

# Impact of Educational Intervention on Compliance of Health Care Workers Towards Chemotherapy Handling Guidelines

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**Background:** Chemotherapy safety guidelines have been enacted to minimize their side effects on healthcare providers when handling medications. The aim of this study is to assess the impact of an educational intervention on healthcare workers' compliance with chemotherapy safety guidelines.

**Methods:** In this study, we used a quasi-experimental, pre-post testing design. It was conducted in the Oncology center at King Saud University Medical City (KSUMC) in Riyadh, Saudi Arabia. All healthcare workers involved in the preparation and administration of chemotherapy medications in KSUMC were invited. We evaluated Educational intervention to ensure the compliance of healthcare workers with standard safety guidelines through a questionnaire with 29 questions in total.

**Results:** Fifty-two participants were eligible in this study. Overall, the score for mean compliance with workplace guidelines among the participants increased from  $17.62 \pm 0.78$  to  $18.17 \pm 0.80$  out of 19. Multiple liner regression indicates that there are no variables among the included variables predicting a change in post-intervention.

**Conclusion:** This study indicates that educational intervention is the only effect of compliance in the included sample. Education safety training could improve healthcare workers' knowledge and consequently improve their compliance in the preparation and administration of chemotherapy medication.

**Keywords:** chemotherapy, safety, pharmacists, nurses

## Background

There is an increasing awareness of cytotoxic hazards among healthcare workers, as cancer patients commonly receive a complex chemotherapy regimen for a longer period of time nowadays.<sup>1,2</sup> Cytotoxic drugs are mainly used as therapeutic agents in chemotherapy due to their ability to kill cancer cells. However, these medicines may not recognize the difference between cancer and normal cells, resulting in well-documented side effects.<sup>3-5</sup>

Drug transportation, preparation, administration, storage, cytotoxic spillage management, and waste disposal are one of the riskiest activities.<sup>6</sup> Long-term occupational exposure to cytotoxic drugs is related to different carcinogenic, teratogenic and mutagenic effects.<sup>7</sup> Some symptoms appearing in nurses exposed to such drugs were infertility, miscarriage, and abnormalities in the fetus.<sup>8,9</sup> Furthermore, various studies have also reported other symptoms such as dermatitis, skin local reactions, abdominal pain, headaches, hair loss and liver damage related to cytotoxic drug exposure.<sup>3,10,11</sup>

Nurses and pharmacists are known to be at significantly higher risk of occupational exposure to chemotherapy drugs because they handle these agents when administering to patients.<sup>12</sup> Educating Healthcare workers about the appropriate handling of chemotherapy agents can assist in raising the level of awareness, and thus reducing the impact of long-term adverse effects.

Chemotherapy safety guidelines agree that to minimize exposure to chemotherapy drugs in the workplace, each facility needs to improve and develop a comprehensive safety program that deals with all aspects of drug handling from selection and receipt of the product to storage, compounding, transport within the facility, administration, spill control, and waste management.<sup>13</sup> Guidelines for the safe handling of hazardous drugs have been available for more than 20 years. These guidelines include those provided by the National Institute for Occupational Safety and Health (NIOSH), the Oncology Nursing Society (ONS), the Occupational Safety and Health Administration (OSHA), and the American Society of Health Pharmacists (ASHP). However, they are not regularly practiced.<sup>14</sup> Reasons include inconvenience, limited time, awkward positions of the precautionary materials and equipment, and the lack of awareness about health risks associated with the handling of chemotherapy agents.<sup>3</sup>

A cross-sectional, multicenter, observational study was conducted between June 2016 and February 2017 at various public hospitals in Riyadh, Saudi Arabia. The study involved oncologists, pharmacists, and nurses who have been prescribing oral chemotherapy. The results obtained have shown a positive and significant association between years of experience and healthcare professionals who received proper training regarding the administration of oral chemotherapy. However, they also stated that there is a need for specific guidelines on the implementation of oral chemotherapy for both healthcare practitioners and patients.<sup>15</sup>

In this study, the researchers aimed to assess the impact of educational intervention on healthcare worker compliance with safety guidelines from the National Institute for Occupational Safety and Health (NIOSH), the American Society of Health System Pharmacists (ASHP), and the Occupational Safety and Health Administration (OSHA) during the preparation and administration of chemotherapy medication before and after an educational intervention.

In the traditional course, multiple workers gather to learn at a specific time and place. However, online courses have been offered due to restrictions during the Coronavirus pandemic and due to the flexibility of choosing the time and place to learn that is most convenient for them. In the research finding from 2015, there were some benefits of online courses over conventional environments. Web-based learning gives people flexibility and accessibility in schedule or location.

