Effect of Multimodal Educational Intervention on Generalist Graduate Level Nursing Students' Knowledge and Confidence Related to Hazardous Medication Safe-Handling Processes

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Abstract

Prelicensure nursing students administer non-antineoplastic hazardous medications/hazardous drugs (HD) in the clinical setting. There are no regulations regarding education or training requirements for prelicensure nursing students related to HD safety. Lack of standardized education related to HD safe-handling processes increases the risk for HD exposure in the clinical setting. The purpose of this project was to measure the effect of a multimodal educational intervention related to HD on generalist graduate level nursing students' knowledge and confidence related to HD safe-handling processes. A quasi-experimental, single group, pre and posttest study design was utilized with Bandura's Social Learning Theory as the theoretical framework. The multimodal educational intervention included low fidelity simulation, an HD safe-handling video, didactic presentation, discussion and HD safe-handling tip-sheets. The adapted revised Hazardous Drug Handling Questionnaire (HDHQ) was used to measure students' knowledge and confidence pre and post-intervention. Eighteen second-year generalist graduate level nursing students enrolled in the Clinical Nurse Leader Program (CNL) and completing practicum clinical rotations at an academic medical center in the Southeastern United States participated in the project. Statistical significance ($p < .05$) was noted in knowledge, confidence, and self-preparedness assessment mean scores. The educational intervention provided validation regarding necessity and benefit of a HD safety program for prelicensure nursing students. Educational intervention content should be multimodal and geared towards HD awareness and identification, safe-handling processes, and interventions to minimize risk of HD exposure in clinical settings.

Keywords: hazardous medications, hazardous drugs, nursing students, multimodal, PPE, CNL, Clinical Nurse Leader

Effect of Multimodal Educational Intervention on Generalist Graduate Level Nursing Students' Knowledge and Confidence Related to Hazardous Medication Safe-Handling Processes

Approximately eight million healthcare workers (HCW) are at risk for occupational exposure to hazardous medications/hazardous drugs (HD) (US Bureau of Labor Statistics, 2007). The risk for occupational exposure to HD occurs in all aspects of the HD process (i.e. receipt, compounding, administration, disposal, contact with bodily fluids from patients who have received a HD within the past 48 hours). According to the National Institute for Occupational Safety and Health (NIOSH), hazardous medications are not limited to antineoplastic or cytotoxic agents but also include hormonal agents and a variety of medications administered for post-transplant immunosuppression, anticoagulation, and antiviral effects (NIOSH, 2015).

Prelicensure nursing students administer non-antineoplastic HD in the clinical setting. In order to minimize risk of exposure they must receive adequate education related to handling HD and safety strategies. General knowledge related to HD and the practical skills associated with safe-handling are critical concepts and foundational competencies necessary for students entering the clinical setting. There is no regulatory mandate or mandatory requirement for these concepts to be included in the nursing curriculum for prelicensure students. Without this knowledge base and skill set, the students are not equipped with adequate resources to safely handle HD or handle the bodily fluids of patients who are receiving or have received a HD within the prior 48 hours. As a result, they are at increased risk for exposure to HD or HD residue while in the clinical setting. The current rates of HD exposure in the prelicensure student population is unknown; however, a thorough evaluation of the current curricula should be performed.

Curricula should be revised to ensure inclusion of appropriate education and clinical competence related to HD identification and safety standards.

Background

Occupational exposure to HD by healthcare providers has been associated with acute and chronic health effects including hair loss, skin irritation and rashes, allergic reactions, contact dermatitis, infertility, congenital malformations, spontaneous abortions, and malignancies (Fransman et al., 2007). The severity of adverse health effects may depend on the type, amount, and duration of exposure to a HD. The impact of occupational exposure to HD has been studied extensively by the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), Center for Disease Control (CDC), and the U.S. Pharmacopeia Convention (USP) in addition to professional organizations such as the Oncology Nursing Society (ONS) (OSHA, 1986; NIOSH, 2004).

OSHA, NIOSH, and USP are key organizations tasked with developing practice recommendations and standards related to HD. Both NIOSH and OSHA are divisions of government entities Centers for Disease Control (CDC-NIOSH, n.d., United States Department of Labor, n.d.). NIOSH is governed by the CDC; whereas, OSHA is a division within the Department of Labor. OSHA has authority to enforce the safety standards and impose fines or initiate a lawsuit for violations of the its own standards. Unlike OSHA, NIOSH does not have the authority to enforce practice or regulatory standards. NIOSH is an education and research institution that focuses on reducing and minimizing work-related injuries, utilizing global collaborations to enhance workplace safety on an international level, and promoting healthy and safe workplaces within the United States (CDC-NIOSH, n.d.).

USP is not a government entity but works closely with regulatory authorities and government agencies to provide standards related to the purity, quality, strength, and identification of pharmaceutical items, dietary supplements, food ingredients, and medical devices (USP, n.d.). The reproducibility and accuracy of these USP Reference Standards are thoroughly tested and evaluated by various independent commercial, regulatory, and academic laboratories. The federal Food, Drug, and Cosmetic Act (FDCA) has recognized the USP standards in laws, policies, and regulations (Recognition of USP Compounding Standards, n.d.). The U.S. Food and Drug Administration (FDA) and state organizations are responsible for enforcing the various USP standards.

OSHA, NIOSH, and USP identified the risks and implemented the initial HD safe-handling recommendations over 30 years ago (OSHA, 1986). The greatest factors impacting the risk of occupational exposure are contaminated work surfaces, inappropriate handling of HD, and non-adherence to HD safe-handling recommendations (NIOSH, 2004). Despite certain OSHA standards being part of the Code of Federal Regulations (CFR) and being enforceable by law, the HD safe-handling guidance documents by OSHA are practice recommendations and not formal mandates or standards. These recommendations are classified as guidelines and some organizations have opted not to enforce these OSHA recommendations. To increase employer accountability and HCW safety, USP has raised certain OSHA HD recommendations to formal standards that are enforceable by the FDA.

The new standards published by USP, USP <800>, will expand on prior USP regulations and impact all areas of HD handling, compounding, administration, and disposal. USP <800> also outlines required organizational policies and annual educational requirements for all HCW who interact with HD in the workplace.

NIOSH has led a national initiative known as Prevention through Design (PtD). PtD was designed to reduce or prevent occupational exposures, injuries, illnesses, and fatalities via implementation of prevention strategies in all areas that impact HCW. The hierarchy of controls is one of the PtD strategies (NIOSH, 2015). The hierarchy of controls determines the feasibility of interventions that will be effective in controlling occupational exposures. This visual diagram identifies the most protective and effective interventions at the top of the pyramid and the least protective and effective at the bottom of the pyramid (Figure 1). Substitution or elimination of the hazard is depicted at the top of the hierarchy of controls pyramid and donning personal protective equipment (PPE) is at the bottom of the pyramid. Despite offering the most protection, NIOSH acknowledges that elimination or substitution of the hazard (i.e. prescribing a non-hazardous medication whenever possible) is difficult to implement in existing structures within various organizations (NIOSH, 2015). To build on the process of elimination or substitution of the hazard, the Oncology Nursing Society (ONS) has released a position statement indicating organizations should offer alternate work assignments for pregnant, breast-feeding, and HCW who are trying to conceive (ONS, 2017). The alternate work assignments should include options that prevent HCW from administering HD or handling bodily fluids of patients on HD precautions. While this position statement was published by ONS, NIOSH, and OSHA also reference alternate assignments for any HCW involved in any aspect of the HD process.

Administrative controls, including providing education and training, and donning appropriate PPE, are the bottom two areas of the hierarchy of controls pyramid. Even though utilization of appropriate PPE is at the bottom of the hierarchy of controls pyramid, it is a feasible option to minimize occupational exposure to HD. Appropriate use of PPE is the last line of defense

against HD entering a HCW's body (Lin et al., 2019). As reported in a study by Sugiura et al. (2011), HD were not present in the urine samples taken from HCW who donned appropriate PPE during the HD handling processes. This study affirms that donning appropriate PPE during all aspects of the HD process can be effective in minimizing occupational exposure risk to HD. Although the importance of donning and doffing of PPE has been incorporated in HD safe-handling documents for several years, studies have shown use of PPE remains inconsistent and nonexistent in some nursing areas (Martin & Lawson, 2003; NIOSH, 2004; Polovich & Martin, 2008). Studies have been performed to identify barriers with PPE use and the impact of various educational modalities on knowledge gain and educational interventions related to HD safety in the setting of oncology nursing (Polovich & Martin, 2011, Friese et al., 2019).

Despite having educational requirements for HCW, currently there are no regulations that specifically discuss the educational or training requirements for prelicensure nursing students who administer HD and/or care for patients receiving HD during their clinical rotation. In addition to the lack of educational standards for prelicensure nursing students, options for pregnant students, or those attempting to conceive are not mentioned in the regulatory documents or position statements. The lack of required standardized education decreases the students' ability to understand the complexity related to the various aspects of HD handling, administration, and disposal while increasing their risk for occupational exposures to HD during the clinical learning experience. The purpose of this project is to measure the effect of a multimodal educational intervention related to HD on the knowledge and confidence of generalist graduate level nursing students.

Literature Search Methodology

Inclusion and Exclusion Criteria

Research articles that described, studied, or reviewed PPE use with HD, barriers to PPE use by nurses, educational interventions that yielded increased nursing knowledge gain, and/or retention in addition to articles focusing on multimodal educational approaches were included. To ensure the most comprehensive literature review, the search terms, search criteria, and initial inclusion criteria were kept broad. No levels of evidence were excluded. Articles regarding research performed outside of the United States were included; however, articles not written in the English language were excluded.

Search Strategy

The comprehensive search included various electronic databases including: CINAHL, Ovid MEDLINE, PubMed, and Cochrane. To yield the most relevant search results and perform a comprehensive search of the current literature, the nursing librarian was consulted. The nursing librarian aided in refining search criteria, key word combinations, and the search strategy. Initial search terms included “hazardous medication”, “hazardous drugs”, “nursing education”, “knowledge retention”, “teaching methods”, “multimodal teaching approaches”, “antineoplastic”, “oncology nursing”, “hazardous medication exposure”, “hazardous drug exposure”, “occupational exposure”, “Personal Protective Equipment (PPE)”, “NIOSH hazardous drug list”, and “USP <800>”. There were no restrictions regarding age or setting.

The gray literature search included searches on the NIOSH, OSHA, and ONS websites in addition to Google Scholar. The focus of the search included best practice recommendation, guidelines, regulatory standards, reference materials, and position statements from the national

organizations related to hazardous medication education and adherence to hazardous medication safety standards in the workplace. A pharmacist at the academic center, who serves on the USP <800> review board and is the co-chair for the USP <800> preparation committee, was consulted prior to performing the gray literature search.

Selection of Articles

After completion of the initial search, all results were added to Zotero reference manager. The initial search yielded 143 articles related to HD safety standards, HD educational interventions, or multimodal educational approaches. A total of 120 articles remained after removing the duplicate articles. Another 10 articles were excluded due to not meeting the inclusion criteria, being deemed irrelevant to the scholarly project question, or having unclear titles or abstracts. Fifty-three articles were read in full, for relevance to the scholarly project question and aims. The reference lists and citation referrals of the final articles were reviewed to identify other potentially relevant articles.

Review of Literature

Of the 53 articles that were read in full, 44 failed to meet the inclusion criteria and nine were included in the final scoping review (see Figure 2). Five articles focused on educational modalities and knowledge retention, three focused on adherence to safe-handling recommendations for HD, and one focused on knowledge retention related to HD safe-handling recommendations.

Knowledge Gain and Retention Educational Interventions

Five articles discussed the effect of different types of educational interventions on knowledge gain and retention in either the nursing student or nursing population. The educational topic for the studies varied due to limited studies related to the effect of HD related educational interventions on knowledge gain and retention.

Rutherford-Hemming et al. (2016) performed a two group, single-blinded, randomized control longitudinal study comparing the impact of simulation versus an online self-study module on skill performance, knowledge gain, and knowledge retention. Obstetric nurses were recruited from four community hospitals associated with a large non-profit academic hospital in Midwest United States. A total of 64 nurses were randomized to either the simulation (n = 35) or online self-study module (n = 29) related to the basic neurological examination and assessment and detection of neurological changes. Those randomized to the simulation group participated in a 30-minute simulation performing a basic neurological exam on a standardized patient. The simulation included time for a 5-minute simulation to be repeated three times and for a 15-minute debriefing session. Those randomized to the online self-study module completed a 30-minute online self-study module related to a basic neurological assessment.

Rutherford-Hemming et al. (2016) utilized a validated, standardized 14-item performance skill checklist to observe and assess participants performing a basic neurological exam on a patient pre-intervention (baseline), within seven days after the intervention, and at the two months post-intervention mark. Knowledge gain was measured at baseline and knowledge retention measured at the same time points as the skill performance assessment. A validated 12-item Neurological Knowledge Assessment tool was used for the knowledge gain and retention

assessment. Knowledge gain and retention was assessed at baseline, within seven days post-intervention and two months post-intervention. There was a statistically significant increase in skill performance in the simulation group compared to the online self- study group. The short-term (within seven days post-intervention) assessments yielded a mean SD of 67.6 (20.2) for simulation versus 29.6 (19.0) for the online self-study group with $p < .001$. The long-term (2 months post-intervention) assessments were 46.1 (17.6) simulation versus 27.5 (15.9) online self-study with $p < .001$. Despite a statistically significant difference in skill performance, there was not a statistically significant difference in knowledge gain or retention between the groups at either the short-term ($p = .86$) or long-term ($p = .59$) assessments. The knowledge assessment results may be skewed due to the high baseline knowledge scores for participants in both groups, similar information provided in both interventions and nurses indicated using the same tool for each assessment made it easier.

Zinsmaster &Vliem (2016) studied the effect of simulation on knowledge retention related to pediatric neurology in the nursing student population. Their study design was quasi-experimental with repeat measures that included a pretest, immediate posttest, and a four-month knowledge retention test. Zinsmaster & Vliem (2016) recruited 44 junior level undergraduate nursing students to participate in the study. The students were randomized to either a control or intervention group. The control group (n = 19) received a lecture and the intervention group (n = 25) received the lecture and a seven to ten-minute simulation session. The levels of knowledge gain and retention were measured immediately post-intervention and four months post-intervention. The post-intervention results were compared to the pre-intervention baseline knowledge assessment. The same validated 11-item multiple choice knowledge test was utilized for all knowledge assessments. There was no statistically significant difference in baseline

knowledge between the control and intervention groups (p = .257) or at the four-month post-intervention knowledge assessment (p = .420). There was a statistically significant difference between the groups immediately post-intervention (p = .002) with the students in the intervention group having higher scores on the knowledge assessment. Despite producing a higher knowledge gain immediate post-intervention, simulation did not increase long-term knowledge retention.

Ghezeljeh et al. (2015) studied the effect of a multimodal program and lecture on nurses' practice, belief, and knowledge related to hand hygiene. A convenience sample of 282 nurses working in three teaching hospitals affiliated with Lorestan University of Medical Sciences in Khorramabad, Iran was randomly assigned to either the lecture (n = 94), multimodal (n = 110) or control group (n = 120). The control group did not receive any education related to hand hygiene. The lecture group received a lecture related to hand hygiene and the multimodal intervention involved a didactic component, 15-minute hand hygiene video, hand hygiene pamphlets and posters, role playing exercises, photo displays related to hand hygiene techniques, audio announcements through a hospital-wide speaker system, screen saver messages for three months, and questioning and feedback from the hospital infection control staff (Ghezeljeh et al., 2015).

Knowledge, belief, and practice related to hand hygiene was measured pre-intervention (T_1) and two weeks (T_2) and three months post-intervention (T_3). The hand hygiene questionnaire was used as the measurement tool (Ghezeljeh et al., 2015). RM-ANOVA testing showed there was no significant difference between the groups prior to the intervention ($p > .05$); however, there were statistically significant differences between the groups at both post-

intervention measurements ($p < .001$). Scheffe post hoc at T_2 also was statistically significant between the control and both intervention groups ($p < .001$). Scheffe post hoc T_3 was statistically significant between the multimodal intervention and the other groups ($p < .001$). Ghezeljeh et al. (2015) also performed within group RM-ANOVA testing to identify any statistically significant within group differences across all three data points. The within group RM-ANOVA testing for the control group did not show statistically significant differences in the knowledge, belief, or practice means. However, the within group RM-ANOVA analysis did indicate statistically significant differences between the knowledge, belief, or practice means for both the multimodal approach and traditional lecture method.

The results of the study by Ghezeljeh et al. (2015) indicated the multimodal intervention resulted in significant improvement in the knowledge, practice, and belief of hand hygiene techniques for at least three months post-intervention. The traditional lecture also resulted in increased knowledge, practice, and belief; however, the results of the multimodal intervention were stronger at both T_2 and T_3. Ghezeljeh et al. (2015) suggested performing additional studies focusing on new objective measures and do a cost-analysis to determine the cost-effectiveness of the recommended intervention.

Zieber & Sedgewick (2011) studied the impact of simulation on knowledge gain and retention on third and fourth-year undergraduate nursing students. Participants in their study received a three-hour educational presentation followed by a three-hour skills session using high-fidelity simulation. The lecture was based on the American Heart Association (AHA) guidelines and taught by a critical care nurse. The simulation session also was based on the AHA Advanced Cardiac Life Support (ACLS) program. Competence, confidence, knowledge, and

skills performance were measured pre-intervention, immediate post-intervention and three months post-intervention.

The results from the Zieber & Sedgewick (2011) study showed an increase in the level of confidence, competence, knowledge, and skills performance between the pre-intervention and post-intervention assessments. Both the level of confidence and perceived level of competence increased between the pre-intervention and immediate post-intervention and again between the immediate-post and three-month post-intervention measurements. The authors indicated continued exposure to the material after the simulation sessions effected the students' levels of confidence and competence. Despite producing an initial increase in the knowledge level between the pre-intervention and post-intervention assessments, the knowledge gain decreased slightly between the immediate post-intervention and three-month post-intervention assessments. The three-month post-intervention results remained higher than the pre-intervention results; however, it is uncertain if the knowledge level will continue to decrease over time and additional post-intervention assessments would be necessary to determine the longer-term impact on knowledge retention. Zieber & Sedgewick (2011) did not have a control group and the study included a small sample size (n = 24). Without having a control group, it is difficult to determine the impact of simulation on confidence, competence, and knowledge related to the standard education involving the lecture alone.

Durkin (2008) performed a quasi-experimental pilot study comparing knowledge gain and retention between text only computer-based learning (CBL) module and an interactive CBL module related to cranial nerve function and assessment. Cranial nerve function and assessment was selected as the topic for the study since patients with neurological disorders typically were

not admitted to the unit participating in the study. The sample used for this study involved 31 nurses from a single patient care unit at Children's Hospital in Boston. The groups were randomized to either the control or intervention group. The study team developed a 20-question pretest/posttest to measure knowledge pre-intervention, immediate post-intervention and two weeks post-intervention. Both groups showed statistically significant improvements in knowledge post-intervention (p = .000 for both the control and intervention groups) with the intervention group having a greater increase post-intervention. Despite the initial increase in knowledge immediate post-intervention, the knowledge assessment scores for the control group returned to pretest levels at the two week post-intervention assessment. The scores for the intervention group did decrease between immediate post-intervention and the two week post-intervention assessments; however, the scores remained higher than the pre-intervention assessment. Mean scores for text only CBL increased from 24.23 % (pretest) to 55.38 % (posttest 1) and decreased to 36.54 % (posttest 2). Mean scores for the interactive CBL increased from 19.44% (pretest) to 64.44% posttest and dropped to 40.28% (posttest 2). The overall knowledge retention was not statistically significant for either the control or intervention group.

Adherence to Hazardous Medication Safe-Handling Recommendations

Three studies addressing HD safe-handling recommendation and adherence to the recommendations were identified in the literature search. The descriptive, correlational study performed by Polovich & Martin (2011) utilized the Hazardous Drug Handling Questionnaire (HDHQ) to inquire about the safe-handling practices of nurses working in the field of oncology. The HDHQ, a 24-item self-report survey, was provided to 400 nurses who attended the Oncology Nursing Society's 31st Annual Congress with a final total of 330 nurses completing the

HDHQ in its entirety. The HDHQ included items related to availability and use of PPE and Biological Safety Cabinets (BSC) in accordance to the NIOSH recommendations.

The convenience sample of oncology nurses invited to participate in the study by Polovich & Martin (2011) included nurses from the Mid-Atlantic region (4%), West (17%), Northeast (18%), and Midwest region (25%) of the United States. These nurses represented both inpatient and ambulatory locations. Although the majority of the nurses were experienced ($\overline{X}$ = 19, SD = 10.2 total years in nursing and $\overline{X}$ = 12, SD = 7.9 for the total years working in oncology), well educated (57% reported having a bachelor's degree or higher), and certified (70% were certified), only 47 % of the participating nurses reported being aware of the NIOSH Alert related to HD.

Per Polovich & Martin (2011), the reported glove use of 95% - 100% was higher than what was reported in previous studies conducted assessing the PPE use with handling HD. Despite an increase in the use of gloves in general, adherence to the recommended double gloving remained suboptimal at 11% - 18%. The use of gowns during aspects of the HD process remained unchanged when compared to prior studies: 65% reported wearing gowns during HD preparation, 23% when handling excreta from patients receiving HD, and 50% during HD administration. Although the disposable gowns identified for use with HD were single-use gowns, 38% of participants reported reusing these disposable gowns.

Due to the study limitations reported by Polovich & Martin (2011), it may not be feasible to generalize the findings to all nurses who handle HD in general. Reported limitations include: the study may have been biased because the nurses who were invited to participate had attended an education session related to HD and may have increased interest in HD safety; only nurses

who attended the ONS Congress were invited to participate; not all practice settings or areas of the United States were represented equally; and all results were self-reported with no objective observations to validate survey responses.

A cross-sectional, mixed methods survey performed by Polovich & Clark (2012) identified both manager and employee perceived barriers to adherence to HD safe-handling recommendations, and factors that either interfered with or fostered adherence to HD safe-handling recommendations. This study involved 165 nurses and 20 managers from various oncology centers throughout the United States. As part of the inclusion criteria, the nurses had to handle chemotherapy and the managers had to manage nurses who administer chemotherapy. A validated instrument, the Revised Hazardous Drug Handling Questionnaire (HDHQ) was utilized to measure the primary outcome variable, use of HD safe-handling precautions by nurses.

Polovich & Clark (2012) mailed the surveys to participating nurses to self-report PPE use, perceived barriers to PPE use, and perceptions of workplace safety. These surveys also assessed knowledge related to chemotherapy exposure. In order to identify the managers' perspectives related to safe-handling precautions, semi-structured telephone interviews with participating managers were conducted. The telephone interview with managers included both open and closed ended questions related to workplace climate, PPE use by the nurses, and HD education and training that was provided to the nursing staff and the Workplace Safety Climate Questionnaire. A structured written guide for the interviews was developed and used by a trained research assistant when performing the telephone interviews.

The nurses participating in the study worked inpatient (n = 24, % = 15), outpatient (n = 112, % = 68), or worked in both areas (n = 27, % = 16). The types of facilities included

community hospitals (n = 112, % = 68); physician offices (n = 46, % = 28); community teaching hospital (n = 36, % = 22); public, government hospital or other (n = 18, % = 11); or academic medical center (n = 7, % = 4). Some survey respondents did not include their work setting or facility (n = 2, % = 1) (Polovich & Clark, 2012).

