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Safe Handling of Cytotoxic Drugs: Oncology Nurses' Knowledge and Practices

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Abstract
The widespread use of cytotoxic drugs in cancer treatment has evolved the urge to nurses' safe handling of such drugs to protect themselves, and their patients as well as their organization against hazards of exposure. ***Aim of the study:*** *to assess nurses' knowledge and evaluate their practices regarding safe handling of cytotoxic drugs.* ***Research design:*** *A descriptive research design was utilized in this study.* ***Setting:*** *This study was carried out at the Oncology Unit, Alexandria Main University Hospital, Egypt.* ***Subjects****: All nurses responsible for handling of cytotoxic drugs at the above mentioned setting, were enrolled. Their number was 30 nurses.* ***Tools:*** *Two tools were developed and tested for clarity and feasibility: a-Safe Handling of Cytotoxic Drugs Structured Interview Questionnaire to assess nurses' knowledge regarding safe handling of cytotoxic drugs. b- Safe Handling of Cytotoxic Drugs: Nurses' Observational Checklist to evaluate nurses' practice regarding safe handling of cytotoxic drugs.* ***Results:*** *The mean age of the studied nurses was 38.93 ± 10.12 years old, and 73.3% of them were diploma graduates. The overall mean percent scores of nurses' knowledge and practices were poor (58.57 ± 11.15, and 36.10±10.76 respectively). Positive statistical significant correlations were elicited between nurses' overall knowledge about safe handling of cytotoxic drugs, and their overall practice where r = 0. 481*, p=0.007*.* ***Conclusion:*** *The majority of nurses had poor knowledge and practices related to safe handling of cytotoxic drugs.* ***Recommendations:*** *Pre-service and continuing education programs should be established within hospitals to enhance nurses' knowledge, and practice related to safe handling of cytotoxic drugs.*
Key words: *Cytotoxic Drugs, Safe handling, Nurses' Knowledge and Practices.*

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I. Introduction

Cancer is a drastic disease that is expected to affect more than sixteen million patients worldwide by the year 2020[1]. The rising patient number increases the use of cytotoxic drugs (CDs) [2]**.** Cytotoxic drugs sometimes known as chemotherapy, or antineoplastic drugs (ANPDs) are systemic drugs that have the potential to kill cancer cells, it can be used as curative or palliative [3]. Unfortunately, these drugs are also classified as hazardous drugs (HDs) since they interfere with normal cell division, prevent their replication or growth, and cause cell damage at low doses [3 – 6].

The Cancer Nurses Society of Australia declared that oncology nurses' role has expanded over the past two decades, and the administration of cytotoxic drugs has become a primary nurses' role [7]. In addition, the widespread use of CDs in the treatment of cancer, negatively affects nurses who administer, and handle these drugs. According to the Centers for Disease Control and Prevention "CDC" (2012), about 8 million healthcare providers in the United States are exposed to hazardous effect of cytotoxic drugs [8].

The primary sources of exposure to CDs occur through inhalation of aerosolized drug or by direct skin contact , ingestion , or contact with conjunctiva that increase the oncology nurses' risk of CDs hazards[9]. Also, Fransman et al (2004) postulated that hospital studies have reported that contaminated surfaces and equipment can transmit CDs [10]. Cytotoxic drugs' risk of exposure usually occurs during nursing activities, such as drug receiving, administration, disposal of equipments, and disposal of patient excreta [11–13].

Cytotoxic drugs are excreted from the body through fluids such as sweat, vomit, stool and urine [1]. Nurses must take precautions against patient body excretions [14, 15]. Staffs, who are handling cytotoxic or contaminated waste, should be familiar with dealing with spillages or contamination of patients or work surfaces. However, the excretion precautions must be continued 48 hour after the end of cytotoxic drugs [14].

Many authors mentioned that nurses' exposure to therapeutic doses of cytotoxic drugs has been associated with adverse outcomes; as hair loss, gastrointestinal tract (GIT) disturbances as well as allergic reactions to the skin, eyes, and mucous membranes. Also, nausea and vomiting and diarrhea may be encountered. Chronic exposure may cause anemia, and chronic liver failure [16,17,18]. In addition, nurses usually

experience adverse reproductive outcomes, including miscarriage, infertility, preterm births; and learning disabilities in offspring [18,19]. Cytotoxic drugs exposure of nurses also has been associated with DNA damage and chromosomal abnormalities [20- 22]

The toxicity of cytotoxic drugs dictates that safe handling precautions are strictly followed to eliminate such hazards [16]. Safe handling refers to the adherence of health care members to evidence- based guidelines set by national organizations over decades to eliminate workplace exposure [23]. Several guidelines have been established by many organizations to safeguard oncology nurses from CDs hazards [2,24,25].

All guidelines emphasized the importance of using closed-system transfer devices, designated personal protective equipment (PPE), and labeling CDs during preparation, administration and disposal to ensure safe handling, and reduce risk of CDs [23, 26 ,27]. Polovich (2010) mentioned that nurses must wear cuffed gowns that are resistant to permeability by hazardous drugs and face shields and/or splash goggles to protect themselves from hazards of splashes [28]. Furthermore, nurses must wash their hands before donning and after removing gloves. Gloves and /or protective clothing that become contaminated, torn or punctured must be changed as soon as possible. Although there has been an increased awareness and concern regarding the issue of safe handling of CDs, many nurses still do not follow the guidelines and procedures in the hospital settings and are not using the recommended safety equipment [29,30].

