the PPE use score was 2.4(1.0) out of a maximum possible score of 5. In particular, 224 respondents (90%) wore only one pair of chemotherapy-tested gloves at least 75% of the time during routine administration/preparation activities. However, 22% to 44% of the nurses reported “never” using other recommended PPE or techniques such as gowns, eye protection, double gloving and closed system transfer devices while handling hazardous drugs.

Table 2 shows results from the multivariable linear model for the outcome of PPE use and were adjusted for non-profit ownership and nursing workloads. Backward selection procedures reduced the number of variables included to five. Increased nurse participation in practice affairs, fewer barriers to PPE use, non-profit ownership, and higher workloads were significantly associated with higher scores on the PPE use scale. Collegial nurse-physician relationships were significantly associated with lower scores on PPE use.

Among nurses who routinely prepared or administered hazardous drugs, 51(26%) reported a spill, drop or leak of hazardous drugs of 5 mLs or more within the last six months. Contextual data regarding the spills are provided below (no table). Five exposed individuals reported skin contact or eye contact and four participants reported acute health problems including coughing, nose-burning sensation, and headache. When asked if nurses were concerned about the spill, 25(50%) of the respondents expressed they were somewhat or strongly concerned about the spill. During the spill response, nurses reported wearing the following PPE: 41(80%) used gowns, 29(57%) used chemotherapy-tested gloves, 20(39%) wore double gloves, 28(55%) wore respirators/masks, and 23(45%) wore eye protection. Spills occurred during the following activities: 8(15%) patient-related issue, 9(18%) prepping/spiking intravenous bags, 25(50%) starting/during infusion, 8(15%) drug storage/disposal, 2(<1%) equipment malfunction. Among 17 nurses who used a closed system transfer device during a recent spill, 10 (62%) of them reported a device malfunction.

Table 3 compares organizational factors for those who did and did not report spills. Nurses who reported a hazardous drug spill within the last six months had significantly lower Safety Organizing Scale scores, lower scores on two PES-NWI subscales (nurse participation in practice affairs and manager ability, leadership & support), and increased barriers to PPE use.

After backward selection procedures, three variables were retained in the logistic regression model that estimated the odds of a hazardous drug spill report (Table 4). After adjusting for barriers to PPE use, nurses who reported favorable nurse manager ability, leadership, and support were significantly less likely to report a hazardous drug spill (OR 0.68, 95% CI: 0.47, 0.98, $p = .04$). As nursing workloads increase by one patient, the odds of a hazardous drug spill increase by 3 percent (OR 1.03, 95% CI: 1.01, 1.06, $p = .01$).

Discussion

For over 30 years, recommendations for hazardous drug safe-handling practices have remained relatively constant, yet suboptimal PPE use and hazardous drug spills among oncology nurses are persistent problems. PPE use has increased overall, as reflected in prior work that documents increased glove use from a historic low of 49% to 90% in the current study (Boiano et al., 2014b; National Institute for Occupational Safety and Health (NIOSH), 2004). However, not all recommended types of PPE are accepted, available or accessible in oncology workplaces. Other recommended types of PPE and procedures, including single-use disposable gowns, double gloving practices, eye protection, respirators, and closed system transfer devices, are used less frequently outside of hospital inpatient settings. In our study, 22% to 44% of nurses reported “never” using the latter items. This finding underscores persistent organizational challenges to improve PPE access and adoption.

Consistent with prior studies, survey findings suggest that improved nursing participation in decision making in the practice and fewer barriers can enhance PPE use (Boiano, Steege, & Sweeney, 2014a; Martin & Larson, 2003; Polovich & Clark, 2012b). We observe a counterintuitive relationship between collegial nurse-physician relationships and lower PPE use. It is possible that practices with positive nurse-physician relationships are less formal work environments and may lack standardized processes for routine work. There may be interaction effects among practice ownership, practice size, and nurse physician relationships that could not be tested in the current study. Efforts to improve PPE use in the workplace can occur through engaging nurses in selecting appropriate PPE for purchase, ensuring open communication with facility administrators, and providing opportunities for nurses to participate in decision making. After adjusting for other factors, perceived barriers to PPE use remains the most significant factor associated with PPE use (Sadoh, Fawole, Sadoh, Oladimeji, & Sotiloye, 2006).

