Effect of Occupational Health Safety Program on Perception and Practices of Nurses Exposed to Chemotherapy Hazards

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Abstract

Background: Occupational exposure to chemotherapeutic drugs occurs in all aspects of drug handling. Safe handlining practices ought to be followed by nurses for prevention and minimize exposure. **Study aimed to** evaluate the effect of an occupational health safety program on perception and practices of nurses exposed to chemotherapy hazards at the oncology center at Tanta University Hospitals. **Subjects& Methods:** An experimental design was used in this study, including all nurses working in the previous setting (n=110) and divided randomly into two equal groups: Study group and control group. **Study tools:** three tools were used: **I-**socio-demographic & occupational characteristics and knowledge of nurses regarding handling of chemotherapy, **II-**beliefs of the nurses regarding chemotherapy occupational hazards, and **III-**observational checklist for nurses' practices**. Results:** All the studied nurses in the age group 26-30 years and graduated from Technical Institute of Nursing. The majority (83.6%) of the study group had good knowledge, (81.8%) had positive beliefs and (87.3%) of them had satisfactory practice at post-program. **Conclusion:** Compared to control group, study group showed a statistically significant improvement in the score of all knowledge, beliefs, and practice items one month after intervention. **Recommendations:** Occupational health nurses need to periodically and continuously conduct orientation and in service training program for all newly employed nurses at oncology centers.

Keywords: chemotherapy hazards, nurses' perception, occupational safety program

Introduction:

Chemotherapeutic drugs (CDs) have an important role in the treatment of over 12.1 million cancer patients globally each year. These medications have unique pharmacological properties that inhibit cell proliferation. Unfortunately, because of their nonselective method of action, they harm both healthy and cancerous cells, which can have a substantial impact on the health of patients and healthcare personnel who deal with them often. (**Chhikara & Parang, 2023**). The growing use of chemotherapy medications in cancer treatment has resulted in increased health risks for nurses, including mutagenicity in urine, skin problems, fetal loss during the third trimester of pregnancy, unexplained abortion, deformities, and genetic toxicity. Nurses who deal with chemotherapeutic

medications exhibited more markers of mutagenic chemicals in their urine than non-exposed professionals.(**Abdel-Rahman& Ghosh, 2022).**

There is a risk of unintentional exposure to chemotherapeutic agents during several stages of handling, including transportation, unpacking, storage, administration and disposal. cytotoxic medications can cause contamination through eating, drinking, inhaling airborne powders and particles, or needle sticking. Oncology nurses may inhale particles and vapors when preparing the medicine or cleaning the affected areas. Furthermore, the skin may become contaminated when making, distributing, or disposal of hazardous chemotherapeutic medications, cleaning patient excrement, or contacting contaminated objects. **(Kadian, Kaur, & Trehan 2020).**

The National Institute for Occupational Safety and Health (NIOSH) recommends that chemotherapeutic agent exposure be prevented at both the primary and secondary levels. Primary preventative recommendations include using a special cabinet to store chemotherapy, wearing personal protective equipment when preparing and administering chemotherapy, and administering the drugs to patients via a needle-free closed system . In the secondary prevention level, there should be medical monitoring programs to assess the extent of chemotherapeutic exposure among healthcare staff. **(Sargidy et al., 2022).** To address healthcare worker safety, the Occupational Safety and Health Administration (OSHA) created a dedicated website, "Worker Safety in Healthcare: Caring for Our Carers," in 2013. OSHA covers the basic components of health and safety management programs in healthcare and discusses the role of the OHN in implementing these programs. **(Hardy, Tukayo, Afzal, & Hadi, 2021).**

Occupational health nurses are responsible for ensuring that chemotherapy medications are handled safely. To accomplish this, they can implement a variety of measures, including establishing an educational intervention program, using clear signs to identify chemotherapy drugs, providing e-reminders to remind nurses about the proper PPE to use, posting flyers in the department to explain the proper way to handle chemotherapy, and providing continuous reminders to nurses from their supervisor to follow the precautions when handling. **(Abu-Alhaija, Bakas, Shaughnessy & Miller, 2023).**

Significance of the study:

Cancer is a major public health concern in Egypt, with over 130000 new cases diagnosed each year. In 2019, Egypt used public funds to treat 324,949 patients with malignant neoplasms. Cancer care in Egypt is provided by the Ministry of Health (MoH), university hospitals, non-governmental organizations (NGOs), military and police oncology units, and the private sector. University hospitals are essential components of the healthcare system that provide cancer treatment options. **(CAPMAS, 2020).**

A study conducted among nurses at Egyptian oncology units founded that nearly 70% reported direct exposure to chemotherapy drugs during their work shifts. Despite the high prevalence of exposure, adherence to safety protocols among Egyptian nurses remains suboptimal, with only 30% consistently using personal protective equipment (PPE) when handling chemotherapy drugs**. (El-Shafei, Abou El-Atta& Ali, 2018).** Although the recommended strategies for safely handling chemotherapy are available, Egyptian nurses do not adhere to safety standards as much as they should, highlighting the need to incorporate guidelines into oncology unit training and call attention to the significance of occupational safety programs. **(Zayed, Saied, El-Sallamy, & Shehata,2019).** Therefore, the study aimed to evaluate the effect of occupational health safety program

on perception and practices of nurses exposed to chemotherapy hazards.