Knowledge is critical to safe nursing practices in all settings, but it is especially significant when a knowledge deficit of the nurse practices threatens personal safety or the safety of the patient [31]. Nurses are the key members to care for cancer patients, thus they must quipped with competent practice, and specialized knowledge to ensure safe and competent administration of cytotoxic drugs [23,31]. It is time for nurses to take their own knowledge, and practice related to workplace safety as seriously as the safety of the patients under their care [10, 31]. Therefore, this study was conducted to assess nurses' knowledge, and practices related to safe handling of cytotoxic drugs.

Aims of the study are:

1. To assess the nurses' knowledge regarding safe handling of cytotoxic drugs: preparation, administration and disposal.
2. To evaluate the nurses' practices regarding safe handling of cytotoxic drugs: preparation, administration and disposal.

Research questions:

1. What is the nurses' knowledge about safe handling of Cytotoxic drugs (CDs)?
2. What is the nurses' practices related to safe handling of Cytotoxic drugs (CDs)?

II. Materials

Design: A descriptive research design was used to fulfill the aims of the present study.

Setting: This study was conducted at the Oncology Unit of Alexandria Main University Hospital, Egypt.

Subjects: The participants of this study included all nurses who were involved in handling cytotoxic drugs (Equipment preparation, administration, disposal of equipment, and disposal of body fluids, and CDs spills) at the above mentioned setting.

- Participants were included in the study according to the following criteria**:** aged from 25 years to less than 60 years old; currently work at the above mentioned setting and involved in administering cytotoxic drugs for a minimum period of one year of experience; and agree to participate in the study. Their number was 30 nurses.

Tools: Two tools were developed by the researchers based on a review of the related literatures for data collection [7,8 ,9, 11,28 , 30].

Tool one: "Safe handling of cytotoxic drugs: A structured interview questionnaire". This tool was utilized to assess nurses' knowledge about safe handling of cytotoxic drugs. It comprised two parts**:**

Part I: This part included nurses' socio-demographic characteristics as: age, sex, marital status, level of education, years of experience in handling of cytotoxic drugs, average patients administering cytotoxic drugs per day, and attendance of pre- or in-service training program(s) related to safe handling of cytotoxic drugs.

Part II: This part included 35 closed ended questions to assess nurses' knowledge related to the following five parameters:

First Parameter: It included (7questions) related to PPE the nurse should use during handling of cytotoxic drugs.

Second Parameter: It included (4 questions) related to the cytotoxic drugs' nature as definition, types, actions, and adverse effects.

Third Parameter: It included (9 questions) related to the perceived cytotoxic drugs' risks.

Fourth Parameter: It included (8 questions) related to sources of exposure to cytotoxic drugs.

Fifth Parameter: It included (7 questions) related to the possible health hazards of handling cytotoxic drugs.

Scoring System:

- Nurses' levels of knowledge were scored as "one" for "Correct answer", and "zero" for "incorrect answer"
- The total score value of nurses' knowledge regarding safe handling of cytotoxic drugs ranged from zero to 35. Total nurses' knowledge score were estimated, then converted to percent score and classified as follows: "Good knowledge": >75%, "Fair knowledge": from 60 % to less than 75% and "Poor knowledge" : <60%.

Tool Two: Safe Handling of Cytotoxic Drugs: Nurses' performance Observational Checklist: This tool was used to assess nurses' practices related to the safe cytotoxic drugs' handling. This tool covered 4 main categories with 35 sub-categories related to: equipment preparations, cytotoxic drug administration, disposal of equipment, and disposal of cytotoxic body fluids & spills.

Scoring system:

- Nurses' levels of practice were scored as: "Two" for each practice "done appropriately", and "One" for "inappropriately done", and "zero" for "not done".
- The total score value of nurses' practice regarding safe handling of cytotoxic drugs ranged from zero to 70. Total nurses' practice scores were estimated, and then converted to percent score. Scores of more than 75% were considered "good practices" & scores from 60-75 % were considered "fair practice", and scores of less than 60% were considered "poor practice".

Method:

- Official permissions to carry out the study from the identified setting authorities were obtained, after explaining the purpose of the study.
- The study tools were developed based on recent review of relevant literature.
- Content and construct validity of the developed tools were ascertained by a jury of five experts in the fields of Medical Surgical Nursing, and Oncology. The necessary modifications were introduced, accordingly.
- A pilot study was conducted initially on (10%) fulfilling the inclusion criteria to test feasibility, clarity and applicability of the developed tools and necessary modifications was done accordingly. Pilot study nurses were excluded from the study sample.
- Internal consistency was used in ascertaining reliability of tool 1 (r = 0.72) and tool II (r = 0.70) using Cronbach's Alpha Coefficient Test.
- Nurses participating in the study were observed individually once, using **(Tool Two),** through concealed observation. Nurses were not made aware of when the actual observations were carried out. Each concealed observation for every nurse, lasted from the point of preparation of equipment until patients had been finished administered with their cytotoxic drugs by the nurse.
- After completing all observations, study participants were interviewed once to answer the "Safe handling of cytotoxic drugs: A Structured Interview Questionnaire using (**Tool One**) to assess their knowledge about safe handling of cytotoxic drugs individually, after explaining the purpose of the study.
- The interviews were carried out during the break hours and the answers were recorded immediately. Time of the interviews ranged from 30 to 40 minutes, for each nurse.
- Data were collected throughout a period of four months starting from beginning of May until end of August 2018.
- **Ethical considerations:** Written consents were obtained from nurses before participation in the study after explaining that the collected data would be used only for study purposes. The studied nurses were ascertained that their participation in the study is voluntary and they could withdraw from the study at any time. Confidentiality and privacy were assured.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**. (**Armonk, NY: IBM Corp**)** Qualitative data were described using number and percent. Quantitative data were described using mean, standard deviation. Significance of the obtained results was judged at the 5% level. **The used tests were:**

