

Oncology Nurses' Knowledge and Practices regarding Safe Administration of Intravenous Chemotherapy

Mona Mamdouh Zakaria (1), Sanaa Mohamed Alaa (2), Gehan Mohamed Desoky (3).

(1) Clinical Instructor – Medical Surgical Nursing, Faculty of Nursing, Damanhur University, Egypt.

(2) Professor of Medical - Surgical Nursing, Faculty of Nursing, Alexandria University, Egypt.

(3) Assistant Professor of Medical - Surgical Nursing, Faculty of Nursing, Alexandria University, Egypt.

Abstract

Background: Nurses are the corner stone in cancer care and the main roles of them are safe administering the therapy, managing side effects, educating patients and their families on the adverse effects of chemotherapy, and providing emotional support to patients through the process. **Aim:** This study aimed to assess oncology nurses' knowledge and practices regarding safe administration of intravenous chemotherapy. **Design:** A descriptive research design was utilized. **Setting:** This study was conducted at Damanhur Oncology Center. **Subjects:** A convenience sample of 35 nurses. **Tools:** Tool I: Oncology Nurse's Knowledge Questionnaire. Tool II: Oncology nurse's practices regarding safe administration of intravenous chemotherapy observational checklist. **Results:** Knowledge level of more than half (60%) of the studied nurses regarding safe administration of intravenous chemotherapy was good. All the studied nurses had unsatisfactory nursing practices before and after administration of intravenous chemotherapy and the majority of them had unsatisfactory practices level regarding verification of the patient and chemotherapy, administration of intravenous chemotherapy and during the administration (82.9%, 88.6%, 94.3% respectively). There were positive statistical significant differences between nurses' knowledge and sex, working shift and attendance of training workshops about patient safety where $p = (0.022, 0.012, 0.046)$ respectively. There was positive statistical significant difference between nurses' practice mean scores and age, working department and attendance of training workshops where $p = (0.021, 0.001, 0.016)$ respectively. **Conclusion:** Nurses' knowledge and practice regarding safe administration of chemotherapy were noticed to be good knowledge and unsatisfactory practices. **Recommendation:** In- service education programs for nurses.

Keywords: chemotherapy, knowledge and practice.

Introduction:

Cancer is a disease caused by changes to genes that control the way our cells function. It is described as a proliferative, invasive, and metastatic disease (Rossi et al., 2020).

It is a major public health problem worldwide and is the second leading cause of death in the United States, according to estimates from the World Health Organization (WHO) in 2019 (Pilleron et al., 2021). In Egypt, according to Global Cancer Observatory (GCO) 2020, number of new cases of cancer is 134,632 and number of deaths due to cancer is 89,042 (Global Cancer Observatory [GCO], 2020).

Chemotherapeutic drugs (CDs) are the most widespread worldwide modality used in cancer treatment. Chemotherapy is a type of cancer treatment that uses drugs to destroy cancer cells. It works by stopping or slowing the growth of cancer cells, which grow and divide quickly. Healthy cells can also be affected by chemotherapy treatments and damage to these healthy cells cause side effects to the patient. (Na et al., 2017).

Cytotoxic drugs (CDs) are mainly used in chemotherapy for their actions on killing cancerous cells, and are known to be mutagenic, teratogenic,

and carcinogenic to humans. Direct exposure of health care providers to these drugs can occur during admixture, transport, preparation, and administration, as well as during waste handling, equipment maintenance and repair (Hanafi et al., 2015).

The goal of chemotherapy is to destroy cancer cells. Traditional chemotherapies work by killing cells that divide rapidly. But as they wipe out fast-growing cancer cells, they also can damage fast-growing healthy cells, causing damage of the cells that line the mucous membranes throughout the body, including those inside the mouth, throat, stomach, blood-forming cells in the bone marrow, hair follicles, and reproductive system (Nurgali, Jagoe & Abalo, 2018).

Also, interventions performed through venous catheterization in oncology clinics provide many advantages for the patient and health professionals but, they may cause many side effects (Pérez Fidalgo et al., 2012; Patel et al., 2014; American Cancer Society, 2020) and the registered nurses providing cancer chemotherapy care should manage these side effects in collaboration with the interdisciplinary healthcare team (Cancer Research UK, 2015; Ahmad, Reinius, Hatcher & Ajithkumar, 2016; American Society of Clinical Oncology [ASCO], 2016).

The role of the oncology nurses in the safe administration of chemotherapy has changed significantly over the past decade with regard to scope of practice, more complex treatment regimens, new chemotherapeutic and supportive care agents, and more complex health care systems. The nurses' responsibilities for chemotherapy administration require the safe and efficient administration of IV chemotherapy medications, careful patient assessment, safely preparing, administering and monitoring before, during and after administration, managing side effects, patient and family education, emotional support and proper documentation of care including the patients' response to treatment (Bayoumi, ohammed, Hassan & Abd El Monem, 2015).

Significance of the study:

Chemotherapeutic drugs are known to be potentially hazardous, due to their unique pharmacological properties that interfere with cell division (Nwagbo et al., 2017). To achieve a successful administration of IV chemotherapy, to prevent complications, and to extend the life of catheters, nurses should have adequate knowledge and competent skills on the field and should refer to evidence-based recommendations and guidelines in their practices (Cicolini et al., 2014; Kapucu et al., 2017). Nursing staff prepare and administer chemotherapeutic drugs, therefore they need more knowledge and competency in order to decrease adverse effects of the drugs to the cancer patients (Abdullah & Rasheed, 2018).

Also, nurses' knowledge is important 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 (Rai, Lama, Badu & Mandal, 2015). Lacking knowledge and training of the staff leads to fatal incidences such as overdose of chemotherapy, wrong calculations of drugs, wrong route of transfusion which sometimes results in patient's death (Waheida, Abd-ELgaffar & Atia, 2015).

Therefore, it is of utmost importance that nurses' knowledge of handling and safety measures is examined because they are at risk of exposure to the drugs during preparation and administration (Nwagbo, Ilesanmi, Ohaeri & Oluwatosin, 2017).

Aim of the Study:

The present study aimed to assess oncology nurses' knowledge and practices regarding safe administration of intravenous chemotherapy.