:**The aim of this study is**

To evaluate the effect of the occupational health safety program on perception and practices of nurses exposed to chemotherapy hazards.

Research hypothesis:

Perception and practices of the nurses at study group expected to improve after implementation of the occupational safety program more than nurses at control group.

Research design: -

Experimental study design was used in this study.

Setting: -

The study was conducted at the Tanta University Oncology Center.

Subjects:

All nurses working in the previous setting were included in this study (n=110 nurses). They were divided randomly using a simple random sample into two equal groups: Study group (n=55) and control group (n=55).

Tools for data collection:

Tool I: Structured Interview Schedule:

It included the following parts:

Part (1): Socio-demographic & occupational characteristics: consisted of the following:

Data related to socio-demographic characteristics of the studied nurses as age, sex, marital status, level of education and residence, and occupational characteristics as working experience in oncology, previous training, number of patients for whom the nurse administers chemotherapy per day, and challenges of safe handling of chemotherapy.

Part (2): knowledge of Nurses Regarding Handling of Chemotherapy:

This part was developed based on the occupational safety standards of the National Institute of Occupational Safety and Health Administration (NIOSH) and relevant literature **(Karaputa, 2022), (Polovich,2004).** It assessed nurses' knowledge regarding chemotherapy adverse effect and occupational hazards and guidelines for safety handling of chemotherapy throughout the life cycle of hazardous drug use.

Knowledge scoring framework:

Each accurate knowledge response received one mark, while incorrect answers or do not know received zero points. The scores were then totaled and converted to percentages. The overall score was classified as follows:

- High knowledge → >80% of the total score.
- Fair knowledge → 60%-80% of the total score.
- Low knowledge → <60% of the total score.

Tool II: Beliefs of the studied Nurses regarding chemotherapy occupational Health hazards based on the Health Belief Model (HBM):

This tool assessed nurses' beliefs regarding chemotherapy occupational hazards by adapting the oncology nurses' health behaviors determinants scale developed by **(Abu-Alhaija, 2021).** That is based on HBM. It assessed: **"**perceived susceptibility, perceived severity, perceived benefits, perceived barriers, perceived self-efficacy, and Cues to action of nurses" to follow safe handling guidelines.

Scoring framework:

- Each statement was evaluated on a Likert scale with five points. The nurses were given the following options: highly agree (5), agree (4), neutral (3), disagree (2), or extremely disagree (1). The scores were added for each construct, then for the six constructions, and the overall score was calculated, converted to percent score, and classed as:
- Negative beliefs < 60% of the total beliefs score.
- Positive beliefs ≥ 60% of the total beliefs score.

Tool III: Observational checklist for nurses' practices.

This tool was developed in the light of the occupational safety standards and related literature **(Power & Coyne, 2018).** It assessed

the nurse practice and skills regarding safe handling of chemotherapy throughout life cycle of chemotherapy drug use and Nurses' risky behavior that affects safe handling of chemotherapy.

Practices scoring system:

The scoring system for nurses' practices in handling chemotherapy was as follows: The item observed to be completed correctly was given a score of one, whereas the item that was not completed or completed wrongly received a score of zero. The scores of the observed elements were added together and translated to percentages. The overall score was classified as follows:

- Satisfactory practices→ ≥80%
- Unsatisfactory practices → < 80%

Methods

a) The study was approved by the Dean of the Faculty of Nursing and the Manager of Tanta University Hospital's Oncology Centre.
b) Faculty of Nursing Ethical Committee approval was granted on November 14, 2021.
c) Participants were informed about the study's objective, nature, and benefits before agreeing to participate voluntarily.
d) Participants were informed that they can withdraw from the study at any time.
e) The study did not injure or cause pain to any of the subjects.
f) Confidentiality of data and nurses' privacy was considered regarding the data collection.
g) **Developing study tools:**

- The study tools (I, II & III) were developed based on review of related literature.
- The developed tools were reviewed by the supervisors. Then interview sheet was submitted to **seven** experts in the field of Community Health Nursing &Oncology department of Tanta University Hospital for testing the face and content validity.
- Validity of the questionnaires based on experts' opinion were calculated and found to be **0.82**

A Pilot study was conducted on **ten nurses** to assess clarity, applicability and reliability of tools. To assess reliability, study tools were given to the previous 10 nurses. The reliability of sheet in total was computed:

Alpha Cronbach Reliability Analysis of the Used Tool was as follow when alpha Cronbach was >0.5:

- knowledge score was 0.845
- practices score was 0.792
- Health beliefs score was 0.813

Developing an occupational safety program:

- The data was collected with each nurse interviewed separately to collect the baseline data as a pre-intervention assessment. The pretest was collected within two months.
- Occupational program was planned according to nurses' needs determined through pre-assessment and based on literature review.
- Interactive lectures, group discussions, demonstration, and role play were used as teaching strategies.
- Audio-visual materials, real objects, PowerPoint presentations, handouts, booklets, and videos were used as teaching aids.
- **Prepare the content of the occupational health program:** The educational program consisted of the following sessions:

Session I: Program orientation and expectation. This session aimed to orient the nurses about the importance of the program, its sessions and expectation of each session, as well as introducing the pre-test.