The response options for questions related to frequency of adherence to recommended HD safe-handling precautions were: 0 = never, 1 = 1% - 25%, 2 = 26% - 50%, 3 = 51% - 75%, 4 = 76% - 99% and 5 = always (Polovich & Clark, 2012). The overall self-reported use of gloves was higher for most activities involving handling HD (preparation: $\overline{X}$ = 4.6, SD = 1.2, administration: $\overline{X}$ = 4, SD = 1.7, disposal: $\overline{X}$ = 3.8, SD = 1.9, handling excreta: $\overline{X}$ = 2.9, SD = 2.3); however use of the recommended double gloving for HD handling activities was much lower (preparation: $\overline{X}$ = 1, SD = 1.7, administration: $\overline{X}$ = 1.2, SD = 1.9, disposal: $\overline{X}$ = 1.1, SD = 1.8, handling excreta: $\overline{X}$ = 1.3, SD = 1.8) (Polovich & Clark, 2012). The use of gowns (preparation: $\overline{X}$ = 3.5, SD = 1.9, administration: $\overline{X}$ = 3, SD = 2.2, disposal: $\overline{X}$ = 2.9, SD = 2.2, handling excreta: $\overline{X}$ = 1.9, SD = 2.1), eye protection (preparation: $\overline{X}$ = 1.5, SD = 2, administration: $\overline{X}$ = 1.3, SD = 1.7, disposal: $\overline{X}$ = 1, SD = 1.6, handling excreta: $\overline{X}$ = 1.2, SD = 1.8) and respirator (preparation: $\overline{X}$ = 0.58, SD = 1.1, administration: $\overline{X}$ = 0.61, SD = 1.1, disposal: $\overline{X}$ = 0.59, SD = 1.2, handling excreta: $\overline{X}$ = 0.67, SD = 1.4) were low as well.

When the managers were asked about HD safe-handling education or training, most (80%) reported having an orientation program related to chemotherapy handling (Polovich & Clark, 2012). The orientation programs included a combination of supervised practice with a preceptor and structured classroom style education. Sixty percent of the managers reported using a skills checklist to validate skills during the orientation process and 25% reported having formal

mechanisms for continued monitoring for nurse adherence to the HD safe-handling polices. An additional 50% reported having an informal process to periodically monitor adherence to the safe-handling policies and 25% of the managers reported not having any process to monitor nurse adherence to the HD safe-handling policies and recommendations (Polovich & Clark, 2012).

Polovich & Clark (2012) also inquired about manager perceptions to barriers associated with adherence to HD safe-handling processes. The main reported barriers included: gowns not provided or being readily available to nursing staff (25%) and the work busyness (pace) of the work setting (25%). Additional barriers included: lack of concern for personal exposure to HD (20%), gowns were too uncomfortable or cumbersome (20%), lack of knowledge related to HD safe-handling precautions (15%), responding to urgent patient situations (15%), HD safe-handling precautions being "too extreme" (5%), patients objecting to use of PPE (5%), cost containment of PPE (5%), and gloves not fitting properly (5%). As Polovich & Clark (2012) discussed, and supported by the study data, the organizational influence on adherence to HD safe-handling policies and procedures is crucial. In order to increase adherence to the safe-handling recommendations, organizations must provide appropriate PPE and have supplies readily available at the point of care. In addition to having supplies readily available, nurses should receive education related to risks for occupational exposure to HD, strategies to risk reduction, and safe-handling recommendations.

Friese et al. (2019) performed a multisite cluster randomized control trial to determine if nurse adherence to PPE recommendations was impacted by using tailored messages related to known barriers to appropriate PPE use and by providing information regarding HD exposure.

The authors focused on the ambulatory oncology setting and utilized a convenience sample from 12 academic health centers within the United States. A total of 396 nurses were enrolled between March 2015 and March 2017. Of these 396 nurses, 257 completed both the baseline and primary endpoint surveys. The primary outcome variable for the study was the nurses' self-reported PPE use during activities involving HD.

Eligibility requirements for the study performed by Friese et al. (2019) included nurses working a minimum average of 16 hours per week and not having received treatment with an antineoplastic agent within the year prior to enrollment. During the recruitment phase, the research team visited potential sites to present an overview of the study. Each participating site identified study champions consisting of onsite employees who helped disseminate the study related information with potential study participants at their respective sites.

Friese et al. (2019) performed randomization at the site level and after enrollment of eligible participants and completion of baseline surveys. Participants at sites randomized to the control group (n = 226) received a one-hour educational intervention that included a slide presentation with synchronized video and audio content related to HD safe-handling. Per Friese et al. (2019), the information in the slide presentation was based on the current NIOSH recommendations, ONS guidelines, and safe practice recommendations from the American Society of Health-System Pharmacists. Participants who completed the educational intervention and associated quiz were eligible for one contact hour of continuing education credit. Participants also received reminder emails quarterly to help reinforce the safe-handling information presented in the slide presentation.

Participants randomized to the intervention group (n = 189) received access to the same educational intervention that had been provided to the control group and additional short videos addressing identified perceived barriers to PPE use. The additional videos were tailored to discuss the perceived barriers identified in the baseline survey results. The participants of the intervention group self-reported chemotherapy spills that occurred during the study period and submitted plasma samples for comparison to plasma samples collected prior to the initiation of the study. These participants also received quarterly emails prompting them to visit the project site to review the new feedback videos.

The Revised HDHQ was used to measure self-reported adherence to PPE use at baseline and identified endpoints approximately 18 months post-intervention. The results of data from both the control and intervention groups demonstrated suboptimal PPE use pre and post educational interventions. At baseline, the PPE use score was 2.4 (SD = 0.8) for the control group and 2.4 (SD = 0.7) for the intervention group. The difference in PPE use scores between the control and intervention groups at the one-year follow-up time point was not statistically significant ($\overline{X}$ = 2.3, SD = 0.9 for both control and intervention groups). Neither group had statistical significance in perceived barriers to PPE use when comparing data from baseline and follow-up assessments. Information regarding the availability of PPE and frequency of HD administration was not reported.

All the studies related to adherence to HD safe-handling recommendations only focused on the oncology nursing population and may not be generalizable to non-oncology areas (Polovich & Martin, 2011, Polovich & Clark, 2012, Friese et al. (2016). All responses related to PPE use were self-reported by the participating nurses and none of these three studies included

an observation method to objectively validate the use of PPE. These three studies indicated the use of appropriate PPE during activities involving HD remained suboptimal. Although the three studies focused on the nurses' perceptions related to barriers to PPE use, Polovich & Clark (2012) also assessed the perceived barriers from a manager standpoint. This study affirmed the importance of engaged leadership within the organization, managers' active involvement in ensuring staff have the appropriate PPE readily available, and barriers to consistent use of appropriate PPE are addressed in a timely manner.

Hazardous Medication Education for Nursing Students

Zimmer et al. (2016) performed a prospective, controlled trial focused on the effects of educational modalities on knowledge retention related to HD. The subjects for this study included nursing students from a vocational nursing school in Germany. All students (n = 53) were invited to participate and 48 students completed the pre and post-intervention surveys. The routine education involving a "chalk-and-talk" teaching session in the classroom was part of the pre intervention phase (referred to as the status-quo period by the authors). The teaching session included background information related to HD exposure and hazard potential related to HD handling. The intervention period included a multimodal approach composed of a simulated practical skills assessment, interactive discussions, and a 45-minute teaching session. The teaching session included information related to HD safe-handling protection, HD formation, HD distribution, and surface decontamination. The simulated practical skills assessment included skills associated with PPE use, manipulation devices, device cleaning processes, and surface decontamination procedures. Data were collected on knowledge of HD handling (questionnaire), practical skills related to HD administration (simulation), and surface decontamination

(fluorescent imaging). There was a statistically significant increase in knowledge, practical skills, and surface decontamination between the pre and post-intervention assessments ($p < .001$ for all areas).

The gray literature search retrieved two safe-handling toolkits of relevance (Joint Commission, 2016, & ONS, 2018). Both toolkits included educational information regarding developing and implementing an HD program. Both toolkits also provided practice recommendations related to HD administration, PPE use, reducing occupational exposures, HD classification, and methods to reduce and monitor adherence to safety standards. No empiric studies specifically focusing on utilization of these toolkits were identified during the review of literature. In addition to the toolkits, position statements and guidelines related to HD safe-handling recommendations, HCW safety, and interventions to minimize occupational exposure risks published by NIOSH (2015) and OSHA (2016) were identified during the literature search.

Discussion

The primary objectives of the literature review were to ascertain literature relevant to adherence to HD safe-handling standards in both oncology and non-oncology practice settings and identify evidence that supports which interventions have the strongest probability of producing positive outcomes related to increased adherence to safe-handling practices for both nurses and nursing students. Additional aims included identification of educational approaches associated with increased knowledge acquisition and knowledge retention; confidence related to HD safety in prelicensure nursing students; and summarizing the literature findings. The literature review and theoretical framework were utilized as a basis for the development of the multimodal educational intervention for this Doctor of Nursing Practice (DNP) scholarly project.

A total of five articles with relevant interventions related to multimodal educational

interventions and knowledge gain in nurses or students were summarized (Rutherford-Hemming et al., 2016; Zinsmaster & Vliem, 2016; Ghezeljeh et al., 2015; Zieber & Sedgewick, 2011; Durkin, 2008). Three of the articles involved simulation as one part of the intervention (Rutherford-Hemming et al., 2016; Zieber & Sedgewick, 2011; Zinsmaster & Vliem, 2016). One of the studies involving simulation focused on nurses (Rutherford-Hemming et al., 2016) and the other two focused on nursing students (Zieber & Sedgewick, 2011; Zinsmaster & Vliem, 2016). One study focused on written material and completion of CBLs as the interventions (Durkin, 2008) and one study compared a multimodal approach, traditional lecture, and no intervention (Ghezeljeh et al., 2015). All the studies had statistically significant increases in knowledge or skill performance post-intervention; however, all indicated additional testing and/or additional educational interventions are necessary for long-term increase in knowledge and/or skill performance.

Three studies reviewed self-reported use of PPE during the HD safe-handling processes and perceived barriers to consistent use of appropriate PPE (Polovich & Martin, 2011; Polovich & Clark, 2012, Friese et al., 2019). All three articles focused on the oncology nursing population and used the Revised Hazardous Drug Handling Questionnaire (HDHQ) as the outcome measure. The results of the studies indicated suboptimal PPE use and adherence to HD safety protocols. Polovich & Martin (2011) and Friese et al. (2019) suggested additional information is needed to identify feasible educational interventions and monitoring processes to increase understanding of HD exposure and health risks, and strategies to increase adherence to safe-handling procedures. Polovich & Clark (2012) also focused on how the relationship between the manager and the nurses and the relationship between the various oncology organization and oncology nurses impact adherence to PPE use by oncology nurses.

The literature search identified one study related to the effects of multimodal educational interventions on knowledge retention related to HD safety (Zimmer et al., 2016). The study focused on prelicensure nursing students and interventions included didactic components, simulated skills assessment, and interactive discussions. The study yielded statistically significant increases in surface decontamination, knowledge of HD safety, and practical skills related to HD processes. Long term follow-up assessments were not performed, so it was not possible to determine the long-term impact of the educational intervention.

Gaps in the literature

The review of literature revealed a significant gap in research related to HD safe-handling practices in the non-oncology practice settings, a paucity of literature addressing HD educational interventions focused on prelicensure nursing students, and the need for additional studies related to knowledge retention after HD safe-handling educational interventions. There were studies that reviewed the impact of simulation, CBLs, and multimodal educational approaches on knowledge acquisition and other studies related to perceived barriers to adherence to HD safe-handling practices; however, few studies were found that have tested interventions outside of the oncology setting or interventions that targeted students or non-nursing personnel. The Zimmer study (2016) involved HD educational interventions and nursing students was not generalizable to all prelicensure students. This study included practices that are not a standard part of the nursing workflow in all healthcare settings. Zimmer et al., (2016) provided education and assessments related to surface decontamination in the nursing practice areas. However, not all settings required nurses to decontaminate their work surfaces using the wipe testing method. Also, the study was performed in Germany and may not be generalizable to practice settings outside of Germany.

The studies of adherence to the HD safety standards utilized a self-reporting questionnaire or survey to assess adherence to safety standards (Polovich & Martin, 2011; Friese et al., 2019). No objective observational data to validate the survey responses was used in either study. Both studies involved adult oncology settings and focused on chemotherapy administration. As indicated in the limitations section, the study performed by Friese et al (2019) may not be generalizable to community-based or smaller oncology settings. Friese et al (2019) did not mention generalizability of the study or findings to non-oncology settings where HD are administered. Polovich & Martin (2011) also indicated the study and results may not be generalizable to all nurses who administer HD.

Theoretical Framework

Bandura's Social Learning Theory (SLT) was the theoretical framework for this scholarly project. Bandura's SLT influenced a variety of areas of inquiry including health sciences, education, and social policy (Muro & Jeffrey, 2008). Bandura's SLT combined the behavioral and cognitive aspects of individual learning (Bandura, 1993). Bandura theorized that learning social context and individual learning are directly impacted by interactions with people, behavior, and environment. The social context included an emphasis on both internal and external social reinforcement and the overall influence of social interactions. SLT further discussed how individuals learn, perform, and maintain behaviors within the social environment (Smith et al., 2017). SLT not only considered the social interactions in present state, but also recognized the impact of prior experiences on whether an individual would engage in certain behaviors.

The concept of self-efficacy was fundamental to both SLT and knowledge acquisition in the health-care arena (Townsend & Scanlan, 2011). Per Smith et al. (2017), the constant interactions

between the behavioral, cognitive, and social realms was the basis of human behavior. These constant interactions, observing the behaviors/actions of others, and observing the consequences of the behaviors/actions directly influenced an individual's desire and ability to change behavior (Bandura, 1993). Individuals imitated and assimilated observed behaviors, especially those that resulted in positive reactions or rewards. According to Bandura (1977), the act of imitation involved actual replication of observed motor skills.

This type of observational learning occurred at any age throughout the lifespan. The three models of observational learning identified by Bandura included: a live model, verbal instructional model, and a symbolic model (Bandura, 1993). The live model involved someone demonstrating a behavior. The verbal instructional model involved verbal explanations of a particular behavior and the symbolic model included fictional or real characters acting out behaviors in video, written, or online media formats. In addition to observational learning, learning new behaviors also occurred via the modeling process (Bandura, 1974).

The modeling process encompassed four main criteria: attention, retention, reproduction, and motivation (Bandura, 1993). Attention involved individuals noticing and paying attention to a particular behavior. If the behavior is regarded as attractive or similar to the individual one is more likely to pay closer attention to the behavior. After paying attention to the behavior, one had to remember the behavior. Retention of the behavior was increased via practicing the behavior. The next criteria in the modeling process was reproduction. Reproduction involved the ability to replicate or mimic the behavior that was just observed and demonstrated. The final criteria for the modeling process was motivation. Motivation involved the individual wanting or desiring to replicate the behavior. The outcome of the observed behavior and both punishment and reinforcement were important factors for motivation.

The concept of the modeling process and how it relates to learning was the foundation for the development of the multimodal educational interventions for this scholarly project. The didactic presentation in addition to the PPE and HD safe-handling video provided exposure to the desired behavior related to safe-handling processes. The easily accessible tip-sheets were designed to reinforce learning and help with knowledge retention. The low fidelity simulation component of the educational intervention allowed the participants to mimic the observed behavior in a safe learning environment. In addition to mimicking the behavior, positive reinforcement was provided to help foster motivation to replicate the desired behavior in the clinical setting. The educational interventions also corresponded with the three models of observational learning: live model (observations in the clinical environment), verbal model (didactic presentation), and symbolic model (video and written tip-sheets).

Design and Methods

This project utilized a quasi-experimental research design with a convenience sample of second year generalist graduate level nursing students enrolled in a school of nursing in the southeastern United States. The generalist graduate nursing degree program for prelicensure nursing students was an intense two-year program. The generalist graduate nursing program and degree qualified the student to sit for the NCLEX exam. Due to the scarcity of available literature regarding HD educational interventions for nursing students, this project was designed to evaluate the effectiveness of a multimodal educational approach on students' knowledge and confidence related to HD safe-handling processes. The proposed educational intervention included an in-person didactic lecture, low-fidelity simulation with PPE and supplies used when handling HD, a video related to HD safe-handling and PPE use, and HD safe-handling tip-sheets.

This intervention allowed students to receive and review the information in a variety of modalities in a safe learning environment.

One outcome measure, a questionnaire adapted from the revised Hazardous Drug Handling Questionnaire (HDHQ), was used in this project. The original revised HDHQ was designed by Dr. Martha Polovich. This questionnaire was adapted and modified, with approval from Dr. Martha Polovich, to reflect utilization in the prelicensure student nursing population. The adapted revised HDHQ measured participant demographic data, knowledge and confidence related to handling HD, safety preparedness for HD administration, disposal and handling bodily fluids, perceived barriers, and perceived risks associated with HD. To determine baseline knowledge, confidence, safety preparedness, barriers, and risks related to HD safe-handling procedures and precautions, the adapted revised HDHQ was completed pre-intervention or time 1 (T_1). After completion of the pre-intervention questionnaire, participants participated in an in-person didactic presentation that reviewed HD safe-handling processes including appropriate PPE use, use of a CSTD, exposure risks, exposure work-up, HD spill management and handling excrement and bodily fluids from patients on HD precautions. After completion of the didactic presentation, those in attendance participated in a low-fidelity simulation that provided the opportunity for low fidelity simulation with the supplies and equipment necessary for adherence with the HD safe-handling practices. Participants also received HD safe-handling tip-sheets that included safe-handling reminders and a list of HD commonly administered by students in the clinical setting. To evaluate the effectiveness of the educational intervention, participants completed the adapted revised HDHQ immediately post-intervention, time 2 (T_2) and at 3 weeks post-intervention, time 3 (T_3).

Prior to implementation of the project, Dr. Martha Polovich, PhD, RN, AOCN®, a clinical expert for HD and chemotherapy in the oncology nursing population, was contacted to obtain approval of the use and modification of the Revised HDHQ. Approval notification is included in Figure 16. After obtaining approval, the Revised HDHQ was modified to reflect use of HD by prelicensure students and the number of questions was reduced to a 50-question survey. The questions were revised to reflect completion by prelicensure nursing students instead of highly experienced oncology nurses. Content validation of the questionnaire was performed using DNP student peers and oncology nursing colleagues prior to submission to the Institutional Review Board (IRB).

Approval to invite the generalist graduate level nursing students to participate in the scholarly project was obtained from the generalist graduate level nursing Program Director. The background, purpose, methodology, and planned timeline was reviewed with the Director prior to implementation of the project. Confirmation of approval to focus on the generalist graduate level nursing students is included in Figure 15. After obtaining approval from the Program Director, meetings with the Program Coordinator and Program Manager were scheduled to review the planned timeline for the educational interventions and forum discussions.

The educational interventions including the didactic presentation, low fidelity simulation, and tip-sheets were developed based on a review of the literature and identified theoretical framework. The use of an educational video related to appropriate use of PPE and safe-handling practice recommendations was part of the educational intervention. The educational video used as part of the educational intervention was developed by B. Braun and available to the public via You Tube (B. Braun, 2017).

Purpose

The purpose of this project was to measure the effect of a multimodal educational intervention related to HD on the knowledge and confidence of generalist graduate level nursing students.

Project/Research Question

In generalist graduate level nursing students, what is the effect of a multimodal educational intervention on knowledge and confidence related to hazardous medication safe-handling processes?

Definition of Terms

Chemotherapy: Antineoplastic medications used in the treatment of malignancies administered via oral, parenteral, intrathecal, intravesicular or other routes (Neuss, et al., 2017).

Closed System Transfer Device (CSTD): "A drug transfer device that mechanically prohibits the transfer of environmental contaminants into the system and the escape of the hazardous drug or vapor concentrations outside the system" (NIOSH, 2004).

Hazardous Medication (HD): Medications that exhibit at least one of the following six characteristics in animals or humans: Teratogenicity or other developmental toxicity, carcinogenicity, genotoxicity, reproductive toxicity, organ toxicity at low doses, or toxicity and structure profiles of new drugs that mimic existing medications classified as hazardous (NIOSH, 2016).

Knowledge about HD exposure is defined as information about both the risks of HD exposure and the effectiveness of precautions in preventing exposure.

Handling HD is defined as preparation, administration and disposal of HD, or handling HD contaminated excreta (Polovich & Clark, 2012)

Personal Protective Equipment (PPE): Equipment utilized to minimize occupational exposure to hazards that have the potential to cause occupational injuries. PPE may include gloves, safety goggles, safety shoes or shoe covers, respiratory protection, protective gowns or clothing and head protection (OSHA, n.d.)

Safe-handling Precautions: The use of PPE, additional safety equipment and modification of work practices to minimize the risk of occupational exposure (Neuss, et al., 2017).

Research Design

This scholarly research project used a quasi-experimental, single group, pre and posttest design.

Setting

The primary setting was a school of nursing (SON) located in the southeastern United States. The educational intervention was provided in a classroom within the school of nursing. The school of nursing included two main buildings, two resilience rooms, high-tech classrooms, a high-tech 9,200 square foot simulation center, a café and a Bjoring Center for Nursing Historical Inquiry. The school of nursing offers four degree programs (BSN, MSN, DNP, PhD). For the 2018-2019 school year, 791 students were enrolled in one of the school's programs. Of these students, 372 were enrolled in the undergraduate program and 419 were enrolled in one of the graduate level programs.

The secondary setting location was the academic medical center that is associated with the school of nursing. The students participating in the project were completing their practicum hours in clinical settings located within the academic medical center or at one of the ambulatory or community clinics associated with the academic medical center. The academic medical center

was a level 1 trauma center with more than 645 beds in the main medical center (Patients & Visitors, n.d.).

Sample

The project convenience sample was obtained from generalist graduate level nursing students enrolled in their second year of the SON's Clinical Nurse Leader Program (CNL). Inclusion criteria included completing clinical rotation hours at the academic medical center or one of their associated ambulatory or community clinics. Participants could have been assigned to any clinical site within or associated with the academic medical center and could have completed clinical hours on any shift. Exclusion criteria included CNL students completing clinical hours at clinical sites outside of the academic center or the associated ambulatory or community clinics. Participation was voluntary and there were approximately 40 students eligible to participate in the scholarly project.

Protection of Human Subjects

The doctoral student completed the mandatory Collaborative Institutional Training Initiative (CITI) (Appendix 2). The project proposal was submitted to the Institutional Review Board (IRB) for approval and approval was obtained prior to beginning the project. The confirmation of approval is included in Appendix 3.

Eligible participants were informed of the project purpose, duration, interventions, benefits, data collection procedures, and project timeline. Participants were provided the opportunity to ask questions and seek clarifications. Additionally, all eligible participants were informed of the right to refuse to participate or withdraw at any time during the project. Refusal to participate or withdrawal from the project did not impact the student's clinical grade. A copy of the consent form was given to participants (Figure 10). The consent information was included as part of the

introductory page of the Qualtrics pre-intervention questionnaire. Participants were prompted to review and acknowledge or decline consent to participate in the project prior to starting the pre-intervention questionnaire.

This project posed no risk to participant and all organizational IRB and institutional policies were adhered to throughout the project duration. The contact information of the DNP student conducting the study was provided to participants in case the participants had questions throughout the study.

Confidentiality of participant information was maintained throughout the duration of the project and post project completion. Collected data was de-identified and stored in the academic medical center and School of Nursing's secure data storage software. The data was only accessible to individuals directly involved with the project process including the DNP student, statistician, academic advisor and practice mentor. Any project related written documents were kept in a secure, locked filing cabinet. All project findings are presented at an aggregate level.

Procedures

Project timeline. The project timeline was August 2019 through December 2019. The scholarly project implementation timeline can be found in Figure 3. Throughout the course of the project the DNP student attended the generalist graduate nursing student classroom discussions and was available to answer any questions received from participating students and associated faculty.

Recruitment. Notice of the DNP Scholarly Project and recruitment occurred via informational flyer (Figure 4), verbal presentation at one of the generalist graduate level nursing student forum discussions, and via email. To recruit students, the DNP student attended one of the generalist graduate level nursing student classroom discussions in August to discuss the

project with the generalist graduate level nursing students and the associated clinical faculty. The associated clinical faculty posted the DNP Project informational flyer to the course Collab site.

The DNP student obtained the email addresses for all eligible generalist graduate nursing students. A group email was sent to all eligible students in August 2019 (Figure 5). The email contained a brief outline of the project, the project purpose and planned begin and end dates.

Two weeks after the initial email a follow-up email was sent to all eligible generalist graduate nursing students including an invitation to participate in the survey (Figure 6). The follow-up email included a link to the pre-intervention questionnaire. The pre and post-intervention questionnaires were completed using the Qualtrics software. The consent for participating in the project was included as part of the introductory page of the pre-intervention questionnaire.