Research questions:

- 1- What is the oncology nurses' level of knowledge regarding safe administration of intravenous chemotherapy?
- 2- What is the oncology nurses' level of practices regarding safe administration of intravenous chemotherapy?

Materials and Method:

Research design:

A descriptive research design was utilized.

Setting:

The study was conducted at Damanhur Oncology Center in the in- patient medical unit and outpatient chemotherapy clinics.

- The in - patient medical unit (oncology department) composed of 10 rooms (5 for males and 5 for females). The bed capacity of the 10 rooms was 32 beds.
- The outpatient chemotherapy clinics (chemotherapy department) composed of 4 rooms (one for males and three for females). All rooms were occupied with 25 beds and chemotherapy infusion chairs. The chemotherapy department is working six days/week from Saturday to Thursday, starting from Nine in the morning to five in the afternoon or, until the completion of chemotherapy session to the last patient.

Subjects:

A convenience sample of thirty-five nurses.

Tools for data collection:

Tool I: "Oncology Nurse's Knowledge Questionnaire".

This tool was developed by the researcher after reviewing related literature (Khan et al., 2012; Al-Attar & Al-Gannem, 2015; Mayor, 2015; ASCO, 2016; Kapucu et al., 2017; Na et al., 2017), to assess nurse's knowledge regarding safe administration of intravenous chemotherapy and translated into Arabic language. It was divided into two parts:

Part (1): It was designed to collect socio demographic data of the studied nurses.

Part (2): It included 49 multiple choice questions, it was constructed to assess nurse's knowledge related to safe chemotherapy administration.

Scoring System:

Total score for nurses' knowledge was classified as follows:

The total nurse's knowledge score was calculated and transferred to percentage as the following:

- Scoring of < 50% was considered as "poor knowledge".
- Scoring of 50% - less than 75% was considered as "fair knowledge"
- Scoring of 75% and more was considered as "good knowledge".

Tool II: "Oncology nurse's practices regarding safe administration of intravenous chemotherapy observational checklist".

This tool was developed by the researcher based on basic nursing care derived from literatures review (Khan et al., 2012; Polovich et al., 2014; OSHA, 2016; Neuss et al., 2017; NSCA, 2017; NIOSH, 2018). To observe actual nursing care provided to cancer patient at the day of chemotherapy session before, during and after administration of chemotherapy, it composed of five parts:

Preparatory phase:

Part (1): It included (6) statements related to: safe handling of chemotherapeutic drugs for nurses, preparation of necessary equipment and patient health assessment.

Part (2): Chemotherapy verification & patient's preparation: It included (7) statements related to; verification of the consent, pre-hydration, pre-medication, checking medication rights, verification of the patient and explaining the procedure to the patient.

Implementation phase:

Part (3): Administration of intravenous chemotherapy: It included (21) statements related to; washing hands, applying personal protective equipment, initiation and infusion of chemotherapy at prescribed rate.

Part (4): During administration of the intravenous chemotherapy: It included (8) main statements related to; instructing patient to inform nurse of any discomfort or pain at the site during administration, monitoring the patient for chemotherapy side effects and monitoring the chemotherapy IV rate closely .

Part (5): After administration of the intravenous chemotherapy: It included (15) main statements regarding termination of chemotherapy session.

Scoring system:

Oncology nurse's practices were scored on 3 points likert scale as the following:

- Practices done correctly and completely = 2
- Practices done correctly and incompletely = 1
- Practices done in correctly/ not done = 0

The total nurse's practices score was calculated and transferred to percentage as the following:

- Scoring of < 75% was considered as "unsatisfactory practices."
- Scoring of 75% and more was considered as "satisfactory practices."

Method:

- Approval from ethical committee, Faculty of Nursing, Alexandria University and directors of the selected setting to take permission to carry out the study after explaining its purpose was obtained.
- The tools of the study were developed by the researcher based on review of the recent relevant literatures. Tool one was translated into Arabic language to be easily answered by nurses.
- The developed tools were submitted to a jury of 5 experts in the fields of Medical-Surgical Nursing department, Faculty of Nursing, Alexandria University and Oncology department at Damamur Oncology Center, to check its content validity, construction clarity, and completeness of items and accordingly, all necessary modifications were introduced.
- All tools (I, II) were tested for its reliability using Cronbach's Alpha statistical test. Results illustrated that, the reliability of the tool I was 0.719 related to 49 items, and for tool II it was 0.969 related to 166 items which indicated that both tools were reliable .
- A pilot study was conducted on 5 nurses, to test tools for its clarity and feasibility. Since the total number of nurses is small, the pilot study was included in the study subjects .
- For knowledge assessment regarding safe administration of intravenous chemotherapy (tool I), all nurses were asked to fill the questionnaire through face to face interviewing at the previously mentioned

setting during morning and afternoon shifts. It took from 30-45 minutes for every nurse to complete the structured questionnaire, according to their break time in their nursing room. Any clarification or instruction statements were given to all nurses during filling the questionnaire.

- The researcher observed each nurse by covert way during their implementation of care before administration of intravenous chemotherapy, during session, and immediately after therapy was received, by using tool II for three different patients, throughout the morning and afternoon shifts, to assess oncology nurses' practices regarding safe administration of intravenous chemotherapy. The average mean of the three observations was calculated and obtained.

The data were collected throughout a period of seven months from the beginning of February 2020 up to August 2020 .

- The collected data were tabulated and analyzed using the appropriate statistical tests to assess nurses' knowledge and practice regarding safe administration of intravenous chemotherapy.

Ethical considerations:

- The researcher introduced herself to the nurses and explained the purpose of the study, then assured that the study was for educational purpose only.
- Written consent for the questionnaire from each nurse and written witness consent from the head nurse, for the application of the observation checklist were obtained.
- Confidentiality of the collected data was assured.
- Participation in the research was voluntary and the right to withdraw from the study was confirmed.

Statistical analysis of the data:

- ❖ The collected data were coded and entered in a special format to be suitable for computer feeding.
- ❖ Following data entry, checking and verification process were carried out to avoid any errors.
- ❖ Data were analyzed using the statistical package for social science SPSS (Version 20).

The following statistical analysis measures were used:

- **Descriptive statistical measures** included: numbers, percentages, and averages [Minimum, Maximum, Arithmetic mean (\bar{X}), Standard deviation (SD)].
- **Statistical analysis tests** included: Chi-square, student T-test, ANOVA test and correlation.
- **Tables** of different characteristics were presented.