Session II: Overview of chemotherapy occupational hazards. This session aimed to provide nurses with knowledge regarding Chemotherapy occupational health risks and occupational health safety recommendations throughout the life cycle of hazardous drug use.

Session III: Cleaning and managing of accidental exposure**.** This session aimed to provide nurses with knowledge regarding principles of cleaning contaminated equipment, linen and managing accidental exposure and spills.

Session IV: Training about safe handling of chemotherapy during administration. This session aimed to provide training to nurses as regard drug administration.

Session V: Proper using of preventive measures. This session aimed to provide training to nurses as regards proper use of PPE, cleanup of hazardous drug spills and cleaning of work surfaces.

Conducting the program:

- The program was conducted in a series five sessions. Each session was 45 minutes. Nurses were divided into groups, each group consisting of 10 nurses.
- The researcher met with all the groups in the pre-mentioned setting, this was three times per week at the morning shift.
- The two groups attended the first session, while other four sessions (2nd -5th) were given only to the study group.
- Each session started with a review of the previous session and explicit objectives for the current session.
- Each nurse in the study group received booklets.
- The control group did not get any education and was only used to assess program effectiveness. However, after termination of the program and post-test II, the researcher gave handouts and booklets for the control group to improve their knowledge and use them as a reference.

Evaluation phase: The same assessment tools were used in evaluation. The interview sheet was introduced to the studied nurses two times as follows: **(pre-test)** before implementation of the occupational safety program, and (posttest) after one-month post program implementation.

Results:

Table (1): Represents the distribution of the study and control nurses according to their socio- demographic and occupational characteristics. This table showed that the age of all the study and control groups ranged from 26-30 years, slightly less than two-thirds (63.6%) of the study group and about (70.9%) of the control group were females, the majority of the study and control groups (80% & 83.6% respectively) were married, and more than half of the study and control nurses (58.1% & 60% respectively) live in rural areas.

Moreover, all the control and study nurses graduated from Technical Institute of Nursing and all of them had five years of experience in specialty. As regards to the number of patients for whom the nurses administer chemotherapy per day less than half of the nurses (43.6% &40%) in the study and control administer chemotherapy to three to four patients every day respectively.

Concerning the previous training on chemotherapy occupational safety all the study and control nurses had **no** previous training. Regarding applying any occupational safety when dealing with chemotherapy about (43.6% & 40%) of the study and control group respectively didn't apply any safety precautions. As regards to the challenges that prevent them from handling chemotherapy drugs safely slightly less than half (41.6% & 41.8%) of the study and control nurses respectively reported lack of information on the risk of chemotherapy.

Table (2): Demonstrates the mean and standard deviation of knowledge score regarding chemotherapy hazards and safety handling guidelines of the study and control nurses throughout the study period. The table shows that in general there was a statistically significant improvement in the total mean score of all items of knowledge pre-intervention and one month after intervention as before implementation of the intervention their total mean score was (8.19±3.49), while total mean score was (46.15±10.71) one month after intervention. On the other hand, for the control group, there was no a statistically significant improvement in the mean score of all the studied items pre intervention and post intervention as their

mean score was (8.18±3.01) before implementation of the intervention and there was no a significant improvement in their knowledge mean score post intervention (8.91±3.74).

Figure (1): Shows the distribution of the study and control nurses in relation to their total knowledge score of safe dealing with chemotherapy pre and post one-month educational program. In this figure, it was clear that preprogram 12.7% of both study and control groups had good knowledge, and more than two-thirds of the study 67.3% had poor knowledge scores, while after one month of educational intervention (78.2%) of the study group had good knowledge. Regarding the control group,) 69.1% &60%) had poor knowledge scores before and after one month the implementation of the intervention respectively.

Table (3): Shows mean and standard deviation of the perceived score of the studied nurses according to the items of health belief model through the study period. Generally, it demonstrates there was a statistically significant improvement in the positive beliefs score of the study group post implementation of educational program, as the total beliefs mean was (78.4±23.47) preprogram compared with (150.1±23.21) after one month of program($p<0.001$). Contrarily, there was no a statistically significant difference in the total beliefs mean score of the control group ($p=0.533$).

Figure (2): Shows distribution of the study and control nurses according to their total scores of Health Belief Model (HBM) throughout the study period. It shows that preprogram, less than one third (30.9% & 27.3%) of both the study and control group had positive beliefs respectively. After one month of educational program more than three quarters (78.2%) of the study group showed significant increase in the positive beliefs. Regarding the control group, there was no improvement in their beliefs score post intervention.

Table (4): Represents mean and standard deviation of the studied nurses of the score of items of practice throughout the study period. It elicits that there was a statistically significant difference between pre, and after one month of the educational program among study group as the total practice mean was (21.06±5.96) preprogram compared with (103.19±20.01) after one month of program($p<0.001$). On the other hand, there was no a statistically significant difference among control group ($p =0.340$)

Figure (3): Elicits the distribution of the studied nurses according to their total score of items of practice throughout the study period. It that (70.9% & 83.6%) of both the study and control group respectively had unsatisfactory level of practice pre intervention. However, the majority (83.6%) of the nurses in the study group had satisfactory level of practice one month post implantation of educational program compared with less than one quarter (23.6%) of the control nurses had satisfactory level of practice.