A reminder email was sent one week after the initial email inviting the generalist graduate level nursing students to participate. This reminder email was sent to all eligible students who have not completed the pre-intervention questionnaire (Figure 7). The date that students complete the consent process and pre-intervention questionnaire were identified as Day 1 of project participation. Immediately following the educational intervention, the participants were sent an email (Figure 8) with a link to a post-intervention questionnaire (Figure 12). A second post-intervention questionnaire was completed three weeks following the educational intervention (Figure 9).

No monetary compensation was provided for participation in this project. Lunch was provided to those who attended the educational intervention.

Multimodal educational intervention. A multimodal intervention was developed and

utilized for this project. The intervention included a didactic presentation, low-fidelity simulation, watching a video related to HD safe-handling, and access to HD safety tip-sheets.

Online computer-based learning module (CBL). As part of the annual competency requirements, the students completed the CBL titled "Hazardous Medications: Safe-Handling". This CBL was available via the academic medical center's Netlearning system and was completed by all students prior to the Fall semester 2019. This CBL is the standard method currently utilized for HD education for all team members working within the academic medical center and ambulatory and community clinic or infusion locations associated with the academic medical center.

Didactic presentation. The in-person didactic presentation included information related to classification of HD by NIOSH, identification of HD and PPE required for handling HD (Figure 13). The didactic presentation lasted approximately 30 minutes and was followed by group discussion and the opportunity to ask clarifying questions.

Low-fidelity simulation. Participants were provided the opportunity to practice donning and doffing PPE required for handling HD in the clinical setting. The low-fidelity simulation also included practicing administration of intravenous (IV) HD, using the CSTD required for administration of HD via IV route and proper procedures for disposing of HD waste.

HD safety video. Participants watched the PPE and HD safe-handling video "Ready for 800 Administering HD and the Necessary PPE" (B. Braun Medical, 2017) and were provided the link to this video for future reference.

HD safe-handling tip-sheets. All participants were given tip-sheets related to HD safe-handling processes, PPE use for the various types of HD administration and disposal of HD

waste (Figure 14). A hard copy of the tip-sheets was provided at the end of the didactic presentation. The tip-sheets also were provided electronically.

Outcome Variables and Outcome Measures

Primary outcome variables for the scholarly project included knowledge and confidence. Secondary outcome variables included safety preparedness, perceived barriers related to adherence to HD safe-handling processes, perceived risks associated with handling HD, and perceived importance of adherence to HD safe-handling processes. All outcome variables were measured using the outcome measure for each data collection timepoint. Qualtrics, a moderately sensitive data portal, was used to enter, record, and store responses to the pre and post-intervention questionnaires.

Participant demographic information was collected as part of the T_1 questionnaire. The demographic information included participant age, gender, clinical rotation site, prior clinical rotation sites, and prior healthcare related experience. There is no evidence in the literature that correlates any specific demographic information to knowledge or confidence related to HD safe-handling processes. Obtaining this demographic information allowed for evaluation of correlation between demographic information and results of the pre and post-intervention questionnaire responses.

Adapted revised HDHQ. The outcome measure was adapted from the revised HDHQ. The revised HDHQ is a 65-question tool developed by Polovich and Clark (2012) to measure seven main predictor variables: knowledge related to HD exposure, barriers to PPE use, self-efficacy, perceived risk related to HD, conflict of interest, workplace safety climate as it pertains to HD, and interpersonal influences. The revised HDHQ is a statistically reliable and valid tool with Cronbach's alphas for the predictor variables ranging from .7 - .93 (Polovich & Clark, 2012).

The adapted revised HDHQ (Figure 12) is a 23-question instrument used to measure knowledge and confidence related to HD, safety preparedness, perceived barriers, and perceived risk related to HD. Content validation for the adapted revised HDHQ was conducted prior to the scholarly project with ten oncology clinicians and four DNP student colleagues. After completion of content validation, the adapted revised HDHQ was entered into Qualtrics.

Pre intervention assessment. A link to the adapted revised HDHQ was sent via email to participants and was completed prior to the educational intervention.

Post-intervention assessments. Links to the adapted revised HDHQ were sent out twice post-intervention (T_2 and T_3 assessments). T_2 data collection occurred immediately post-intervention to measure initial knowledge gain. T_3 data collection was three weeks post-intervention to assess knowledge retention and any changes in confidence related to HD safe-handling practices.

Data Analysis

Both descriptive and inferential statistical analysis was performed on primary and secondary outcome variables. All statistical analysis was performed utilizing IBM SPSS statistical software version 26. All assumptions for parametric tests were performed. If assumptions were not met for parametric tests, the appropriate non-parametric tests were used for analysis. All testing of significance was conducted at the .05 level of significance.

Pre and post-intervention knowledge and confidence related to HD safe-handling processes were measured and reported. The adapted revised HDHQ included true/false questions related to general HD knowledge and Likert scales were used to measure level of confidence related to handling HD. Likert scales also were utilized to measure safety preparedness related to handling HD, perceived barriers and risks associated with HD, availability of PPE, use of PPE, and perceived importance of utilizing PPE in the clinical setting. The data were analyzed for

correlation between demographic data, level of knowledge and confidence, safety preparedness, PPE use, and perceived barriers and risk.

Descriptive Statistics. Descriptive statistical analysis (median, mean, standard deviation, percentages, and frequencies) were computed on all demographic data characteristics and outcome variables. The demographic data included age, gender, current clinical rotation site, prior clinical rotation sites, and prior healthcare related experience.

Inferential Statistics. Paired *t*-test was utilized to determine statistical significance between the pre and post assessments for all outcome variables: knowledge, confidence, safety preparedness, perceived barriers, perceived risks, and perceived importance of HD safety processes. Bivariate correlations were evaluated to determine the relationships between the outcome variables and demographic data. Spearman rank coefficients (r_s) were used due to the non-normal variable distributions of the data.

Mann-Whitney U and Kruskal-Wallis H tests were used to compare the means of the pre and post-intervention changes in levels of confidence and knowledge assessments using the demographic data categories of age, year in the generalist graduate level nursing program, and prior healthcare experience.

Results

A total of 18 students participated in the multimodal intervention and completed the T_1 questionnaire. Two did not complete the T_2 and/or the T_3 questionnaire. Final data analysis included 16 student participants who completed all questionnaires.

Demographic Data

A total of 16 students completed all aspects of the project. Demographic data was collected as part of the T_1 questionnaire and results are shown in Table 4. All participants were

female with ages ranging between 22 and 40 years of age (M = 28.25, SD = 5.1). A majority self-identified as being White/Caucasian (n = 11, 68.8%) with a majority completing their Fall 2019 clinical hours in a specialty area such as pediatrics or obstetrics (n = 8, 50 %). Prior clinical experiences included acute care units (medical surgical, oncology, orthopedics, cardiovascular, neurology, or solid organ transplant) (n = 16, 100%), critical care units (any intensive care or progressive care unit) (n = 12, 75.0 %), and specialty areas (n = 15, 93.8%). The total years of prior healthcare experience ranged from 0 – 10 years (M = 1.81, SD = 2.61) with prior experience including experience as an emergency medical technician (EMT) or paramedic (n = 2, 12.5%) or certified nurse aid (CNA) or certified medical aid (CMA) (n = 5, 31.3%).

Adapted revised HDHQ

The adapted revised HDHQ consisted of 23 questions related to HD knowledge, confidence related to handling HD, safety preparedness, perceived barriers related to HD safety processes, perceived risks associated with handling HD, and perceived importance of adhering to HD safe-handling processes, in addition to seven demographic questions. The demographic related questions were only completed as part of T_1. Despite only including 12 total questions related to the primary and secondary outcome variables, each main question consisted of multiple items.

Knowledge. The knowledge related question included 12 separate general HD knowledge related items. Each item included a true/false/I don't know answer choice. A point was provided for each correct answer. The total possible range for the knowledge related question was 0 – 12 and the observed range for T_1 was 8 – 12 (67 % - 100% correct answers) (Table 5). The observed range for both T_2 and T_3 was 10 – 12 (83 % - 100 % correct answers).

A higher score indicated a greater number of correct answers and a higher level of basic knowledge related to HD. There was a slight increase in the mean score between T_1 (M = 10.25, SD = 1.24), T_2 (M = 11.50, SD = .63) and T_3 (M = 11.56, SD = .63). There was a statistically significant increase in the overall knowledge scores between T_1 and T_2 (t (15) = -3.73, $p < .05$ (two-tailed)) and between T_1 and T_3 (t (15) = -3.63, $p < .05$ (two-tailed)). The results of the t-tests for the knowledge scores are displayed in Table 6.

Two items were further analyzed using McNemar's test. These items had the lowest number of correct answers on the T1 questionnaire. Participants frequently answered incorrectly to the following items within the knowledge question: "Hazardous medications cannot enter the body through contact with contaminated surfaces" (n = 6, 37.5 %); and "A surgical mask provides protection from hazardous medication aerosols" (n = 8, 50 %).

Confidence. The adapted revised HDHQ included two confidence related questions: "*I am confident I can use PPE properly*" and "*I am confident that I can protect myself from hazardous medication exposure*". A Likert scale was used for each question with each answer option having an associated score: 4 = *Strongly Agree,* 3 = *Agree*; 2 = *Disagree;* 1 = *Strongly Disagree*. This Likert scale is also used for the questions related to safety preparedness, perceived barriers, and perceived risks. The total possible range for the knowledge related question was 2 – 8 and the observed range for T_1 was 2 – 5 (Table 5). The observed range for both T_2 and T_3 was 6 – 8. A higher score indicated a greater confidence related to HD safe-handling. There was an increase in the mean score between T_1 (M = 4.25, SD = .93), T_2 (M = 6.88, SD = .62) and T_3 (M = 6.81, SD = .98). There was a statistically significant increase in the overall confidence scores between T_1 and T_2 (t (15) = -10.97, $p < .05$ (two-tailed)) and between T_1 and T_3 (t (15) = -7.03, $p < .05$ (two-tailed)). The results of the t-tests for the confidence scores

are displayed in Table 7.

Safety preparedness. There were four questions related to being prepared to administer and dispose of HD safely. A higher score on the Likert scale indicated a greater level of preparedness related to HD safety. The total possible range for the safety preparedness related question was 4 – 16 and the observed range for T_1 was 5 – 11 (Table 5). The observed ranges for T_2 and T_3 were 9 – 15 and 8 – 16 respectively. There was an increase in the mean score between T_1 (M = 8.75, SD = 1.53) and T_2 (M = 7.56, SD = 1.86); however, the mean score decreased between T_2 and T_3 (M = 7.44, SD = 1.86). There was a statistically significant increase in the overall safety preparedness scores between T_1 and T_2 (t (15) = -7.70, $p < .05$ (two-tailed)) and between T_1 and T_3 (t (15) = -6.67, $p < .05$ (two-tailed)). The results of the t-tests for the safety preparedness scores are displayed in Table 8.

Perceived barriers. Two questions and a total of 19 items were related to barriers to PPE use. The total possible range for the perceived barriers to PPE use related questions was 19 – 76 (Table 5). The observed range for T_1, T_2, and T_3 were 27 – 53, 19 – 52 and 25 – 52 respectively. The higher scores corresponded with a higher level of agreement with the proposed barriers. There were no statistically significant changes between the various pre and post questionnaires (Table 9). There were four items that consistently received higher levels of "*Strongly Agree*" or "*Agree*" responses from the participants in all three time points: "*PPE is uncomfortable to wear*"; "*PPE is not always available*"; "*Others around me don't use PPE*" and "*People would think I am overly cautious*" (Figure 17).

Perceived risks. Three items address perceived health risks associated with handling HD in the clinical environment. A 4-point Likert scale (1=*Strongly Disagree* and 4= *Strongly Agree*) was used to measure agreeance with the risk statement. The total possible range for

perceived health risks was 3 – 12 (Table 5). The observed range for T_1 perceived risk was 3 – 7 (M = 5.06, SD = 1.24). Both T_2 and T_3 had an observed range of 3 - 8 with M = 3.88 and SD = 1.63 for T_2 and M = 3.88 and SD = 1.54 for T_3.

Correlation. Bivariate correlations were evaluated utilizing Spearman's rho coefficients (r_s). Spearman's rho is a non-parametric test that was used to determine the strength of association between the various outcome variables and certain demographic variables and time points T_1, T_2, and T_3. The demographic variable used for the correlation testing included years in healthcare, age group, race, and current clinical setting. The results are displayed in Tables 11 – 15. There were no significant correlations between the demographic data and the outcome variables.

Discussion

Currently, there are no requirements or standardization related to whether HD safety processes are included in the nursing curriculum for prelicensure students. This lack of consistency, lack of sufficient training, and resources has contributed to the decreased overall knowledge and confidence associated with HD safety processes. Similar to the study by Zimmer et al. (2016), this study measured basic knowledge related to HD safety processes pre-intervention and again post-intervention to assess knowledge gain. This study also collected an additional knowledge assessment three weeks post-intervention to measure knowledge retention. Consistent with the results of Zimmer et al.'s 2016 study, there was an increase in overall knowledge post-intervention that included didactic education and practical skills practice.

Of the 16 students whose data was included in the final data analysis, 25% scored less than 75% on the overall knowledge assessment at the T_1 time point assessment. The two questions that were answered incorrectly most frequently were "A surgical mask provides

protection from hazardous medication aerosols", and "hazardous medications cannot enter the body through contact with contaminated surfaces". No students scored less than 75% on either of the post-intervention knowledge assessments (timepoints T_2 and T_3). In addition to an increase in the overall knowledge scores, the mean knowledge scores increased between T_1 to T_2 (M = 10.25 with SD = 1.24 and M = 11.50 with SD = .63 respectively) and again between T_2 to T_3. Like the overall results in the study performed by Zimmer et al. (2016), there was a statistically significant increase knowledge scores between T_1 and T_2 and between T_1 and T_3.

The safety preparedness section of the adapted revised HDHQ included questions related to whether the student felt prepared to administer HD, if adequate training and resources related to HD safety had been provided to the student. There was a statistically significant increase in the overall safety preparedness scores between T_1 and T_2 and between T_1 and T_3 (Table 8). Despite a statistically significant change knowledge, confidence, and safety preparedness between T_1 and T_2 and also between T_1 and T_3, there is no correlation between these variables.

Similar to studies by Polovich & Martin (2011) and Polovich & Clark (2012) the most frequently barriers to adherence to donning appropriate PPE included the PPE being uncomfortable to wear, PPE not readily available, and perception of being viewed as being overly cautious. These perceived barriers identified by the students participating in the study may be related to what they see in the clinical setting and conversations with other student colleagues, clinical instructors, preceptors and others in the clinical setting. The identified barriers may be related to the suboptimal use of required PPE by the students. Studies performed by Polovich & Martin (2011), Polovich & Clark (2012) and Friese et al. (2019) utilized the HDHQ to have participants self-report PPE use. In all three studies the self-reported use of PPE was suboptimal pre-intervention and post-intervention. The results of this project were in

alignment with these studies with over 40 % of the students reporting never using a CSTD or donning impervious gowns during HD administration at T_1 and over 25% reporting never using a CSTD or donning the impervious gowns at T_2 and T_3.

The studies by Polovich & Martin (2011), Polovich & Clark (2012) and Friese et al. (2019) utilized self-reporting as a way to measure adherence to HD safety standards and identify barriers to adherence to the HD standards; however, there was no objective component to validate the self-reported utilization of PPE or confirm the perceived barriers. Since this project used the adapted revised HDHQ, which was adapted from the HDHQ, there was no objective component of the project. Having an objective component and validation of PPE use and barriers would provide valuable information necessary to determine the true impact and effectiveness of the educational intervention.

Several studies have examined the effect of multimodal educational interventions on knowledge gain. Studies by Rutherford-Hemming et al. (2016); Zinsmaster & Vliem (2016); Ghezeljeh et al. (2015); Zieber & Sedgewick (2011) and Durkin (2008) revealed utilization of a multimodal approach was effective in increasing knowledge. Despite an initial increase in knowledge, all studies indicated additional testing or interventions were necessary to determine if the increase in knowledge would be sustained long-term. This project also showed an increase in overall knowledge immediate post-intervention (T_2) and three weeks post-intervention (T_3). Similar to the studies found as part of the literature review, additional assessments are needed to determine if the multimodal approach resulted in long-term knowledge retention related to HD safety.

In order to provide more generalizable results and increase the success of similar projects, additional post-intervention assessment time points would be necessary to measure knowledge

gain and sustained confidence and adherence to HD safe-handling practices. A larger *n* and a more diverse study population also is necessary. Identifying motivating factors or incentives that would increase participation is necessary for future follow-up studies. Halpern et al., (2004), Cho et al. (2013), and Yu et al. (2017) all discussed how monetary incentives, frequent reminders, and offering refreshments increased participation rates. Appropriate incentives to increase participation rates by students has not been well studied and can be difficult to identify since students are considered a vulnerable population. For this project, students did receive frequent email reminders and lunch during the educational intervention. Factors that may have impacted the low participation rate included the timing of the project, competing school related priorities, and lack of understanding of HD they administer while in the clinical setting.

In addition to the quantitative data, T_3 adapted revised HDHQ collected qualitative data to help assess the effectiveness of the multimodal educational approach. Comments submitted included: “We needed this information before any clinical”, “Perhaps more practice time with being donned in PPE and administering medication”, “Did not know how much I did not know. Had no idea so many medications are hazardous”, “The education session is crucial for rising nurses. I had no idea that some of the drugs I have given often are hazardous! I will be sure to wear the correct PPE in the future”. These comments validated the need for incorporating education related to identification of HD and HD safe-handling processes prior to the first semester of clinical experiences.

Strengths and Weaknesses of the Design

Strength of the design. Strengths of the project included the use of evidence-based interventions, supporting regulatory documents, and clinical location. The scholarly project will contribute to current literature due to the paucity of literature related to HD education in

prelicensure nursing student programs. Literature had a lack of consistent results related to multimodal educational interventions on HD safe-handling knowledge. Also there was inconsistent results related to how the interventions correlate to knowledge and confidence related to HD safe-handling and caring for patients receiving HD. Other strengths included utilizing a self-controlled strategy for implementation of the multimodal interventions and providing the interventions in a safe learning environment outside of the clinical setting. The use of videos, didactic discussions, and low fidelity simulation with the supplies used in the clinical setting allowed the generalist graduate level nursing students the opportunity to see and handle the supplies and PPE in addition to practicing the safe-handling procedures. This additional practice provided the opportunity to enhance the psychomotor skills related to the procedures and increase confidence in HD safe-handling procedures and processes.

Weakness of the design. Limitations of the project included the use of a convenience sample, a lack of a control group or randomization, and limited prior published research related to the topic. Due to the limited inclusion criteria, the low number of participants, and no male student participation, the results of the project cannot be generalized to other nursing student groups. The revised HDHQ had not been tested in the nursing student population and the results may not be as statistically significant in this population. Having a control group and expanding the inclusion criteria could help strengthen a similar future project involving nursing students. Utilizing a more comprehensive and multisite approach would allow the opportunity to produce results that are more generalizable for the general nursing student population. Due to the on-line completion of the assessments, it is possible that the participants used additional resources or collaborated on the questions when completing the assessment questionnaires. Additional information regarding long-term knowledge retention and confidence levels would strengthen the

project; however, due to time constraints, long-term post-intervention assessments were not feasible for this project.

Nursing Practice Implications

Occupational exposure to HD and HD waste can occur in all clinical settings and during all aspects of the HD process. Identification of HD and patients on HD precautions combined with consistent use of the appropriate PPE during all aspects of the HD process can minimize the risk of occupational exposure. In order to properly identify HD and know which PPE is required, anyone involved in the HD process or care for patients receiving HD must receive education related to the HD process. Currently, there are no documented recommendations or HD regulations addressing the educational requirement for nursing students involved in the HD process during their clinical rotations.

Use of a multimodal educational intervention related to HD safety increased the generalist graduate level nursing students' knowledge and confidence related to HD. In addition to increased knowledge and confidence related to HD safety, the results of this project were in alignment with studies by Polovich & Clark (2012) in terms of perceived barriers to adherence to HD safe-handling processes.

Products of the DNP Project

A report regarding the effectiveness of a multimodal education approach related to HD safe-handling processes with a focus on generalist graduate level nursing students will be one product of this DNP scholarly project. Since the project findings indicate a multimodal approach is effective in increasing the knowledge and confidence related to HD safe-handling processes, this project can be incorporated into the training requirements for nursing students in clinical settings. After completion of the scholarly project an abstract was submitted to the 45th Annual ONS

Congress and accepted for poster presentation. Abstracts will be submitted to the 2021 Virginia DNP Annual Meeting and the Virginia Association of Clinical Nurse Specialists (VACNS) Conference. The manuscript will be submitted for publication in *The Oncology Nursing Forum*, the author guidelines for this publication can be found in Appendix 1.

Conclusion

The literature related to HD and HD safety has been focused on education and occupational exposure preventative measures for the healthcare workers. There are estimates related to the number of healthcare workers at risk for occupational exposure to HD. However, due to the lack of research and literature regarding exposures for prelicensure students, the exposure risk for this population is unknown. The exposure risk for students may exceed the exposure risk for HCW due to their lack of education related to HD safety.

Due to the scarcity of information related to HD education for prelicensure nursing students, additional research is necessary to identify the extent of the gap in knowledge and confidence related to HD. The educational intervention utilized and results from this project contribute to the development of educational standards for a variety of learners, such as nursing, medical, therapy, and other students entering the healthcare profession. These learners are exposed to HD in their clinical experiences either via the compounding, administration, and disposal of HD or caring for patients on HD precautions. Additional education related to safety precautions should be required to minimize their exposure risk while in the clinical environment.

The multimodal educational interventions that were used in this project are feasible and relevant for Schools of Nursing. Utilization of this approach for HD safety can be translated and implemented in the clinical setting for all types of healthcare providers. The qualitative feedback affirms the need for structured HD safety education for learners within the healthcare arena.

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Table 1

Articles on Knowledge Gain and Retention: Educational Interventions (n = 5)

Reference	Study Design	Subjects & Setting	Period of Data Collection	Intervention: Control & Comparison	Outcomes
Durkin (2008)	Quasi-experimental study	41 nurses from a single patient care unit at Children's Hospital Boston enrolled and 31 successfully completed all aspects of the study including pretest and posttest	Data related to knowledge gain and knowledge retention at a specified timeframe after the educational intervention was measured using questionnaires and surveys	Group 1 (Control) received text only compared to Group 2 (Comparison) which received an interactive educational intervention	Both groups demonstrated significant knowledge gain and retention between the pretest and posttest 1 ($p < .000$). The comparison group also showed an increase between posttest 1 and posttest 2 ($p < .000$). The interactive educational intervention appeared to be more effective for knowledge retention.
Rutherford-Hemming, T. et al. (2016)	Multisite single-blinded randomized control trial	64 OB nurses from 4 community hospitals associated with a large nonprofit academic hospital in the Midwest US.	Data was collected using the written Neurological Knowledge Assessment and observed performance of completing a basic neurological examination on a standardized patient using the Performance Observation Measurement Tool. This served as baseline data. These assessments were repeated within 7 days following the intervention or completion of the self-study online module and again 2 months later.	Randomization to either the online self-study module (n = 29) or simulation (n = 35).	There was a statistically significant increase in skill performance in the simulation group compared to the online self- study group. The short-term (within 7 days post intervention) assessments yielded a mean SD of 67.6 (20.2) for simulation versus 29.6 (19.0) for the online self-study group with $p < .001$. The long term (2 months post intervention) assessments were 46.1 (17.6) simulation versus 27.5 (15.9) online self-study with $p < .001$

Table 1 (cont.)