Graphical presentation included: Bar graphs were done for data visualization

Limitation of the study;

There were a few limitations to this study:

- The work over load on nurses' to some extent might affect the results of nurses' practice.
- The study was conducted only in one hospital on a small size of nurses, so every nurse was

observed three times on three different patients. For this reason, these findings can't be generalized to the broader community based on this study alone.

- The spread of COVID-19 had prolonged the time of data collection, because some nurses were in sick leave, so Alex University, took official decision to extend the time for all researchers at the period of COVID-19 to accomplish their theses.

Results:

Table (1): Shows that the highest percent (62.9%) of the studied nurses was female, less than half (48.6%) of them was in the age group from 20 to less than 30 years and nearly half of them (51.4%) had technical institute.

Table (2): Shows that knowledge level of more than half (60%) of the studied nurses regarding safe administration of intravenous chemotherapy was good. While (40%) of them had fair total knowledge score.

Table (3): Shows that more than half of the studied nurses didn't handle chemotherapeutic drugs nor assess patient's health correctly (54.3%, 57.1% respectively) and the highest percentage of them didn't prepare equipment, nor assess patients' psychological condition, physical examination and pain assessment correctly (62.9%, 62.9%, 77.1%, 77.1% respectively) before administration of intravenous chemotherapy. Also the table shows that minor proportion of the studied nurses verified chemotherapy consent, pre-hydration and pre-medication (8.6%, 14.3%, 14.3% respectively) and the majority of them correctly determined the sequence of the drugs, checked medication rights, verified that the full name and patient identification number on the chemotherapy drug label matched the full name and patient identification number on the patient's identification armband (77.1%, 77.1%, 71.4%).

Table (4): Shows that only one quarter of the studied nurses (25.7%) correctly washed hands, less than one quarter of them 20.0% correctly donned PPE and minor proportion of them (6.7%) correctly work over a plastic backed absorbent pad. The majority of them disinfected the selected site with

alcohol sponge, used clear dressing to ensure visualization of the access site at all times, tested vein integrity and patency, if extravasation of saline was obvious, selected another site and avoided a distal point on the same vein because of the potential for extravasation (94.3%, 97.1%, 62.9%, 77.1%, 77.1% respectively).

As well as, the table shows that all the studied nurses checked for blood return correctly, the majority of them (94.3%) instructed patient to inform her of any discomfort or pain at the site during administration of chemotherapy and less than half of them (45.7%) correctly maintained measures for environmental protection.

Table (5): Shows that all the studied nurses correctly disposed the IV chemotherapy administration set intact into the cytotoxic waste container and the highest percentage of them correctly assessed the site of insertion, used disposable square gauze and removed IV lines intact, covered the site of intravenous administration with small gauze and waterproof tape, disposed empty IV bags/infusion syringes with the administration set still attached, discarded all equipment into cytotoxic waste container and gave the patient health teaching (60.0%, 80.0%, 74.3%, 74.3%, 74.3%, 60.0%).

Table (6): Shows that Practice level of all the studied nurses was unsatisfactory before and after administration of intravenous chemotherapy .

Table (7): Shows that, there were positive statistical significant differences between nurses' knowledge and sex, working shift and attendance of training workshops about safely administration of chemotherapy. There was positive statistical significant difference between nurses' practice mean scores and age, working department and attendance of training workshops.

Table (8): Shows that, no statistical significant differences were found between nurses' practice mean scores and their knowledge levels where $p = 0.0805$.

Table (1): Frequency distribution of the studied nurses, according to their sociodemographic characteristics

Oncology nurses' sociodemographic data	No.	Total N=35
		%
Sex		
- Male.	13	37.1
- Female.	22	62.9
Age (years)		
- <20	1	2.9
- 20-	17	48.6
- 30-	14	40.0
- 40-	2	5.7
- ≥50	1	2.9
Min – Max	20-55	
Mean ± SD	21.25 ± 7.841	
Level of education		
- Diploma of Secondary School of Nursing.	9	25.7
- Diploma of Technical Institute of Nursing.	18	51.4
- Bachelor Degree of Nursing.	8	22.9
Working department		
- Oncology.	24	68.6
- Chemotherapy.	11	31.4
Working shift		
- Morning	24	68.6
- Evening	11	31.4
Years of experience		
- <5	18	51.4
- 5-	4	11.4
- 10-	2	5.7
- 15-	4	11.4
- 20-25	7	20.0
Min – Max	2-22	
Mean ± SD	9.75 ± 6.99	
Years of experience in oncology department		
- <5	12	34.3
- 5-	8	22.9
- 10-	4	11.4
- 15-	4	11.4
- 20-25	7	20.0
Min – Max	2-25	
Mean ± SD	9.87 ± 6.08	
Attendance of training workshops about oncology/ chemotherapy		
- Yes.	22	62.9
- No.	13	37.1
Forms of the training program #	N= 22	
- Cancer (definition, types, management).	10	45.5
- Administration of Chemotherapy.	20	90.9
- Resuscitation.	2	9.1
- Infection control.	2	9.1
Time of the training program		
- Before work in oncology department.	4	18.2
- During work in oncology department.	18	81.8

Multiple responses were allowed

Table (2): Frequency distribution of the nurses according to their level of knowledge & mean score regarding intravenous chemotherapy

Item	Levels of knowledge						Mean ± SD
	Poor		Fair		Good		
	No.	%	No.	%	No.	%	
Definition of chemotherapy.	11	31.4	4	11.4	20	57.1	1.257 ± 0.918
Indications for chemotherapy.	9	25.7	4	11.4	22	62.9	1.371 ± 0.877
Administration of safe intravenous chemotherapy.	3	8.6	14	40.0	18	51.4	16.28 ± 3.015
Criteria for vein selection.	1	2.9	1	2.9	33	94.3	1.914 ± 0.373
Side effects of chemotherapy:	1	2.9	11	31.4	23	65.7	18.40 ± 3.639
- Local.	6	17.1	12	34.3	17	48.6	4.457 ± 1.686
- Systemic.	2	5.7	12	34.3	21	60.0	13.94 ± 2.919
Management of common side effects.	0	0.0	8	22.9	27	77.1	22.86 ± 2.745
Chemotherapy safety measures related to nurses.	4	11.4	18	51.4	13	37.1	6.543 ± 1.559
Chemotherapy safety measures related to patients.	2	5.7	20	57.1	13	37.1	2.628 ± 1.165
Emergency treatment of the patient.	0	0.0	4	11.4	31	88.6	3.771 ± 0.645
Total knowledge level	0	0.0	14	40.0	21	60.0	75.03 ± 8.803

