Improving nurses’ performance in the safe handling of antineoplastic agents: a quasi-experimental study

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Abstract

Background: The safe and standard handling of antineoplastic drugs can reduce the effects of occupational exposure and promote safe behaviors in nurses. Thus, the present study aimed to determine the effects of standard guidelines education on the safe handling of antineoplastic drugs among oncology nurses in Ardabil, Iran.

Methods: The quasi-experimental study with a one-group pretest-posttest design was performed among 32 nurses working in the oncology wards of two educational hospitals in Ardabil city, during 2020. All the nurses in the wards who met the inclusion criteria participated in the study. The data were collected by using a demographic information form and nurses' knowledge assessment questionnaire regarding the standard guidelines for working with antineoplastic drugs, and a standard checklist for examining their performance in this regard. Subsequently, they were analyzed by descriptive (mean and standard deviation) and inferential statistics (t-test) and Pearson's correlation coefficient in SPSS 22.

Results: The mean and standard deviation of the knowledge and performance scores of the oncology nurses was 59.56±6.41 and 18.96±2.54 respectively, which changed to 66±4.82 and 32.03±2.45 respectively three months after training. The results of the t-test represented a statistically significant difference between the level of knowledge and performance before and after the intervention (P=0.001).

Conclusions: Based on the results, the standard guidelines education improved the nurses’ knowledge and performance on the safe handling of antineoplastic drugs in the chemotherapy wards. Therefore, it is advised to increase the awareness of the oncology nurses in this regard in the planning and policy-making of healthcare centers.

Keywords: Antineoplastic drugs, Knowledge, Oncology nurse, Performance, Standard guidelines

Introduction

Cancer is the leading cause of death worldwide, accounting for an estimated 10 million deaths, in 2020 [1]. According to the latest reports of Iran’s Ministry of Health, cancer is currently the third leading cause of death in Iran after coronary heart disease and traffic accidents, which is becoming the second cause because of aging of the population and decreasing deaths due to accidents [2]. Antineoplastic drugs are cytotoxic agents which are widely used in healthcare centers to treat patients with cancer [3]. Researchers have confirmed that the adverse drug reactions (ADRs) associated with antineoplastic agents may occur in both patients and individuals involved in the treatment chain [4, 5]. The US National Institute of Occupational Safety and Health (NIOSH)
Nurses are at risk for the harmful effects of antineoplastic drugs due to long-term occupational exposure [7]. They play the most important role in providing care for cancer patients, and have the following roles: safe treatment and management of ADRs, training patients and their families on the potential ADRs, and providing emotional support to patients during the treatment process [5]. In addition, nurses may be occupationally exposed to the drugs during drug preparation, intravenous administration, specialized stages in administration (e.g., intraperitoneal, pleural, pericardial, and cerebrospinal fluid), drug delivery, or waste disposal, as well as cleaning drug leaks [8]. The significant amounts of antineoplastic drugs can lead to contamination through eating, drinking, and inhaling airborne powders and particles, as well as hand-mouth contact, unprotected skin, and mucous membranes, or needle sticking [9]. Based on the results of hospital studies, the level of antineoplastic drugs is significant in the air, surfaces, gloves, and various parts of the treatment team [10]. Organizations such as NIOSH and Oncology Nurses Society (ONS) have recommended safety guidelines for antineoplastic drugs. Some of the guidelines include modifying the physical structure of the workplace in terms of isolating the drug preparation space, minimizing nurses’ contact with the drug, applying standard work methods, and utilizing personal protective equipment to achieve the minimum contact of antineoplastic drugs with the skin or respiratory system of nurses [11, 12].

Nurses should be aware of the risks and safe handling of antineoplastic drugs to enhance the safety of both patients and themselves. The use of biological safety cabinets (BSCs) against inhalation exposure during drug preparation and nonpermeable gowns and double gloves are among the methods recommended for reducing exposure to antineoplastic drugs. Other approaches include wearing two pairs of powder-free latex gloves, and face shields or goggles, protecting the face from drug splashes, as well as utilizing surveillance systems and precise procedures to reduce exposure opportunities. The occupational exposure to antineoplastic drugs can decrease if all precautions are taken consistently [13].

