Improving Nurses' Performance in Safe Handling of Antineoplastic Agents: a Quasi-experimental Study

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Abstract

Background: The safe, principled, and standard handling of anticancer 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 anti-neoplasm drugs among oncology nurses in Ardabil, Iran.

Methods: The quasi-experimental study with one-group pretest-posttest design was performed among 32 nurses employed in the oncology wards of two educational hospitals in Ardabil city, during 2020. All of 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. Then, they were analyzed through 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 respectively determined 59.56 ± 6.41 and 18.96 ± 2.54 , which changed to 66 ± 4.82 and 32.03 ± 2.45 three months after training. The results of 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 anticancer drugs in the chemotherapy wards. Therefore, it is suggested to pay attention to the promotion of the oncology nurses' awareness in the planning and policy-making of healthcare centers.

Introduction

Cancer is considered as a major public health problem in the world, which is responsible for 13% of all deaths and can affect all age groups worldwide. According to the latest reports of the Ministry of Health and Medical Education, cancer is currently the third leading cause of death in Iran after coronary heart disease and accidents, which is becoming the second cause because of aging the population and decreasing deaths due to accidents (1). Chemotherapy drugs are known as cytotoxic agents, which are widely used in healthcare centers to treat cancer patients (2). Researchers have confirmed that the side effects associated with chemotherapy agents may occur in both patients and individuals involved in the treatment chain (3, 4). The US National Institute of Occupational Safety and Health (NIOSH) classified the drugs as high risk since they are mutagenic, teratogenic, and carcinogenic (5).

Nurses are at risk for the harmful effects of chemotherapy drugs due to long-term occupational exposure (6). They play the most important role in caring cancer patients, and have the four main roles of safe treatment and side effect management, as well as training patients and their families on the side effects, and providing emotional support to patients in the chemotherapy prescription process (4). In addition, the 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 (7). The significant amounts of cytotoxic 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. Oncology nurses may inhale particles and vapors while preparing the drug or cleaning the spots caused by airborne particles. Further, the skin may be contaminated when preparing, prescribing, or disposing hazardous chemotherapy drugs, cleaning patient's excrement, or touching contaminated surfaces (8). Based on the results of hospital studies, the level of cytotoxic drugs is significant in the air, surfaces, gloves, and various parts of the treatment team (9). Thus, the assessment of nurses' knowledge regarding how to deal with cytotoxic drugs and observe safety measures when preparing and prescribing drugs is considered as important (4). The organizations such as NIOSH, Oncology Nurses Society (ONS), and Occupational Safety and Health Administration (OSHA) have recommended safe guidelines for cytotoxic drugs. Some of the guidelines include modifying the physical structure of workplace in terms of isolating the drug preparation space, minimizing nurses' contact with drug, training staff in the specialized field, applying standard work methods, and utilizing personal protective equipment to achieve the minimum contact of cytotoxic drugs with the skin or respiratory system of nurses (10, 11).

Nurses should be aware of the risks and safe performance of handling cytotoxic drugs to enhance the safety of both patient and nurse. The use of biological safety cabinets (BSCs) against inhalation exposure during drug preparation and non-absorbable disposable gowns with long-sleeved goggles is among the methods recommended for declining the exposure to hazardous drugs (HDs). The other approaches are wearing two pairs of powder-free latex gloves, the breathing masks against aerosols, 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 cytotoxic drugs can decrease if all precautions are taken consistently (12). Along with the chemical and physical properties, and dose of the prescribed drugs, as well as available protective measures, researchers have reported that the chemotherapy drug side effects in patients and individuals involved in the treatment affect significantly the knowledge and skills of the team. Frequent exposure to even low doses of the drugs for long periods may have profound effects (4). The several recent studies have referred to the contamination of the workplace and healthcare workers, especially nurses and in the developing countries, although the guidelines for the safe use of cytotoxic drugs have been in place since the past 20 years (13). 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 is considered as main reasons for the unsafe management of cytotoxic drugs. Accordingly, the guidelines cannot guarantee safe behaviors, and awareness is an important factor in changing individuals' performance (14).

Given that unsafe drug treatment process leads to side effects and sometimes irreversible disorders, a standard drug treatment is required to decline the side effects of exposing to cytotoxic 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 specify the effects of standard guidelines education on the safe handling of anti-neoplasm drugs among oncology nurses.

Method

Study design

This study with a quasi-experimental one-group pretest-posttest design was performed among all of the 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 working in the mentioned wards, having at least three months of experience in the oncology wards, and inclining to participate in this study, among which 32 nurses were entered into the study.

In the present study, the researcher attended in the hospital director and nursing offices of the intended hospitals, followed by introducing to the oncology wards. Additionally, she explained the research objectives, assured about 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 in 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 chemotherapy 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, the first of which was a researcher-made questionnaire to assess the nurses' knowledge on the standard guidelines for handling anti-neoplasm drugs. The second was an observational checklist to examine their performance in accordance with the standard guidelines among inpatient and outpatient wards.