1 - Chi-square test: For categorical variables, to compare between different groups

2 - Monte Carlo correction: Correction for chi-square when more than 20% of the cells have expected count less than 5

3 - Pearson coefficient: To correlate between two normally distributed quantitative variables

III. Results

Table (1) Presents distribution of the studied nurses according to their socio-demographic characteristics (n=30).

The mean age of the studied nurses was 38.93 ± 10.12 years old and nearly half of them (43.3%) were within the age group 30 > 40 years. All of the studied nurses were females, and the majority of them (86.7%) were married. Nearly three quarters of the studied nurses (73.3%) were diploma graduates compared to 6.7% who were bachelor. The majority of the studied nurses (73.3%) had 10- 20 years of experience in handling of cytotoxic drugs. As evident, none of the studied nurses attended training programs related to safe handling of cytotoxic drugs.

Table (1): Distribution of the studied nurses according to their socio-demographic characteristics (n=30)

Socio-demographic characteristics	No.	%
Age		
20 > 30	4	13.3
30 > 40	13	43.3
40 > 50	7	23.3
50 – 60	6	20.0
Mean ± SD	38.93 ± 10.12	
Sex		
Male	0	0.0
Female	30	100.0
Education		
Diploma degree	22	73.3
Associate degree	6	20.0
Bachelor degree	2	6.7
Marital status		
Single	4	13.3
Married	26	86.7
Divorced/ Widow	0	0.0
Years of experience in handling of cytotoxic drugs		
< 1 year	2	6.7
1 > 5	2	6.7
5 > 10	4	13.3
10 – 20	22	73.3
Average patients administered / day		
10	11	36.7
15	13	43.3
20	6	20.0
Mean ± SD	8.93 ± 2.39	
Attendance of in- service training programs related to safe handling of cytotoxic drugs		
Yes	0	0.0
No	30	100.0

Table (2): Shows distribution of the studied nurses according to their knowledge about PPE, Cytotoxic Drugs' nature, perceived risks, source of exposure, and possible health hazards of handling cytotoxic drugs (n=30).

The table illustrates that all nurses knew the importance of hand washing, while the majority were not aware of the appropriate PPE they should use when handling CDs. The table also elicits that the majority of nurses knew meaning, types, and adverse effects of CDs (66.7%, 93.3%, and 86.7%) respectively, while 76.6% didn't know their action.

As regards Knowledge related to perceived risks of CDs, the results denote that all nurses were aware of the importance of safe handling of CDs to themselves, patients, and hospital. Also, all nurses identified that eating is prohibited in/ near CDs areas. In addition, the majority of nurses appreciated the importance of safety cabinets, and spill kits (86.7%, 80%), respectively. Also, 73.3% of the respondents knew that they should implement cytotoxic precautions during and for 48 hours post administration.

Concerning nurses' knowledge about source of exposure to CDs, the table shows that all nurses knew that CDs can enter the body via damaged skin, and contaminated food. More than three quarters of the studied nurses (86.6%) knew that CDs can be transmitted via inhalation, while 93.3% of them identified that CDs can enter the body via contaminated equipments, and during various nursing activities. The table shows that all nurses had knowledge related to allergic reactions as a hazard of CDs handling, while the majority of them didn't know the rest of CDs handling hazards.

Table (2): Distribution of the studied nurses according to their knowledge about PPE, Cytotoxic drugs' nature, Perceived risks, Source of exposure, and Possible health hazards of handling cytotoxic drugs (n=30)