Articles on Knowledge Gain and Retention: Educational Interventions (n = 5)

Reference	Study Design	Subjects & Setting	Period of Data Collection	Intervention: Control & Comparison	Outcomes
Zieber, M. & Sedgewick, M. (2011)	Mixed method qualitative and quantitative	180 eligible, 24 responded and met all inclusion criteria. All participants were third or fourth year students enrolled in a Canadian undergraduate nursing program	A pretest, immediate posttest and a follow up posttest three months after the intervention. The pretest and posttests involved the following: competence test, confidence test, advanced cardiac skills and knowledge test	No control group. Interventions involved a three-hour knowledge presentation by a critical care RN. The presentation was based on American Heart Association information. The presentation was followed by a three-hour practical skills session involving high fidelity simulation.	The R-M ANOVA analysis of the competence test indicated a statistically significant increase in perceived competence between the pretest to immediate posttest and also between immediate posttest and posttest at the three month mark. The increase noted between the pretest and immediate posttest was the largest increase in the competence testing. There also was a statistically significant increase in the confidence testing between the pretest and immediate posttest in addition to between the immediate and three month posttests. Unlike the competence test scores, the increase between the immediate and three month posttests was larger than that between the pretest and immediate posttest. There also was a statistically significant increase in the knowledge and skills tests. Similar to the confidence and competence tests, there was a statistically significant increase in knowledge gain between the pre and immediate posttests.

Table 1 (cont.)

Articles on Knowledge Gain and Retention: Educational Interventions (n = 5)

Reference	Study Design	Subjects & Setting	Period of Data Collection	Intervention: Control & Comparison	Outcomes
Zinsmaster, J. & Vliem, S. (2016)	Quasi-experimental with repeat measures	44 junior level nursing students were randomized into either control or intervention group based on their simulation day.	Data was collected pre, post and 4 months after lecture or lecture with simulation. Knowledge acquisition and retention were measured using a validated 11-item multiple choice knowledge test.	Control group consisted of 19 students (3 male and 16 female); intervention/comparison group consisted of 25 students (3 male and 22 female)	Paired and independent *t*-tests were performed on all knowledge tests. There was no statistically significant difference between the groups at baseline ($t = -1.15$, $df = 42$, $p = .257$). There was a statistically significant difference in knowledge acquisition between the control and comparison group ($t = -3.39$, $df = 29$, $p = .002$), with the comparison group having higher levels of knowledge acquisition. The results were consistent to prior studies referenced by the authors. Despite having a higher level of knowledge acquisition and incorporating proven methods for increasing knowledge retention during the simulation sessions, there was no statistically significant difference between the groups at the four month mark.
Ghezeljeh et al. (2015)	Repeat measures	282 nurses working in three teaching hospitals affiliated with Lorestan University of Medical Sciences in Khorramabad, Iran	Data was collected pre intervention, two weeks post-intervention and three-months post-intervention. A validated hand hygiene questionnaire was used for all data collection	Control group received the traditional lecture. The intervention group received a multimodal educational approach consisting of: didactic presentation, hand hygiene video, role playing exercises, hand hygiene pamphlets, photo displays related to hand hygiene technique, audio announcements through hospital-wide speaker system, screen saver messages for three-months	No significant difference between groups at baseline ($p > .05$); however, there was statistically significant differences between the groups at both post-intervention measurements ($p < .001$ for both post-intervention assessments)

Table 2

Articles on Adherence to Hazardous Medication Safe-handling Recommendations (n = 3)

Reference	Study Design	Subjects & Setting	Period of Data Collection	Intervention: Control & Comparison	Outcomes
Friese, C. et al. (2019)	Cluster randomized control trial	396 nurses from a convenience sample of 12 ambulatory settings were enrolled in the study and 257 completed both the baseline and primary endpoint surveys. Randomization occurred at the site level after participants were enrolled and completed the baseline survey.	Data collection occurred between 2015- 2017. Baseline, primary endpoint surveys and quarterly data related to PPE use was collected and analyzed	Control group consisted of 136 nurses who received a one-hour educational module focused on PPE use and quarterly reminders. Comparison group consisted of 121 nurses who received the one-hour educational module and tailored messages to address perceived barriers to PPE use.	Both control and comparison groups had suboptimal use of appropriate PPE both pre and post intervention. No statistically significant differences were noted in perceived barriers to PPE use or in knowledge related to appropriate PPE use.
Polovich, M. & Clark, (2012)	Cross-sectional, mixed methods survey	165 nurses and 20 managers from various oncology centers throughout the United States	The revised Hazardous Drug Handling Questionnaire, a self-reported survey, was used for nurses to describe their HD safe-handling precaution methods	The questionnaire was handed out to the nurses to gather information related to HD safe-handling, PPE use, barriers to PPE use and general HD knowledge assessment. The study team conducted telephone interviews with the managers to inquire about manager perspectives related to PPE use and barriers to appropriate PPE use.	Identified barriers: gowns not readily available (25%), work area is too busy to wear the appropriate personal protective equipment (PPE) (25%), lack of concern for personal exposure to HD (20%), gowns were too uncomfortable (20%), lack of knowledge related to HD safe-handling precautions (15%), urgent patient situations (15%), HD safe-handling precautions are "too extreme" (5%), patients objecting to staff wearing PPE (5%), cost-containment of PPE (5%), gloves did not fit properly (5%)

Table 2 (cont.)

Articles on Adherence to Hazardous Medication Safe-handling Recommendations (n = 3)

Reference	Study Design	Subjects & Setting	Period of Data Collection	Intervention: Control & Comparison	Outcomes
Polovich, M. & Martin, S. (2011)	Descriptive, Correlational	330 nurses who have prepared and/or administered chemotherapy	The Hazardous Drug Handling Questionnaire, a self-reported survey, was used for nurses to describe their HD safe-handling precaution methods. Data was collected during the Oncology Nursing Society's 31st Annual Congress in 2006.	The questionnaire was handed out to nurses at the beginning of each of the three educational sessions related to hazardous drug safe-handling. Participants were allowed 5-10 minutes to complete the questionnaire before they were collected at the end of the educational sessions. No control group. All participants attended one of the educational sessions.	Despite specializing in an area where HD are administered on a regular basis, several nurses continue to report not being compliant with the safe-handling recommendations. Although, as compared to prior studies, the use of gloving when handling a HD has increased, but few reported double-gloving as recommended. The nurses reported higher use of the required gown when compared to prior surveys; however less than half reported wearing the gown during HD administration and even fewer reported wearing the gown during HD disposal. Other nurses reported re-using the single-use gowns. Even though NIOSH and OSHA require face and respiratory protection be readily available, some participants noted these items are not available in their practice setting. Despite having safe-handling recommendations published since 1985, there continues to be a need for continued education, monitoring and culture change in order to ensure staff are following the safe-handling recommendations and have the necessary supplies readily available in all settings were HD are prepared, administered, stored and/or disposed of.

Table 3

Article on Hazardous Medication Safety Education for Nursing Students (n = 1)

Reference	Study Design	Subjects & Setting	Period of Data Collection	Intervention: Control & Comparison	Outcomes
Zimmer, J. et al. (2016)	Prospective controlled	53 nursing students invited and participated. 48 completed the pre and post intervention surveys. Setting was one vocational nursing school in Germany.	Data related to knowledge of hazardous medication handling (questionnaire), practical skills related to hazardous medication administration (simulation), surface contamination was collected in two different study periods (status-quo period and intervention period). A Hazardous medication questionnaire was created by the study team and used for all data collection.	Status-quo period involved routine education related to hazardous medication. Intervention period included the routine education in addition to an innovative teaching session on handling HD.	There was median knowledge gain between status quo (39% answered questions correctly) and intervention period (65% answered questions correctly, $p < .001$). Practical skills also improved between the status quo period (53% cleaned the work surface) and intervention period (92%, $p < .001$). The median number of particles/m2 on the work surfaces decreased from the status quo to intervention periods (932/97, $p < .001$). There was a significant improvement in knowledge and practical skills after the innovative educational intervention.

Table 4

Demographic Characteristics of Participants (N = 16)

	n	%	Range	*M (SD)*
Age (years)	16		22-40	28.25 (5.1)
Gender				
Female	16	100		
Race				
White	11	68.8		
African American	2	12.5		
Asian	1	6.3		
Hispanic/Latino	1	6.3		
Other	1	6.3		
Current Clinical Setting				
Acute Care	1	6.3		
Critical Care	6	37.5		
Specialty Area	8	50.0		
Other	1	6.3		
Prior Clinical Settings				
Acute Care	16	100		
Critical Care	12	75.0		
Specialty Area	15	93.8		
Other	5	31.3		

Table 4 (cont.)

	n	%	Range	*M (SD)*
Healthcare Experience (years)			0 - 10	1.81 (2.61)
0	7	43.8		
1 - 3	7	43.8		
4 - 6	1	6.3		
7 - 10	1	6.3		
Healthcare Experience				
EMT or Paramedic	2	12.5		
CNA or CMA	5	31.3		
Other	13	81.3		

Note: Acute Care = Medical-Surgical, Oncology, Orthopedics, Cardiovascular, Neurology, Solid Organ Transplant; Critical Care = any intensive care or progressive care unit; Specialty = pediatrics, obstetrics, labor and delivery; EMT = Emergency Medical Technician; CNA = Certified Nurse's Aide; CMA = Certified Medical Assistant; Other = any healthcare role outside of EMT, Paramedic, CNA, CMA, Registered Nurse, Physician, Physician Assistant, Respiratory Therapist, Physical Therapist

Table 5

Descriptive Statistics for Predictor Variables (N = 16)

Variable	*M*	*SD*	*Observed Range*	*Possible Range*
T_1 Knowledge	10.25	1.24	8 – 12	0 - 12
T_1 Confidence	4.25	.93	2 – 5	2 - 8
T_1 Safety Preparedness	8.75	1.53	5 – 11	4 - 16
T_1 Perceived Barriers	40.50	7.17	27 - 53	19 - 76
T_1 Perceived Risks	5.06	1.24	3 – 7	3 - 12
T_2 Knowledge	11.50	.63	10 - 12	0 - 12
T_2 Confidence	6.88	.62	6 – 8	2 - 8
T_2 Safety Preparedness	12.50	1.79	9 - 15	4 - 16
T_2 Perceived Barriers	38.31	10.17	19 – 52	19 - 76
T_2 Perceived Risks	3.88	1.63	3 - 8	3 - 12
T_3 Knowledge	11.56	.63	10 - 12	0 - 12
T_3 Confidence	6.81	.98	6 - 8	2 - 8
T_3 Safety Preparedness	12.56	1.86	8 - 16	4 - 16
T_3 Perceived Barriers	37.13	7.21	25 - 52	19 - 76
T_3 Perceived Risks	3.88	1.54	3 - 8	3 - 12

Note: T_1 = Time 1; T_2 = Time 2; T_3 = Time 3

Table 6

Results of t-tests and Descriptive Statistics for Knowledge Scores (N = 16)

Outcome	M	SD	95% Confidence Interval	t	df
$T_1 - T_2$	-1.25	1.34	-1.96, -.54	-3.73*	15
$T_2 - T_3$	-.06	.57	-.52, .39	-.44	15
$T_1 - T_3$	-1.31	1.45	-2.02, -.60	-3.63*	15

Note: T_1 = Time 1; T_2 = Time 2; T_3 = Time 3; $T_1 - T_2$= difference in knowledge scores between T_1 and T_2; $T_2 - T_3$= difference in knowledge between T_2 and T_3; $T_1 - T_3$=difference in knowledge between T_1 and T_3

*p < .05 (2-tailed)

Table 7

Results of t-tests and Descriptive Statistics for Confidence Scores (N = 16)

Outcome	M	SD	95% Confidence Interval	t	df
$T_1 - T_2$	-2.63	.96	-3.14, -2.11	-10.97*	15
$T_2 - T_3$	.06	1.12	-.54, .66	.22	15
$T_1 - T_3$	-2.56	1.45	-3.34, -1.78	-7.03	15

Note: T_1 = Time 1; T_2 = Time 2; T_3 = Time 3; $T_1 - T_2$= difference in confidence scores between T_1 and T_2; $T_2 - T_3$= difference in confidence scores between T_2 and T_3; $T_1 - T_3$=difference in confidence between T_1 and T_3

*p < .05 (2-tailed)

Table 8

Results of t-tests and Descriptive Statistics for Safety Preparedness Scores (N = 16)

Outcome	M	SD	95% Confidence Interval	t	df
$T_1 – T_2$	-3.75	1.96	-4.79, -2.71	-7.70*	15
$T_2 – T_3$	-.06	2.02	-1.13, 1.01	-.12	15
$T_1 – T_3$	-3.81	2.29	-5.03, -2.59	-6.67*	15

Note: T_1 = Time 1; T_2 = Time 2; T_3 = Time 3; $T_1 – T_2$= difference in safety preparedness scores between T_1 and T_2; $T_2 – T_3$= difference in safety preparedness scores between T_2 and T_3; $T_1 – T_3$=difference in safety preparedness between T_1 and T_3
*p < .05 (2-tailed)

Table 9

Results of t-tests and Descriptive Statistics for Perceived Barriers Scores (N = 16)

Outcome	M	SD	95% Confidence Interval	t	df
$T_1 – T_2$	2.19	10.29	-3.30, 7.67	.85	15
$T_2 – T_3$	1.19	2.86	-4.91, 7.28	.42	15
$T_1 – T_3$	3.38	2.92	-2.84, 9.59	1.16	15

Note: T_1 = Time 1; T_2 = Time 2; T_3 = Time 3; $T_1 – T_2$= difference in perceived barriers scores between T_1 and T_2; $T_2 – T_3$= difference in perceived barriers scores between T_2 and T_3; $T_1 – T_3$=difference in perceived barriers between T_1 and T_3

*p < .05 (2-tailed)

Table 10

Results of t-tests and Descriptive Statistics for Perceived Risks Scores (N = 16)

Outcome	M	SD	95% Confidence Interval	t	df
$T_1 - T_2$	1.19	2.13	.05, 2.33	2.22*	15
$T_2 - T_3$	.00	2.13	-1.13, 1.13	.00	15
$T_1 - T_3$	1.19	2.01	.12, 2.26	2.37*	15

Note: T_1 = Time 1; T_2 = Time 2; T_3 = Time 3; $T_1 - T_2$= difference in perceived risks scores between T_1 and T_2; $T_2 - T_3$= difference in perceived risks scores between T_2 and T_3; $T_1 - T_3$=difference in perceived risks between T_1 and T_3

*p < .05 (2-tailed)

Table 11

Correlation between Knowledge Scores, Years in Healthcare, Age, Race and Current Clinical Setting

	T_1 N = 16	T_2 N = 16	T_3 N = 16
Years in Healthcare	-.23	.15	.10
Age Group	.08	.55*	.31
Race	.02	.13	.07
Current Clinical Setting	-.15	.25	.23

Note: T_1 = Time 1, T_2 = Time 2, T_3 = Time 3
r_s = *p < .05 (2-tailed)

Table 12

Correlation between Confidence Scores, Years in Healthcare, Age, Race and Current Clinical Setting

	T_1 N = 16	T_2 N = 16	T_3 N = 16
Years in Healthcare	-.48	-.04	-.60*
Age Group	-.28	-.17	.04
Race	-.22	-.24	.46
Current Clinical Setting	.02	-.27	-.39

Note: T_1 = Time 1, T_2 = Time 2, T_3 = Time 3
r_s = *p < .05 (2-tailed)

Table 13

Correlation between Safety Preparedness Scores, Years in Healthcare, Age, Race and Current Clinical Setting

	T_1 N = 16	T_2 N = 16	T_3 N = 16
Years in Healthcare	-.39	.00	.37
Age Group	-.12	-.26	-.02
Race	-.18	.08	.38
Current Clinical Setting	-.27	-.05	-.48

Note: T_1 = Time 1, T_2 = Time 2, T_3 = Time 3
r_s = *p < .05 (2-tailed)

Table 14

Correlation between Perceived Barriers Scores, Years in Healthcare, Age, Race and Current Clinical Setting

	T_1 N = 16	T_2 N = 16	T_3 N = 16
Years in Healthcare	.05	.06	-.34
Age Group	-.54*	-.31	.40
Race	-.25	-.48	.06
Current Clinical Setting	-.27	-.13	.29

Note: T_1 = Time 1, T_2 = Time 2, T_3 = Time 3
r_s = *p < .05 (2-tailed)

Table 15

Correlation between Perceived Risks Scores, Years in Healthcare, Age, Race and Current Clinical Setting

	T_1 N = 16	T_2 N = 16	T_3 N = 16
Years in Healthcare	-.42	-.10	-.07
Age Group	-.13	-.15	-.26
Race	-.36	-.28	-.20
Current Clinical Setting	.19	.40	.05

Note: T_1 = Time 1, T_2 = Time 2, T_3 = Time 3
r_s = *p < .05 (2-tailed)

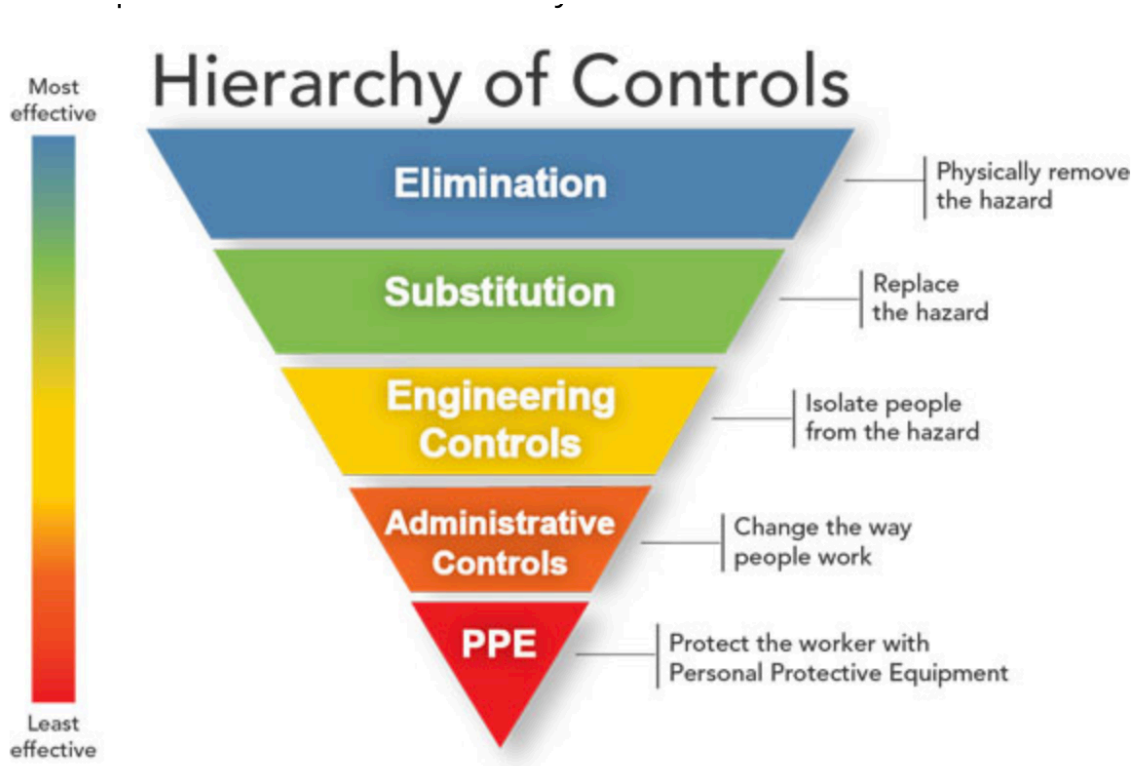

Figure 1. Hierarchy of Controls presented by NIOSH and OSHA to provide guidance on determining feasible and effective interventions to reduce risk for occupational exposure to hazardous medications and hazardous medication waste. (CDC, n.d.).

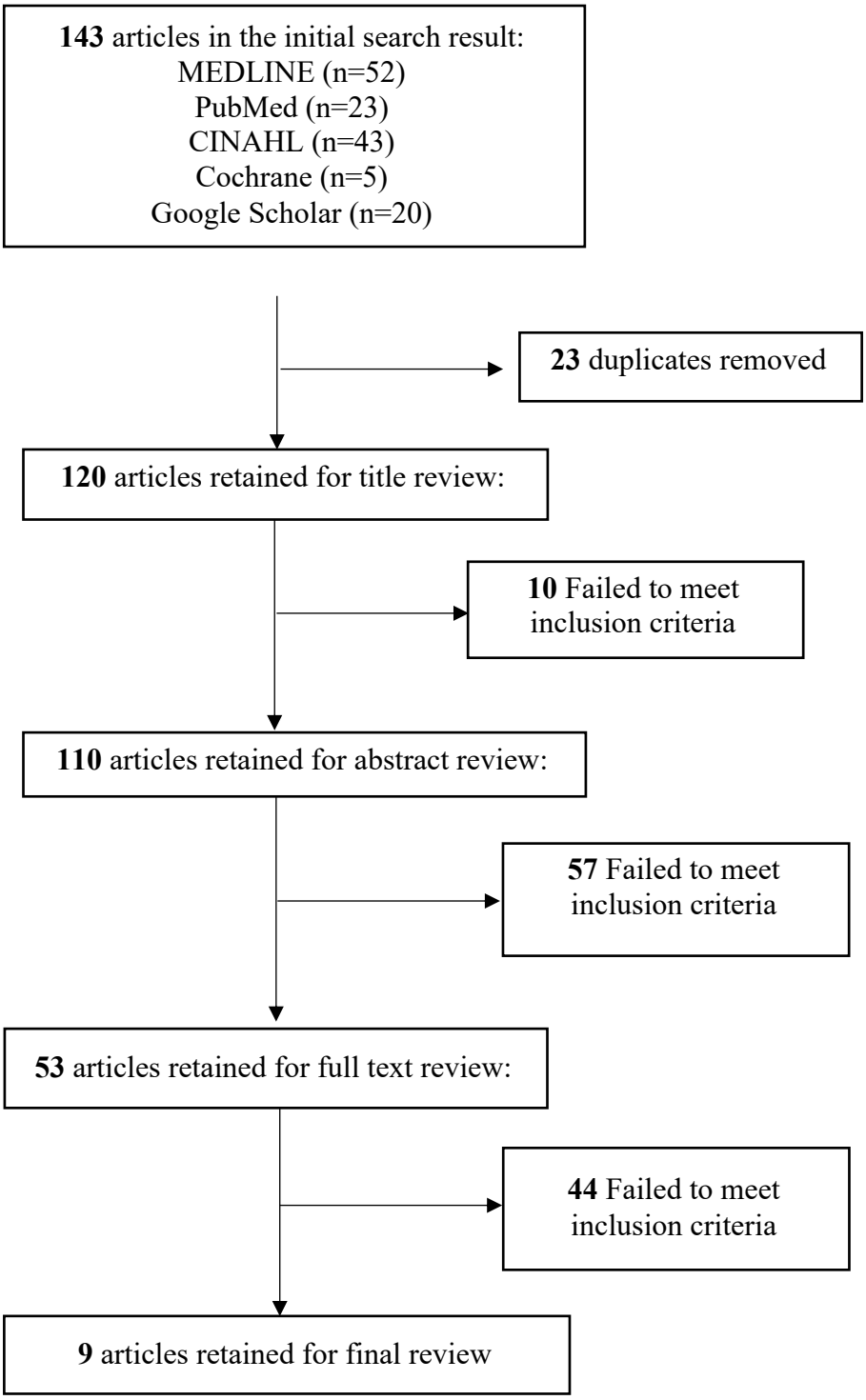

Figure 2. Literature review flow chart

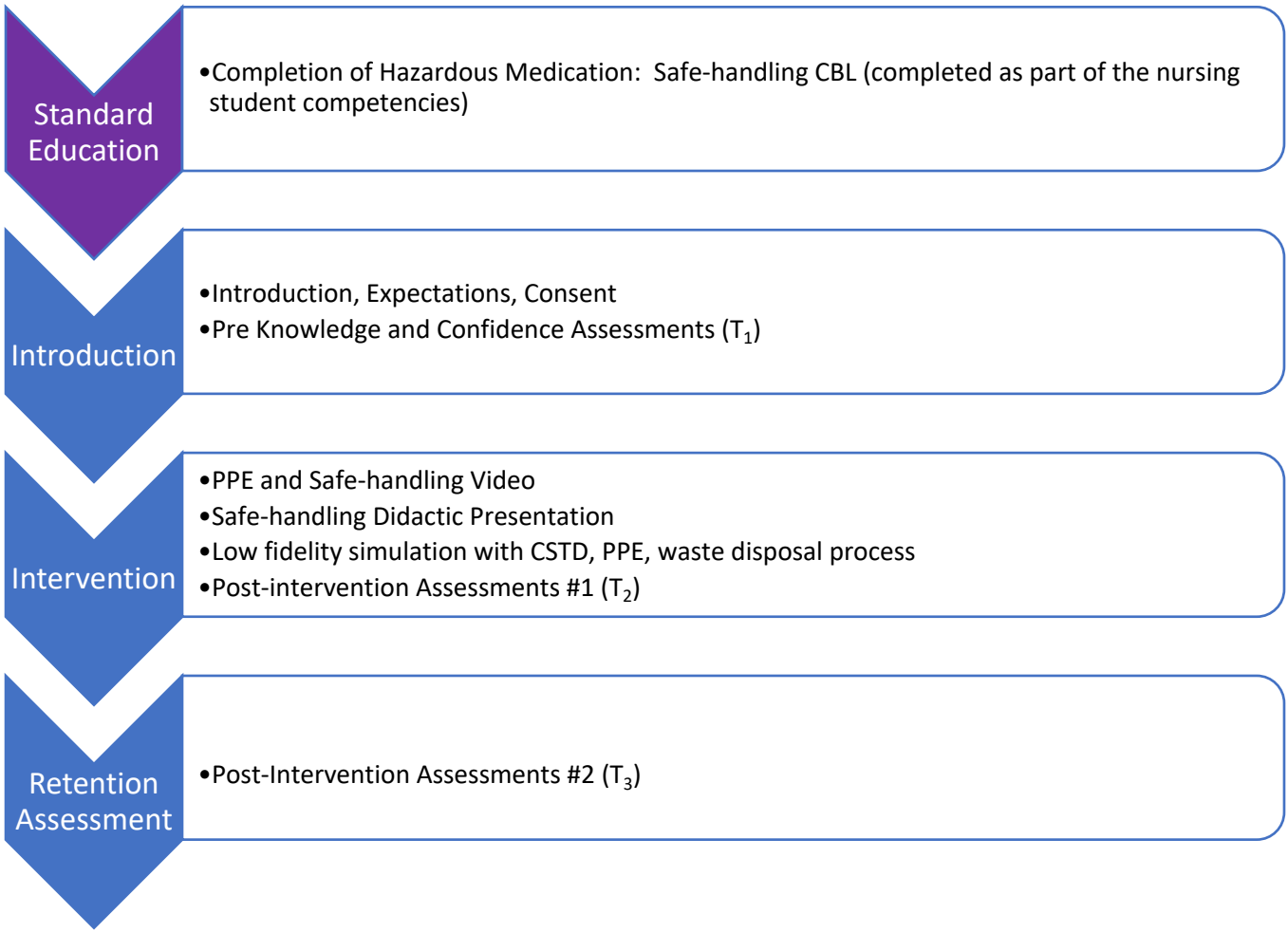

Figure 3. Scholarly project implementation flow diagram

Effect of Multimodal Educational Intervention on Generalist Graduate Level Nursing Students' Confidence and Knowledge Related to Hazardous Medication Safe-Handling Processes: A Doctor of Nursing Practice Scholarly Project Proposal

The Scholarly Project will evaluate the effect of a multimodal educational intervention on knowledge and confidence related to safe-handling of hazardous medications and caring for patients receiving hazardous medications.

