BMC Nursing

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

A Nouri[1], M Seyed Javadi[2], E Iranijam[3] and M Aghamohammadi[1*]

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 ofstandard guidelines education on the safe handling of antineoplastic drugs among oncologynurses in Ardabil, Iran.

Methods: Thequasi-experimental study with a one-group pretest-posttest design was performed among 32 nursesworking in the oncology wards of two educational hospitals in Ardabil city, during 2020. Allthe nurses in the wards who met the inclusion criteria participated in the study. The data were collectedby usinga demographic information form and nurses'knowledge assessment questionnaire regardingthe standard guidelines for working with antineoplastic drugs, and a standard checklist for examiningtheir 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 was59.56±6.41and 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 ofhealthcare 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 causebecause of aging of the population and decreasing deaths due to accidents [2]. Antineoplastic drugs are cytotoxic agentswhich are widely used in healthcare centers to treat patients with cancer [3].Researchers have confirmed that theadverse 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)

* Correspondence: agamohammadim@gmail.com
[1]Department of Nursing, School of Nursing and Midwifery, Ardabil University of Medical Sciences, Ardabil, Iran
Full list of author information is available at the end of the article

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classified these drugs as high risk since they are mutagenic, teratogenic, and carcinogenic [6].

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 the past 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 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

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performance were re-evaluatedthree 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 handlingantineoplastic drugs and second,an observational checklist to examinetheperformance of the nurses by the standard guidelinesamong 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 thelevel of education, typeandduration of employment in the oncologyward, type of shift, and numberof working hours per week. Additionally information on the completion ofprevious training workshops, along with standard environment and facilities, periodic tests, and occupational accidents were also obtained.The second part of the questionnaire assessed theirawareness 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 airborneantineoplasticparticles,, 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 itemis either1 (yes) or 0 (I do not knowand no). Receiving a score of 1forall questionsrepresents the desired level of knowledge, while a score of 0 reflects a knowledge gap.

Thechecklistcontained 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 antineoplastic Services Management(2017), as well asnursing services standards [16].Some items included the following: wash your hands with soap and water before preparing antineoplastic drugs, wear non-absorbable disposable gownswith long-sleeved goggles when injecting, usea face shield when preparing drugs,place the devices used in the injection of antineoplastic drugs in impermeable bags, etc.The score of each itemwas0 (no)or1(yes) so thatthe nurses' performance scores in the safe drug treatment processcould 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 calculatedat 93.2 for the knowledge questionnaire and at 92.8 performance checklist.Regarding the reliability, Cronbach's alpha coefficient was computed0.74 and 0.72 for the questionnaireand 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 thisstudy, most nurses were female (96.9%) with a mean age of 32.68±4.70 years.The mean work experience in the oncologywardwas 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 handlingantineoplasticdrugs, the mean and standard deviation of their knowledge scores was 59.56±6.41 before the intervention, which increasedto 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 scoresfollowing 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±0.07respectively after the training. Moreover, mean scores for leakage, waste disposal, and overall performance were initially0.07±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 oneperformedwell.However, 29 participants (90.7%) hada 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 onthe safe handlingof antineoplastic drugs statistically significantly increasedfollowingtrainingthe standard

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

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Table 2 Difference between mean scores of nurses' knowledge regarding antineoplastic drugs safe handling pre andpost 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

guidelines,Regarding the participants' performance, a statistically significant difference was observedin the mean scores before and after the intervention. In addition, their performance significantly improvedfollowing training in all stages of drug preparation, drug administration, drug leakage, andwaste disposal. This clearly demonstrated the positive effect of the intervention onthe safe handling of antineoplasticdrugs among oncologynurses.An increase in the nurses'-knowledge and performance can be attributed to the effectiveness of the trainingcoursesonenhancingtheir knowledge and performance about antineoplastic drugs.Further, theresultsreflected the nurses' tendency to gain knowledge onantineoplastic 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 wardwhich 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 handlingantineoplastic drugs among nurses, which contained all the necessary informationonantineoplastic 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 improvementin the knowledge and performance of oncology nurses to a good and excellent level after training [16]. Additionally, TaghizadehKermani et al. (2015) and Mohsen and Fareed(2013) found a significant increase inthe knowledge and performance of oncology nursesfollowing a short training course, as well as implementing the training protocol, respectively [17, 18].Further, Shrestha et al. (2017) suggested thatatraining intervention positively affectsthe knowledge of nurses' regarding the safe use of antineoplasticdrugs in

Table 3 Difference between mean scores of nurses' safe handling practices of antineoplastic drugs pre and postguidelines 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 postguidelines intervention

Practice Items	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	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

Nepal [19].Mahdy et al. (2017) also conducted a study titled"the effect of safetyguidelines 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 toKoulountiet 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 ofBolbol 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 safetyguidelines for antineoplastic drugs has a positive effect on improving the knowledge and performance of oncology 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 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 resultsindicate anincrease in the knowledge and performance of the oncologynurses on the safe handling ofantineoplastic 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.

Declarations

Ethics approval and consent to participate
The study was approved by the Ethics Committee in Biomedical Research atArdabil University of Medical Sciences (ARUMS) (ethic codeIR.ARUMS.REC.1398.040). The researchers obtained written informed consentfrom each participant as one of the criteria for them to join the study. Theconsent form outlined that participation is voluntary, participant anonymitywill be protected, participants may withdraw their participation wheneverthey 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.

Author details
[1]Department of Nursing, School of Nursing and Midwifery, Ardabil University of Medical Sciences, Ardabil, Iran. [2]Department of Nursing, Moghan School of Nursing and Midwifery, Ardabil University of Medical Sciences, Moghan, Iran. [3]Department of Internal Medicine, School of Medicine, Ardabil University of Medical Sciences, Ardabil, Iran.

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