Area of nurses' knowledge	Know		Don't know	
	No.	%	No.	%
Knowledge related to Personal Protective Equipment (PPE)				
- Importance of hand washing is mandatory before, after handling of CDs	30	100.0	0	0.0
- Efficacy of alcohol /soap and water in removing cytotoxic residue	0	0.0	30	100.0
- Type of gloves the nurse should wear.	2	6.7	28	93.3
- Importance of surgical mask	0	0.0	30	100.0
- All type of protective clothing provide the same level of protection	3	10.0	27	90.0
- A disposable safety gown can be re-use	7	23.3	23	76.7
- Importance of wearing goggles during handling of CDs	28	93.3	2	6.7
Knowledge related to cytotoxic drugs' nature				
- Definition of CDs.	20	66.7	10	33.3
- Action of CDs.	7	23.3	23	76.7
- Types of CDs.	28	93.3	2	6.7
- Name at least two adverse effects of CDs.	26	86.7	4	13.3
Knowledge related to perceived risks of CDs				
- Safe handling of CDs protects nurses from hazard of exposure to CDs.	30	100.0	0	0.0
- Safe handling of CDs protects patients from hazard of exposure to CDs.	30	100.0	0	0.0
- Safe handling of CDs protects the hospital from drugs particles hazards.	30	100.0	0	0.0
- The international guidelines prohibit eating in CDs areas.	30	100.0	0	0.0
- A Biological Safety Cabinet should be available in oncology unit.	26	86.7	4	13.3
- CDs / waste are labeled with "C" symbol.	26	86.7	4	13.3
- A spill kits are available in oncology unit.	24	80.0	6	20.0
- Dealing with cytotoxic spills should be done by trained staff.	28	93.3	2	6.7
- The nurse should implement cytotoxic precautions during and for 48 hours post administration.	22	73.3	8	26.7
Knowledge related to source of exposure to cytotoxic drugs				
- CDs can enter the body via inhalation / breathing of drug particles.	26	86.7	4	13.3
- Contaminated surfaces, and equipment can transmit CDs.	28	93.3	2	6.7
- Cytotoxic gas can enter the body via intact skin.	28	93.3	2	6.7
- Oral forms of CDs can be absorbed through the skin.	26	86.7	4	13.3
- Liquid CDs can be absorbed through the skin.	28	93.3	2	6.7
- CDs can enter the body via damaged skin.	30	100.0	0	0.0
- Cytotoxic particles can enter the body via contaminated food.	30	100.0	0	0.0
- CDs can enter the body during nursing activities. as changing tubes, lines or cleaning up spills.	28	93.3	2	6.7
Knowledge related to possible health hazards of handling CDs				
- Allergic reactions to mucous, eyes, skin	30	100.0	0	0.0
- Fertility problems, abortion, and abnormalities in the fetus.	4	13.3	26	86.7
- Dizziness/ light headache.	3	10.0	27	90.0
- Hair loss.	7	23.3	23	76.7
- Alteration to normal blood cell count.	12	40.0	18	60.0
- GIT distress (anorexia, nausea, vomiting).	8	26.7	22	73.3
- Cancer.	11	36.7	19	63.3

CDs= Cytotoxic Drugs

Table (3) and Fig 1. Displays distribution of the studied nurses according to their knowledge about PPE, cytotoxic drugs' nature, perceived risks, source of exposure, and possible health hazards of handling cytotoxic drugs.

The results reveal that all of the studied nurses had poor knowledge related to PPE and the majority of them (83.3%) had poor knowledge related to possible health hazards of handling cytotoxic drugs. Around two thirds of the respondents (63.3%) had fair knowledge related to cytotoxic drugs' nature with mean percent score of 67.50 ± 17.56. High percentage of the studied nurses had good knowledge about perceived risks, and source of exposure to cytotoxic drugs, with mean percent score of (91.11 ± 17.60 and 93.33 ± 16.65) respectively. The overall nurses' knowledge was poor with mean percent score of 58.57 ± 11.15.

Table (3): Distribution of the studied nurses according to their total knowledge, mean percent score about PPE, cytotoxic drugs' nature, perceived risks, source of exposure, and possible health hazards of handling cytotoxic drugs (n=30)

Areas of nurses knowledge	Good >75%		Fair 60-75%		Poor <60%		Total score	%score
	No.	%	No.	%	No.	%	Mean ± SD.	Mean ± SD.
- PPE	0	0.0	0	0.0	30	100.0	4.67 ± 1.32	33.33 ± 9.44
- Cytotoxic drugs' nature	9	30.0	19	63.3	2	6.7	5.40 ± 1.40	67.50 ± 17.56
- Perceived risks of CDs	26	86.7	0	0.0	4	13.3	16.40 ± 3.17	91.11 ± 17.60
- Source of exposure to cytotoxic drug	26	86.7	2	6.7	2	6.7	14.93 ± 2.66	93.33 ± 16.65
- Possible health hazards of handling cytotoxic drugs	3	10.0	2	6.7	25	83.3	5.0 ± 3.74	35.71 ± 26.73
Overall knowledge	3	10.0	11	36.7	16	53.3	41.0 ± 7.80	58.57 ± 11.15