The multimodal educational approach will include:

- A 5 minute PPE and Hazardous Drug Safety video
- Hazardous medication safe-handling didactic presentation
- Hands-on practice with supplies used to minimize occupational exposure to hazardous medications: closed system transfer device, PPE, waste containers
- Hazardous medication safe handling tip-sheets

Inclusion criteria:

- 2nd year generalist graduate level nursing students completing clinical hours at UVA Medical Center

Principal Investigator: Tanya D. Thomas, MSN, RN, AGCNS-BC, OCN
University of Virginia School of Nursing DNP student
Email: tdt4m@virginia.edu
Phone: 540-280-9711
IRB SBS # 2861

UVA | SCHOOL of NURSING

Figure 4. Scholarly project informational flyer

Good Morning,

Thank you for allowing me the opportunity to discuss my DNP project and answer questions regarding the project. I wanted to send a follow-up email with additional information regarding the time commitment and dates for the educational intervention. The total time commitment is less than 2 hours. The pre and post-intervention questionnaires take approximately 15 minutes to complete (total of 45 minutes for all 3 questionnaires) and the educational intervention will take approximately 30 minutes and will include a didactic component, a 5 minute safe-handling video and the opportunity for low fidelity simulation with the safety devices and equipment that should be used when handling a hazardous medication and a debriefing.

The Hazardous Medication Simulations are scheduled for 1200-1300 on either 20 September and 04 October in the Simulation Center in McLeod Hall. Three weeks after the educational intervention, you will be sent a link to complete the final post-intervention questionnaire. Refreshments will be provided after the educational intervention since food/drink is not allowed in the simulation center. You also will receive a certificate of completion after completing the last post-intervention questionnaire.

Your participation is greatly appreciated and results will add to the literature related to hazardous medication education and also will help guide the educational interventions for fellow students and healthcare professionals. If you are interested in participating, please send an email with the date you plan to attend the educational session (need a headcount for ordering lunch 🙂). If you would like to participate, but cannot attend on 20 September 2019 or 04 October 2019, please let me know and we can find a date/time that will work.

If you are not in clinical/practicum at one of the UVA Health locations, you still are welcome to participate; however, I will exclude your data from my final project. The basic principles related to Hazardous Medication Safety is universal and applicable to any practice setting. The closed system transfer device being used at the various medical centers does vary, so I will be discussing what is in use at UVA Health.

Remember: **FREE LUNCH,** snack/goodie bags and certificate of completion for less than 2 hours of your time receiving information that will provide guidance for reducing your risk for HD exposure and for helping with my DNP project 🙂!

Thank you for your consideration.
Sincerely,
Tanya

Tanya D. Thomas, MSN, RN, AGCNS-BC, OCN
DNP student
University of Virginia School of Nursing

Figure 5. E-mail: Introduction to scholarly project and invitation to participate

Hi,

Thank you for expressing interest in participating and helping with my DNP project. We will be in McLeod 1003 starting at noon. I plan to order pizza for lunch--please let me know if there are any food allergies and/or preferences for toppings.

Please take a few minutes to complete the pre-intervention questionnaire. If you have difficulty accessing the questionnaire, please let me know (for those using a Mac, you will need to do Command+click to access the link below. You will be asked for an identification number--please enter the last 5 digits of your phone number. You will enter this number for each questionnaire. The identification number will be used to link all of your responses, but not to identify who completed the questionnaire. Please do not use any references when completing the questionnaire. The pre questionnaire (T1) is used to measure your baseline knowledge related to hazardous medications.

Adapted revised HDHQ (T1)

Immediately post-intervention, you will be asked to complete T2. I will send this link out during the presentation so that you will be able to complete it immediately after we finish.

Please do not hesitate to reach out if you have any questions/concerns. I look forward to seeing you all tomorrow. If you know of CNL colleagues who plan to attend, please encourage them to send me an email tomorrow am so that I have enough supplies/materials for the low fidelity portion.

Thanks,
Tanya

Tanya D. Thomas, MSN, RN, AGCNS-BC, OCN
DNP student
University of Virginia School of Nursing

Figure 6. Email: Follow-up email with link to pre-questionnaire (T_1)

Hello,

I wanted to send a quick reminder regarding the Hazardous Medication Education and Simulation Sessions. The first session will be tomorrow from 1200-1300 in McLeod 1003 (Please note the room change). We moved it to McLeod 1003 for more of a "lunch and learn" so that you can eat while listening to the presentation. Thank you to those who have complete the pre questionnaire. If you have not completed the pre questionnaire, please take a few minutes to complete it prior to the educational session.

If you have difficulty accessing the questionnaire, please let me know (for those using a Mac, you will need to do Command+click to access the link below. You will be asked for an identification number--please enter the last 5 digits of your phone number. You will enter this number for each questionnaire. The identification number will be used to link all of your responses, but not to identify who completed the questionnaire. Please do not use any references when completing the questionnaire. The pre questionnaire (T1) is used to measure your baseline knowledge related to hazardous medications.

Adapted revised HDHQ (T1)

Thank you.

Sincerely,
Tanya

Tanya D. Thomas, MSN, RN, AGCNS-BC, OCN
DNP student
University of Virginia School of Nursing

Figure 7. Follow-up Email: Reminder to complete pre-intervention questionnaire

Good Evening,

Thank you for participating in the Hazardous Medication Safety education session earlier today. I appreciate your willingness to help with my DNP project and to learn about Haz Med Safety. I also appreciate your high level of engagement and your questions related to feasibility in the clinical setting. All of your questions have been identified as barriers to adherence to PPE in the clinical setting.

A few key points to remember:

- Adherence to PPE does minimize your risk for occupational exposure to HD
- Administering and handling HD can be safe if the proper safety precautions are followed
- Use your resources
- Continue to ask questions
- Make your safety a priority--you are worth it!! Taking a few extra minutes to don the appropriate PPE, use the closed system transfer devices and follow the Haz med safety precautions can greatly reduce your risk of adverse health effects due to occupational exposure to haz meds

I have attached the PPT from today with the active links for the videos, etc. Here is the link to the tip sheets on the PNSO site: https://www.uvapnso.org/intranet/clinical-practice-and-quality/education/hazardous-drug/

Please do not hesitate to reach out if there are questions regarding any of the information we discussed today. I do hope the session was helpful and will be useful in your clinical experiences.

Below is the link to the immediate post-intervention questionnaire. Please use the same number you used for the pre questionnaire.

Adapted revised HDHQ (T2)

I will send the link to the final postintervention questionnaire 3 weeks from today.

Again, thank you so much! I appreciate any feedback you may have regarding the information and/or low fidelity simulation with the administration set-ups.

Thanks,
Tanya

Tanya D. Thomas, MSN, RN, AGCNS-BC, OCN
DNP student: University of Virginia School of Nursing

Figure 8. Email: Immediate post-intervention questionnaire

Good Afternoon,

Thank you for participating in my DNP project. I appreciate your willingness to help and to learn about Haz Med Safety. I also appreciate your high level of engagement and your questions related to feasibility in the clinical setting.

A few key points to remember:

- Adherence to PPE does minimize your risk for occupational exposure to HD
- Administering and handling HD can be safe if the proper safety precautions are followed
- Use your resources
- Continue to ask questions
- Make your safety a priority--you are worth it!! Taking a few extra minutes to don the appropriate PPE, use the closed system transfer devices and follow the Haz med safety precautions can greatly reduce your risk of adverse health effects due to occupational exposure to hazardous medications

Please do not hesitate to reach out if there are any questions regarding any of the information we discussed today. I do hope the session was helpful and will be useful in your clinical experiences.

Below is the link to the final post-intervention questionnaire. Please use the same number you used for the prior questionnaires. Your feedback related to the process will be beneficial for identifying gaps in practice and recommendations for increasing awareness related to hazardous medication safety for both practicing clinicians and students in the clinical environment.

After completion of the questionnaire, please send me an email indicating completion of the 3 questionnaires. I then will send you the certificate of completion with the IRB number listed. You will be able to add participation in this study/project to your resume/CV.

Adapted revised HDHQ (T3)

Again, thank you so much! I appreciate any feedback you may have regarding the information and/or low fidelity simulation with the administration set-ups.

Thanks,
Tanya

Tanya D. Thomas, MSN, RN, AGCNS-BC, OCN
DNP student
University of Virginia School of Nursing

Figure 9. Email: Post-intervention questionnaire completion

Protocol #: Project Title: Effect of Multimodal Educational Intervention on Generalist Graduate Level Nursing Students' Confidence and Knowledge Related to Hazardous Medication Safe-Handling Processes

Informed Consent Agreement

Please read this consent agreement carefully before you decide to participate in the study.

Purpose of the research study: The purpose of this project is to measure the effect of a multimodal educational intervention related to hazardous medications on the knowledge and confidence of generalist graduate level nursing students. The educational intervention will include a 5 minute video related to hazardous medication safe-handling processes, an in-person didactic presentation, tip-sheets and hands-on practice using the supplies and equipment involved in the hazardous medication safe-handling processes.

What you will do in the study: You will be asked to complete the modified Revised Hazardous Drug Handling Questionnaire before, immediately after and 3 weeks after the multimodal educational intervention.

Time required: The study will require about 2 hours of your time. Completion of the modified Revised Hazardous Drug Handling Questionnaire will take approximately 15 minutes each time for a total of 45 minutes. The multimodal educational intervention will take approximately 45-60 minutes.

Risks: There are no anticipated risks in this study.

Benefits: There are no direct benefits to you for participating in this scholarly project. The project may help us understand the effectiveness of a multimodal educational intervention to increase knowledge of hazardous medication safety practices and confidence related to caring for patients on hazardous medication precautions and safe handling practices associated with hazardous medications.

Confidentiality: Your data will be anonymous which means your name will not be collected or linked to the data. You will be assigned a sticker with a randomly generated ID number and will be instructed to keep the sticker with this ID number on the back of your badge for the duration of the study. You will enter or write this unique number on the pre and post knowledge assessment and confidence surveys. The knowledge assessments and confidence surveys will be sent via an anonymous link. Due to the nature of the data, it may be possible to deduce your identity; however, there will be no attempt to do so and the data will be reported and analyzed in a way that will not identify you.

Voluntary participation: Your participation in the study is completely voluntary.

Right to withdraw from the study: You have the right to withdraw from the study at any time without penalty.

How to withdraw from the study: In order to withdraw from the study, you can discard the surveys and knowledge assessments without returning or elect to not attend the educational intervention. Please note that after the survey has been returned, it will be impossible to withdraw due to the survey being anonymous.

Payment: You will receive no payment for participating in the study.

Protocol #: Project Title: Effect of Multimodal Educational Intervention on Generalist Graduate Level Nursing Students' Confidence and Knowledge Related to Hazardous Medication Safe-Handling Processes

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If you have questions about the study, contact:
Tanya D. Thomas, MSN, RN, OCN
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Charlottesville, VA 22908
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Charlottesville, VA 22903
Telephone: (540) 280-9711
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Faculty Advisor: Regina M. DeGennaro, DNP, RN, CNS, AOCN, CNL
Associate Professor, Oncology Clinical Nurse Specialist
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225 Jeannette Lancaster Way, Box 800826
Telephone: 434.924.0116
Email: rmd3e@virginia.edu

To obtain more information about the study, ask questions about the research procedures, express concerns about your participation, or report illness, injury or other problems, please contact:
Tonya R. Moon, Ph.D.
Chair, Institutional Review Board for the Social and Behavioral Sciences
One Morton Dr Suite 500
University of Virginia, P.O. Box 800392
Charlottesville, VA 22908-0392
Telephone: (434) 924-5999
Email: irbsbshelp@virginia.edu
Website: www.virginia.edu/vpr/irb/sbs
Website for Research Participants: http://www.virginia.edu/vpr/participants/

Agreement:
I agree to participate in the research study described above.

Signature: _____ **Date:** _____

You will receive a copy of this form for your records.

Revision date: 05/30/2019
Page 2

Figure 10. Consent to participate in the scholarly project

Figure 11. Certificate of participation

Adapted revised HDHQ

Thank you for agreeing to participate in this DNP Scholarly Project. This scholarly project focuses on generalist prelicensure generalist graduate-level students who handle hazardous medications or care for patients who are or have received hazardous medications in the clinical setting. "Handling" refers to preparation, administration, disposal and coming into contact with patient's excreta that may be contaminated with hazardous medications.

By **preparation**, we mean transferring hazardous medications from vials or ampoules to syringes or IV containers.
By **administration**, we mean giving hazardous medications to patients by IV, injection, orally, etc.
By **disposal**, we mean discarding equipment/supplies used in hazardous medication preparation or administration.
By **handling excreta**, we mean emptying bedpans, urinals or emesis basins.

Please read each item carefully.
Please answer all the questions.
Please select only one option per question unless the question asks for more than one response.

Enter the unique ID located on your information sheet.

Select one answer to each of the following statements about hazardous medications **exposure**.

	True	False	Don't Know
Hazardous medications can enter the body through breathing it in	○	○	○
Hazardous medications can enter the body through ingesting it	○	○	○
Hazardous medications cannot enter the body through contact with contaminated surfaces	○	○	○
Hazardous medications can enter the body through contact with spills and splashes	○	○	○
Hazardous medication gas and vapor in the air can enter the body through skin and mucous membranes	○	○	○

Oral forms of hazardous medications do not have the potential to be absorbed	○	○	○
Hazardous medications in liquid form can be absorbed through the skin	○	○	○
A surgical mask provides protection from hazardous medications aerosols	○	○	○
All types of gloves provide the same level of protection	○	○	○
Hazardous medications can more easily enter the body through damaged skin	○	○	○
Hazardous medications can enter the body through contaminated foods, beverages, or cosmetics	○	○	○
Alcohol hand sanitizer is as effective as soap and water in removing hazardous medication residue.	○	○	○

Indicate your level of agreement with each of these statements about using personal protective equipment (PPE) when handling Hazardous medications.

SA=Strongly Agree
A=Agree
D=Disagree
SD=Strongly Disagree

	SA	A	D	SD
I am confident that I can use PPE properly	○	○	○	○
I am confident that I can protect myself from hazardous medication exposure	○	○	○	○
I am given enough information on how to protect myself from hazardous medication exposure	○	○	○	○
My clinical faculty goes out of his/her way to make sure I am protected	○	○	○	○
Reuse of disposable PPE makes me feel less protected	○	○	○	○
I am provided with the best available PPE	○	○	○	○

What personal protective equipment is **available** for performing the following hazardous medication handling activities? Select all that apply.

	Gloves	Impervious Gowns	Eye Protection	Respirator/Mask
Preparation	☐	☐	☐	☐
Administration	☐	☐	☐	☐
Handling Excreta	☐	☐	☐	☐
Disposal	☐	☐	☐	☐
Cleaning Spills	☐	☐	☐	☐

What personal protective equipment do **you wear** when performing the following hazardous medication handling activities? Select all that apply.

	None	Single nitrile gloves	Dual nitrile gloves	Hazardous medication designated gown	Isolation gown	Respirator/ Face mask
Preparation	☐	☐	☐	☐	☐	☐
Administration	☐	☐	☐	☐	☐	☐
Handling Excreta	☐	☐	☐	☐	☐	☐
Disposal	☐	☐	☐	☐	☐	☐
Cleaning Spills	☐	☐	☐	☐	☐	☐

Please indicate how often you use the following while **administering hazardous medications**?

	Always	76-99%	51-75%	26-50%	1-25%	Never
Closed system transfer device	○	○	○	○	○	○
Gloves labeled for use with hazardous medications	○	○	○	○	○	○
Other gloves (e.g. vinyl)	○	○	○	○	○	○
Double gloves	○	○	○	○	○	○
Gowns labeled for use with hazardous medications	○	○	○	○	○	○
Other gowns (e.g. isolation)	○	○	○	○	○	○
Do you re-use disposable gowns?	○	○	○	○	○	○
Eye protection	○	○	○	○	○	○
Respirator/mask	○	○	○	○	○	○

Please indicate how often you use the following when **disposing of hazardous medications**?

	Always	76-99%	51-75%	26-50%	1-25%	Never
Gloves labeled for use with hazardous medications	○	○	○	○	○	○
Other gloves (e.g. vinyl)	○	○	○	○	○	○
Double gloves	○	○	○	○	○	○
Gowns labeled for use with hazardous medications	○	○	○	○	○	○
Other gowns (e.g. isolation)	○	○	○	○	○	○
Do you re-use disposable gowns?	○	○	○	○	○	○
Eye protection	○	○	○	○	○	○
Respirator/mask	○	○	○	○	○	○

Please indicate how often you use the following when **handling excreta**?

	Always	76-99%	51-75%	26-50%	1-25%	Never
Gloves labeled for use with hazardous medications	O	O	O	O	O	O
Other gloves (e.g. vinyl)	O	O	O	O	O	O
Double gloves	O	O	O	O	O	O
Gowns labeled for use with hazardous medications	O	O	O	O	O	O
Other gowns (e.g. isolation)	O	O	O	O	O	O
Do you re-use disposable gowns?	O	O	O	O	O	O
Eye protection	O	O	O	O	O	O
Respirator/mask	O	O	O	O	O	O

Indicate your level of agreement with each of the following statements.

SA=Strongly Agree
A=Agree
D=Disagree
SD=Strongly Disagree

	SA	A	D	SD
I don't think PPE is necessary	O	O	O	O
I don't think PPE works	O	O	O	O
I don't have the time to use PPE	O	O	O	O
I was not trained to use PPE	O	O	O	O
PPE is uncomfortable to wear	O	O	O	O
PPE makes it harder to get the job done	O	O	O	O
PPE is not always available	O	O	O	O
Others around me don't use PPE	O	O	O	O
There is no policy requiring PPE	O	O	O	O
People would think I am overly cautious	O	O	O	O
It is hard to get hazardous medication designated PPE	O	O	O	O
PPE makes me feel too hot	O	O	O	O
PPE is too expensive to use it all the time	O	O	O	O

Indicate your level of agreement with each of the following statements about the risks of hazardous medication exposure.

SA=Strongly Agree
A=Agree
D=Disagree
SD=Strongly Disagree

	SA	A	D	SD
Hazardous medication exposure is not as harmful as some people claim	○	○	○	○
Compared to other work-related health risks, hazardous medication exposure is less serious	○	○	○	○
I am not worried about future negative health effects from hazardous medication exposure	○	○	○	○

How often do the following people wear PPE when handling hazardous medications?

	Never	Sometimes	About half the time	Most of the time	Always	Does not apply
My student colleagues	○	○	○	○	○	○
My clinical faculty	○	○	○	○	○	○
My preceptor	○	○	○	○	○	○
Other nurses at my clinical site	○	○	○	○	○	○

According to the following people, how important is wearing PPE when handling hazardous medications?

	Not at all important	Sort of important	Very important	Does not apply
My student colleagues	O	O	O	O
My clinical faculty	O	O	O	O
My preceptor	O	O	O	O
Other nurses at my clinical site	O	O	O	O

Indicate your level of agreement with each of the following statements.

SA=Strongly Agree
A=Agree
D=Disagree
SD=Strongly Disagree

	SA	A	D	SD
PPE keeps me from caring for patients to the best of my abilities	O	O	O	O
Wearing PPE makes my patients worry	O	O	O	O
Patient care often interferes with my ability to wear PPE	O	O	O	O
I cannot always wear PPE because my patient's needs come first	O	O	O	O
Sometimes I choose between wearing PPE and caring for my patients	O	O	O	O
Wearing PPE makes my patients feel uncomfortable	O	O	O	O

What is your GENDER?

- Male
- Female
- Other

What is your RACE or ETHNIC IDENTITY?