## Materials and Methods

### Study Design

This study was a quasi-experimental, pre-post testing design evaluating the effect of a four-week educational intervention on participants' compliance with chemotherapy safety guidelines from the National Institute for Occupational Safety and Health (NIOSH), American Society of Health System Pharmacists (ASHP), and Occupational Safety and Health Administration (OSHA)<sup>13</sup> during the preparation and administration of chemotherapy medication. The test-retest method was used alongside group analysis. One recorded educational session was conducted and assessed at King Saud University medical City (KSUMC).

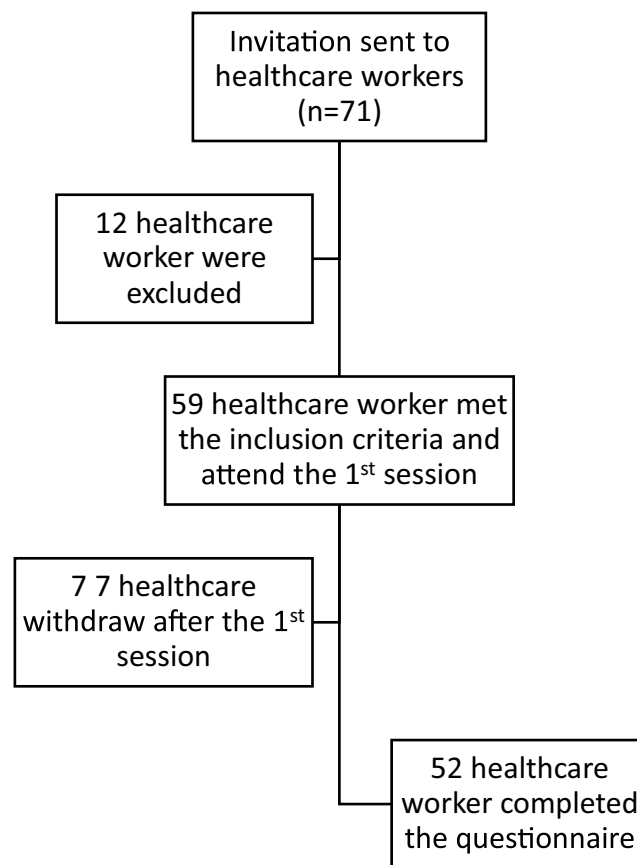
Before the educational session began, participants were emailed a questionnaire to complete the baseline evaluation. Two weeks later, the participants underwent the second session.

### Sample Size Calculation and Sampling Procedure

Between November 2020 and January 2021, registered healthcare workers in the ministry of health were invited to participate (n=71). Invitation letters were sent to healthcare workers who met the inclusion criteria (n=59). Inclusion criteria included those who worked in KSUMC, in Riyadh, Saudi Arabia, with at least one year of experience. The study also included pharmacists and nurses who have been working in the preparation and administration of chemotherapy and who were willing to complete the pre-post assessment. As depicted in Figure 1, fifty-two healthy employees attended all courses. The analysis excluded health professionals who did not fill out the questionnaire prior to or after the education sessions or who did not attend all of the sessions.

### Variables and Measurement

Online recorded education sessions were suggested due to the circumstances of COVID-19. We decided to create an online education program as it is preferred by workers who may not be able to make it to the traditional classes in



**Figure 1** A flowchart displaying the involvement of healthcare workers.

hospitals for various reasons. For example, there is no cost for commuting, transport, and public transportation. Moreover, online education can cost less.

The educational sessions' topics were based on recent, current, and internationally reputable training criteria (NIOSH) (ASHP) (OSHA). The educational sessions were performed during two different periods (one hour each) followed by question-and-answer sessions. The instructional material used pictures, objective statements, and questions that were relevant to each section. The way the training material was presented adhered to the fundamentals of instruction, which are based on logical, known-to-unknown, and general-to-specific sorting techniques.<sup>16</sup> The presentation content included defining of chemotherapy drugs, risks of hazardous drug exposure, storage, transport and administration, personal protective equipment, medical surveillance, decontamination, and safety.

There were two sections and a total of 29 questions on the questionnaire. Nine questions about sociodemographic details were in the first segment (age, gender, marital status, occupation, degree, experience, and number of preparations or administrations weekly). The second section of the survey consisted of 19 questions (with a maximum score of 19), and the answers were graded as follows: "Yes" received a 1, and "No" received a 0. The compliance level of healthcare staff was divided into two groups based on the results: good ( $> 17$ ) and bad ( $\leq 17$ ).