CDs= Cytotoxic Drugs

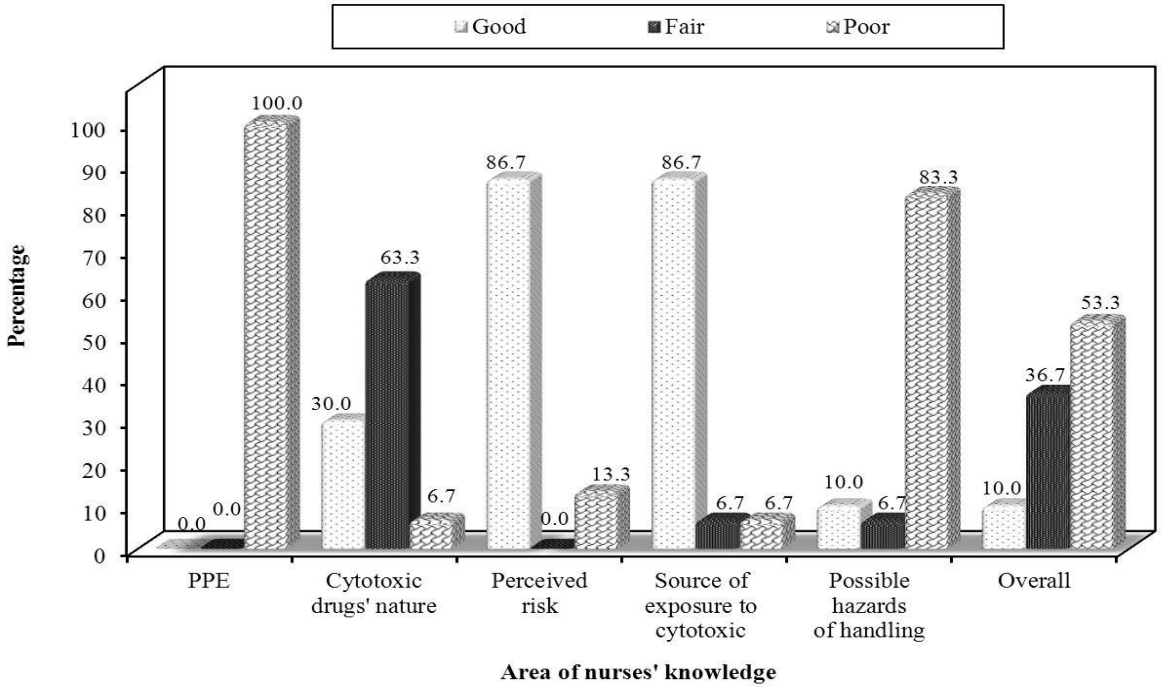

Figure (1): Distribution of the studied nurses according to their total knowledge mean percent score (n=30)

Table (4): Shows distribution of the studied nurses' practices related to safe handling of cytotoxic drugs (n=30)

As regards equipment preparations, the table displays that the majority of the studied nurses (93.3%) inappropriately prepare gloves. Also the majority to all of them didn't prepare appropriate mask or gown (93.3%, 100%) respectively.

Concerning CDs administration, it was found that, the majority of the studied nurses were inappropriately washing their hands, and inappropriately wearing gloves before drugs administration (73.3%, 93.3%) respectively. Also, the majority of them neither wore any additional PPE required for administration nor inspected CDs bag for leakage (93.3%, 60%) respectively. The table also shows that more than half of the studied nurses (53.3%) didn't remove PPE when leaving the administration area compared to one third of them 33.3% who were not changing PPE even when soiled, torn, or contaminated. In addition, all nurses performed high risk behavior at ease in / near CDs administration area.

As regards disposal of equipment, the table denotes that none of the studied nurses wore PPE, while the majority of them (80%) appropriately placed used equipment in the appropriate containers. Only 20% of the studied nurses were appropriately cleaning the work surface, chairs with detergents after administration, compared to one third, who appropriately washed their hands after procedure.

The same table illustrates that the majority of nurses neither wore appropriate PPE during disposal of cytotoxic body fluids, nor used cleaning re-agents (60% , 80%) respectively. All of the studied nurses were inappropriately cleaning the spill area and the majority of them (60%) inappropriately washed hands after spills disposal, compared to one third who didn't wash their hands at all after procedures.

Table (4): Distribution of the studied nurses' practices related to safe handling of cytotoxic drugs (n=30)

Area of nurses' practices	Not Done		Inappropriately Done		Done Appropriately	
	No.	%	No.	%	No.	%
Equipment preparations						
- Selects appropriate gloves.	2	6.7	28	93.3	0	0.0
- Selects appropriate gown.	30	100.0	0	0.0	0	0.0
- Select appropriate (N95) mask.	28	93.3	2	6.7	0	0.0
- Obtains cytotoxic waste containers.	6	20.0	10	33.3	14	46.7
- Locates spill kit and eye wash station.	20	66.7	6	20.0	4	13.3
- Receives drugs from pharmacy in labeled zip lock bags in a closed container	0	0.0	26	86.7	4	13.3
- Keeps CDs' container in Biological Safety Cabinet until time of Administration	2	6.7	26	86.7	2	6.7
Cytotoxic drugs administration						
- Washes hands	2	6.7	22	73.3	6	20.0
- Wears glove before opening drug delivery bag.	2	6.7	28	93.3	0	0.0
- Inspects CDs bag to ensure it is properly spiked, clamp is closed, line is primed and capped.	18	60.0	8	26.7	4	13.3
- Prepares to administer all CDs at chair side/bedside.	0	0.0	18	60.0	12	40.0
- Places CDs on a plastic backed absorbent pad when removed from container.	25	83.3	4	13.3	1	3.3
- Places a plastic backed absorbent pad on chair side/bedside to absorb leakage and to protect patient/staff from droplets.	24	80.0	4	13.3	2	6.7
- Wears any additional PPE (mask).	28	93.3	2	6.7	0	0.0
- Does not expel air from syringes/needleless connectors.	24	80.0	0	0.0	6	20.0
- Places gauze under injection site when administering drugs.	20	66.7	2	6.7	8	26.7
- Observes for any leakage during infusion	14	46.7	12	40.0	4	13.3
- At completion of treatment, discontinues IV bag and tubing.	0	0.0	24	80.0	6	20.0
- Avoids high risk behavior (eating, chewing gum, applying cosmetics) in / near CDs administration area.	30	100.0	0	0.0	0	0.0
- Removes PPE when leaving the CDs administration area	16	53.3	12	40.0	2	6.7
- Changes PPE regularly, when soiled, torn, contaminated	10	33.3	18	60.0	2	6.7
Disposal of equipment						
- Wears PPE.	12	40.0	18	60.0	0	0.0
- Places used equipment in appropriate containers (sharps in sharp container).	0	0.0	6	20.0	24	80.0
- Removes properly PPE and dispose in cytotoxic waste container.	12	40.0	18	60.0	0	0.0
- Washes hands thoroughly.	2	6.7	18	60.0	10	33.3
- Avoids overfilling containers.	2	6.7	12	40.0	16	53.3
- Cleans work surface, chairs with detergent after administration.	2	6.7	22	73.3	6	20.0
- Closes cytotoxic containers prior to storage and transport for incineration.	2	6.7	20	66.7	8	26.7
Disposal of cytotoxic body fluids & spills						
- Wears appropriate PPE during disposal of cytotoxic body fluids.	18	60.0	12	40.0	0	0.0
- Demarcates the area of cytotoxic spills before cleaning.	30	100.0	0	0.0	0	0.0
- Begins cleaning from outside the spill area toward the center	0	0.0	30	100	0	0.0
- Uses cleaning re-agents.	24	80.0	6	20.0	0	0.0
- Covers waste containers to protect from spillage.	24	80.0	6	20.0	0	0.0
- Collects drainage of body fluids in a closed system.	0	0.0	28	93.3	2	6.7
- Washes hands immediately with soap, water.	10	33.3	18	60.0	2	6.7