Table (5): Shows correlation between total score of knowledge, health beliefs, practice of study and control nurses about chemotherapy occupational hazards and its preventive measures pre and post program. The table illustrated that, there was a statistically significant positive correlation between the total knowledge, belief and practice scores pre and one month post program for both the study and control groups ($p< 0.05$). This suggests that a higher practice score was linked to higher knowledge scores and positive beliefs.

Table (1): Distribution of the study and control nurses in relation to their socio-demographic & occupational characteristics.

Socio-demographic & Occupational data	Study (N=55)		Control (N=55)		Chi-square	
	N	%	N	%	X^2	P-value
socio demographic data						
Age (years)						
26-30	55	100	55	100	0.000	1.000
Sex						
Female	35	63.6	39	70.9	0.661	0.416
Male	20	36.4	16	29.1		
Marital status						
Single	11	20	9	16.4	0.244	0.621
married	44	80	46	83.6		
Residence						
Rural	32	58.1	33	60	0.897	0.523
Urban	23	41.9	22	40.0		
Educational level						
technical institute of nursing	55	100	55	100	0.000	1.000
Occupational data						
years of experience in specialty.						
5 years	55	100	55	100	0.000	1.000
No of patients for whom the nurse administer chemotherapy per day						
3-4	24	43.6	22	40.0	0.379	0.828
5-6	16	29.1	19	34.5		
7	15	27.3	14	25.5		
previous training on chemotherapy occupational safety						
No	55	100	55	100	0.000	1.000
Applying any occupational safety when dealing with chemotherapy						
Completely	15	27.3	14	25.5	0.379	1.000
Partially	16	29.1	19	34.5		
Not applying	24	43.6	22	40.0		
***If no, what are the challenges that prevent following chemotherapy drugs safely**						
Increased working pressure	2	8.3	5	20.8	0.442	0.506
Lack of personal protective equipment	6	25	1	4.1	0.170	0.680
Lack of information on the risk of chemotherapy	10	41.6	13	41.8	0.344	0.558
Not feeling comfortable wearing personal protective equipment	2	8.3	2	8.3	0.236	0.429
Crowded work environment	4	16.6	1	4.1	0.170	0.369

Table (2): Mean and standard deviation of the score of knowledge regarding safe handling of chemotherapy of the study and control nurses throughout the study period.

Items of knowledge	Study		Paired t-test	Control		Paired t-test
	Pre	after one month	t P	Pre	after one month	t P
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Chemotherapy and occupational hazards resulting from	1.14±0.60	6.98±2.10	19.518 0.001*	0.82±0.32	0.96±0.57	1.588 0.115
Personal protective equipment (PPE)	3.05±1.12	10.70±2.40	22.361 0.001*	2.80±0.67	2.93±0.93	0.841 0.402
guidelines for safe handling of chemotherapy	2.18±0.94	15.84±2.16	33.288 0.001*	2.90±0.80	2.94±0.94	0.240 0.810
Daily cleaning and disinfection for tools and surfaces contaminated with chemotherapy	1.02±0.45	3.43±1.67	15.781 0.001*	0.73±0.30	0.78±0.37	0.778 0.438
guidelines for dealing with accidental exposure and spills	0.80±0.38	9.20±2.38	24.749 0.001*	1.20±0.91	1.30±0.93	0.570 0.569
Total	8.19±3.49	46.15±10.71	0.001*	8.18±3.01	8.91±3.74	0.609