- American Indian/Alaskan Native
- Asian
- Black/African American
- Hispanic/Latino
- Native Hawaiian
- White/Caucasian
- Biracial
- Other

Please select your **current** clinical/practicum area:

Acute care examples: 3E, 3C, 3W, 4E, 4C, 4W, 5C, 5W, 6E, 6C, 6W, 8W
Intermediate Care or Critical Care examples: MICU, STICU, NNICU, TCV-ICU, SIMU, NIMU, SCTU
Specialty areas examples: Pediatrics, OB

- Acute Care
- Critical Care
- Specialty Area
- Other

Please select your **prior** clinical/practicum areas (select all that apply):

Acute care examples: 3E, 3C, 3W, 4E, 4C, 4W, 5C, 5W, 6E, 6C, 6W, 8W
Intermediate Care or Critical Care examples: MICU, STICU, NNICU, TCV-ICU, SIMU, NIMU, SCTU
Specialty areas examples: Pediatrics, OB

- Acute Care
- Critical Care
- Specialty Area
- Other

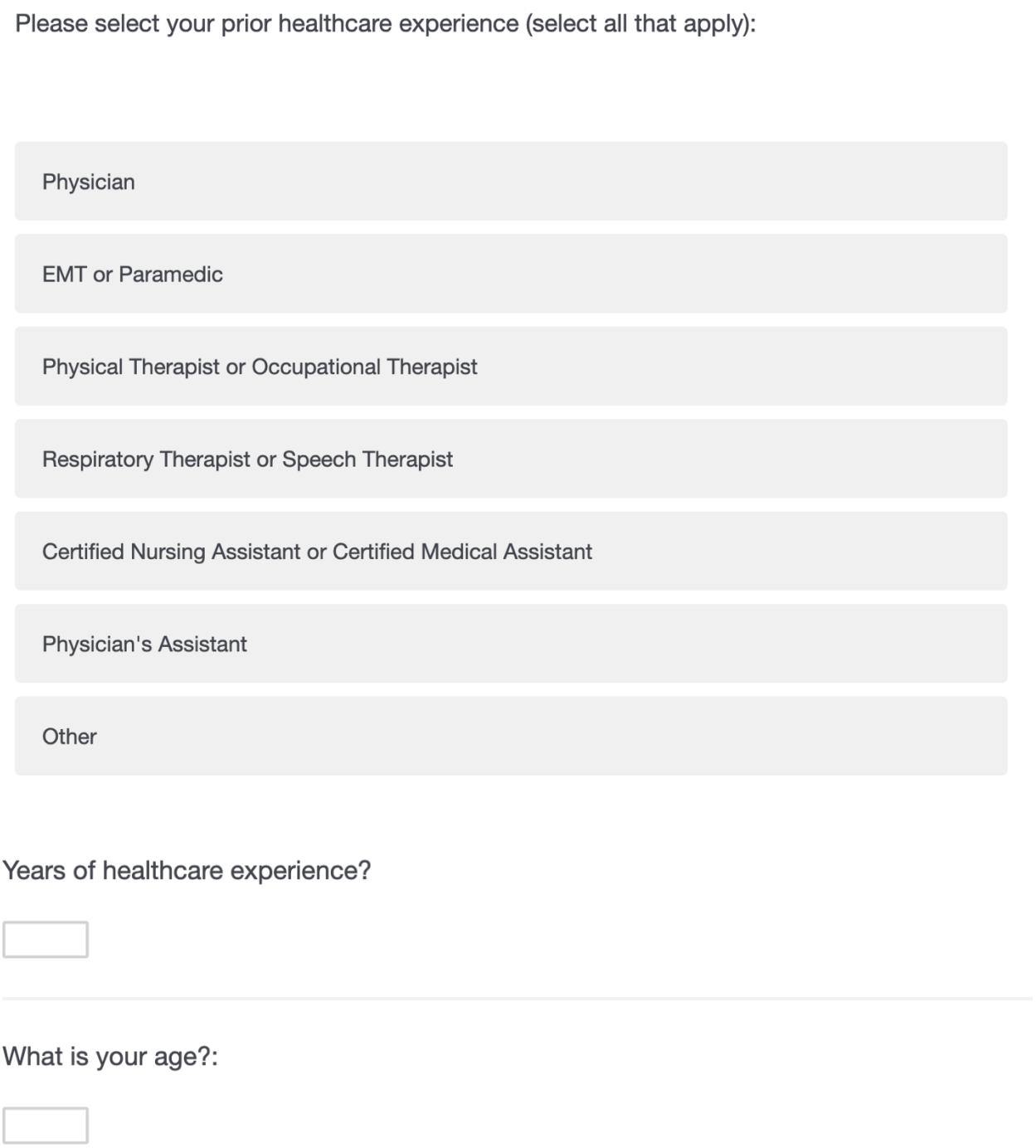


Figure 12. Adapted revised HDHQ (adapted from the Revised Hazardous Medication Questionnaire, Polovich & Clark, 2012)

Hazardous Medication Safe-Handling Processes

Tanya Thomas, MSN, RN, OCN
Doctor of Nursing Practice Scholarly Project Defense

Objectives

At the conclusion of this session, the participant will be able to:

- Describe safety issues involved in the preparation, administration and disposal of hazardous medications.
- Describe guidelines for ensuring the safe-handling of hazardous medications.
- Discuss how to safely and appropriately prepare, administer, and dispose of hazardous medications.

BACKGROUND

Useful Terms

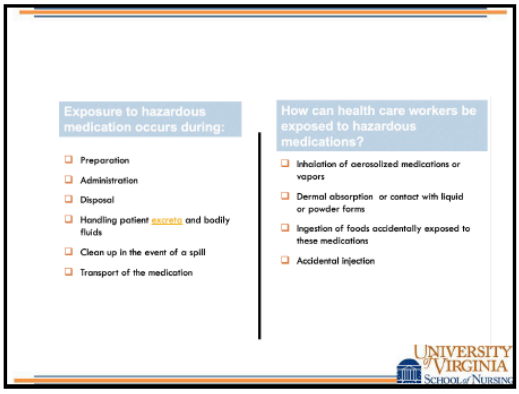
- ***Chemotherapy:*** Antineoplastic medications used in the treatment of malignancies administered via oral, parenteral, intrathecal, intravesicular or other routes (Neuss, et al., 2017).
- ***Closed System Transfer Device (CSTD):*** "A drug transfer device that mechanically prohibits the transfer of environmental contaminants into the system and the escape of the hazardous drug or vapor concentrations outside the system" (NIOSH, 2004).
- ***Hazardous Medication (HD):*** Medications that exhibit at least one of the following six characteristics in animals or humans: Teratogenicity or other developmental toxicity, carcinogenicity, genotoxicity, reproductive toxicity, organ toxicity at low doses, or toxicity and structure profiles of new drugs that mimic existing medications classified as hazardous (NIOSH, 2016).
- ***Knowledge about HD exposure:*** Understanding information about both the risks of HD exposure and the effectiveness of precautions in preventing exposure.
- ***Personal Protective Equipment (PPE):*** Equipment utilized to minimize occupational exposure to hazards that have the potential to cause occupational injuries. (OSHA, n.d.)
- ***Safe Handling Precautions:*** The use of PPE, additional safety equipment and modification of work practices to minimize the risk of occupational exposure (Neuss, et al., 2017).

Characteristics of HD

- Hazardous medications are capable of causing toxicity to personnel or others who come in contact with them through acute or chronic exposure.
- These medications exhibit one or more of the following characteristics:
  - Genotoxic: the ability to cause a change or mutation in genetic material; a mutagen.
  - Carcinogenic: the ability to cause cancer in humans, animal models, or both; a carcinogen.
  - Teratogenic: the ability to cause defects in fetal development or fetal malformation; a teratogen.
  - Fertility impairment or reproductive toxicity
  - Organ toxicity at low doses
  - Chemical structure and toxicity profile that mimic existing medications classified as hazardous

Occupational Exposure to HD

- Approximately eight million healthcare workers (HCW) potentially are at risk for occupational exposure to hazardous medications (HD) annually (US Bureau of Labor Statistics, 2007).
- The risk for occupational exposure to HDs occurs in any aspect of the HD process
- Hazardous medications are not limited to anti-neoplastic or cytotoxic agents used in the treatment of a malignancy in the oncology patient population. They include hormonal agents and a variety of medications administered for post-transplant immunosuppression, anti-coagulation, and their anti-viral effects (NIOSH, 2015).


Exposure to hazardous medication occurs during:
Preparation
Administration
Disposal
Handling patient excreta and bodily fluids
Clean up in the event of a spill
Transport of the medication
How can health care workers be exposed to hazardous medications?
Inhalation of aerosolized medications or vapors
Dermal absorption or contact with liquid or powder forms
Ingestion of foods accidentally exposed to these medications
Accidental injection
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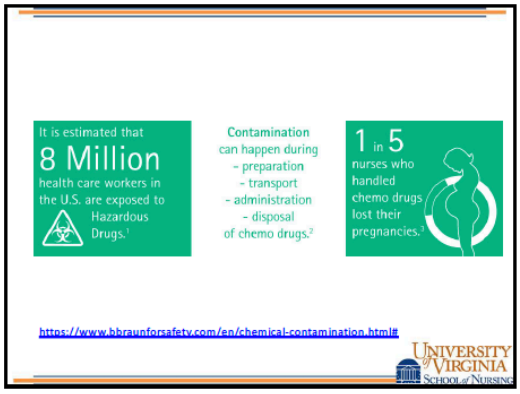
It is estimated that
8 Million
health care workers in the U.S. are exposed to Hazardous Drugs.[1]
Contamination can happen during
- preparation
- transport
- administration
- disposal
of chemo drugs.[2]
1 in 5
nurses who handled chemo drugs lost their pregnancies.[3]
https://www.bbraunforsafety.com/en/chemical-contamination.html#
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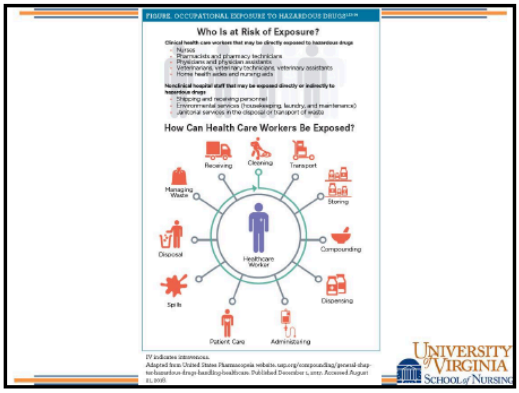
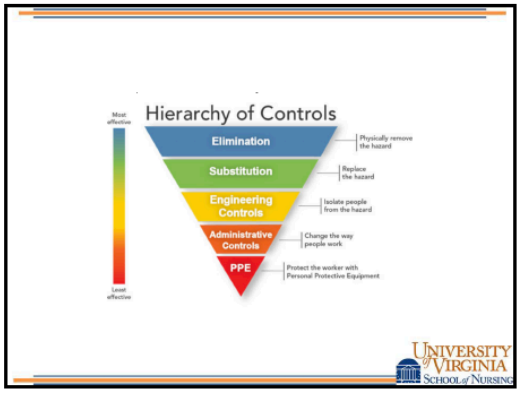
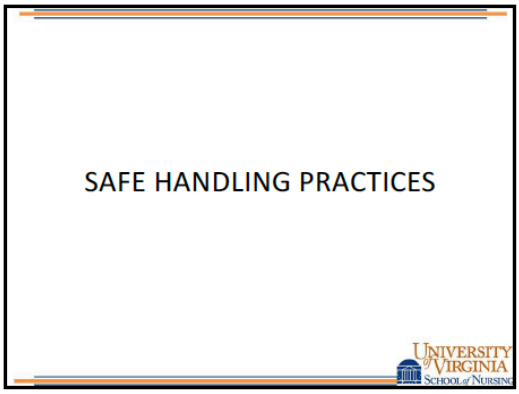
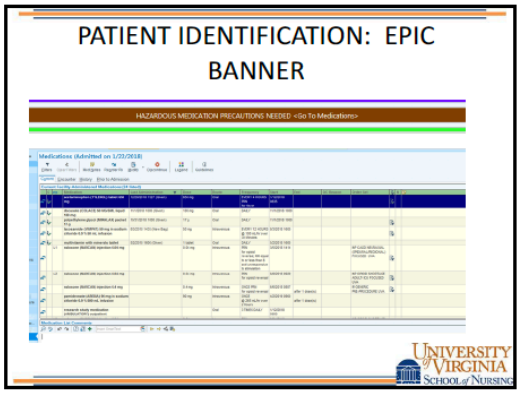

Who Is at Risk of Exposure?
How Can Health Care Workers Be Exposed?
Receiving
Cleaning
Transport
Storing
Compounding
Dispensing
Administering
Patient Care
Spills
Disposal
Managing Waste
Healthcare Worker
UNIVERSITY of VIRGINIA SCHOOL of NURSING


Hierarchy of Controls
Most effective
Least effective
Elimination
Physically remove the hazard
Substitution
Replace the hazard
Engineering Controls
Isolate people from the hazard
Administrative Controls
Change the way people work
PPE
Protect the worker with Personal Protective Equipment
UNIVERSITY of VIRGINIA SCHOOL of NURSING


SAFE HANDLING PRACTICES
UNIVERSITY of VIRGINIA SCHOOL of NURSING


PATIENT IDENTIFICATION: EPIC BANNER
HAZARDOUS MEDICATION PRECAUTIONS NEEDED <Go To Medications>
UNIVERSITY of VIRGINIA SCHOOL of NURSING

PATIENT IDENTIFICATION: SIGNAGE

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MEDICATION IDENTIFICATION: HD LABEL

- Labeling: All first dose bags of hazardous medications will be labeled with a "HD" label in the pharmacy.

- New hazardous medication orders in Epic provide warnings and information about required PPE for that medication.
- Using a Biological Safety Cabinet (BSC) when compounding hazardous medications does not eliminate the need for personal protective equipment.

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PERSONAL PROTECTIVE EQUIPMENT (PPE)

- Use of appropriate PPE must be worn during all aspects of hazardous medication handling: receipt, storage, transport, compounding, administration, deactivation/decontamination, cleaning, disinfecting, spill management, waste disposal.
- PPE also must be worn when handling the bodily fluids of someone who is receiving or has received hazardous medications within the past 48 hours.

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PPE

Routes of Administration	Required Personal Protective Equipment (PPE)
Intact oral tablet or capsule	• Impervious gown with cuffed sleeves • Two pair of Nitrile gloves
Oral liquids Topical agents IM SQ	• Impervious gown with cuffed sleeves • Two pair of Nitrile gloves • Goggles and NIOSH approved respiratory mask (if there is a risk for splashing into the face)
IV Push and IV Infusions	• Impervious gown with cuffed sleeves • Two pair of Nitrile gloves • Goggles and NIOSH approved respiratory mask

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CLOSED SYSTEM TRANSFER DEVICE (CSTD)

- A CTSD prevents the transfer of environmental contaminants into the medication system and the escape of hazardous medication or hazardous vapors into the environment.
- Use of a CSTD is required during all IV, SQ and IM administrations in addition to other administration methods where a syringe, IV bag and/or tubing is used.

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HD MEDICATION WASTE

Type of Hazardous Waste	Disposal Container
Soft waste (i.e PPE)	Regular Trash
Sharps, IV bags and tubing with TRACE amounts of hazardous medication	Yellow Hazardous Waste Container 
IV bags and tubing with MORE than trace amounts of hazardous medication (no spikes/sharps)	White Hazardous Waste Container 

UNIVERSITY of VIRGINIA SCHOOL of NURSING

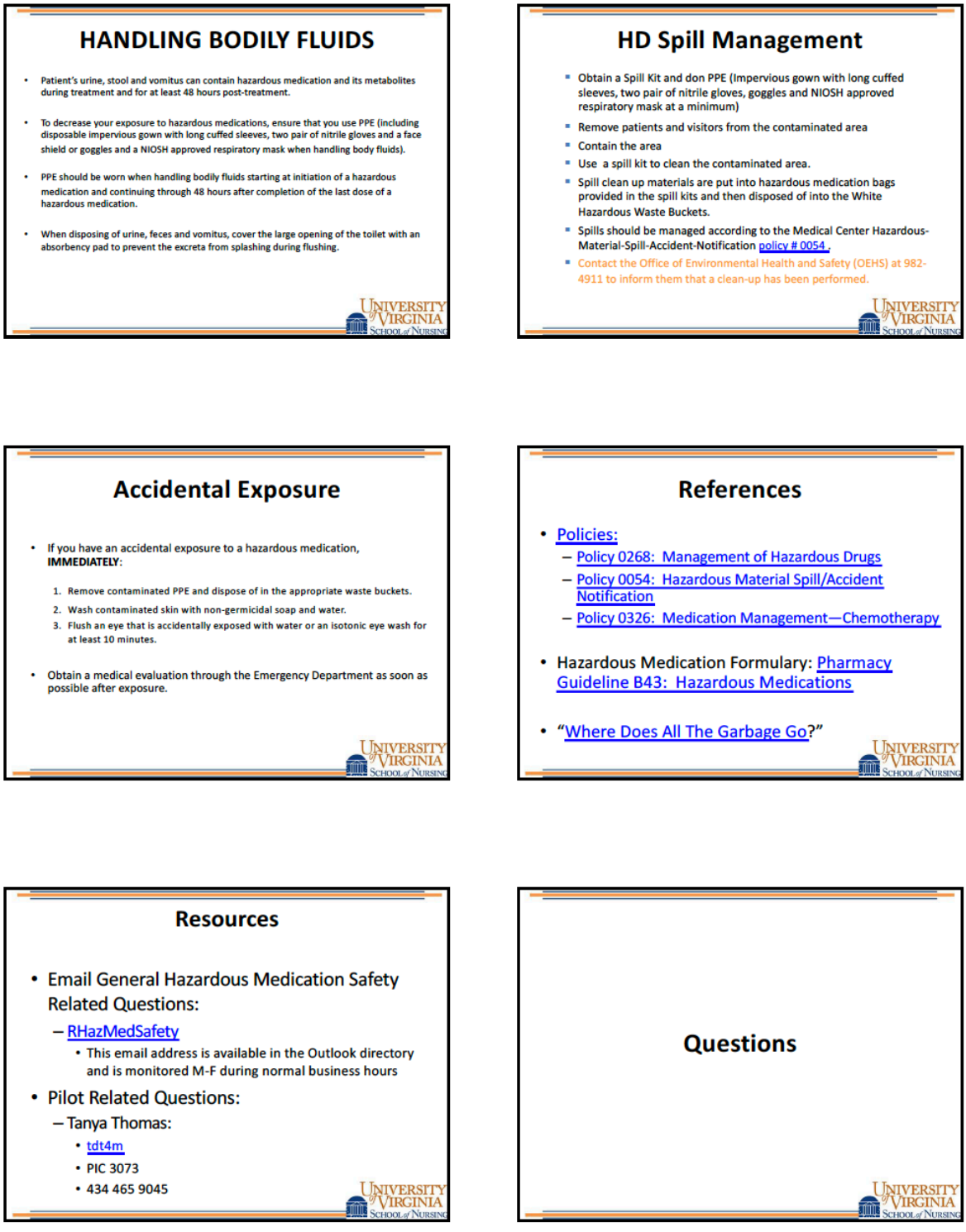

Figure 13. Hazardous medication: safe-handling processes module

UNIVERSITY of VIRGINIA HEALTH SYSTEM

Safe Handling of Hazardous Medications Tip Sheet

PPE (Personal Protective Equipment) Reminders

- PPE must be worn when administering/disposing of hazardous medications, handling bodily fluids for patients on hazardous medication precautions or cleaning up a hazardous medication spill. The below table includes PPE recommendations from *NIOSH, OSHA and ONS; additional PPE may be required due to the "Safety in Pairs" and/or "Safety in Triplets" initiatives.

  ***NIOSH**=National Institute for Occupational Safety and Health; **OSHA**=Occupational Safety and Health Administration; **ONS**=Oncology Nursing Society.

CSTD=Closed System Transfer Device

Routes of Administration	Required Personal Protective Equipment (PPE)
Intact oral tablet or capsule	• Two pair of Nitrile gloves
Oral liquids Topical agents IM SQ	• Impervious gown with cuffed sleeves • Two pair of Nitrile gloves • Goggles and NIOSH approved respiratory mask (if there is a risk for medication aerosolization/vaporization) • CSTD for IM & SQ
IV Push and IV Infusions	• Impervious gown with cuffed sleeves • Two pair of Nitrile gloves • Goggles and NIOSH approved respiratory mask if there is a risk for medication aerosolization/vaporization • CSTD
Sublingual	• Impervious gown with cuffed sleeves • Two pair of Nitrile gloves • Goggles and NIOSH approved respiratory mask if there is a risk for medication aerosolization/vaporization

Administration and Safe Work Practices Quick Tips

- Not all chemotherapy agents are hazardous. Non-chemotherapy agents may be hazardous. Pay close attention to the EPIC orders.
- Use the appropriate Hazardous Medication Precautions signage to identify patients who are receiving or have received a hazardous medication within the past 48 hours. Hazardous medication precautions should be started when the first dose of a hazardous medication is administered and remain in place for at least 48 hours after the last dose of a hazardous medication has been administered.

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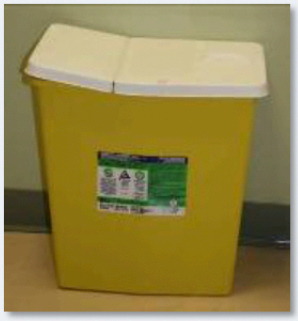
- Patient's urine, stool and vomitus can contain hazardous medications and its metabolites during treatment and up to 48+ hours after the last dose of treatment.
- When disposing of urine, feces and vomitus, cover the large opening of the toilet with an absorbency pad (if a lid is not present) to prevent the excreta from splashing during flushing.

Hazardous Medication Waste Disposal

Type of Hazardous Medication Waste	Disposal Container
Soft waste (i.e PPE)	Regular Trash
Sharps, IV bags and tubing with TRACE amounts of hazardous medication	Yellow Hazardous Waste Container 
IV bags and tubing with MORE than trace amounts of hazardous medication	Black Hazardous Waste Container 

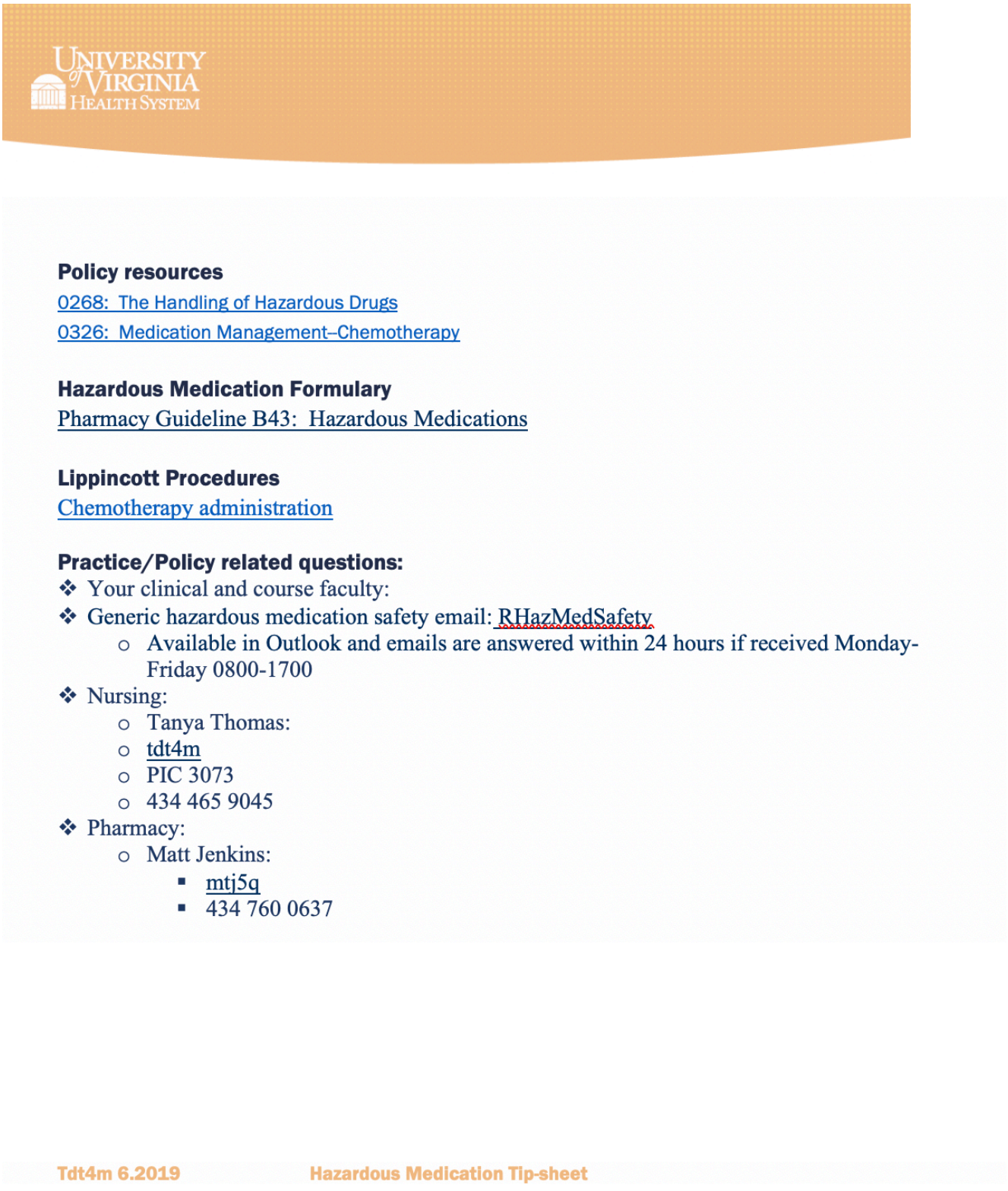
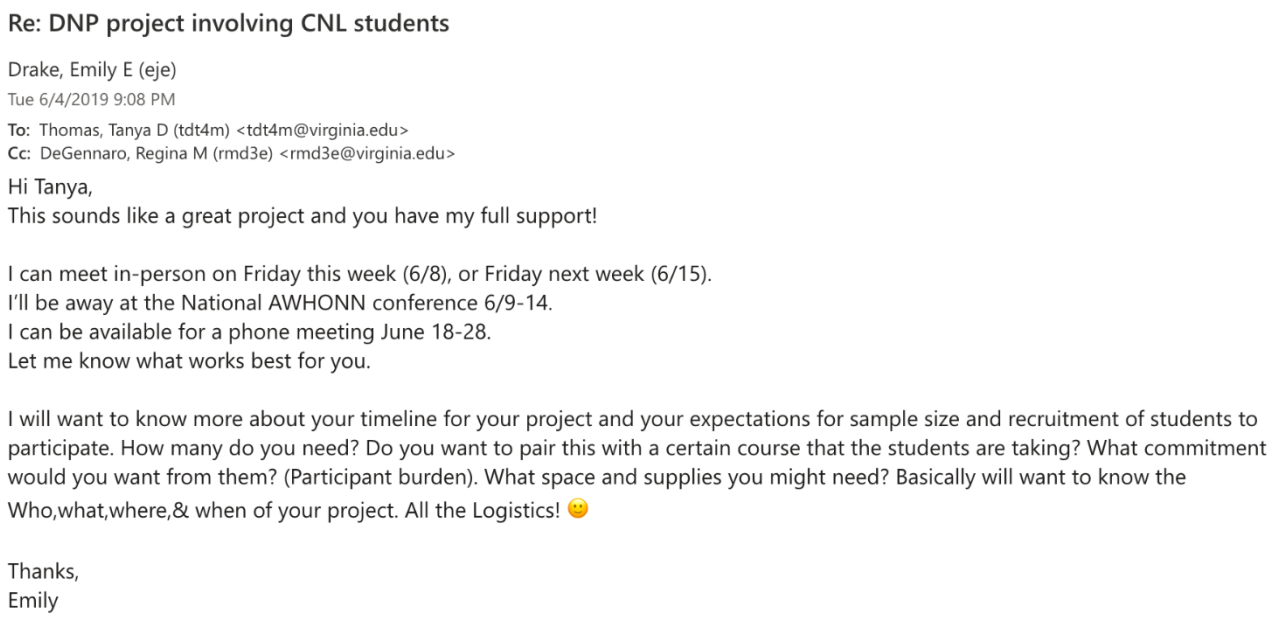


Figure 14. Hazardous medication safe-handling tip-sheet



Re: DNP project involving CNL students

Drake, Emily E (eje)
Tue 6/4/2019 9:08 PM

To: Thomas, Tanya D (tdt4m) <tdt4m@virginia.edu>
Cc: DeGennaro, Regina M (rmd3e) <rmd3e@virginia.edu>

Hi Tanya,
This sounds like a great project and you have my full support!