Table (3): Frequency distribution of the nurses according to their practices before administration of intravenous chemotherapy (mean of the three observations):

Items	Levels of Performance					
	Done in correctly/ Not done		Done correctly and incompletely		Done correctly and completely	
	No.	%	No.	%	No.	%
A- Safe handling of chemotherapeutic drugs for nurses.	19	54.3	2	5.7	14	40.0
B- Prepare the following equipment:	22	62.9	5	14.3	8	22.9
1- Personal protective equipment (PPT):	28	80.0	3	8.6	4	11.4
I. Gloves.	22	62.9	7	20.0	6	17.1
II. Gowns.	28	80.0	3	8.6	4	11.4
III. N95 mask.	35	100.0	0	0.0	0	0.0
2- Plastic backed absorbent pad.	35	100.0	0	0.0	0	0.0
3- Alcohol swabs.	35	100.0	0	0.0	0	0.0
4- 2 × 10 mL pre-filled normal saline syringes.	13	37.1	20	57.1	2	5.7
5- Water proof tape.	0	0.0	18	51.4	17	48.6
6- Pre-filled elastomeric ambulatory infusion pump.	10	28.6	0	0.0	25	71.4
7- Carrying device / pouch.	19	54.3	0	0.0	16	45.7
8- Transparent dressing.	0	0.0	0	0.0	35	100.0
9- Spill kit.	13	37.1	13	37.1	9	25.7
C- Patient health assessment:	20	57.1	2	5.7	13	37.1
I- Assess patient's past medical history.	28	80.0	3	8.6	4	11.4
II. Assess patient's present history (current status).	18	51.4	3	8.6	14	40.0
III. Check laboratory investigation.	14	40.0	0	0.0	21	60.0
D- Assess patients' psychological condition.	22	62.9	4	11.4	9	25.7
E- Physical examination:	27	77.1	3	8.6	5	14.3
1- Determine anthropometric measurements.	22	62.9	10	28.6	3	8.6
2- Examine all systems for chemotherapy side effects.	27	77.1	3	8.6	5	14.3
F- Pain assessment:	27	77.1	3	8.6	5	14.3
1- Assess cause of pain.	27	77.1	1	2.9	7	20.0
2- Assess pain characteristics.	28	80.0	3	8.6	4	11.4
3- Ask patient about aggravating and alleviating factors of pain.	22	62.9	5	14.3	8	22.9
4- Observe patient's for verbal and nonverbal reactions to pain.	28	80.0	4	11.4	3	8.6
G - Chemotherapy verification & patient's preparation						
1. Verify that the consent has been obtained.	30	85.7	2	5.7	3	8.6
2. Verify pre-hydration if ordered.	27	77.1	3	8.6	5	14.3
3. Verify pre-medication as ordered.	27	77.1	3	8.6	5	14.3
4. Determine the sequence of the drugs to be infused; vesicants, then irritants, then non-irritants, unless otherwise specified.	8	22.9	0	0.0	27	77.1
5. Check medication rights:	6	17.1	2	5.7	27	77.1
6. Verify that the full name and patient identification number on the chemotherapy drug label matches the full name and patient identification number on the patient's identification armband.	10	28.6	0	0.0	25	71.4
7. Explain the procedure to the patient.	5	14.3	14	40.0	16	45.7
8. Check medication rights:	6	17.1	2	5.7	27	77.1

Table (4): Distribution of the nurses according to their practices regarding administration of intravenous chemotherapy (mean of the three observations):

Items	Levels of Performance					
	Done in correctly/ Not done		Done correctly and incompletely		Done correctly and completely	
	No.	%	No.	%	No.	%
A. Wash hands.	23	65.7	3	8.6	9	25.7
B. Don PPE.	14	40.0	14	40.0	7	20.0
C. Work over a plastic backed absorbent pad at waist level.	16	45.7	17	48.6	2	6.7
D. Initiate port-a-Cath, CVAD or peripheral IV access as per facility policy and procedure.	18	51.4	9	25.7	8	22.9
E. If peripheral access is chosen, assess status of veins to determine vein puncture site.	9	25.7	13	37.1	13	37.1
F. Select an infusion.	5	14.3	11	31.4	19	54.3
G. Disinfect the selected site with alcohol sponge in one direction (at least 3 swabs).	0	0.0	2	5.7	33	94.3
H. Insert a cannula with only one venipuncture into a vein.	0	0.0	0	0.0	35	100.0
I. Use clear dressing to ensure visualization of the access site at all times.	1	2.9	0	0.0	34	97.1
J. Test vein integrity and patency.	0	0.0	13	37.1	22	62.9
K. If extravasation of saline is obvious, select another site.	4	11.4	4	11.4	27	77.1
L. Avoid a distal point on the same vein because of the potential for extravasation.	5	14.3	3	8.6	27	77.1
M. Monitor vital signs before initiating the chemotherapy.	1	2.9	21	60.0	13	37.1
N. Administer pre-hydration and pre-medication as ordered.	9	25.7	13	37.1	13	37.1
O. Connect chemotherapy as a secondary infusion.	11	31.4	18	51.4	6	17.1
P. Don't prime any IV line with chemotherapy drug. All IV lines are primed with a non-drug solution.	4	11.4	30	85.7	1	2.9
Q. Ensure all connections are intact, free of leaks throughout administration and taped with waterproof tape.	5	14.3	24	68.6	6	17.1
R. Check the spike connection to the bag is secure.	12	34.3	18	51.4	5	14.3
S. Infuse approximately 10-20 ml of IV fluid prior to chemotherapy to verify patency of IV access site.	15	42.9	18	51.4	2	5.7
T. Verify blood return immediately prior to initiating.	21	60.0	7	20.0	7	20.0
U. Infuse chemotherapy at prescribed rate.	2	5.7	13	37.1	20	57.1
During administration of chemotherapy.						
V. Check medication rights:	6	17.1	2	5.7	27	77.1
W. Monitor the patient for chemotherapy induced hypersensitivity reactions.	20	57.1	7	20.0	8	22.9
X. Monitor the IV rate closely.	25	71.4	10	28.6	0	0.0
Y. Ensure the drug is infusing at the required rate.	21	60.0	4	11.4	10	28.6
Z. Assess for signs and symptoms of infiltration/ extravasation at the access site.	6	17.1	8	22.9	21	60.0
AA. Check for blood return.	0	0.0	0	0.0	35	100.0
BB. Monitor tube for any kinking or obstruction.	12	34.3	8	22.9	15	42.9
CC. Maintain measures for environmental protection.	15	42.9	4	11.4	16	45.7