** Significant at p< 0.01 (2 tailed). *Significant at p< 0.05 (2 tailed)

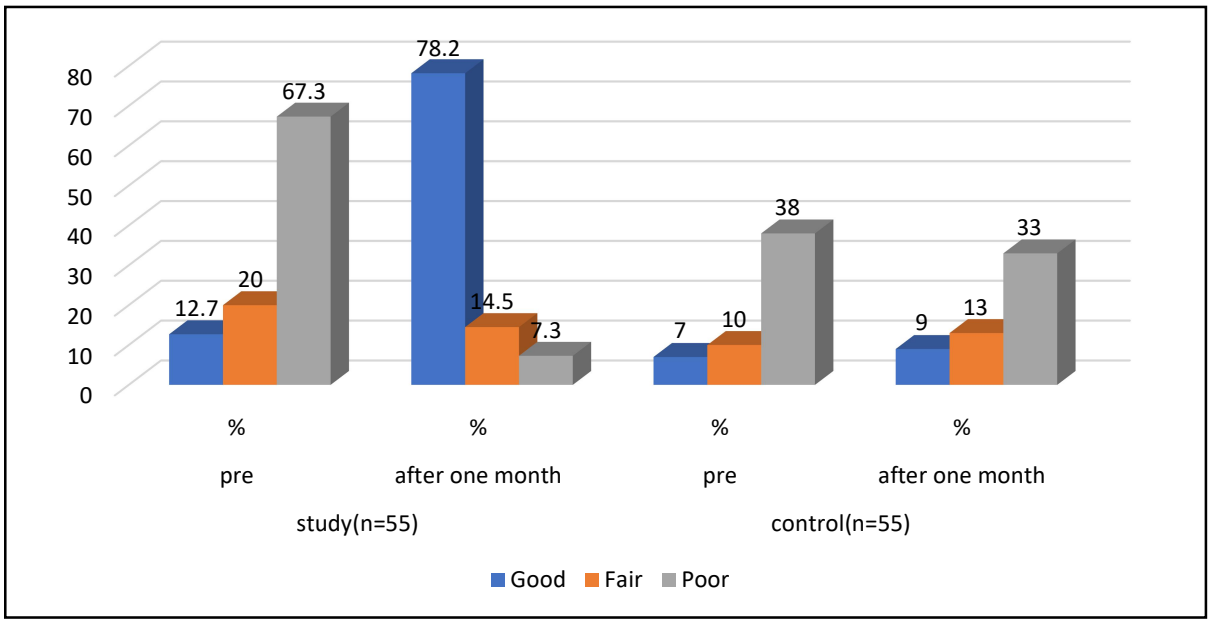

Figure (1): Distribution of the study and control nurses in relation to their total knowledge score throughout the study period.

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Table (2): Mean and standard deviation of the perceived score of the study and control nurses as regards chemotherapy occupational hazards according to the Items of health belief model scores throughout the study period

Items of beliefs	Study		Paired t-test	Control		Paired t-test
	Pre	After one month	t P	Pre	After one month	t P
Susceptibility	9.25±3.64	18.3±3.31	14.025 0.001*	10.8±2.4	11.2±5.6	1.704 0.091
Severity	13.56±3.57	23.1±4.7	12.660 0.001*	12.9±3.5	13.3±6.3	0.412 0.681
Benefits	11.78±4.19	22.2±4.5	13.207 0.001*	12.2±2.3	12.9±4.7	1.276 0.205
Barriers	17.32±3.87	36.8±3.2	30.033 0.001*	16.3±2.1	16.4±5.5	1.386 0.169
self-efficacy	10.04±4.26	22.9±4.3	18.318 0.001*	11.2±3.9	11.8±3.8	1.226 0.223
Cues to action	16.45±3.94	26.7±3.2	13.844 0.001*	17±4.11	17.2±2.4	1.402 0.164
Total	78.4±23.47	150.1±23.21	0.001*	80.40±18.31	82.80±28.3	0.533

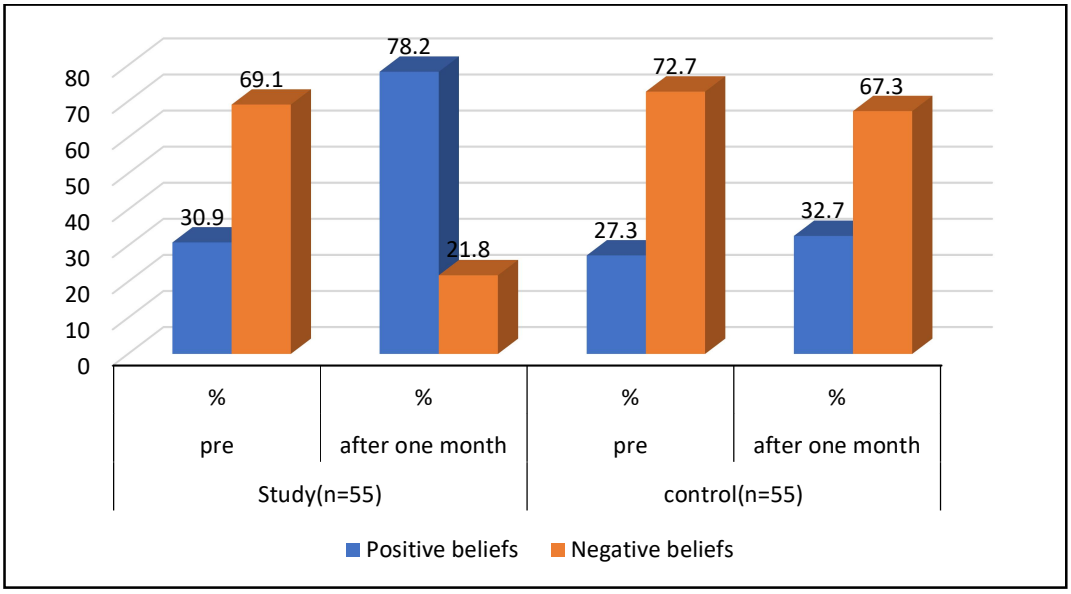

Figure (2): Distribution of the studied nurses according to their total scores of Health Belief Model (HBM) as regards chemotherapy occupational hazards throughout the study period.

Table (4) :Mean and standard deviation of the total score of items of practices regarding the safe handling of chemotherapy drugs of the studied nurses throughout the study period.