Our study found higher PPE use among nurses employed by university, public, and government practices. As practice ownership cannot likely be modified, the study findings underscore the need to improve individual adherence through modifiable administrative controls (e.g., commitments to safety culture, improved nurse practice environments, thoughtful attention to nursing workloads, and deployment of engineering controls).

Our findings suggest lower nursing workloads and more favorable manager support are correlated with fewer reported drug spills. Hazardous drug spills occur relatively frequently, which speaks to the need for increased management attention. Study results document spills relating to infusion, patient handling, medical device malfunction, and storage/disposal. Engineering controls did not reliably operate as designed.

There are several limitations to the current study. The internal reliability of our dependent variable – the PPE use scale – was lower in our sample (0.61) than reported previously (Geer et al., 2006). The distribution of various types of PPE (included on the PPE use scale) had a bimodal pattern; many respondents either reported using PPE very frequently or never. Other limitations included a varying number of respondents per practice and missing data. The cluster size varied from 1 to 12 nurses per practice, and roughly one-third of practices had

only one nurse informant. These limitations are somewhat offset by a large sample size, excellent response rate, and geographic diversity.

Implications for Nursing Practice and Research

Three decades of study have failed to solve the problem of inadequate attention to hazardous drug handling. Our study identifies the need for intervention at both the personal and organizational level. Employers need to ensure workers are adequately protected through increased adherence to engineering, administrative, and PPE control measures. Health care facilities managers may benefit from guidance in how to reduce the risk of hazardous drug exposure among employees, such as by facilitating clinician input on decisions and smooth workloads, and eliminating structural barriers to PPE use. Indeed, the barriers identified in this study were used to design the intervention to improve PPE use examined in a multi-site randomized clinical trial (Friese et al., 2015). Finally, additional longitudinal studies are needed to test the efficacy and effectiveness of interventions that are designed at both the individual and organizational level.

Conclusions

In this three-state sample of oncology nurses who administer hazardous drugs, more frequent use of PPE was associated with higher nurse participation in practice affairs and non-profit ownership. Inverse associations between PPE use and higher physician-nurse collaboration and patient workloads per shift. Self-reported hazardous drug spills occurred less often with increased performance of safety behaviors, more favorable perceptions of management, adequate staffing and resources, and lower barriers to using PPE. The high rate of spills and associated risk of exposure to hazardous drugs suggests that there is a need for employers to increase their efforts to protect workers through use of more effective engineering, administrative, and PPE controls.

References

Boiano JM, Steege AL, Sweeney MH. Adherence to safe handling guidelines by health care workers who administer antineoplastic drugs. Journal of Occupational and Environmental Hygiene. 2014a; 11(11):728–40. http://doi.org/10.1080/15459624.2014.916809. [PubMed: 24766408]

Boiano, JM.; Steege, AL.; Sweeney, MH. Adherence to Safe Handling Guidelines By Healthcare Workers Who Administer Antineoplastic Drugs; Journal of Occupational and Environmental Hygiene. 2014b Sep. p. 37-41.http://doi.org/10.1080/15459624.2014.916809

Cherry, DK.; Woodwell, DA.; Rechtsteiner, EA. National Ambulatory Medical Care Survey: 2005 summary; Advance Data. 2007. p. 1-39.Retrieved from http://www.cdc.gov/nchs/data/ad/ad387.pdf

Connor TH, DeBord DG, Pretty JR, Oliver MS, Roth TS, Lees PSJ, … McDiarmid Ma. Evaluation of antineoplastic drug exposure of health care workers at three university-based US cancer centers. Journal of Occupational and Environmental Medicine. 2010; 52(10):1019–27. http://doi.org/10.1097/JOM.0b013e3181f72b63. [PubMed: 20881620]

Connor TH, McDiarmid MA. Preventing occupational exposures to antineoplastic drugs in health care settings. CA: A Cancer Journal for Clinicians. 2006; 56(6):354–365. http://doi.org/10.3322/canjclin.56.6.354. [PubMed: 17135692]

Dillman DA, Smyth JD, Christian LM. Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method. 2008

Donabedian A. Evaluating the Quality of Medical Care. The Milbank Quarterly. 2005; 83(4):691–729. http://doi.org/10.1111/j.1468-0009.2005.00397.x. [PubMed: 16279964]

Friese CR, Himes-Ferris L, Frasier MN, McCullagh MC, Griggs JJ. Structures and processes of care in ambulatory oncology settings and nurse-reported exposure to chemotherapy. BMJ Quality & Safety. 2012; 21(9):753–9. http://doi.org/10.1136/bmjqs-2011-000178.