Table (5): Frequency distribution of the nurses according to their practices after administration of intravenous chemotherapy (mean of the three observations)

Items	Levels of Performance					
	Done in correctly/ Not done		Done correctly and incompletely		Done correctly and completely	
	No.	%	No.	%	No.	%
A. Use disposable gauze squares around syringe site.	31	88.6	0	0.0	4	11.4
B. Remove cytotoxic agent bag at waist level using disposable gauze squares and a non- touch technique.	29	82.9	6	17.1	0	0.0
C. Flush the line following chemotherapy administration and/or between drugs, with 50 mL of compatible IV solution, unless otherwise indicated.	34	97.1	1	2.9	0	0.0
D. Dispose of the IV chemotherapy administration set intact into the cytotoxic waste container.	0	0.0	0	0.0	35	100.0
E. Assess the site of insertion.	13	37.1	1	2.9	21	60.0
F. Use disposable square gauze and remove IV lines intact.	7	20.0	0	0.0	28	80.0
G. Cover the site of intravenous administration with small gauze and waterproof tape.	8	22.9	1	2.9	26	74.3
H. Dispose empty IV bags/infusion syringes with the administration set still attached.	8	22.9	1	2.9	26	74.3
I. Discard all equipment into cytotoxic waste container.	8	22.9	1	2.9	26	74.3
J. Give the patient health teaching.	14	40.0	0	0.0	21	60.0
K. Monitor vital signs.	16	45.7	0	0.0	19	54.3
L. Remove PPE (including gloves).	35	100.0	0	0.0	0	0.0
M. Discard PPE into appropriate cytotoxic waste container.	35	100.0	0	0.0	0	0.0
N. Wash hands with soap and water following administration and disposal of cytotoxic agents and related waste.	35	100.0	0	0.0	0	0.0
O. Document chemotherapy administration on the patient's chart.	29	82.9	1	2.9	5	14.3

Table (6): Frequency distribution of the nurses according to their levels of practices before, during and after administration of intravenous chemotherapy (By domains)

Items	Levels of Performance				Mean ± SD	Mean percent Score
	Unsatisfactory		Satisfactory			
	No.	%	No.	%		
1- Before administration of intravenous chemotherapy.	35	100.0	0	0.0	48.29±10.95	26.5%
2- Verification of the patient and chemotherapy.	29	82.9	6	17.1	17.97±4.026	64.2%
3- Administration of intravenous chemotherapy.	31	88.6	4	11.4	38.40±9.778	58.2%
4- During administration of chemotherapy.	33	94.3	2	5.7	29.63±8.941	52.9%
5- After administration of chemotherapy.	35	100.0	0	0.0	25.14±15.48	34.9%
Total nurses' practices	35	100.0	0	0.0	159.43±59.19	39.5%

Table (7): The relationship between the studied nurses' knowledge levels and practice mean scores regarding to their demographic characteristics

Nurses' characteristics	Knowledge				Knowledge Mean Score Mean ± SD	Test of Significance	Practice Mean Score Mean ± SD	Test of Significance
	Fair (N=14)		Good (N=21)					
Sex								
- Male.	2	15.4	11	84.6	78.46 ± 9.718	X ² = 5.221	167.38± 75.786	t=0.367
- Female.	12	54.5	10	45.5	73.00 ± 7.740	P=0.022*	154.73± 48.248	P=0.549
Age (years)								
- <20	0	0.0	1	100.0	77.00 ± 0.000	X ² = 1.877 P=0.758	84.00± 0.000	F= 3.379 P= 0.021*
- 20-	8	47.1	9	52.9	72.88 ± 8.253		172.76± 45.859	
- 30-	5	35.7	9	64.3	78.14 ± 9.130		161.50± 66.744	
- 40-	1	50.0	1	50.0	69.00 ± 12.73		107.00± 36.770	
- ≥50	0	0.0	1	100.0	78.00 ± 0.000		84.00± 0.000	
Level of education								
- Diploma of Secondary School.	4	44.4	5	55.6	76.00 ± 10.05	X ² = 0.972 P=0.615	139.22± 39.006	F= 0.923 P=0.408
- Diploma of Technical Institute.	8	44.4	10	55.6	74.06 ± 7.017		161.28± 50.311	
- Bachelor Degree of Nursing.	2	25.0	6	75.0	76.13 ± 11.67		178.00± 91.054	
Working department								
- Oncology.	9	37.5	15	62.5	74.58 ± 8.572	X ² =0.199	180.46± 57.732	t=13.058
- Chemotherapy.	5	45.5	6	54.5	76.00 ± 9.644	P=0.656	113.55± 29.473	P=0.001*
Working shift								
- Morning.	13	54.2	11	45.8	72.88 ± 9.009	X ² = 6.386	159.21± 59.316	t=0.001
- Evening.	1	9.1	10	90.9	79.73 ± 6.436	P=0.012*	159.91± 61.799	P=0.975
Years of experience								
- <5	8	44.4	10	55.6	73.11 ± 8.065	X ² = 1.154 P=0.886	174.61± 64.371	F= 0.877 P= 0.490
- 5-	1	25.0	3	75.0	77.50 ± 6.557		139.00± 64.260	
- 10-	1	50.0	1	50.0	76.50 ± 4.950		177.50± 17.678	
- 15-	2	50.0	2	50.0	74.00 ± 11.92		153.00± 24.372	
- 20-25	2	28.6	5	71.4	78.71 ± 11.21		130.57± 60.174	
Years of experience in oncology department								
- <5	7	58.3	5	41.7	75.50 ± 8.361	X ² = 3.353 P=0.501	181.33± 66.977	F= 0.863 P=0.498
- 5-	5	25.0	3	75.0	77.38 ± 5.097		152.25± 66.866	
- 10-	1	25.0	3	75.0	78.50 ± 4.655		165.00± 29.878	
- 15-	2	50.0	2	50.0	74.00 ± 11.92		153.00± 24.372	
- 20-25	2	28.6	5	71.4	78.71 ± 11.22		130.57± 60.174	
Attendance of training workshops about patient safety								
- Yes.	6	27.3	16	72.7	76.00 ± 10.92	X ² = 3.998	215.50± 79.790	t=2.537
- No.	8	61.5	5	38.5	75.42 ± 8.106	P=0.046*	153.63± 47.191	P=0.016*