CDs= Cytotoxic Drugs

Table (5) , and Fig 2. Displays distribution of the studied nurses according to their total practice mean percent score (n=30)

It is observed that all nurses had poor practice related to equipment preparations, cytotoxic drugs administration, and disposal of cytotoxic body fluids/spills with mean percent scores of (34.76 ± 11.52, 30.95±16.84, 25.71 ± 11.80) respectively. Only one fifth of the study respondents 20% had good practice related to disposal of equipment compared to 26.7% of them with fair practice. The overall practice of the majority of nurses (93.3%) related to safe handling, and disposal of cytotoxic drugs was poor with a mean percent score of 36.10±10.76.

Table (5): Distribution of the studied nurses according to their total practice mean percent score (n=30)

Area of nurses' practice	Good >75%		Fair 60-75%		Poor <60%		Total score	% Score
	No.	%	No.	%	No.	%	Mean ± SD.	Mean ± SD.
A)Equipment preparations	0	0.0	0	0.0	30	100.0	4.87±1.61	34.76±11.52
B) Cytotoxic drugs administration	0	0.0	0	0.0	30	100.0	8.67±4.71	30.95±16.84
C) Disposal of equipment	6	20.0	8	26.7	16	53.3	8.07±2.50	57.62±17.89
D) Disposal of cytotoxic body fluids & spills	0	0.0	0	0.0	30	100	3.60 ± 1.65	25.71 ± 11.80
Overall practice	0	0.0	2	6.7	28	93.3	25.27±7.53	36.10±10.76

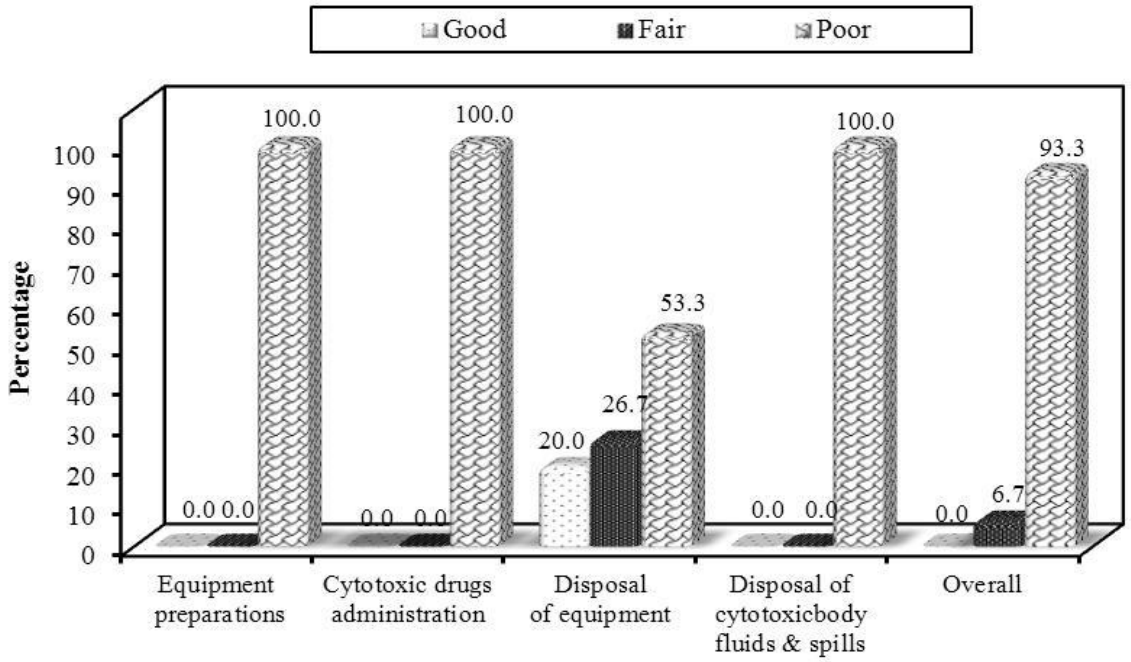

Figure (2): Distribution of the studied nurses according to their total practice mean percent score (n=30)

Table (6): Represents Pearson correlation coefficient between nurses' overall knowledge and practice scores related to safe handling of cytotoxic drugs (n=30).

Statistical positive significant correlations were identified between nurses' overall knowledge about safe handling of cytotoxic drugs, and their overall practice where r= 0. 481*, p=0.007*

Table (6): Pearson correlation coefficient between nurses' overall knowledge and practice scores related to safe handling of cytotoxic drugs (n=30).