## Data Analysis

The sample size calculation showed that for detecting a difference of 0.3–0.4 between proportions (ie, a 30–40% difference in compliance of workplace guidelines between pre-intervention and post-intervention), a sample of 40 participants would achieve a statistical power of 80% and a two-sided significance of 5% [ie, two-sided p-value less than 0.05] [M. S. Dhand, N. K., and Khatkar, "An online statistical calculator. Sample Size Calculator for Comparing Two Paired Proportions"<sup>17</sup>].

Applying IBM SPSS Statistics for Windows, Version 25.0, the data were examined (IBM Corp., Armonk, NY, USA]. To determine how healthcare professionals' compliance varied across the various social and demographic characteristics, descriptive statistics such as frequencies, percentages, and cross-tabulations were acquired. Marginal homogeneity tests for three categories of variables and the McNemar test for two categories of variables were used to find within-group differences and post-intervention. In order to compare the pre-post intervention score, Mann-Whitney U was used. The study's p-value for significance is  $< 0.05$ .

## Ethical Condition

Ethics approval was obtained from the King Saud university medical city (KSUMC) institutional review board (IRB) committee (E20-5284). Detailed bilingual informed consent forms were used. All participants provided written informed consent at enrollment.

## Results

### Participants' Characteristics

The socio-demographic characteristics of participants indicated that the majority were female and more than 35 years old. Regarding education level, 59.7% had bachelor degrees as shown in Table 1. Around one third of the participants were married. Experience as a healthcare worker was more than 10 years (53.2%). More than half (56.9%) of the participants prepared and administered less than 100 preparations weekly.

**Table 1** Respondents' Characteristics (n=52)

Variables	Categories	Frequency	Percent
Age (years)	20–35	26	41.9
	35<	36	58.1
Sex	Male	20	32.3
	Female	42	67.7
Occupation	Pharmacy technician	22	35.5
	Pharmacist	15	24.2
	Nurse	25	40.3
Degree	Diploma	22	35.5
	Bachelor's	37	59.7
	Master's	3	4.8
Marital status	Single	16	25.8
	Married	46	74.2
Duration in working as a health care worker	< 5 years	5	8.1
	5–10 years	24	38.7
	More than 10 years	33	53.2
Number of preparations or administrations weekly (Typical week)	< 100	35	56.9
	More than 100	27	34.4

## Relationship Between Compliance of Workplace Guidelines among Healthcare Providers' and the Socio-Demographic Characteristics

The results reported that there was no significant relationship between participants' workplace guidelines compliance and the socio-demographic characteristics ( $p\text{-value} \geq 0.05$ ) in [Table 2](#).

## The Difference in Healthcare Workers Compliance Pre-Post Intervention

Overall, the mean compliance score of workplace guidelines among the participants improved from  $17.62 \pm 0.78$  to  $18.17 \pm 0.80$  out of 19 ([Table 3](#)).

Before the education intervention, nearly half of the sample had good compliance in the workplace with all requirements of the guidelines. After the intervention, two-thirds of participants were classified as in good compliance in workplace with all requirements of the guideline categories as shown in [Table 3](#).

## The Impact of Predictor Variables on the Overall Score

Multiple Regressions (ML) were conducted using the overall score of the compliance as the dependent variables. The predictor variables were age group, gender, occupation, degree, marital status, experience, number of preparations or administrations per week.

**Table 2** Relationship Between Mean Compliance Scores for Workplace Guidelines and the Socio-Demographic Characteristics

Variable	Mean Scores $\pm$ SD
<b>Age (years)</b>	
20–35	17.46 $\pm$ 0.76
35–50	17.72 $\pm$ 0.77
<b>Gender</b>	
Male	17.85 $\pm$ 0.67
Female	17.50 $\pm$ 0.80
<b>Occupation</b>	
Pharmacy technician	17.50 $\pm$ 0.74
Pharmacist	17.80 $\pm$ 0.86
Nurse	17.60 $\pm$ 0.76
Diploma	17.50 $\pm$ 0.74
Bachelor's	17.62 $\pm$ 0.79
Master's	18.33 $\pm$ 0.57
Single	17.62 $\pm$ 0.80
Married	17.61 $\pm$ 0.77
< 5 years	17.20 $\pm$ 0.44
5–10 years	17.62 $\pm$ 0.82
10 years <	17.67 $\pm$ 0.77
< 100	17.63 $\pm$ 0.77
100 $\leq$	17.59 $\pm$ 0.79

**Table 3** The Impact of the Educational Intervention on the Compliance Scores of Workplace Guidelines

Intervention	Compliance of Workplace Guidelines		p-value
	Poor ≤17	Good >17	
<b>Pre (n, %)</b>	23 (24.2%)	29 (55.8%)	0.012
<b>Post (n, %)</b>	11 (21.2)	41 (78.8%)	