Recent studies have shown the contamination of the workplace and healthcare workers, especially nurses, and in developing countries, although the guidelines for the safe use of antineoplastic drugs have been in place for more than 20 years [14]. The results have raised serious concerns about nurses’ knowledge and performance on safe procedures. The lack of knowledge, as well as failing to follow the guidelines, are considered the main reasons for the unsafe handling of antineoplastic drugs. Accordingly, the guidelines cannot guarantee safe behaviors, and awareness is an important factor in changing individuals’ performance [15].

Given that an unsafe drug treatment process leads to ADRs and sometimes irreversible disorders, standard drug treatment is required to reduce the side effects of exposure to antineoplastic drugs among patients and nurses and improve nurses’ performance in managing occupational exposure and safe medication. Thus, regarding the safety tips in using the drugs, the awareness of oncology nurses is important. Therefore, the present study sought to determine the effects of standard guidelines education on the safe handling of antineoplastic drugs among oncology nurses.

Method

Study design

This study with a quasi-experimental one-group pretest-posttest design was performed among all nurses employed in the oncology wards of two educational hospitals in Ardabil city during 2020. The ethical approvals were obtained from the Bioethics Committee of the Ardabil University of Medical Sciences, Iran (Approval No. IR.ARUMS.REC.1398.040). All participants gave written informed consent.

Participants

The study population consisted of all the nurses working in the oncology wards of Imam Khomeini and Bu-Ali educational hospitals in Ardabil (n = 35) as the only centers for chemotherapy in the province. The inclusion criteria included full-time occupation in the mentioned wards, having at least three months of experience in the oncology wards, and agreeing to participate in this study. 32 nurses were eventually entered into the study.

In the present study, the researcher attended the hospital director and nursing offices of the intended hospitals, followed by introducing them to the oncology wards. Additionally, she explained the research objectives, assured the information confidentiality, and proceeded to obtain informed written consent from the participants. Further, a questionnaire and a performance checklist were respectively utilized to examine the nurses’ knowledge, as well as performance at all stages of the drug treatment process. After the initial evaluation, the nurses participated in a two-day workshop. In the workshop, an oncologist and an experienced nursing professor presented the content of the training package in the form of lectures, group discussions, film screenings, and educational booklets to the individuals. The content of the training package was extracted from the latest guidelines for the management of antineoplastic drugs services (National Cancer Management Program (2017)) and standards for nursing services in chemotherapy. Finally, the nurses’ knowledge and
performance were re-evaluated three months after the end of the training course.

Data collection and statistical analysis

Two tools were applied for data collection. First, a researcher-made questionnaire to assess the nurses’ knowledge of the standard guidelines for handling antineoplastic drugs and second, an observational checklist to examine the performance of the nurses by the standard guidelines among inpatient and outpatient wards.

The nurses’ knowledge questionnaire consisted of two parts (37 questions). The first part included the demographic characteristics of nurses such as age, sex, marital status, as well as the level of education, type and duration of employment in the oncology ward, type of shift, and number of working hours per week. Additionally, information on the completion of previous training workshops, along with standard environment and facilities, periodic tests, and occupational accidents were also obtained. The second part of the questionnaire assessed their awareness of the proper principles of drug preparation, ways of drug absorption, ADRs of antineoplastic drugs, correct method of using personal protective equipment, and knowledge of the necessary measures in case of occupational exposure to antineoplastic drugs and waste disposal (for example, exposure through inhalation and the use of N95 masks to protect against airborne antineoplastic particles, the equal effectiveness of disinfectant solution and soap and water to remove the remnants of antineoplastic drugs, managing accidental ocular exposure to antineoplastic drugs by washing the face, etc.). In the questionnaire, the score of each item is either 1 (yes) or 0 (I do not know and no). Receiving a score of 1 for all questions represents the desired level of knowledge, while a score of 0 reflects a knowledge gap.