I can meet in-person on Friday this week (6/8), or Friday next week (6/15).
I'll be away at the National AWHONN conference 6/9-14.
I can be available for a phone meeting June 18-28.
Let me know what works best for you.

I will want to know more about your timeline for your project and your expectations for sample size and recruitment of students to participate. How many do you need? Do you want to pair this with a certain course that the students are taking? What commitment would you want from them? (Participant burden). What space and supplies you might need? Basically will want to know the Who,what,where,& when of your project. All the Logistics! 🙂

Thanks,
Emily

Figure 15: Approval from generalist graduate degree nursing Program Director

RE: Questionnaire related to hazardous medication safety and prelicensure nursing students

Martha Polovich <mpolovich2@gsu.edu>
Thu 6/6/2019 12:44 PM
To: Thomas, Tanya D (tdt4m) <tdt4m@virginia.edu>

3 attachments (107 KB)
Nurse questionnaires scoring guide 2018.docx; Safe Handling Survey.docx; Overview of instruments & Reliability.docx;

Tanya,
Thank you for your interest in the instruments that I developed. You have my permission to use them for your DNP project, and to modify them for that purpose. I ask that you reference the original instrument and me as the author should you publish the results of your project. The questionnaire and scoring guide are attached.

These instruments have never been used in pre-licensure students. Because reliability is sample-specific, it may not perform as well in your project. Should you analyze the reliability in your sample, please share that information with me. Reliability information in an oncology nurse sample is attached for your reference.

Good luck with your scholarly project.
Sincerely,

Martha Polovich, PhD, RN, AOCN
Director-at-Large
Oncology Nursing Society
marty@polovich.com
404-408-3890

"Be who you are and say what you feel, because those who mind don't matter and those who matter don't mind." Dr. Seuss

Figure 16. Approval to use and modify the Revised Hazardous Drug Handling Questionnaire

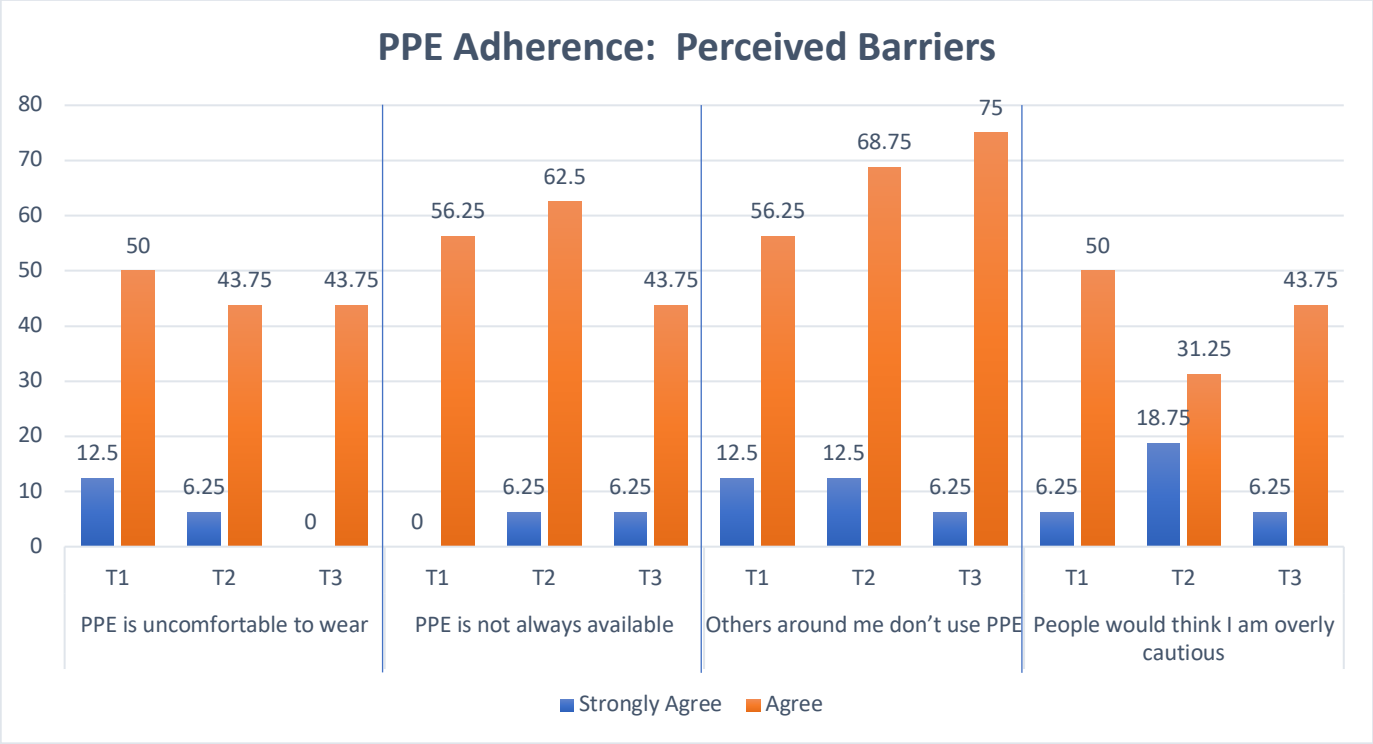


Figure 17. Perceived barriers to PPE adherence: Questions with greatest percentage of "Strongly Agree" or "Agree"

Appendix 1

Author Guidelines:

For ONF Authors

The *Oncology Nursing Forum (ONF)* publishes peer-reviewed findings from oncology nursing research and fosters the translation of research evidence to practice.

Manuscripts are accepted for consideration with the understanding that they are contributed solely to this journal, that the material is original, and that the articles have not been published previously. All manuscripts will be reviewed for originality. Manuscripts found to plagiarize the work of others will be prohibited from publication in *ONF* or the *Clinical Journal of Oncology Nursing*.

If a work has multiple authors, the paper is reviewed on the assumption that all authors have granted approval for submission. All submitted papers are subject to blind peer review. Papers will be judged on the quality of the work and suitability for the audience. Questions should be sent directly to

ONF Editor

Debra Lyon, RN, PhD, FNP-BC, FAAN

ONFEditor@ons.org

Manuscript Preparation

Papers should be prepared using standard manuscript form according to the *Publication Manual of the American Psychological Association* (APA), 7th edition (2019). (Visit www.apastyle.org for

assistance.) Length should be 12–15 pages (4,000 words), exclusive of tables, figures, and references. Integrative reviews are limited to 5,000 words, exclusive of tables, figures, and references.

Title page: Include names, credentials, titles, and affiliations of all authors.

Authorship/contributors: All authors must contribute significantly to the manuscript and identify those contributions when prompted via the author form emailed to each author upon manuscript submission; authorship contributions are conceptualization and design, data collection, statistical support, analysis, and manuscript preparation. Those who do not meet authorship criteria should instead be acknowledged as contributors along with their contributions (e.g., recruitment, technical assistance).

Structured abstracts: An abstract is required for **all** articles and is limited to 200 words.

Quantitative research: The following headings for reports of quantitative research **must** be included.

1. Objectives
2. Sample and Setting
3. Methods and Variables
4. Results
5. Implications for Nursing
6. Knowledge Translation: Include three points indicating new knowledge or cutting-edge practice innovations that may influence practice.

Qualitative research: The following headings for reports of qualitative research **must** be included.

1. Purpose
2. Participants and Setting
3. Methodologic Approach

4. Findings
5. Implications for Nursing
6. Knowledge Translation: Include three points indicating new knowledge or cutting-edge practice innovations that may influence practice.

Integrative/systematic reviews: Integrative reviews are limited to 5,000 words, exclusive of tables, figures, and references. In addition, authors should ensure that these reviews follow the PRISMA 2009 Checklist. For a full description regarding preparation of an integrative review, see: Whittmore, E.R., & Knafl, K. (2005). The integrative review: Updated methodology. *Journal of Advanced Nursing,52,* 546–553.

The following headings **must** be included in an abstract for an integrative review.

1. Problem Identification
2. Literature Search
3. Data Evaluation
4. Synthesis (evaluate applicability and develop recommendations)
5. Implications for Practice or Research
6. Knowledge Translation: Include three points indicating new knowledge or cutting-edge practice innovations that may influence practice.

Mixed methods: The following headings for mixed methods research **must** be included.

1. Problem Statement
2. Design
3. Data Sources
4. Analysis
5. Findings
6. Implications for Practice or Research
7. Knowledge Translation: Include three points indicating new knowledge or cutting-edge practice innovations that may influence practice.

Research Briefs: Preliminary research, pilot studies, and studies with very small samples or negative results may be submitted for publication consideration as Research Briefs. These brief reports of research should not exceed 1,500 words, exclusive of tables, figures, and references. They may be accompanied by a maximum of two tables or figures. Include a structured abstract (200 words maximum) with Objectives, Sample and Setting, Methods and Variables, Results, and

Implications for Nursing. Three Knowledge Translation statements indicating new knowledge should be included. A maximum of 15 key references may be included. In addition to newly submitted manuscripts, full-length research manuscripts that previously have been deferred through the *ONF* peer review process may be reworked and resubmitted for consideration as a Research Brief.

Keywords: Please include three to six keywords. For examples, visit the MeSH Browser.

Text: Use headings and subheadings as appropriate. Include the names of the institutions participating in the study.

Implications for Nursing: Authors MUST include a section on "Implications for Nursing" after the Discussion and before the Conclusion. This section must highlight how the findings of the research or review can be used to change nursing practice or describe important knowledge that has the potential to increase nurses' knowledge on the topic. Manuscripts that omit this section will not be considered for publication.

Patient confidentiality: All patient information included in manuscripts, tables, or figures must be de-identified to avoid compromising patient privacy and confidentiality. Only those details essential for understanding and interpreting a specific case report or case series should be provided.

Tables: Each should be typed, double spaced on separate pages placed at the end of the text. Every table must be referred to in the text.

Figures: Include on separate pages at the end of the manuscript. Every figure must be referred to in the text.

References: Authors are responsible for the accuracy and correct formatting of all reference citations. References will be checked for accuracy at the time of editing. Manuscripts found to contain errors are subject to delays in publication.

Permissions: The author is responsible for obtaining written permissions from the copyright owner for the use of any material (e.g., text, tables, figures, forms) previously published or printed elsewhere and to bear the cost, if any, of using the material. **Permission is required for both print and electronic use.** Original letters granting permission must be submitted when the final manuscript is uploaded. If the manuscript reports the results of an investigational study involving human subjects, the text must include a statement indicating approval by an institutional review board and cite its name, as well as noting informed consent when appropriate. Authors must obtain and forward a signed statement of informed consent to publish in print and online patient descriptions or case studies, photographs, and pedigrees from all individuals or parents or legal guardians of minors who can be identified in such written descriptions, photographs, or pedigrees. Such individuals should be shown the manuscript before its submission.

Acknowledgments: Any acknowledgments should be submitted with the manuscript.

NIH Funding: Authors receiving government funding are required to comply with all of the terms of the NIH Public Access Policy, including submitting their funded articles to NIH for posting on PubMed Central. Authors are permitted to post the original draft of the article on PubMed Central no sooner than six months after the article's publication.

Plagiarism: All manuscripts will be reviewed for originality with a plagiarism software product. Manuscripts found to plagiarize the work of others will be prohibited from publication in *ONF*.

Dissertations and theses: A thesis or dissertation in entirety is not appropriate for submission to the *Oncology Nursing Forum.* Manuscript submissions that are substantially similar to or the same as a previously published dissertation or thesis will *not* be considered for publication. Text, tables, figures, etc., should be paraphrased to avoid duplication (self-plagiarism) and content should be substantially condensed. Submissions that fail to comply with this policy will be removed from publication consideration.

Online Manuscript Submission

All manuscripts must be submitted electronically via Editorial Manager. Complete instructions are provided, and assistance is available by contacting pubONF@ons.org.

All manuscript submissions (both original and revisions) should include the title page (including author names, credentials, titles, affiliations, and email addresses), the abstract, text, references, and all tables and figures. Do not blind the manuscript. (*Note:* Even though the title, abstract, and authors are entered into the information pages, they must still be included with the manuscript files.)

Financial Disclosure

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Online Versus Print Publication

Selection of articles for print versus online publication is at the discretion of the editor.

Appendix 2

CITI Training Certificate

Institutional Review Board for Social & Behavioral Sciences
University of Virginia

Office of the Vice President for Research

Human Research Protection Program

Institutional Review Board for the Social and Behavioral Sciences

IRB-SBS Chair: Moon, Tonya

IRB-SBS Director: Blackwood, Bronwyn

Protocol Number (2861) Approval Certificate

The UVA IRB-SBS reviewed "Effect of a Multimodal Educational Intervention on Generalist Graduate Level Nursing Students' Confidence and Knowledge Related to Hazardous Medication Safe-Handling Processes" and determined that the protocol met the qualifications for approval as described in 45 CFR 46.

Principal Investigator: Thomas, Tanya

Faculty Sponsor: DeGennaro, Regina

Protocol Number: 2861

Protocol Title: Effect of a Multimodal Educational Intervention on Generalist Graduate Level Nursing Students' Confidence and Knowledge Related to Hazardous Medication Safe-Handling Processes

Is this research funded? No

Review category: Exempt Review

3B. Benign behavioral interventions: no risk to criminal/civil liability, financial standing, employability, education advancement, reputation

Review Type:

Modifications: No
Continuation: No
Unexpected Adverse Events: No

Approval Date: 2019-08-12

As indicated in the Principal Investigator, Faculty Sponsor, and Department Chair Assurances as part of the IRB requirements for approval, the PI has ultimate responsibility for the conduct of the study, the ethical performance of the project, the protection of the rights and welfare of human subjects, and strict adherence to any stipulations imposed by the IRB-SBS.

The PI and research team will comply with all UVA policies and procedures, as well as with all applicable Federal, State, and local laws regarding the protection of human subjects in research, including, but not limited to, the following:

1. That no participants will be recruited or data accessed under the protocol until the Investigator has received this approval certificate.
2. That no participants will be recruited or entered under the protocol until all researchers for the project including the Faculty Sponsor have completed their human investigation research ethics educational requirement (CITI training is required every 4 years for UVA researchers). The PI ensures that all personnel performing the project are qualified, appropriately trained, and will adhere to the provisions of the approved protocol.
3. That any modifications of the protocol or consent form will not be implemented without prior written approval from the IRB-SBS Chair or designee except when necessary to eliminate immediate hazards to the participants.
4. That any deviation from the protocol and/or consent form that is serious, unexpected and related to the study or a death occurring during the study will be reported promptly to the SBS Review Board in writing.
5. That all protocol forms for continuations of this protocol will be completed and returned within the time limit stated on the renewal notification letter.
6. That all participants will be recruited and consented as stated in the protocol approved or exempted by the IRB-SBS board. If written consent is required, all participants will be consented by signing a copy of the consent form unless this requirement is waived by the board.
7. That the IRB-SBS office will be notified within 30 days of a change in the Principal Investigator for the study.
8. That the IRB-SBS office will be notified when the active study is complete.
9. The SBS Review Board reserves the right to suspend and/or terminate this study at any time if, in its opinion, (1) the risks of further research are prohibitive, or (2) the above agreement is breached.

Date this Protocol Approval Certificate was generated: 2019-09-12

Effect of Multimodal Educational Intervention on Generalist Graduate Level Nursing Students' Knowledge and Confidence Related to Hazardous Medication Safe-Handling Processes

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Abstract

PURPOSE: To measure the effect of a multimodal educational intervention on generalist graduate level nursing student's knowledge and confidence related to hazardous medication/hazardous drug (HD) safe-handling processes.

SAMPLE AND SETTING: 18 second-year generalist graduate level nursing students enrolled in the Clinical Nurse Leader Program (CNL) at the University of Virginia School of Nursing (UVA SON) and completing practicum clinical rotations at UVA Health.

METHODS: A quasi-experimental, single group, pre and posttest design was used. The multimodal educational intervention included low fidelity simulation, an HD safe-handling video, didactic presentation and HD safe-handling tip-sheets. All data was collected using an adapted version of a validated questionnaire.

RESULTS: Statistically significant increase in both knowledge and confidence was noted post-intervention. Statistical and clinical significance was noted in the questions associated with self-preparedness.

NURSING IMPLICATIONS: The study design, materials and results can contribute to the development of education standards for nursing students involved in any aspect of the HD process.

Keywords: hazardous medications, hazardous drugs, nursing students, Clinical Nurse Leader, CNL, PPE

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Approximately eight million healthcare workers (HCW) are at risk for occupational exposure to hazardous medications/hazardous drugs (HD) (US Bureau of Labor Statistics, 2007). Risk for occupational exposure to HD occurs in all aspects of the HD process (i.e. receipt, compounding, administration, disposal, contact with bodily fluids from patients exposed to HD within the past 48 hours). According to the National Institute for Occupational Safety and Health (NIOSH), hazardous medications are not limited to antineoplastic or cytotoxic agents but include hormonal agents and various medications administered for post-transplant immunosuppression, anticoagulation, and antiviral effects (NIOSH, 2015).

Background

Occupational exposure to HD by healthcare providers has been associated with acute and chronic health effects including hair loss, skin irritation and rashes, allergic reactions, contact dermatitis, infertility, congenital malformations, spontaneous abortions, and malignancies (Fransman et al., 2007). Severity of adverse health effects may depend on type, amount, and duration of exposure to a HD. The impact of occupational exposure to HD has been studied extensively by the Occupational Safety and Health Administration (OSHA), NIOSH, Center for Disease Control (CDC) the U.S. Pharmacopeia Convention (USP) and professional organizations such as the Oncology Nursing Society (ONS) (NIOSH, 2004; OSHA, 1986).

OSHA, NIOSH and USP are key organizations providing practice recommendations and standards related to HD. Both NIOSH and OSHA are divisions of government entities (CDC-NIOSH, n.d.; United States Department of Labor, n.d.). NIOSH is governed by the CDC whereas OSHA is a division within the Department of Labor. Under the OSHA Act of 1970, OSHA was tasked with creating enforceable safety standards requiring employer adherence.

OSHA has authority to enforce standards and impose fines or initiate legal proceedings for violations of OSHA standards. Unlike OSHA, NIOSH does not have authority to enforce practice or regulatory standards. NIOSH is an education and research institution that focuses on minimizing work-related injuries, utilizing global collaborations to enhance workplace safety on an international level and promoting safe workplaces within the United States (CDC-NIOSH, n.d.).

Unlike both NIOSH and OSHA, USP is not a government entity, but works closely with regulatory authorities and government agencies to provide standards related to purity, quality, strength and identification of pharmaceutical items, dietary supplements, food ingredients and medical devices (USP, n.d.). The reproducibility and accuracy of these USP Reference Standards are tested and evaluated by various independent commercial, regulatory, and academic laboratories. The federal Food, Drug and Cosmetic Act (FDCA) has recognized the USP standards in laws, policies and regulations (Recognition of USP Compounding Standards, n.d.). The U.S. Food and Drug Administration (FDA) and other oversight and state organizations enforce the USP standards.

These organizations identified risks and implemented initial HD safe-handling recommendations over 30 years ago (OSHA, 1986). The greatest factors impacting risk of occupational exposure are contaminated work surfaces, inappropriate handling of HD, and non-adherence to HD safe-handling recommendations (NIOSH, 2004). Despite certain OSHA standards being part of the Code of Federal Regulations (CFR) and being enforceable by law, HD safe-handling guidance documents by OSHA are practice recommendations and not formal mandates or standards. These recommendations are classified as guidelines and some organizations have opted not to enforce these OSHA recommendations. The implementation of

<USP 800> as formal standards enforceable by the FDA will increase employer accountability for ensuring safety standards are in place for HCW.

The new standards published by USP, USP <800>, expand on prior USP regulations and impact all areas of HD handling, compounding, administration and disposal. USP <800> outlines required organizational policies and annual educational requirements for all HCW who have risk for HD exposure in the workplace.

NIOSH has led a national initiative known as Prevention through Design (PtD). PtD was designed to reduce or prevent occupational exposures, injuries, illnesses and fatalities via implementation of prevention strategies in all areas that impact HCW. The hierarchy of controls is one PtD strategy (NIOSH, 2015). The hierarchy of controls determines feasibility of effective interventions in controlling occupational exposures. This visual diagram identifies the most protective and effective interventions at the top of the pyramid and the least protective and effective at the bottom of the pyramid (Figure 1). Substitution or elimination of the hazard is depicted at the top of the hierarchy of controls pyramid and donning personal protective equipment (PPE) is at the bottom of the pyramid.

Administrative controls, including providing education and training, and donning appropriate PPE are the bottom two areas of the hierarchy of controls pyramid. While at the bottom of the hierarchy of controls pyramid, providing training and utilization of appropriate PPE are feasible options to minimize occupational exposure to HD. Appropriate use of PPE is the last line of defense against HD entering a HCW's body (Lin et al., 2019). As reported by Sugiura et al. (2011), HD were not present in urine samples taken from HCW who donned appropriate PPE during the HD handling processes. This study affirms that donning appropriate PPE during all aspects of the HD process can be effective in minimizing occupational exposure risk to HD.