X² Chi Square Test

t student t test F ANOVA test

* Statistically significant at p ≤ 0.05

Table (8): The relationship between the studied nurses' practice mean scores and their knowledge levels

Items	Practice Mean Score	Test of Significance
	Mean ± SD	
Knowledge level		
- Fair.	157.61 ± 60.863	t=0.062
- Good.	162.92 ± 58.310	P=0.805

Discussion:

Cancer incidence is dramatically rising worldwide with an expected increase reaching up to 22.2 million in 2030. Worldwide, an estimated 18.1 million new cancer cases and almost 9.9 million cancer deaths occurred in 2020 (Sung et al., 2021). Anti-cancer agents (ACAs) are used for the treatment of different types of cancer including solid tumors and hematological malignancies. They belong to different classes of medications with different mechanisms of action and different toxicity profiles (Snyder & Stringer, 2018).

Intravenous chemotherapy, which can provide rapid drug delivery to the body of cancer patients, thus initiating a rapid systemic response, is essential treatment for most cancer patients, however, intravenous chemotherapy, is a complex process requiring proper drug preparation before administration to the patients and errors occurring at any stage can lead to harmful clinical outcomes to the patients, which may cause morbidity and mortality (Na et al., 2017). So, the present study was conducted to assess oncology nurses' knowledge and practices regarding safe administration of intravenous chemotherapy .

The findings of the present study showed that, as regards to socio demographic characteristics of the studied nurses: concerning "age", less than half of the studied nurses were in the age group from 20 to less than 30 years old. This result may be interpreted by unwillingness of the older nurses to work in oncology department. These findings agree with the study done by Khalefa et al. (2018) and founded that, more than one thirds of the studied subjects were ranged between 20-29 years.

As regarding to " sex", the results of the current study revealed that the highest percentage of the studied nurses were females. This may be due to increased number of female nurses than male nurses all over the world not only in Egypt. This finding to some degree consistent with the study done by Schwappach et al. (2018) in Bern, and found that, the majority of the study participants were females .

As regarding to distribution of the nurses according to their "level of knowledge regarding intravenous chemotherapy", the results of the current study revealed that more than half of the studied nurses had good total knowledge score, regarding intravenous chemotherapy. These findings go on the same line with the study done by (Hosen et al. 2019) in chemotherapy department and found that, most of the respondents had good level of knowledge regarding chemotherapy.

As regarding to distribution of the nurses according to their "practices before administration of intravenous chemotherapy", (mean of the three observations)

concerning safe handling of chemotherapeutic drugs for nurses, more than half of the studied nurses didn't handle chemotherapeutic drugs safely. These findings go on the same line with the study done by Zayed et al. (2019) and found that, there was inadequate practice regarding safe handling of CDs.

Regarding to distribution of the nurses according to their "practices regarding chemotherapy verification & patient's preparation", the results of the current study revealed that more than three quarters of the studied nurses determined the sequence of the drugs to be infused, highest percentage of them correctly checked medication rights. This result may be due to importance of chemotherapy verification as a procedure to help in prevention of errors.

These findings to some degree matched with the study done by Wyant (2017) in Ohio State, and found more than two thirds of the study participants had satisfactory practice regarding patient preparation for chemotherapy administration.

Regarding to distribution of the nurses according to their "practices regarding administration of intravenous chemotherapy", the results of the current study revealed that the majority of the studied nurses correctly disinfected the selected site with alcohol sponge, used clear dressing to ensure visualization of the access site at all times, tested vein integrity and patency, if extravasation of saline was obvious, selected another site and avoided a distal point on the same vein because of the potential for extravasation.

These findings completely agree with the study done by El-Seadi, Maria, Ahmed, El-Hay and Seham (2020) in Tanta, Egypt and revealed that vein quality assessment among the majority of the control group and study group was good pre implementation of the protocol.

Regarding to distribution of the nurses according to their "practices during administration of intravenous chemotherapy", the results of the current study revealed that regarding to distribution of the nurses according to their "practices during administration of intravenous chemotherapy", the tables revealed that the majority of the studied nurses instructed patient to inform her of any discomfort or pain at the site during administration of chemotherapy and less than half of them correctly maintained measures for environmental protection.

These findings to some degree matched with the study done by Sarita et al. (2019), and reveals that the overall findings of the study indicated that, in majority of skill items nurses have poor performances during administration of chemotherapy

Regarding to distribution of the nurses according to their practices "after administration of intravenous chemotherapy", the result of the current study

revealed that, all the studied nurses correctly disposed the IV chemotherapy administration set intact into the cytotoxic waste container and the highest percentage of them correctly assessed the site of insertion, used disposable square gauze and removed IV lines intact, covered the site of intravenous administration with small gauze and waterproof tape, disposed empty IV bags/infusion syringes with the administration set still attached, discarded all equipment into cytotoxic waste container and gave the patient health teaching. These findings were inconsistent with the study done by Keat et al. (2013) and found poor nurses' performance related to waste disposal and decontamination after administration of cytotoxic drug .

Also regarding to distribution of the nurses according to their "levels of practices before, during and after administration of intravenous chemotherapy", the results of the current study revealed that all the studied nurses had unsatisfactory total score of nursing practices before and after administration of intravenous chemotherapy.

These findings disagree with the study done by Mun and Hwang (2020) in Korea, and reveals that, the nurses had satisfactory level of practice before and after administration of chemotherapy. These differences may be due to differences in demographic characteristics between the studied groups.