The checklist contained four main subscales of drug preparation (before injection), injection, leakage, and waste disposal (18, 14, 4, and 6 items, respectively) based on the guidelines of the Ministry of Antineoplastic Services Management (2017), as well as nursing services standards [16]. Some items included the following: wash your hands with soap and water before preparing antineoplastic drugs, wear non-absorbable disposable gowns with long-sleeved goggles when injecting, use face shield when preparing drugs, place the devices used in the injection of antineoplastic drugs in impermeable bags, etc. The score of each item was 0 (no) or 1 (yes) so that the nurses’ performance scores in the safe drug treatment process could vary from 0 to 42. Further, the scores of 0-8, 9-17, 18-25, 26-33, and 34-42 indicate a very poor, poor, medium, good, and excellent performance, respectively.

In order to validate the content of the training package and the above-mentioned tools, they were provided to 10 nursing professors and their expert opinions were received. Furthermore, content validity ratio coefficients (CVR) and content validity index (CVI) were used to measure the quantitative content validity index. Based on the Waltz and Basel method, CVR was calculated at 93.2 for the knowledge questionnaire and at 92.8 for the observational checklist. Regarding the reliability, Cronbach’s alpha coefficient was computed 0.74 and 0.72 for the questionnaire and checklist, respectively.

The data were analyzed using descriptive (mean and standard deviation) and inferential statistics (Pearson’s correlation coefficient and t-test) in SPSS 22 software.

Results

Participants’ demographics

In this study, most nurses were female (96.9%) with a mean age of 32.68 ± 4.70 years. The mean work experience in the oncology ward was 4.31 ± 3.53 years. (Table 1).

Description and correlation of major variables

Based on the results related to the participants’ knowledge of the standard guidelines for handling antineoplastic drugs, the mean and standard deviation of their knowledge scores was 59.56 ± 6.41 before the intervention, which increased to 66 ± 4.82 three months after training (P = 0.001) (Table 2). In the pre-intervention stage, 24 nurses (75%) possessed excellent knowledge, while 29 (90.7%) obtained excellent knowledge scores following the training workshop.

As shown in Tables 3 and 4, the meanscores (±standard deviation) of drug preparation and injection time were 0.56 ± 0.09 and 0.41 ± 0.10 respectively which increased to 0.79 ± 0.06, 0.78 ± 0.07 respectively after the training. Moreover, mean scores for leakage, waste disposal, and overall performance were initially 0.07 ± 0.02, 0.48 ± 0.10, and 18.96 ± 2.54 respectively. These scores were raised to 0.50 ± 0.20, 0.76 ± 0.09, and 32.03 ± 2.45 (P < 0.001) respectively.

During the pre-intervention stage, 30 nurses (93.7%) exhibited moderate performance and no one performed well. However, 29 participants (90.7%) had good performance and no poor performance was observed after training.

Discussion

Based on the results of the present study, the level of the nurses’ knowledge on the safe handling of antineoplastic drugs statistically significantly increased following training.

Table 1 Demographic characteristics of the studied nurses

| Nurses’ characteristics | Mean ± SD |
|-------------------------|-----------|
| Age                     | 32.68±4.70|
| Years of experience in chemotherapy drug administration | 4.31±3.53|
| Working hours during the week | 46.34±5.72|
nurses ing intervention positively affectsthe knowledge of
18]. Further, Shrestha et al. (2017) suggested that a train-
as implementing the training protocol, respectively [17,
oncology nurses following a short training course, as well
significant increase in the knowledge and performance of
for oncology nurses to a good and excellent level
ported an improvement in the knowledge and perform-
example, Hazrati et al. (2008) reported an improvement in
standard guidelines for handlingantineoplastic drugs among
were approved by the Ministry of Health and Medical Educa-
ty nurses and nursing students [22–27].