The nurses' knowledge questionnaire consisted of two parts (37 questions). The first included the demographic characteristics of nurses such as age, sex, marital status, as well as the level of education, kind of employment, duration of employing in the oncology ward, type of shift, and amount of working hours per week, passing previous training workshops, along with standard environment and facilities, periodic tests, and occupational accidents. However, the second part assessed their awareness on the proper principles of drug preparation, ways of drug absorption, side effects of chemotherapy drugs, correct method of using personal protective equipment, and knowledge of the necessary measures in case of occupational exposure to cytotoxic drugs and waste disposal. In the questionnaire, the score of each item can be 1 (yes) or 0 (I do not know and no). Receiving a score of 1 in all items represents the desirable level of knowledge, while a score of 0 reflects the undesirable level of knowledge. In addition, the scores of 0–14, 15–29, 30–44, 45–59, and 60–74 are respectively considered as a very low, low, medium, good, and a high level of knowledge.

The checklist contained four main subscales of drug preparation (before injection), injection, leakage, and waste disposal performance (18, 14, 4, and 6 items, respectively) based on the guidelines of the Ministry of Chemotherapy Services Management (2017), as well as nursing services standards (15). The score of each item may be 0 (no) or 1 (yes) so that the nurses' performance scores in the safe drug treatment process varies 0–42. Further, the score of 0–8, 9–17, 18–25, 26–33, and 34–42 indicates a very poor, poor, medium, good, and excellent performance, respectively.

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

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

Results

Participants' demographics

In the study, most of the nurses were female (96.9%) and married (71.9%). Additionally, their mean age and work experience in the oncology ward were obtained 32.68 ± 4.70 and 4.31 ± 3.53 years, respectively (Table 1).

Table 1
Demographic characteristics of the studied nurses

Nurses' characteristics	Mean $\pm$ SD
Age	32.68 $\pm$ 4.70
Years of experience in cytotoxic drug administration	4.31 $\pm$ 3.53
Working hours during the week	46.34 $\pm$ 5.72

Description and correlation of major variables

Based on the results related to the participants' knowledge of the standard guidelines for handling anti-neoplasm drugs, the mean and standard deviation of their knowledge scores was 59.56 ± 6.41 before the intervention, which changed 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 ones (90.7%) obtained excellent knowledge scores following the training workshop.

Table 2
Difference between mean scores of nurses' knowledge regarding cytotoxic 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				

As shown in Tables 3 and 4, the mean and standard deviation scores of drug preparation, injection time, leakage, and waste disposal, and overall performance is respectively determined 10.18 ± 1.78 , 5.78 ± 1.45 , 0.09 ± 0.29 , 2.90 ± 0.64 , and 18.96 ± 2.54 . Further, they are respectively upgraded to 14.37 ± 1.15 , 11.03 ± 1.03 , 2.03 ± 0.82 , 4.59 ± 0.55 , and 32.03 ± 2.45 ($P < 0.001$).

Table 3
Difference between mean scores of nurses' safe handling practices of cytotoxic 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				

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.

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

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

Discussion

Based on the results of the present study, the level of the nurses' knowledge about cytotoxic drugs safe handling enhanced following training the standard guidelines, which their difference was statistically significant. Regarding the participants' performance, a statistically significant difference was obtained 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, which demonstrated the positive effect of the intervention on the safe handling of anti-neoplasm drugs among oncology nurses. An increase in the nurses' knowledge and performance can be attributed to the effectiveness of the training courses on enhancing their knowledge and performance about cytotoxic drugs. Further, the result reflected the nurses' tendency to gain knowledge on chemotherapy drugs for protecting themselves and their patients from the side effects of the drugs. Most of the nurses complained about the lack of the guidelines for chemotherapy drugs in the ward which were approved by the Ministry of Health and Medical Education, and written training programs on how to deal with the drugs, as well as their prescription process. The educational pamphlet focused on standard guidelines for working with chemotherapy drugs among nurses, which contained all the necessary information about cytotoxic 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, Hazrati et al. (2008) reported an enhancement in the knowledge and performance of oncology nurses to good and excellent level after training (15). Additionally, Taghizadeh Kermani et al. (2015) and Mohsen and Fareed (2013) found that the knowledge and performance of oncology nurses increase significantly following a short training course, as well as

implementing the training protocol, respectively (16, 17). Further, Shrestha et al. (2017) pointed out that the training intervention positively affects the knowledge regarding the safe use of cytotoxic drugs in Nepal (18). Mahdy et al. (2017) also conducted a study entitled “the effect of safe guidelines for cytotoxic drugs on the knowledge and practice of nurses in Ain al-Shams hospitals in Egypt”, which the results were consistent with the findings of the present study (19). According to Koulounti et al. (2019), the nurses receiving specialized training in chemotherapy drugs represent higher performance compared to the others (20). These results were also confirmed by the studies of Bolbol et al. (2016), Karpagam 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 safe guidelines for cytotoxic drugs has a positive effect on improving the knowledge and practice of oncology nurses and nursing students (21–26).

Limitations

The inadequacy of the drug preparation space (isolator) and lack of personal protective equipment to implement the guidelines completely are among the limitations of the present study.

Conclusion

In general, the results indicated an increase in the knowledge and performance of the oncology nurses on the safe handling of cytotoxic drugs after training standard guidelines. Thus, paying attention to the promotion of nurses' knowledge and performance in the field of the safe management of chemotherapy drugs is considered as essential in the planning and policies of the healthcare system.

Abbreviations

NIOSH: National Institute of Occupational Safety and Health; ONS: Oncology Nurses Society; OSHA: Occupational Safety and Health Administration; BSCs: Biological Safety Cabinets

Declarations

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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 the corresponding author on reasonable request.

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 IR.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 in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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