Regarding to "relationship between the studied nurses' knowledge levels and their demographic characteristics according to age", the results of the current study revealed that there were no statistical significant differences found between nurses' knowledge levels and nurses' age. These findings completely matched with the study done by Habiba, Eldin and Ibrahim (2018) in Damanhur, Egypt and revealed that, there were no statistical significant differences between the mean score of total knowledge and nurses' age also .

Regarding to "relationship between the studied nurses' knowledge levels and their demographic characteristics in accordance to level of education", the results of the current study revealed that about three quarters of the studied nurses with bachelor degree of nursing had good knowledge score. These findings may be related to the fact that the level of education of nurses had a major effect on nurse's knowledge and the amount of information she acquired, and this reflected in the clinical practice. These findings completely agree with the study done by Abu Sharour (2018) in Jordan and revealed that, more than half of the studied nurses with Bachelor of Science in Nursing had a satisfactory level of total knowledge score .

Regarding "relationship between the studied nurses' practice mean scores and their demographic characteristics", the results of the current study revealed that no statistical significant differences were found between nurses' practice mean scores and nurses' sex, level of education, years of experience and years of experience in oncology department. However, there was positive statistical significant difference between nurses' practice mean scores and age, working department and attendance of training workshops. These findings to some degree inconsistent with the study done by Achsah Merlight (2018) and revealed that, there was no significant association between practice with age and marital status. These findings may be related to the difference in socio demographic characteristics of the studied nurses.

Regarding to "relationship between the studied nurses' practice mean scores and their knowledge levels", the results of the current study revealed that no statistical significant differences were found between nurses' practice mean scores and their knowledge levels. These alarming findings reveal that nurses may not follow the best recommended practices, even if they are known and available. Also, these findings may be due to lack of supervision and work overload.

These findings completely inconsistent with the study done by Seddek (2018) in oncology units in El-Fayoum, Egypt and Nwagbo et al. (2017) in oncology unit of the University College hospital Nigeria, and revealed that, there were statistically significant relations between the nurses' level of knowledge, practice and attitude. These findings may be related to the difference in age and years of experience between the studied nurses. Finally, this study confirmed its research questions

Conclusion:

Based on the findings of current study, it can be concluded that: knowledge mean score for studied nurses regarding safe administration of intravenous chemotherapy was good, while, practice mean score was unsatisfactory. There were positive statistical significant differences between nurses' knowledge and sex, working shift and attendance of training workshops about safely administration of chemotherapy.

There was positive statistical significant difference between nurses' practice mean scores and age, working department and attendance of training workshops. No statistical significant differences were found between nurses' practices mean scores and their knowledge levels.

Recommendations

Based on the results of the current research

Recommendations for nurses:

- In- service education programs for nurses to update their knowledge and practices concerning safe administration of intravenous chemotherapy using updated manual procedure.

Recommendations for administrators:

- The hospital policy rules and regulations should be available at each hospital unit, and every nurse should be clearly oriented with them, concerning the procedure of intravenous chemotherapy administration, how to handle and how to avoid patient's complications.

Recommendations for further studies:

- Replication of the same study on a larger sample of oncology nurses in different geographical areas for evidence of the results and generalization.

References

- Abdullah, D.A.H., & Rasheed, O.H. (2018). Nursing Staff Knowledge regarding Safe Chemotherapy Administration at Oncology Center in Kirkuk City. *Kirkuk university journal for scientific studies*, 13(1), 144-155.
- Abu Sharour, L. (2018). Oncology nurses' knowledge about central line catheter: Caring, complications, and applications among cancer patients-A cross-sectional study. *Journal of vascular nursing*, 36(3), 145-148.
- Achsah Merlight, A. (2018). A study to assess the effectiveness of video assisted teaching on safety measures while handling chemotherapy drugs on knowledge, attitude and practice of nurses in selected hospital at Kanyakumari District (Doctoral Thesis). Christian College of Nursing, Neyyoor.
- Ahmed, A.E., & Jaddoue, I.A. (2016). Assessment of Nurses' Intervention toward Treatment Modalities of Oncology Unit in Baghdad Pediatric hospitals. *International Journal of Scientific and Research Publications*, 6(9), 364-368.
- Al-Attar W and Al-Gannem M. Effectiveness of the nursing educational program upon nurse's knowledge and practices concerning chemotherapy precautions. *IOSR J. Nurs. Health Sci.* 2015; 4(6):7-13.
- Alehashem M and Baniyasi S. Safe handling of anti-neoplastic drugs in the university hospitals: A descriptive survey study among oncology nurses. *Int. J. Cancer Manag.* 2018; 11(2):e6482.
- American Cancer Society. *Cancer Facts & Figures*. USA: American Cancer Society, 2019.
- American Society of Clinical Oncology [ASCO]. (2016). *Side Effects of Chemotherapy*. USA: ASCO.
- Arul P. (2016). A study to assess the effectiveness of structured teaching program for nurses administering intravenous chemotherapy, in PSG hospital, Coimbatore (Master Thesis). PSG College of Nursing, Coimbatore.
- Bayoumi, O., oammed, N., Hassan, M., & Abd El Monem, A. (2015). Prevention and Management of Chemotherapy Extravasation: Effect of Intervention Guidelines on nurses' performance. Retrieved from https://www.academia.edu/28785699/Prevention_and_Management_of_Chemotherapy_Extravasation_Effect_of_Intervention_Guidelines_on_nurses_performance. [Accessed in; Oct, 2020].
- Cancer Research UK. (2015). *Side effects of chemotherapy*. England: Cancer Research UK.
- Cicolini, G., Simonetti, V., Comparcini, D., Labeau, S., Blot, S., Pelusi, G., & Di Giovanni, P. (2014). Nurses' knowledge of evidence-based guidelines on the prevention of peripheral venous catheter-related infections: a multicentre survey. *Journal of clinical nursing*, 23(17-18), 2578-2588.
- Devi S and Sharma P. Safe Handling of Chemotherapeutic Drugs in Oncology Nursing Practice. *Int. J. Practical Nurs.* 2019; 7(1):41-47.
- El-Seadi, A.W., Maria, A.M., Ahmed, R.E., El-Hay, A., & Seham, A. (2020). Effect of Implementing a Protocol of Nursing Care on Peripheral Venous Access Complications for Patients Undergoing Chemotherapy. *Tanta Scientific Nursing Journal*, 19(1), 120-151.
- El Hosseini DM, Ghanem EA and Gamal DA. Health Hazards, Occupational safety Measures and Knowledge assessment among nurses exposed to chemotherapy drugs in Ain Shams University Hospitals,