Friese CR, McArdle C, Zhao T, Sun D, Spasojevic I, Polovich M, McCullagh MC. Antineoplastic drug exposure in an ambulatory setting: a pilot study. Cancer Nursing. 2014; 38(2):111–7. http://doi.org/10.1097/NCC.0000000000000143.

Friese CR, Mendelsohn-Victor K, Wen B, Sun D, Sutcliffe K, Yang JJ, … McCullagh MC. DEFENS - Drug Exposure Feedback and Education for Nurses' Safety: study protocol for a randomized controlled trial. Trials. 2015; 16(1):171. http://doi.org/10.1186/s13063-015-0674-5. [PubMed: 25928792]

Geer LA, Curbow BA, Anna DH, Lees PSJ, Buckley TJ. Development of a questionnaire to assess worker knowledge, attitudes and perceptions underlying dermal exposure. Scandinavian Journal of Work, Environment & Health. 2006; 32(3):209–18.

Jacobson JO, Polovich M, McNiff KK, Lefebvre KB, Cummings C, Galioto M. … Oncology Nursing Society. American Society Of Clinical Oncology/Oncology Nursing Society chemotherapy administration safety standards. Oncology Nursing Forum. 2009; 36(6):5469–75. http://doi.org/10.1200/JCO.2009.25.1264.

Knol MJ, VanderWeele TJ. Recommendations for presenting analyses of effect modification and interaction. International Journal of Epidemiology. 2012; 41(2):514–520. http://doi.org/10.1093/ije/dyr218. [PubMed: 22253321]

Kopp B, Schierl R, Nowak D. Evaluation of working practices and surface contamination with antineoplastic drugs in outpatient oncology health care settings. International Archives of Occupational and Environmental Health. 2013; 86(1):47–55. http://doi.org/10.1007/s00420-012-0742-z. [PubMed: 22311009]

Lake ET, Friese CR. Variations in Nursing Practice Environments. Nursing Research. 2006; 55(1):1–9. [PubMed: 16439923]

Martin S, Larson E. Chemotherapy-Handling Practices of Outpatient and Office-Based Oncology Nurses. Oncology Nursing Forum. 2003; 30(4):575–581. http://doi.org/10.1188/03.ONF.575-581. [PubMed: 12861318]

McCullagh MC, Ronis DL, Lusk SL. Predictors of use of hearing protection among a representative sample of farmers. Research in Nursing & Health. 2010; 33(6):528–38. http://doi.org/10.1002/nur.20410. [PubMed: 21053386]

National Institute for Occupational Safety and Health (NIOSH). Preventing occupational exposures to antineoplastic and other hazardous drugs in healthcare settings. 2004; 2004 Retrieved from http://www.cdc.gov/niosh/docs/2004-165/pdfs/2004-165.pdf.

Occupational Safety and Health Administration. Controlling Occupational Exposure To Hazardous Drugs: OSHA Technical Manual. 1999. Retrieved from http://www.osha.gov/dts/osta/otm/otm_vi/otm_vi_2.html#5

Polovich M, Clark PC. Factors influencing oncology nurses' use of hazardous drug safe-handling precautions. Oncology Nursing Forum. 2012a; 39(3):E299–309. http://doi.org/10.1188/12.ONF.E299-E309. [PubMed: 22543401]

Polovich M, Clark PC. Factors influencing oncology nurses' use of hazardous drug safe-handling precautions. Oncology Nursing Forum. 2012b; 39(3):E299–309. http://doi.org/10.1188/12.ONF.E299-E309. [PubMed: 22543401]

Randolph, SA. Hazardous drugs in health care settings--recognition and control. Workplace Health & Safety. 2012. http://doi.org/10.3928/21650799-20120828-06

Sadoh WE, Fawole AO, Sadoh AE, Oladimeji AO, Sotiloye OS. Practice of universal precautions among healthcare workers. Journal of the National Medical Association. 2006; 98(5):722–6. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16749647. [PubMed: 16749647]