Items of practice	Study		Paired t-test	Control		Paired t-test
	Pre	After one month	P1 t P	Pre	After one month	t P
1-Handling of chemotherapy drugs waste, contaminated excreta, and contaminated bed linen.	8.86±2.13	44.17±6.75	47.666 0.001*	15.23±2.49	15.26±2.54	0.0626 0.950
2-Transportation and Administration of chemotherapy drug	4.06±0.76	27.36±2.74	46.791 0.001*	3.49±1.64	3.55±1.62	0.193 0.847
3-Cleaning and decontaminating of hazardous equipment and work surfaces	2.83±1.02	10.26±2.16	19.593 0.001*	1.74±0.84	1.76±0.86	0.123 0.902
4-Waste management	1.02±0.43	6.54±1.64	25.088 0.001*	1.31±0.65	1.43±0.75	0.897 0.372
5-Nurses risky behavior that affects safe handling of chemotherapy	9.60±2.37	1.02±0.43	26.003 0.001*	1.40±0.84	1.40±0.84	0.000 1.000
6- Dealing with spill (spill management)	3.09±1.27	15.45±3.84	29.801 0.001*	3.71±1.12	3.81±1.14	0.464 0.643
Total	21.06±5.96	103.19±20.01	0.001*	26.88±7.58	27.21±7.75	0.340

** Significant at p< 0.01 (2 tailed). *Significant at p< 0.05 (2 tailed) .

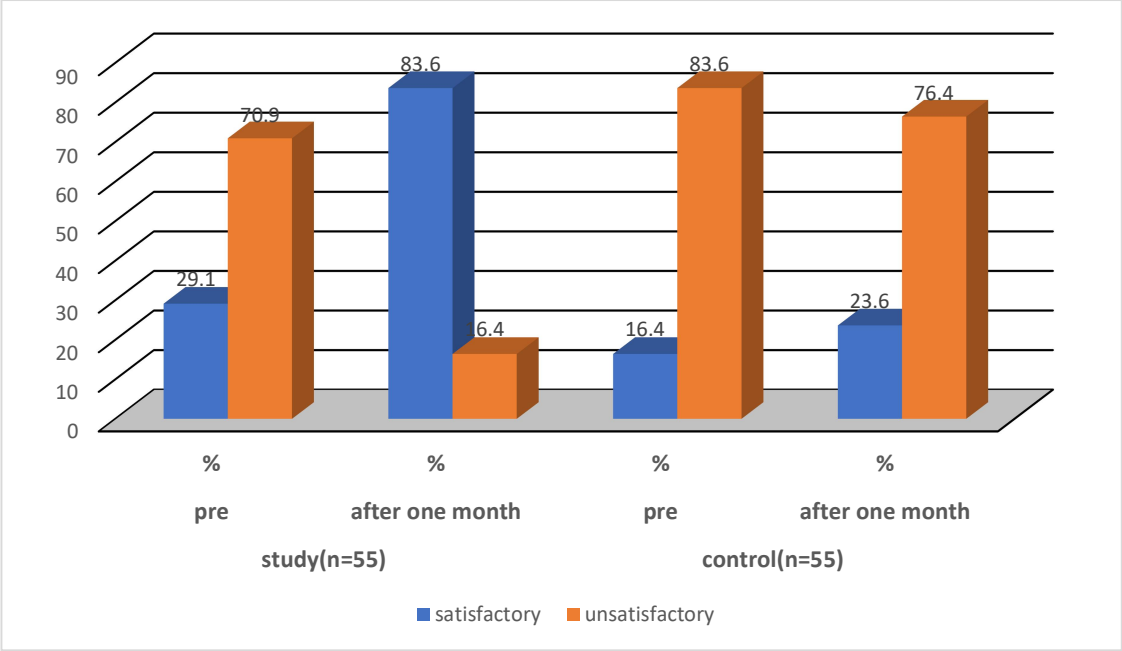

Figure (3): Distribution of the study and control nurses according to their total score of items of practice throughout the study period.

Table (5): correlation between total score of knowledge, health beliefs, practices of study and control nurses about chemotherapy occupational hazards and its preventive measures pre and post the program.

Variables	Study group (n=55)				Control group(n=55)			
	Pre-intervention		post one month		Pre-intervention		post one month	
	Knowledge score	**Practice score**	**Knowledge score**	**Practice score**	**Knowledge score**	**Practice score**	**Knowledge score**	**Practice score**
	r P	**r P**	**r P**	**r P**	**r P**	**r P**	**r P**	**r P**
Total practice score	0.725 0.001*	-------	0.507 0.001*	--------	0.231 0.004*	--------	0.230 0.004*	----------
Total belief score	0.684 0.001*	0.806 0.001*	0.753 0.001*	0.762 0.001*	0.521 0.001*	0.198 0.035*	0.395 0.001*	0.234 0.003*

** correlation is significant at p< 0.01 (2 tailed). * Correlation is significant at p< 0.05 (2 tailed)

Discussion:

Occupational exposure to chemotherapy drugs is a worldwide concern. Nurses who are exposed to chemotherapy drugs have reported acute health effects such as hair loss, skin rash, eczema, skin flush, lightheadedness, nausea, dizziness, and vomiting, and gastro intestine symptoms. Among the possible reproductive side effects experienced by exposed nurses were infertility, abortion, and abnormalities in fetuses **(Zayed et al., 2019).**

The findings of this study revealed that the age of the study and control groups ranged from 26-30 years and less than two-thirds of the study group were females, while about three-quarters of the control group were females. **(Table 1).** This result agreed with the result of a study performed by **Asefa et al. (2021)** who found that most of the participants (70.1%) were females, in the age category of 22 to 29 (63.6%).