Nurses' overall knowledge	Nurses' overall practice
58.57 ± 11.15	36.10±10.76
r (p)0.481* (0.007*)	

r: Pearson coefficient

*: Statistically significant at $p \leq 0.05$

Table (7) demonstrates relationship between nurses 'overall knowledge & practice and their socio-demographic characteristics (n = 30).

The table reveals that there were significant relationships between nurses' over all knowledge, and practice and their level of education, as nurses with bachelor degree achieved higher knowledge, and practice scores (fair) about safe handling of cytotoxic drugs, as χ^2 (^{MC}p)= 8.006* (0.049*), 11.854* (0.003*) respectively. No significant relationships were detected between nurses' knowledge, practice and their age or their years of experience in handling of cytotoxic drugs.

Table (7) Relationship between nurses 'overall knowledge & overall practice, and their socio-demographic characteristics (n = 30).

Socio-demographic data	Overall Knowledge						Overall practice			
	Good >75% (n = 3)		Fair 60 -75% (n = 11)		Poor <60% (n = 16)		Fair 60 -75% (n = 2)		Poor <60% (n = 28)	
	No.	%	No.	%	No.	%	No.	%	No.	%
Age										
20 <30	0	0.0	0	0.0	4	100.0	0	0.0	4	100.0
30 <40	1	7.7	6	46.2	6	46.2	0	0.0	13	100.0
40 <50	0	0.0	3	42.9	4	57.1	2	28.6	5	71.4
50 – 60	2	33.3	2	33.3	2	33.3	0	0.0	6	100.0
χ^2 (^{MC}p)	6.688 (0.301)						4.591 (0.100)			
Education										
Diploma	3	13.6	9	40.9	10	45.5	0	0.0	22	100.0
Associate degree	0	0.0	0	0.0	6	100.0	0	0.0	6	100.0
Bachelors	0	0.0	2	100.0	0	0.0	2	100.0	0	0.0
χ^2 (^{MC}p)	8.006* (0.049*)						11.854* (0.003*)			
Years of experience in handling of cytotoxic drugs										
<1year	0	0.0	0	0.0	2	100.0	0	0.0	2	100.0
1 – 5	0	0.0	0	0.0	2	100.0	0	0.0	2	100.0
5 – 10	0	0.0	2	50.0	2	50.0	0	0.0	4	100.0
10 – 20	3	13.6	9	40.9	10	45.5	2	9.1	20	90.9
χ^2 (^{MC}p)	4.106 (0.759)						1.621 (1.000)			

χ^2: **Chi square test** MC: **Monte Carlo**

p: p value for associated between different category

*: Statistically significant at $p \leq 0.05$

IV. Discussion

The widespread use of cytotoxic drugs (CDs) in cancer treatment has evolve the urge to nurses' safe handling of such drugs to protect themselves, their patient as well as their organizations against hazards of exposure [2, 24, 25, 31]. Thus, nurses' up to date knowledge and refined practical nursing skills are the cornerstones to improve their safe practice and to prevent the harmful effects of CDs [17].

The present study has highlighted that the overall scores of nurses' knowledge and practices related to safe handling of CDs were poor. These findings go in the same line with Rinke et al (2007) & Chaudhary and Karn (2012) , and Keat (2013),who found that their participant nurses had poor knowledge and skills related to safe handling of CDs [32 -34]. On the contrary, Esmail et al (2016) found that, nurses' overall knowledge and practices scores for safe handling of CDs were fair [31]. Also, Kyprianou et al (2010), and Shrestha (2012) found that oncology nurses' overall practice scores about the safe handling of CDs were satisfactory [35, 36].

The poor nurses' overall knowledge and practice scores in the present study could be interpreted by our findings, as none of the studied nurses had received any training programs related to safe handling of CDs, and they were not equipped with the appropriate equipment/supplies or even written protocols related to safe handling of CDs as reported by many of them. In the same line, Kubilay, and FesciErdem (1997) found that the majority of their respondents didn't receive any in-service training related to safe handling of CDs [29]. In this regard, Alehashem and Baniasadi (2018) emphasized that education, and in-service training of oncology nurses related to safe handling of CDs are important in preventing hazardous effects of these drugs [37].

Eskander et al (2013) mentioned that achieving nurses' safe practices depends on nurses' knowledge, and other organizational factors such as nurses to patients' ratio and sufficient supplies [38]. In this context, the present study elicited that the highest percentage of the studied nurses had diploma degree, who didn't receive even undergraduate education related to safe handling of CDs in their nursing school programs. In this regard, Boiano et al (2014) mentioned that in-service training and education are imperative for nurses who handle hazardous drugs to minimize their exposure [39]. Mohans et al (2005), Ben-Ami (2001) and Crannell (2012) stated that increasing the knowledge level of the nurses is important to improve their adherence to the safe handling guidelines [40- 42]. Furthermore, Alehashem, & Baniasadi, (2018) stated that working in high risk areas as oncology units without in-service training is unsafe for nurses particularly at early stage of their career[37].

Boiano et al (2014) mentioned that safe handling guidelines related to the appropriate PPE used when handling CDs should include: double CDs gloves, non-absorbent gowns and eye/face protection [39]. It was alarming that the majority of the studied nurses in the present study had poor knowledge related to the appropriate PPE they should wear. This could be due to nurses' underestimation of the significance of PPE, lack of time, limited resources and insufficient in-service training programs. Similar findings were emphasized in many similar studies [43, 44, 45]. This however is in contrast to the results of Leon and Pase (2004) who indicated that the majority of their studied nurses took precautions during CDs procedures in their study [46].