In this study, all nurses of two main chemotherapy centers in Ardabil received the necessary training on how to handleantineoplastic drugs according to the latest guidelines of the Ministry of Health and Medical Education of Iran. In addition, an educational package was distributed among all oncology nurses. These interventions were found to improve the health of nurses and to increase in the quality of nursing services in dealing with chemotherapy drugs.

Limitations
This study has a number of limitations including its small number of samples and the lack of a control group. The reason for both issues is the small number of nurses working in Ardabil chemotherapy wards.

Conclusions
All in all, the results indicate an increase in the knowledge and performance of the oncology nurses on the safe handling of antineoplastic drugs after training according to the standard guidelines. Thus, raising the knowledge and improving the performance of nurses in the field of the safe management of antineoplastic drugs is considered essential in the planning and policies of the healthcare system.

Table 2 Difference between mean scores of nurses’ knowledge regarding antineoplastic drugs safe handling pre and post guidelines intervention

| Knowledge | Mean ± SD | Min | Max | P-value |
|-----------|-----------|-----|-----|---------|
| Pre-intervention | 59.56±6.41 | 11 | 36 | 0.001* |
| Post-intervention | 66±4.82 | 20 | 37 | |

*Paired Sample Test

Table 3 Difference between mean scores of nurses’ safe handling practices of antineoplastic drugs pre and post guidelines intervention

| Practice | Mean ± SD | Min | Max | P-value |
|----------|-----------|-----|-----|---------|
| Pre-intervention | 18.96±2.54 | 14 | 23 | 0.001* |
| Post-intervention | 32.03±2.45 | 28 | 38 | |

*Paired Sample Test

Table 4 Difference between mean scores of nurses’ safe handling practices of antineoplastic drugs in the indicators of drug preparation, drug injection, drug leakage, and waste disposal pre and post guidelines intervention

| Items | Practice | Mean ± SD | Post-intervention | T-test | P-value |
|-------|----------|-----------|-------------------|--------|---------|
| Drug preparation | 0.56±0.09 | 0.79±0.06 | -12.20 | 0.001 |
| Drug injection | 0.41±0.10 | 0.78±0.07 | -15.91 | 0.001 |
| Drug Leakage | 0.07±0.02 | 0.50±0.20 | -13.04 | 0.001 |
| Waste Disposal | 0.48±0.10 | 0.76±0.09 | -10.65 | 0.001 |

Regarding the participants’ performance, a statistically significant difference was observed in the mean scores before and after the intervention. In addition, their performance significantly improved following training in all stages of drug preparation, drug administration, drug leakage, and waste disposal. This clearly demonstrated the positive effect of the intervention on the safe handling of antineoplastic drugs among oncology nurses. An increase in the nurses’ knowledge and performance can be attributed to the effectiveness of the training course on enhancing their knowledge and performance about antineoplastic drugs. Further, this result reflected the nurses’ tendency to gain knowledge on antineoplastic drugs for protecting themselves and their patients from the ADRs of these drugs. Most nurses complained about the lack of guidelines for using antineoplastic drugs in the ward which were approved by the Ministry of Health and Medical Education, and written training programs on how to handle these drugs, as well as their prescription process. The educational pamphlet focused on standard guidelines for handling antineoplastic drugs among nurses, which contained all the necessary information on antineoplastic drugs, as well as improving the knowledge and practice among nurses.