While the importance of donning PPE has been incorporated in HD safe-handling documents for several years, studies have shown use of PPE remains inconsistent (Martin & Lawson, 2003; NIOSH, 2004; Polovich & Martin, 2008). Studies identified barriers with PPE use and impact of various educational modalities on knowledge gain and educational interventions related to HD safety in the setting of oncology nursing (Polovich & Martin, 2011, Friese et al., 2019).

Despite having educational requirements for HCW, currently there are no regulations that specifically outline training requirements for nursing students who administer HD and/or care for patients receiving HD during their clinical rotation. In addition, options for pregnant students or those attempting to conceive are not mentioned in regulatory documents or position statements. Lack of required standardized education decreases student's ability to understand the complexity related to aspects of HD handling, administration and disposal and increases risk for occupational exposures to HD during the clinical learning experience. Thus, the purpose of this project was to measure the effect of a multimodal educational intervention related to HD on the knowledge and confidence of generalist graduate level nursing students.

Objective

The purpose of this project was to measure the effect of a multimodal educational intervention related to HD on the knowledge and confidence of generalist graduate level nursing students.

Sample and Setting

Sample

The project convenience sample was obtained from second year generalist graduate level nursing students enrolled in the University of Virginia School of Nursing's (UVA SON) Clinical Nurse Leader (CNL) Program. Inclusion criteria included completing clinical rotation hours at

UVA Health or one of the associated ambulatory or community clinics. Exclusion criteria included generalist graduate level nursing students completing clinical hours at clinical sites outside of UVA Health or the associated ambulatory or community clinics. There were approximately 40 students eligible to participate in the project. Participation was voluntary.

Setting

The primary setting was a UVA SON which is located in the southeastern United States. The educational intervention was provided in a classroom within UVA SON.

The secondary setting location was UVA Health, an academic medical center (AMC) that is a level 1 trauma center. The students participating in the project were completing their practicum hours in clinical settings located within UVA Health's main hospital or at one of the ambulatory or community clinics associated with UVA Health.

Methods and Variables

This project utilized a quasi-experimental research design with a convenience sample of second year CNL students. The CNL program is an accelerated two-year program that qualifies the student to sit for the NCLEX exam. Due to the scarcity of available literature regarding HD educational interventions for nursing students, this project was designed to evaluate the effectiveness of a multimodal educational approach on students' knowledge and confidence related to HD safe-handling processes. The proposed educational intervention included an in-person didactic lecture, low fidelity simulation with donning appropriate PPE, appropriate use of the closed system transfer device (CSTD) and a video related to HD safe-handling and PPE use and HD safe-handling tip-sheets. This intervention allowed students to receive and review the information in a variety of modalities. Prior to implementation, Institutional Review Board (IRB) approval was received.

The data collection instrument used was adapted from the revised Hazardous Drug Handling Questionnaire (HDHQ; Martin & Larsen, 2003; Polovich & Martin,2008). The revised HDHQ was tested and validated with nurses in the clinical setting. The data collection tool was further adapted for this project with permission from the author. The instrument was modified to reflect HD instead of chemotherapy and the number of questions was reduced to a 23-question survey. Questions were revised to reflect completion by prelicensure nursing students instead of highly experienced oncology nurses. The adapted revised HDHQ measured participant demographic data, knowledge and confidence related to handling HD, safety preparedness for HD administration, disposal and handling bodily fluids, perceived barriers and perceived risks associated with HD.

To determine baseline knowledge, confidence, safety preparedness, barriers and risks related to HD safe-handling procedures and precautions, the adapted revised HDHQ was completed pre-intervention or time 1 (T_1). After completion of the pre-intervention questionnaire, participants participated in an in-person didactic presentation that reviewed HD safe-handling processes including: appropriate PPE use, use of a CSTD, exposure risks, exposure work-up, HD spill management and handling excrement and bodily fluids from patients on HD precautions. After completion of the didactic presentation, participants had the opportunity for low fidelity simulation with supplies and equipment necessary for adherence with HD safe-handling practices. Participants received HD safe-handling tip-sheets that included safe-handling reminders and a list of HD commonly administered by students. To evaluate effectiveness of the educational intervention, participants completed the adapted revised HDHQ immediately post-intervention, time 2 (T_2) and at three weeks post-intervention, time 3 (T_3).

The educational interventions including the didactic presentation, low fidelity simulation, and tip-sheets were developed based on a review of the literature. The use of an educational video related to appropriate use of PPE and safe-handling practice recommendations was part of the educational intervention. The educational video was selected based on type of learner and amount of time for completion, It was developed by B. Braun and is available to the public via You Tube (B. Braun, 2017).

Data analysis

Both descriptive and inferential statistical analysis was performed on primary and secondary outcome variables. All statistical analysis was performed utilizing IBM SPSS statistical software Version 26. All assumptions for parametric tests were performed. If assumptions were not met for parametric tests, the appropriate non-parametric tests were used for analysis. For all testing the significance level was set at 05.

Pre and post-intervention knowledge and confidence related to HD safe-handling processes were measured and reported. The adapted revised HDHQ included true/false questions related to general HD knowledge, Likert scales were used to measure level of confidence related to handling HD. Likert scales were utilized to measure safety preparedness related to handling HD, perceived barriers and risks associated with HD, availability of PPE, use of PPE and perceived importance of utilizing PPE in the clinical setting. The data were analyzed for correlation between demographic data, level of knowledge and confidence, safety preparedness, PPE use and perceived barriers and risk.

Results

A total of 18 students participated in the multimodal intervention and completed the T_1 questionnaire. One did not complete the T_2 questionnaire and 2 did not complete the T_3

questionnaire. Final data analysis included 16 student participants who completed all questionnaires.

Demographic data

A total of 16 students completed all aspects of the project. Demographic data was collected as part of the T_1 questionnaire and results are shown in Table 1. All participants were female with ages ranging between 22 and 40 years of age (M = 28.25, SD = 5.1). A majority self-identified as being white (n = 11, 68.8%) with a majority completing their Fall 2019 clinical hours in a specialty area such as pediatrics, labor and delivery or obstetrics (n = 8, 50 %). Prior clinical experiences included acute care units (medical surgical, oncology, orthopedics, cardiovascular, neurology or solid organ transplant) (n = 16, 100%), critical care units (any intensive care or progressive care unit) (n = 12, 75.0 %) and specialty areas (n = 15, 93.8%). The total years of prior healthcare experience ranged from 0 – 10 years (M = 1.81, SD = 2.61) with prior experience including experience as an emergency medical technician (EMT) or paramedic (n = 2, 12.5%) or certified nurse aid (CNA) or certified medical aid (CMA) (n = 5, 31.3%).

Knowledge. The knowledge related questions included 12 items. Each item included a true/false/I don't know answer choice. A point was provided for each correct answer. The total possible range for the knowledge related question was 0 – 12 and the observed range for T_1 was 8 – 12 (67 % - 100% correct answers). The observed range for both T_2 and T_3 was 10 – 12 (83 % - 100 % correct answers). A higher score indicated a greater number of correct answers and a higher level of basic knowledge related to HD. There was a slight increase in the mean score between T_1 (M = 10.25, SD = 1.24), T_2 (M = 11.50, SD = .63) and T_3 (M = 11.56, SD = .63) (Table 2). There was a statistically significant increase in the overall knowledge scores between T_1 and T_2 (t (15) = -3.73, p < .05 (two-tailed)) and between T_1 and T_3 (t (15) = -3.63, p < .05

(two-tailed)).

Two items were further analyzed using McNemar's test. These items had the lowest number of correct answers on the T1 questionnaire. Participants frequently answered incorrectly to the following items within the knowledge question: "Hazardous medications cannot enter the body through contact with contaminated surfaces" (n = 6, 37.5 %); and "A surgical mask provides protection from hazardous medication aerosols" (n = 8, 50 %).

Confidence. The adapted revised HDHQ included 2 confidence related questions: "I am confident I can use PPE properly" and "I am confident that I can protect myself from hazardous medication exposure". A Likert scale was used for each question with each answer option having an associated score: 4 = *Strongly Agree*, 3 = *Agree*; 2 = *Disagree*; 1 = *Strongly Disagree*. This Likert scale was also used for the questions related to safety preparedness, perceived barriers and perceived risks. The total possible range for the knowledge related question was 2 – 8 and the observed range for T_1 was 2 – 5. The observed range for both T_2 and T_3 was 6 – 8. A higher score indicated a greater confidence related to HD safe-handling. There was an increase in the mean score between T_1 (M = 4.25, SD = .93), T_2 (M = 6.88, SD = .62) and T_3 (M = 6.81, SD = .98) (Table 2). There was a statistically significant increase in the overall confidence scores between T_1 and T_2 (t (15) = -10.97, p < .05 (two-tailed)) and between T_1 and T_3 (t (15) = -7.03, p < .05 (two-tailed)).

Safety Preparedness. There were 4 questions related to being prepared to administer and dispose of HD safely. A higher score on the Likert scale indicated a greater level of HD safety preparedness. The total possible range for the safety preparedness related question was 4 – 16 and the observed range for T_1 was 5 – 11. The observed ranges for T_2 and T_3 were 9 – 15 and 8 – 16 respectively. There was an increase in the mean score between T_1 (M = 8.75, SD = 1.53)

and T_2 (M = 7.56, SD = 1.86); however, the mean score decreased between T_2 and T_3 (M = 7.44, SD = 1.86) (Table 2). There was a statistically significant increase in the overall safety preparedness scores between T_1 and T_2 (t (15) = -7.70, $p < .05$ (two-tailed)) and also between T_1 and T_3 (t (15) = -6.67, $p < .05$ (two-tailed)).

Perceived barriers. Two questions and a total of 19 items were related to barriers to PPE use. The total possible range for the perceived barriers to PPE use related questions was 19 – 76. The observed range for T_1, T_2 and T_3 were 27 – 53, 19 – 52 and 25 – 52 respectively. The higher scores corresponded with a higher level of agreement with the proposed barriers. There were no statistically significant changes between the various pre and post questionnaires. There were 4 items that consistently received higher levels of "*Strongly Agree*" or "*Agree*" responses from the participants in all 3 time points: "PPE is uncomfortable to wear"; "PPE is not always available"; "Others around me don't use PPE" and "People would think I am overly cautious."

Perceived risks. Three items addressed perceived health risks associated with handling HD in the clinical environment. A 4- point Likert scale (1= *Strongly Disagree* and 4 = *Strongly Agree*) was used to measure agreeance with the risk statement. The total possible range for perceived health risks was 3 – 12. The observed range for T_1 perceived risk was 3 – 7 (M = 5.06, SD = 1.24). Both T_2 and T_3 had an observed range of 3 - 8 with M = 3.88 and SD = 1.63 for T_2 and M = 3.88 and SD = 1.54 for T_3 (Table 2).

Correlations. Bivariate correlations were evaluated utilizing Spearman's rho coefficients (r_s). Spearman's rho was used to determine the strength of association between the various outcome variables and certain demographic variables and time points T_1, T_2 and T_3. The demographic variables used for the included: years in healthcare, age group, race and current clinical setting. No significant correlations between demographics and outcome variables were noted.

Discussion

Knowledge and confidence did improve among students who participated in this project. Of the 16 student participants, 25% scored less than 75% on the overall knowledge assessment at T_1. The 2 questions that were answered incorrectly most frequently were "*A surgical mask provides protection from hazardous medication aerosols*", and "*hazardous medications cannot enter the body through contact with contaminated surfaces*". No students scored less than 75% on either of the postintervention knowledge assessments (timepoints T_2 and T_3). In addition to an increase in the overall knowledge scores, the mean knowledge scores increased betweenT_1 to T_2 (M = 10.25 with SD = 1.24 and M = 11.50 with SD = .63 respectively) and again between T_2 to T_3. Similar to overall results in the study performed by Zimmer et al. (2016), there was a statistically significant increase knowledge score between T_1 and T_2 and also between T_1 and T_3.

Similar to studies by Polovich & Martin (2011) and Polovich & Clark (2012) the most frequent identified barriers to adherence to donning appropriate PPE included: PPE being uncomfortable to wear, PPE not readily available and perception of being viewed as being overly cautious. These perceived barriers identified by students participating in the study may be related to what they see in clinical settings and conversations with student colleagues, clinical instructors, preceptors and others in clinical settings. The identified barriers may be related to suboptimal use of required PPE by students. Studies performed by Polovich & Martin (2011), Polovich & Clark (2012) and Friese et al. (2019) utilized the HDHQ to have participants self-report PPE use. In all 3 studies, self-reported use of PPE was suboptimal pre-intervention and post-intervention. The results of this project were in alignment with these reported observations with over 40 % of students reporting never using a CSTD or donning impervious gowns during HD administration at T_1, and over 25% reporting never using a CSTD or donning impervious

gowns at T_2 and T_3.

The studies by Polovich & Martin (2011), Polovich & Clark (2012) and Friese et al. (2019) utilized self-reporting to measure adherence to HD safety standards and identify barriers to adherence to HD standards; however, there was no objective component to validate self-reported utilization of PPE or confirm perceived barriers. Since this project used the adapted revised HDHQ, there was no objective component of the project. Having an objective component and validation of PPE use and barriers would provide valuable information necessary to determine the true impact and effectiveness of the educational intervention.

In order to provide generalizable results and increase the success of similar projects, additional post-intervention assessment time points would be necessary to measure knowledge gain and sustained confidence and adherence to HD safe-handling practices. A larger and more diverse study population would strengthen data. Identifying motivating factors or incentives to increase participation is necessary for future follow-up studies. Halpern et al., (2004), Cho et al. (2013) and Yu et al. (2017) discussed how monetary incentives, frequent reminders and offering refreshments increased participation rates. For this project, students received frequent email reminders and lunch during the educational intervention. Factors that may have impacted the low participation rate included: timing of the project, competing school related priorities, and lack of understanding of HD administered while in clinical settings.

In addition to the quantitative data, the adapted revised HDHQ completed at T_3 collected qualitative data to help assess effectiveness of the multimodal educational approach. Comments included: “We needed this information before any clinical,” “Perhaps more practice time with being donned in PPE and administering medication,” “Did not know how much I did not know. Had no idea so many medications are hazardous,” “The education session is crucial for rising

nurses. I had no idea that some of the drugs I have given often are hazardous! I will be sure to wear the correct PPE in the future." These comments validated the need for incorporating education related to identification of HD and HD safe-handling processes prior to the first semester of clinical experiences.

Nursing practice implications

Occupational exposure to HD can occur in all clinical settings and during all aspects of the HD process. Identification of HD and patients on HD precautions combined with consistent use of the appropriate PPE can minimize risk of occupational exposure. In order to properly identify HD and understand the required PPE, anyone involved in the HD process or care for patients receiving HD must receive education related to the HD process. Currently, there are no documented recommendations or HD regulations addressing educational requirements for nursing students involved in the HD process during clinical rotations.

Use of a multimodal educational intervention related to HD safety increased the CNL students' knowledge and confidence related to HD safe-handling processes. The results of this project validated studies by Polovich & Clark (2012) in terms of perceived barriers to adherence to HD safe-handling processes.

Knowledge translation

The literature related to HD and HD safety has been focused on education and occupational exposure preventative measures for the HCW. There are estimates related to the number of HCW at risk for occupational exposure to HD. However, due to the lack of evidence regarding exposures for prelicensure students, exposure risk for this population is unknown. The exposure risk for students may exceed exposure risk for HCW due to lack of education related to HD safety.

Additional research is necessary to identify the extent of the gap in knowledge and confidence related to HD safety in the student nurse population. The educational intervention and results from this project contribute to development of educational standards for all learners entering the healthcare profession. These learners are exposed to HD in their clinical experiences and require education related to HD safety precautions to minimize exposure risk.

The multimodal educational interventions used in this project are feasible and relevant for Schools of Nursing. Utilization of a multimodal educational approach for HD safety can be translated and implemented in clinical settings for all healthcare providers. The qualitative feedback affirms the need for structured HD safety education for learners within the healthcare arena.

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Table 1

Demographic Characteristics of Participants (N = 16)

	n	%	Range	*M (SD)*
Age (years)	16		22-40	28.25 (5.1)
Gender				
Female	16	100		
Race				
White	11	68.8		
African American	2	12.5		
Asian	1	6.3		
Hispanic/Latino	1	6.3		
Other	1	6.3		
Current Clinical Setting				
Acute Care	1	6.3		
Critical Care	6	37.5		
Specialty Area	8	50.0		
Other	1	6.3		
Prior Clinical Settings				
Acute Care	16	100		
Critical Care	12	75.0		
Specialty Area	15	93.8		
Other	5	31.3		

Table 1 (cont.)

	n	%	Range	*M (SD)*
Healthcare Experience (years)			0 - 10	1.81 (2.61)
0	7	43.8		
1 - 3	7	43.8		
4 - 6	1	6.3		
7 - 10	1	6.3		
Healthcare Experience				
EMT or Paramedic	2	12.5		
CNA or CMA	5	31.3		
Other	13	81.3		

Note: Acute Care = Medical-Surgical, Oncology, Orthopedics, Cardiovascular, Neurology, Solid Organ Transplant; Critical Care = any intensive care or progressive care unit; Specialty = pediatrics, obstetrics, labor and delivery; EMT = Emergency Medical Technician; CNA = Certified Nurse's Aide; CMA = Certified Medical Assistant; Other = any healthcare role outside of EMT, Paramedic, CNA, CMA, Registered Nurse, Physician, Physician Assistant, Respiratory Therapist, Physical Therapist

Table 2

Mean and Standard Deviations for Participants' Scores over time (N = 16)

Variable	*Time 1 M(SD)*	*Time 2 M(SD)*	*Time 3 M(SD)*
Knowledge (K)	10.25 (1.24)	11.50 (.63)	11.56 (.63)
Confidence (C)	4.25 (.93)	6.88 (.62)	6.81 (.98)
Safety Preparedness (SP)	8.75 (1.53)	12.50 (1.79)	12.56 (1.86)
Perceived Barriers (PB)	40.50 (7.17)	38.31 (10.17)	37.13 (7.21)
Perceived Risks (PR)	5.06 (1.24)	3.88 (1.63)	3.88 (1.54)

Note: Time 1= pre-intervention; Time 2 = immediate post-intervention; Time 3 = three weeks post-intervention

Table 3

Results of t-tests for Outcome Variables (N = 16)

Outcome	M	SD	95% Confidence Interval	t	df
K: $T_1 – T_2$	-1.25	1.34	-1.96, -.54	-3.73*	15
K: $T_2 – T_3$	-.06	.57	-.52, .39	-.44	15
K: $T_1 – T_3$	-1.31	1.45	-2.02, -.60	-3.63*	15
C: $T_1 – T_2$	-2.63	.96	-3.14, -2.11	-10.97*	15
C: $T_2 – T_3$	.06	1.12	-.54, .66	.22	15
C: $T_1 – T_3$	-2.56	1.45	-3.34, -1.78	-7.03*	15
SP: $T_1 – T_2$	-3.75	1.96	-4.79, -2.71	-7.70*	15
SP: $T_2 – T_3$	-.06	2.02	-1.13, 1.01	-.12	15
SP: $T_1 – T_3$	-3.81	2.29	-5.03, -2.59	-6.67*	15
PB: $T_1 – T_2$	2.19	10.29	-3.30, 7.67	.85	15
PB: $T_2 – T_3$	1.19	2.86	-4.91, 7.28	.42	15
PB: $T_1 – T_3$	3.38	2.92	-2.84, 9.59	1.16	15
PR: $T_1 – T_2$	1.19	2.13	.05, 2.33	2.22*	15
PR: $T_2 – T_3$	.00	2.13	-1.13, 1.13	.00	15
PR: $T_1 – T_3$	1.19	2.01	.12, 2.26	2.37*	15

Note: K = Knowledge; C = Confidence; SP = Safety Preparedness; PB = Perceived Barriers, PR = Perceived Risks; T_1 = Time 1; T_2 = Time 2; T_3 = Time 3;
*p < .05 (2-tailed)

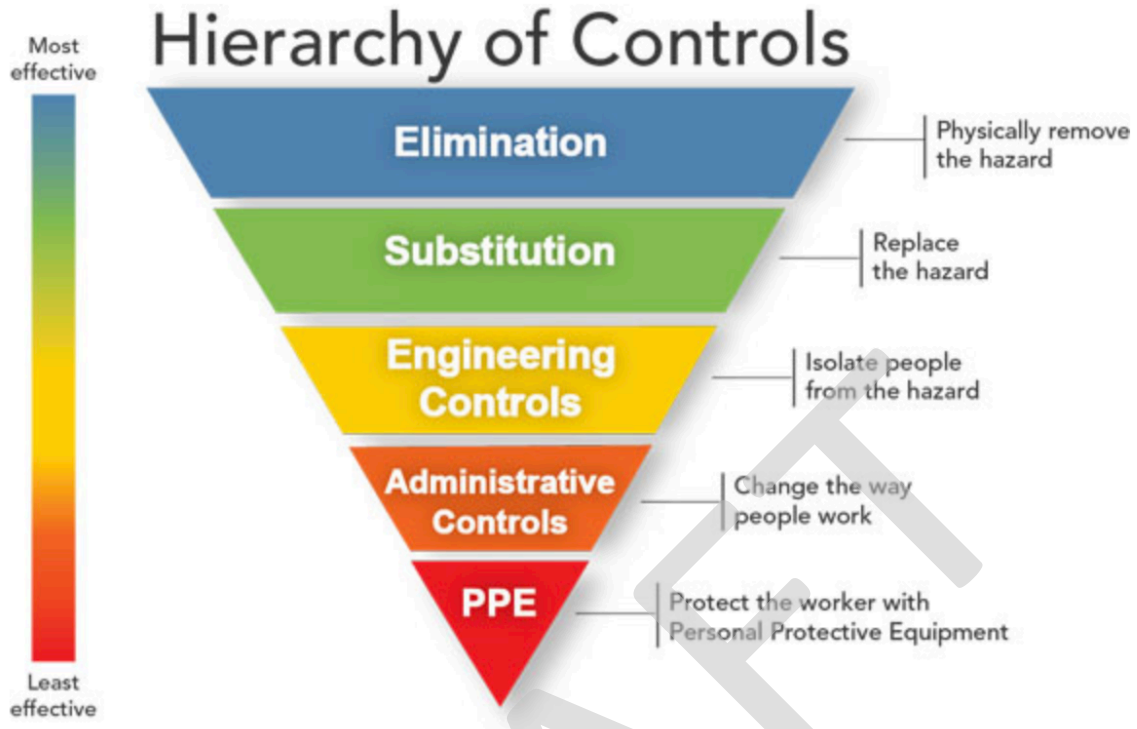

Figure 1. Hierarchy of Controls presented by NIOSH and OSHA to provide guidance on determining feasible and effective interventions to reduce risk for occupational exposure to hazardous medications and hazardous medication waste. (CDC, n.d.).

RE: Questionnaire related to hazardous medication safety and prelicensure nursing students

Martha Polovich <mpolovich2@gsu.edu>
Thu 6/6/2019 12:44 PM
To: Thomas, Tanya D (tdt4m) <tdt4m@virginia.edu>

3 attachments (107 KB)
Nurse questionnaires scoring guide 2018.docx; Safe Handling Survey.docx; Overview of instruments & Reliability.docx;

Tanya,
Thank you for your interest in the instruments that I developed. You have my permission to use them for your DNP project, and to modify them for that purpose. I ask that you reference the original instrument and me as the author should you publish the results of your project. The questionnaire and scoring guide are attached.

These instruments have never been used in pre-licensure students. Because reliability is sample-specific, it may not perform as well in your project. Should you analyze the reliability in your sample, please share that information with me. Reliability information in an oncology nurse sample is attached for your reference.

Good luck with your scholarly project.
Sincerely,

Martha Polovich, PhD, RN, AOCN
Director-at-Large
Oncology Nursing Society
marty@polovich.com
404-408-3890

"Be who you are and say what you feel, because those who mind don't matter and those who matter don't mind." Dr. Seuss

Figure 2. Permission to use and modify the revised Hazardous Drug Handling Questionnaire.