The observed sex distribution within the study and control groups can be attributed to a broader trend in the nursing profession, where there is a globally notable predominance of female nurses compared to their male counterparts. Furthermore, establishment of the Tanta University Oncology Center in 2018 is a crucial contextual factor to consider when interpreting the age distribution of the participants, as a recent batch of graduates of the Technical Institute of Nursing were hired to work at it.

Regarding the nurses' marital status, it was found that most of the study and control nurses were married. **(Table 1).** Many studies support this result as most of their studied nurses in oncology centers were married [**Gamal et al., (2019); Abu Sharour et al., (2021); Soheili et al. (2021); Asefa et al., (2021); Sargidy et al., (2022);** & **Sayed et al., (2023)**]. Married females in the fertility age are more susceptible to health hazards related to occupational exposure to chemotherapy, such as miscarriages, infertility, and congenital abnormalities. This emphasizes the crucial role of occupational training and educational programs in empowering nurses exposed to chemotherapy

hazards, particularly during their fertile years.

Regarding the nurse's educational level, the current study revealed that all the control and study nurses graduated from Technical Institute of Nursing, and all had five years of experience on oncology and had full-time work (**Table 1**). These results are in the same line with the study **Hosen et al. (2019)** who found that, 91.7% of studied nurses had a minimum qualification i.e., diploma and nursing schools. Results of the present study may be attributed to the nature of nursing education in Egypt, as nurses' preferred technical institutes to work after two years of secondary school.

As regards to the number of patients for whom nurses administer chemotherapy per day the current study noted that less than half of the nurses in both the study and control groups administer chemotherapy to three to four patients every day respectively. Moreover, more than a quarter of them in both groups administer chemotherapy to seven patients daily. **(Table 1). Oncology Nursing Society, 2012** reported that there is no exact ratio in chemotherapy unit for nurses and the number of patients, but the accepted average ratio was 1:4 or 1:3. However, the increase in the number of patients for one nurse in the present study may lead to more occupational hazards and medication error.

Concerning the previous training on chemotherapy safety guidelines, the current study revealed that all of the study and control nurses had no previous training. **(Table 1).** These results are in the same line with the study [**Sargidy et al. (2022); Bolbol, Hassan, El-Naggar,and Zaitoun (2016**)] depicted that all of the studied nurses had no training on hazards of exposure to chemotherapy and relevant safety measure. These findings highlight the need for giving importance of baseline work training of nurses in these settings to protect them from the toxic effects of CDs

Regarding the application of safety guidelines when dealing with chemotherapy the current study showed that about two-fifths of the study and control groups didn't apply any safety guidelines and about one -thired of study and control groups reported wearing gloves or\and gown (partially applied of safety guidelines). **(Table 1).** This wasn't in the same line with a study by **Sayed, Gaber, El-Sayed, and Mohamed (2023)** reported that all the nurses didn't apply any safety guidelines about chemotherapy administration at the department of oncology. This may be due to they didn't know about these safety guidelines or they didn't receive any training on it. However, the presence of clinical pharmacists at Tanta University Oncology Center who informally give some instructions to nurses regarding the safety administration of chemotherapy explains the nurses' partial practice of safety measures.

As regards to the reported challenges that prevent nurses from handling chemotherapy drugs safely, the current study revealed that slightly less than half of the study and control nurses reported lack of information on the risk of chemotherapy (**Table 1**). The results of this study are in the same line with a study conducted by **Waheida, Abd-EL gaffar, and Atia (2015)** which indicated that 26.8% of nurses preparing and administering chemotherapy reported challenges as lack of basic information on chemotherapy handling. These results were in contrast with the study performed by **Sargidy et al. (2022)** who found that about half (53%) of the studied nurses reported that the most challenges that prevent them from handling chemotherapy drugs safely is lack of the accessibility of

PPF. This can be attributed to a lack of strict guidelines and regulations in hospitals, variations in standard guidelines, and the unavailability of in-service training and limited resources.

Concerning the Knowledge of the study and control nurses regarding chemotherapy occupational hazards and its preventive measures the current study revealed that there was a statistically significant improvement in the mean score of all items of knowledge (chemotherapy occupational hazards, PPE, safety occupational guidelines of handling chemotherapy and dealing with accidental exposure) pre-intervention, and one month after intervention for the study group ($p < 0.001$). (**Table 2).** This result is similar many studies [**Zagade, Shinde, Mohite, Pawar, and Katti (2022); AbdElrazik et al. (2018); Rayan, Adam, and Abdrabou. (2021)]** that there were highly statistically significant differences in improvement in nurse's mean knowledge scores regarding safe handling of chemotherapy in pre, and after implementing safe handling chemotherapy protocol ($p < 0.001$).This showed the positive effect of educational program that highlighted the importance of using PPF in decreasing occupational hazards of CD.

In relation to the knowledge score of the control group the current study illustrated that, there was no a statistically significant difference in the knowledge score of the control group pre- and post-implementation of the program. **(Table 2).** This highlights the importance of the educational health safety program in improving nurses' knowledge regarding chemotherapy occupational hazards.