The results of most studies in this field confirmed the effect of the training interventions on nurses’ knowledge and performance. For example, Hazzrati et al. (2008) reported an improvement in the knowledge and performance of oncology nurses to a good and excellent level after training [16]. Additionally, Taghizadeh-Kermani et al. (2015) and Mohsen and Fareed (2013) found a significant increase in the knowledge and performance of oncology nurses following a short training course, as well as implementing the training protocol, respectively [17, 18]. Further, Shrestha et al. (2017) suggested that training intervention positively affects the knowledge of nurses’ regarding the safe use of antineoplastic drugs in Nepal [19]. Mahdy et al. (2017) also conducted a study titled “the effect of safety guidelines for antineoplastic drugs on the knowledge and practice of nurses in Ain al-Shams hospitals in Egypt”, in which the results were consistent with the findings of the present study [20]. According to Koulountiet al. (2019), the nurses receiving specialized training in antineoplastic drugs represent higher performance compared to the others [21]. These results were also confirmed by the studies of Boibol et al. (2016), Karapgam et al. (2017), Keat et al. (2013), Jeong et al. (2015), Zayed et al. (2019), and Angel and Soli (2017) which showed that the implementation of safety guidelines for antineoplastic drugs has a positive effect on improving the knowledge and performance of oncology nurses and nursing students [22–27].
Abbreviations
NIOSH: National Institute of Occupational Safety and Health; ONS: Oncology Nurses Society; OSHA: Occupational Safety and Health Administration; BSCs: Biological Safety Cabinets

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Authors’ contributions
AN, and MA designed the study. MS and EI held training sessions. AN collected the data. AN, and MS analyzed the data. AN, and MA had a role in preparing the manuscript. Also, all authors approved the final manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from public, commercial, or non-profit sectors.