Shang J, Friese CR, Wu E, Aiken LH. Nursing practice environment and outcomes for oncology nursing. Cancer Nursing. 2013; 36(3):206–12. http://doi.org/10.1097/NCC.0b013e31825e4293. [PubMed: 22751101]

Valanis B, Vollmer WM, Labuhn K, Glass A, Corelle C. Antineoplastic Drug Handling Protection after OSHA Guidelines: Comparison by Profession, Handling Activity, and Work Site. Journal of Occupational and Environmental Medicine. 1992; 34(2)

Vogus TJ, Sutcliffe KM. The Safety Organizing Scale: development and validation of a behavioral measure of safety culture in hospital nursing units. Med Care. 2007; 45(1):46–54. [PubMed: 17279020]

Wilson DS. Registered nurses' collective safety organising behaviours: the association with perceptions of patient safety culture. Journal of Research in Nursing. 2013; 18(4):320–333. http://doi.org/10.1177/1744987112461781.

Table 1

Participant Characteristics

	Analytic Sample (N=252)		**Survey Sample (N=437)**	
	Mean (±SD)		**Mean (±SD)**	
Age	51 (± 10.5)		50 (± 10.5)	
Years in Oncology	13.1 (± 9.5)		14 (± 9.5)	
Nurse Workload	8.6 (± 7.6)		9.9 (± 18.2)	
	n	Percent	n	Percent
Practice Ownership				
-Private	103	42	153	36
-Non-Private	142	58	275	64
States				
-California	157	63	250	57
-Georgia	43	17	79	18
-Michigan	52	20	108	25
Education				
-Diploma or Associate degree	128	51	182	42
-Bachelor’s degree or higher	121	49	248	58

Table 2

Organizational Factors and Personal Protective Equipment Use*

	Parameter Estimate	(95 % CI)	*p* value
Nurse participation in hospital affairs	0.25	0.10 to 0.41	.001
Collegial nurse-physician relations	−0.19	−0.35 to −0.03	.02
Barriers to protective equipment use**	0.65	0.36 to 0.93	<.001
Nursing workloads	0.03	0.01 to 0.04	<.01
Non-private practice ownership	0.37	0.10 to 0.64	<.01

*Multivariable linear regression analysis using generalized estimating equations to account for clustering of nurses within practices.

**Barriers to Protective Equipment Use scale is reverse scored (higher score reflects fewer barriers).

Table 3

Organizational Factors and Nurse-Reported Hazardous Drug Spills

	Spill Reported N= 51 (26%)		Spill Not Reported N=199 (74%)		
	Mean	**SD**	**Mean**	**SD**	**P value***
Safety Organizing Scale	5.2	1.0	5.6	1.0	.03
Nurse Participation in Practice Affairs	2.8	0.9	3.1	0.9	.05
Nurse Manager Ability, Leadership, Support	3.3	1.0	3.6	0.9	.04
Collegial Nurse-Physician Relations	3.8	0.9	4.0	0.8	.15
Staffing and Resource Adequacy	3.3	1.0	3.4	1.0	.50
Nursing Foundations for Quality of Care	4.1	0.4	4.3	0.6	.09
Supportive Medical Assistant Relations	3.6	1.0	3.9	0.87	.15
Barriers to Protective Equipment Use	3.0	0.5	3.3	0.5	.03
Nursing Workload	10.0	12.0	8.0	6.0	.29
Years of Oncology Experience	13.0	9.6	13.0	9.5	.66
Ownership	N	Percent	N	Percent	P value†
Non-Profit	27	52.9	114	59.4	.41
Private, For-Profit	24	47.1	78	40.6	

*p values obtained from independent sample t-tests.

†p values obtained from Likelihood Ratio Chi-square tests. SD: standard deviation.

Table 4

Organizational Factors and Hazardous Drug Spills

	OR	(95 % CI)	P value
Nurse Manager Ability, Leadership, and Support	0.68	0.47 to 0.98	.04
Barriers to Protective Equipment Use	0.65	0.35 to 1.21	.17
Nursing Workloads	1.03	1.01 to 1.06	.01

Logistic regression using generalized estimating equations to account for clustering of nurses within practices. OR: odds ratio. 95% CI: 95% confidence interval.