As regards to the beliefs of the studied nurses regarding chemotherapy occupational hazards and its preventive measures based on health belief model (HBM) pre and post-intervention the current study demonstrated that there was a statistically significant positive improvement in the mean score of all HBM constructs pre intervention, and one month post intervention of the study group. On the other hand, for the control group, there was no statistically significant improvement in the mean score of all the studied items pre intervention and one month post intervention (**Table 3).**

These results are similar to the study conducted by **Hojati et al. (2023)** who found that training through mobile applications was effective, there was a significant difference between the mean score in nurses' beliefs toward the occupational hazards of chemotherapy (perceived susceptibility) and the benefits of following safety standards (perceived benefits), over time ($P < 0.001$). Also, with finding of **Ali, Arif, and Pesnani, (2015)** who demonstrated that 43.35 % of the nurses believed that PPE was not necessary while handling chemotherapy drugs (perceived barriers), 77% of the registered nurses agreed that training was important for the handling of cytotoxic drug (cues of action). This inadequate knowledge about the different contamination routes and surfaces can be linked to an inappropriate perceived risk of the nurses. Along with the present study [**Keat et al. (2013); Khan, Khowaja, and Ali (2012)]**

On the other hand, the results of the current study of nurses' beliefs toward the safe use of chemotherapeutic drugs are in contrast with the study of **Alehashem and Baniasadi (2018)** who reported that 70% of nurses had desired level of positive beliefs before implementation of educational program. These differences could be attributed to variables such as physical environment, personal characteristics, cultural environment, and measurement tools.

Concerning the Practices of the studied nurses regarding preventive measures of chemotherapy occupational hazards, the study illustrated that there was a statistically significant improvement in the mean score of all items of practice for the study group pre-intervention, and after one month of implementation of educational intervention. As for the control group there was no statistically significant improvement pre- and post-educational intervention. ($p < 0.001$). (**Table 4).** These results were in consistent with the study performed by **Abd – Elrazik et al., 2018** which reported that there were a statistically significant improvements between nurses' practices in pre- and post-two months after implementing safe handling chemotherapy protocol.

The results of the present study are also, in accordance with the study conducted by **Elshamy, El-Hadidi, El-Roby, and Fouda (2010)** reported that expelling air from syringes filled with CDs were common risky nursing behavior. In the same line, **Shrestha,2012** mentioned that there was poor use of gloves, gowns and personal protective equipment by study nurses when handling patient waste, and when cleaning up spills.

The findings of the present study may be justified by a lack of knowledge about the hazards effect of cytotoxic drugs and preventive measures that can reduce the risk of these drugs during exposure or it may be related to negligence of nurses or overwork load. However, the change of nurses practice after program implementation **(Table 4)** was due to the training that done during the practical sessions which showed actually the correct way of dealing with and the safe handling technique of cytotoxic drugs.

As regards to the correlation between total score of knowledge, health beliefs, practice of study and control nurses about chemotherapy occupational hazards and its preventive measures pre and one month post the program. The present study illustrated that there was a statistically significant positive correlation between the total knowledge, belief and practice scores pre and one month post program for both the study and control groups. **(Table 5).** This mean that increased knowledge score was associated with increased practices score and positive beliefs. These findings were similar to the study conducted by [**Sayed et al. (2023)** ; **Rayan et al. (2021)** ;**Arcanjo, Christovam, Oliveira, and da Costa, (2018)** ; **Asefa et al. (2021) ;Elbilgahy, Elwasefy, and Abd El Aziz, (2019)**] These findings may be due to the effect of occupational health safety program that increase the knowledge and awareness of nurses about chemotherapy hazards, and this was reflected positively in an increase in their beliefs and an improvement in their practices.

On the other hand, this result was in contrast with a study conducted by **Sayed et al. (2023)** who found that there was statistically no significant relation between nurses' knowledge and beliefs and attitude. Also, **Zayed et al. (2019)** who reported that there was no significant correlation between knowledge and practice or between attitude and practice. The disagreement may be due to the lack of training that could influence both knowledge and practices.

In the current study, there was a positive impact of knowledge regarding occupational health hazards in improving nurse total practices score. This finding supported the hypotheses of the study, which assumed that there would be an improvement in nurse knowledge, beliefs, and practices regarding occupational health hazards after implementing the program. These results are considered satisfactory and demonstrated the

achievement of the expected outcomes of the study.

Conclusion:

The results of this study indicate a significant improvement of knowledge, beliefs and practices among nurses handling chemotherapy drugs after a series of educational sessions for the study group. Increasing the knowledge of nurses about the nature and potential hazards of chemotherapeutic drugs, as well as the in-service training on safe handling of chemotherapy drugs play an important role to improve the nurses' practice in handling these drugs safely.

Recommendations

The following suggestions are recommended based on the present findings:

1. Occupational health nurses need to periodically and continuously conduct orientation and in service training program for all newly employed nurses at oncology centers.
2. Occupational health nurses ought to schedule regular evaluations of nurses' performance. This should be done to improve the quality of their performance in handling chemotherapy drugs.
3. Occupational health nurse should provide a medical surveillance program to all health care workers who handle chemotherapy drugs, which assess and documents symptom complaints, physical findings, and laboratory values.

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