Although, all of the studied nurses had good knowledge related to the importance of hand hygiene, the majority of them performed hand hygiene inappropriately. Nurses attributed their poor practice of hand hygiene, to high work load, and difficulty of frequent hand washings after each intervention. This result is in line with Kim et al (2003), and Smith & Kagan (2005) who reported reduced nurses' compliance with appropriate hand hygiene, and added that clinicians are not always compliant in washing their hand before and after patients contact in spite of its importance in prevention of infection [47, 48]. Furthermore, Bayoumy (2016) found that their respondent nurses were washing their hand only if contaminated with blood and before eating [49]. On the other hand, Kosgeroglu et al (2006) had found higher rates of hand washing, compared to other personal protective measures, as hand washing is an easy procedure, and requires no equipment [17].

In addition, the present study results revealed that the majority of the studied nurses didn't wear gloves, during administrating, or disposing of cytotoxic body fluids. Also, none of the studied nurses wore PPE during disposal of equipment, and more than half of them didn't remove PPE when leaving the administration area. This could be related to the high workload, as the majority of the studied nurses had 10 -15 patients administering CDs per day. In this regard, Ovayolu et al (2003), and Turk et al (2004) reported that the higher the nurse to patient ratio, the lower the nurses' use of PPE during CDs handling [50, 51]. Most of the studied nurses reported that PPE are uncomfortable to wear, and the appropriate PPE /spill kits are not available in their practice area. Similar findings were reported by Boiano et al (2015) [39]. This result is in harmony with a study carried out by Rizalar et al (2012), and Esmail et al (2016) who reported that none of their respondent nurses used the appropriate protective equipment during handling and administering of CDs[1,31]. Chaudhary &Karn (2012), however found that their nurses' usage of personal protective equipment during CDs therapy preparation in their study were satisfactory [33].

The present study showed that the majority of the studied nurses had poor knowledge about possible hazards of handling CDs. In this regard, Kosgeroglu et al (2006) emphasized that nurses should have satisfactory level of knowledge related to handling CDs, which can prevent the potential harmful effects of these agents [17]. In addition, many studies showed that the cytotoxic hazardous effect is increased by frequent exposures to the secretions and metabolic products of patients [14, 15, 52]. Interestingly, Connor and Mc Diarmid, (2006) demonstrated that, nurses involved in handling CDs had higher indicators of mutagenic substances in their urine compared with nurses in other areas[2].

In addition, the present study findings elicited that the majority of the studied nurses had good knowledge about perceived risks to CDs exposure, and sources of exposure to cytotoxic drugs. Similar findings were reported by Rai et al (2015) who found that the majority of their respondent nurses were aware of the main source of cytotoxic drug exposure [23]. Surprisingly, the present study findings denoted that all nurses consumed food, drank, chewed gum in / near CDs administration area(s) in spite of their good knowledge related to those high risk behaviors. This could be related to the unavailability of special room for CDs preparation in the practice unit. Similar findings were reported by Ben- Ami et al (2001) and Türk et al (2004) who found that the majority of their respondent nurses stored food, beverages, and ate, drank, chewed gum in the CDs handling area [41,51]. No doubt, food / beverages could be contaminated with airborne particles of CDs if prepared, stored, or consumed in working areas [31].

However, the present study revealed that there were statistical significant positive correlations between nurses' overall knowledge and practice, which proves that nurses' poor practice is due to their poor knowledge. In this context, Bolbol et al (2016) , and Alehashem (2018) reported that there has been positive significant correlation between change of knowledge and change of practice, as knowledge improved, practice improved [53,37].

The current study revealed that there were significant relationships between nurses' over all knowledge, overall practice and their level of education, as nurses with bachelor degree achieved higher knowledge, and higher practice scores (fair) about safe handling of CDs. In this context, Deghidi and Growder (2010) reported that education alters perception, increases awareness, and knowledge, and consequently changes work practice [54]. Also, the present study revealed that no significant relationships were detected between nurses' knowledge, and practice and their age or their years of experience in handling of cytotoxic drugs. In agreement with the current results, Bolbl (2016) found that socio-demographic characteristics had no role in improvement of knowledge nor practice of nurses related to handling of CDs [53]. Also Fahimi et al (2008) found no significant relationships between the rate of errors and age of nurses, years of experience and marital status [55].

V. Conclusion

Based on the finding of the present study, it can be concluded that the overall nurses' knowledge and practices about safe handling of cytotoxic drugs were poor. However, the present study revealed that there were statistical positive significant correlations between nurses' overall knowledge and practice, which proves that nurses' poor practice is due to their poor knowledge. Therefore, efforts are needed to improve the poor nurses' knowledge, and practices related to safe handling of CDs.

Recommendations

- Pre- and in-service training programs should be established within oncology settings to enhance nurses' practice related to safe handling of CDs.
- Introduction of topics, related to safe handling of cytotoxic drugs, should be more articulated to undergraduate nursing courses, including diploma, and bachelor programs.
- Upgrading the current systems of supervision and evaluation of nurses' performance in practice area, to ensure higher levels of practice related to safe handling of CDs practices, is highly advocated.
- Provision of standards and procedure manuals on safe handling of CDs at oncology units is mandatory.
- Further studies related to nurses perception of barriers affecting their compliance to safe handling of CDs and suggestions for improvements, are required.

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