Declarations

Ethics approval and consent to participate
The study was approved by the Ethics Committee in Biomedical Research at Ardabil University of Medical Sciences (ARUMS) (ethic code: ARUMS.REC.1398.040). The researchers obtained written informed consent from each participant as one of the criteria for them to join the study. The consent form outlined that participation is voluntary; participant anonymity will be protected, participants may withdraw their participation whenever they desire with no repercussions. All methods were carried out by relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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References
1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020. GLOBOCAN Estimates incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA: Cancer J Clin. 2021;71:209–49.
2. Amirkhah R, Naderi-Meshkin H, Mirahmadi M, Allahyari A, Sharifi HR. Cancer statistics in Iran: towards finding priority for prevention and treatment. Multidisciplinary Journal of Cancer Pathophysiology. 2017;3(2):27–38.
3. Alehashem M, Baniasadi Sh. Safe handling of anti-neoplastic drugs in the university hospitals: a descriptive survey study among oncology nurses. Int J Cancer Manag. 2018;11(2): e6482.
4. Shahzadi AA, Afshar M, Shokraney F, Monaj F, Noroozi M, Ebrahim-Mohojin M, et al. Risks to health professionals from hazardous drugs in Iran: a pilot study of understanding of healthcare team to occupational exposure to cytotoxic. EXCLI J. 2014;13:491–501.
5. Nwagbo SE, Ilesanmi RE, Ohaeri GM, Oluwatosin AO. Knowledge of chemotherapy and occupational safety measures among nurses in oncology units. J Clin Sci. 2017;14(3):131–37.
6. Gavee CJ, McGovern PM, Alexander B, Church T, Ryan A, Polovich M, et al. Occupational exposure to antineoplastic agents: an analysis of health care workers and their environments. Workplace Health Saf. 2017;65(1):9–20.
7. Callahan A, Arnes NJ, Manning MJ, Touchton-Leonard K, Yang L, Wallen GR. Factor influencing nurses’ use of hazardous drug safe-handling precautions. Oncol Nurs Forum. 2016;43(3):342–49.
8. Delboy DM, Smith TD, Woldu H, Dyal M-A, Steege AL, Boiano J, et al. Effects of organizational safety practices and perceived safety climate on PPE usage, engineering controls, and adverse events involving liquid antineoplastic drugs among nurses. J Occup Environ Hyg. 2017;14(7):485–93.
9. Johnson T. Long-term care: safe drug handling of oral chemotherapy. ASCP. 2017;32(2):74–83.
10. Aristizabal-Pachon AF, Castillo WO. Genotoxic evaluation of occupational exposure to antineoplastic drugs. Toxicol Res. 2019;36(1):29–36.
11. Al-Azzam SI, Awaddeh BT, Alzoubi KH, Khader YS, Aljaleel AM. Compliance with safe handling guidelines of antineoplastic drugs in Jordanian hospitals. J Oncol Pharm Pract. 2015;21(1):3–9.
12. Benabed-Martinez MA, Merino MR, Gago JMS, Sabucedo LMA, Wanden- Berghs C, Sanz-Valero J. Guidelines for safe handling of hazardous drugs: a systematic review. PLoS One. 2018;13(5):e0197172.
13. Connor TH, MacKenzie BA, DeBord DG, Trout DS, O’Callaghan JP. NIOSH list of antineoplastic and other hazardous drugs in healthcare settings 2016. Department of Health and Human Services. Centers for Disease Control and Prevention: National Institute for Occupational Safety and Health; 2016.
14. Jung J, Park JY. Factors influencing compliance with safety guidelines of anticancer drugs among nurses in general hospitals. Asian Oncol Nurs. 2019;19(2):106–13.
15. Guideline: preventive chemotherapy to control soil-transmitted helminth infections in at-risk population groups. WHO Library Cataloguing-in-Publication Data. Ministry of Health and Medical Education: Deputy of Treatment; 2017.
16. Hazrati M, Raeisi H, Torabzadeh K, Payar N. The effect of education standard instructions for working with anti-neoplasim drugs on the drug delivery process in chemotherapy wards affiliated to Shiraz University of Medical Sciences. Hormozgan Medical Journal. 2008;12(2):103–107 [Persian].
17. Taghzadeh Kermani A, Hoseinii S, Salek R, Pourali L. Improving knowledge and attitude of nurses working in chemotherapy wards through a short medical education course: a successful experience in Masjhad. Future of Medical Education Journal. 2015;5(4):10–13.
18. Mohsen MM, Fared ME. Chemotherapy safety protocol for oncology nurses: it’s the effect on their protective measures practices. WASET. 2013;7(9):529–37.
19. Shrestha(Rai) DK, Lama S, Badu A, Mandal GN. Impact of educational intervention on knowledge regarding safe handling of cytotoxic drugs among the nursing personnel working in BPKHIS. Health Renaissance. 2017; 13(1):13–22.
20. Mahdy NE, Abdel Rahman A, Hassan H. Cytotoxic drugs safety guidelines: Its effect on awareness and safe handling practices of oncology nurses. IOSR JNSHS. 2017;6(3):22–33.
21. Kououri M, Roupa Z, Charalambous C, Noulas M. Assessment of nurses’ safe behavior towards chemotherapy management. Mater SocioMed. 2019;41(3):282–85.
22. Bolbol SA, Hassan AA, El-Naggar SA, Zaitoun MF. Role of occupational health and safety program in improving knowledge and practice among nurses exposed to chemotherapy at Zagazig university hospitals. Egypt J Occup Med. 2016;40(2):219–35.
23. Karpagam K, Mangalagowr P, Aruna S. Effectiveness of planned teaching program on safe handling of chemotherapy drugs among staff nurses. Int J Pharm Biocl Sci. 2017;8(1):180–84.
24. Keat CH, Sooaid NS, Yun CY, Sriraman M. Effectiveness of structured education on safe handling guidelines of antineoplastic drugs in Jordanian hospitals. Int J NCU. 2017;32(2):74–83.
25. Jeong KW, Lee B-Y, Kwon MS, Jang J-H. Safety management status among nursing staff handling hazardous drugs. Korean J Occup Environ Health. 2008;52(2):107–111.
26. Zayed HA, El-Sallamy RM, Shehata WM. Knowledge, attitudes and practices of safe handling of cytotoxic drugs among nurses in Tanta university hospitals. Egyp J Occup Med. 2019;43(1):75–92.
27. Angel RG, Soli TK. Effectiveness of structured education on safe handling and disposal of chemotherapeutic drugs among nursing students. Int J Pharmocol Clin Res. 2017;1(1):15–18.

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