**Table 4** Predictors of Change in Compliance After Intervention

Predictors	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Tolerance	Adjusted R Square
	B	Std. Error	Beta				
(Constant)	18.024	0.594		30.325	0.000		0.001
Age	−0.540	0.327	−0.356	−1.649	0.106	0.430	
Sex	0.030	0.262	0.017	0.113	0.911	0.855	
Occupation	0.027	0.163	0.029	0.165	0.870	0.647	
Degree	0.335	0.244	0.236	1.374	0.176	0.678	
Marital status	0.039	0.324	0.021	0.120	0.905	0.626	
Duration of working as a health care worker	0.411	0.257	0.339	1.601	0.117	0.446	
Number of preparations or administrations weekly (Typical week)	0.017	0.217	0.012	0.078	0.938	0.852	

The results of the multiple liner regression indicate that there are no variables among the included variables predicting the change in the post-intervention, which indicates that the intervention is the only effect of compliance among the included sample ( $R^2 \text{ adj} = 0.001$ ). Results are shown in [Table 4](#).

## Discussion

This study was conducted to evaluate healthcare workers' compliance pre- and post-education intervention with standard safety guidelines (NIOSH, ASHP, and OSHA) during the preparation and administration of chemotherapy medication. Prior to the educational intervention, approximately 50% of the sample exhibited satisfactory adherence to workplace guidelines. Following the intervention, a higher proportion, specifically two-thirds of the participants, were categorized as demonstrating good compliance with all aspects of the guideline categories within the workplace. The findings showed that there was no association between healthcare workers' sociodemographic traits and compliance ( $P\text{-value} > 0.05$ ).

According to a recently published systematic review,<sup>18</sup> Numerous strategies were identified to enhance compliance with safe handling of hazardous drugs (HDs). These interventions included web-based courses, educational modules, implementation of safety protocols, practical demonstrations with subsequent reviews, instructional videos, PowerPoint presentations, seminars, and workshops.

Monitoring nurses' performance after the application of these diverse educational approaches revealed a notable improvement in their adherence to safe HD handling practices. These educational interventions were found to positively impact self-confidence, nursing proficiency, attitudes, knowledge levels, and practical skills related to the management of cytotoxic drugs.<sup>18</sup> Specifically, nurses demonstrated better compliance in using standard personal protective equipment, adhering to safety protocols during administration, handling body fluids, and responding to HD spills.

Our findings supported those of Keat et al (2016)<sup>7</sup> who found that for all domains, the mean scores for the 96 participating nurses before training were lower than after training. These domains included drug preparation, drug transportation, drug storage, drug administration, spillage management, waste disposal, and decontamination. Another cross-sectional research of 50 nurses in Nepal revealed instructional sessions that were similar to our findings. According to this study, the pre-education intervention average knowledge score for safe handling of cytotoxic medications was 35.3%, whereas the post-education intervention average knowledge score was 83.7%.<sup>19</sup>

## Strength and Limitations

To our knowledge, this study is the first in Saudi Arabia to provide an educational intervention for healthcare workers who prepare and administer chemotherapy medication. Educational programs for healthcare workers had a significant effect on increasing the compliance of healthcare workers with standard safety guidelines regarding preparation and administration of chemotherapy medication.

The small sample size of this study, which also lacked a randomized design and a control group, is one of its weaknesses despite its positives. The primary objective, however, was to offer a campaign of awareness and education to the medical staff. Therefore, it was determined that the inclusion of a control group was unethical. More sessions in a variety of settings would be required in order to scale up this intervention. Additionally, longitudinal studies are advised to examine the impact of education over a longer time span and determine whether healthcare workers require ongoing education.

## Conclusion

In this study, we found that education safety training could improve healthcare workers' knowledge and consequently improve healthcare workers' compliance in preparation and administration of chemotherapy medication. This study recommended that special education programs offered at the time of appointment could raise the compliance level for health personnel.

## Abbreviations

KSUMC, King Saud University Medical City; ML, Multiple NIOSH, Regressions; Occupational Safety and Health; ONS, Oncology Nursing Society; OSHA, Occupational Safety and Health Administration; ASHP, American Society of Health Pharmacists.

## Ethics Approval and Consent to Participate

All methods were performed in accordance with the guidelines and regulations contained in the Declaration of Helsinki. This study was approved by king Saud university medical city ethics committee. All participants provided written informed consent at enrollment.

## Data Sharing Statement

The data analysed in this study are available from the corresponding author on reasonable request, subject to ethical approval.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare that they have no competing interests in this work.

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