- Egypt. *Egypt. J. Occup. Med.* 2019; 43(3):361-377.
- Global Cancer Observatory [GCO]. (2020). Egypt: Source: Globocan. Retrieved from <https://gco.iarc.fr/today/data/factsheets/populations/818-egypt-fact-sheets.pdf>. [Accessed in: July, 2021].
- Habiba, A., Eldin, Y.K.Z., & Ibrahim, E.M. (2018). Oncology nurses' knowledge and practices regarding handling hazardous drugs: developing procedure manual for safe handling Of hazardous drugs. *Drugs*, 16, 17.
- Hanafi, S., Torkamandi, H., Bagheri, S., Tavakoli, M., Hadav, N., & Javadi, M. (2015). Safe handling of cytotoxic drugs and risks of occupational exposure to nursing staffs. *Journal of Pharmaceutical Care*, 11-15.
- Hosen MS, Hasan M, Saiful Islam M, Raseduzzaman M, Tanvirul Islam M and Tazbiul Islam M. Evaluation of knowledge and practice of handling chemotherapy agents by nurses: a multi-centre studies in Bangladesh. *Int. J. Community Med. Public Health* 2019; 6:4175-4180.
- Kapucu S, Özkaraman A, Uysal N, Bağcivan G, Şeref F and Elöz A. Knowledge Level on Administration of Chemotherapy through Peripheral and Central Venous Catheter among Oncology Nurses. *Asia. Pac. J. Oncol. Nurs.* 2017; 4(1):61-68.
- Keat CH, Soaid NS, Yun CY and Sriraman M. Improving safety-related knowledge, attitude and practices of nurses handling cytotoxic anticancer drug: pharmacists' experience in a general hospital, Malaysia. *Asian Pac. J. Cancer Prev.* 2013; 14(1):69-73.
- Khalefa AA, Ismail MS and Ali FS. Assessment of Critical Care Nurse's Knowledge and Practices Regarding Care of Patients Receiving Total Parenteral Nutrition. *Med. J. Cairo Univ.* 2018; 86(5):2763-2773.
- Khan N, Khowaja KZA and Ali TS. Assessment of knowledge, skill and attitude of oncology nurses in chemotherapy administration in tertiary hospital Pakistan. *Open J. Nurs.* 2012; 2(2):97-103.
- Mayor S. (2015). Recognizing and reducing the risk of chemotherapy extravasation. *European School of Oncology. Cancer World*. Retrieved from <https://cancerworld.net/e-grandround/recognising-and-reducing-the-risk-of-chemotherapy-extravasation/>. [Accessed in: Oct, 2020]
- Mun MY and Hwang SY. Development and Evaluation of a Web-based Learning Course for Clinical Nurses: Anticancer Chemotherapy and Nursing. *Korean J. Adult Nurs.* 2020; 32(4):364-373.
- Na Z, Qiaoyuan Y, Bingham W, Qin Z, Yue C, Xin P, et al. A developed model of cancer patients participation in intravenous chemotherapy safety. *Oncotarget* 2017; 8(50):87598-87606.
- National Institute for Occupational Safety and Health [NIOSH]. Preventing Occupational Exposure to Antineoplastic and Other Hazardous Drugs in Health Care Settings. Washington, D.C.: NIOSH, 2018.
- National Strategy for Chemotherapy Administration [NSCA]. Standards and Competencies for Cancer Chemotherapy Nursing Practice. Canada: Canadian Association of Nurses in Oncology, 2017. Neuss MN, Gilmore TR, Belderson KM, Billett AL, Conti-Kalchik T, Harvey BE, et al. 2016 Updated American Society of Clinical Oncology/Oncology Nursing Society Chemotherapy Administration Safety Standards, Including Standards for Pediatric Oncology. *J. Oncol. Pract.* 2017; 12(12):1262-1271.
- Neuss, M.N., Gilmore, T.R., Belderson, K.M., Billett, A.L., Conti-Kalchik, T., Harvey, B.E., . . . & Polovich, M. (2017). 2016 Updated American Society of Clinical Oncology/Oncology Nursing Society Chemotherapy Administration Safety Standards, Including Standards for Pediatric Oncology. *Journal of oncology practice*, 12(12), 1262-1271.
- Nwagbo, S.E., Ilesanmi, R.E., Ohaeri, B.M., & Oluwatosin, A.O. (2017). Knowledge of chemotherapy and occupational safety measures among nurses in oncology units. *Journal of Clinical Sciences*, 14(3), 131-137.
- Occupational Safety and Health Administration [OSHA]. Controlling occupational exposure to hazardous drugs. Washington, DC: OSHA, 2016.
- Patel, G.S., Jain, K., Kumar, R., Strickland, A.H., Pellegrini, L., Slavotinek, J., . . . & Karapetis, C.S. (2014). Comparison of peripherally inserted central venous catheters (PICC) versus subcutaneously implanted port-chamber catheters by

- complication and cost for patients receiving chemotherapy for non-haematological malignancies. *Supportive care in cancer*, 22(1), 121-128.
- Pérez Fidalgo, J.A., García Fabregat, L., Cervantes, A., Margulies, A., Vidall, C., & Roila, F. (2012). Management of chemotherapy extravasation: ESMO-EONS Clinical Practice Guidelines. *Annals of oncology*, 23(Suppl 7), 167-173.
- Pilleron, S., Soto-Perez-de-Celis, E., Vignat, J., Ferlay, J., Soerjomataram, I., Bray, F., & Sarfati, D. (2021). Estimated global cancer incidence in the oldest adults in 2018 and projections to 2050. *International journal of cancer*, 148(3), 601-608.
- Polovich M, Olsen M and Lefebvre K. *Chemotherapy and biotherapy guidelines and recommendations for practice*. 4th ed. Pittsburgh: Oncology Nursing Society, 2014.
- Rai DKS, Lama S, Badu A and Mandal G. Impact of educational intervention on knowledge regarding safe handling of cytotoxic drugs among the nursing personnel working in BPKIHS. *Health Renaissance* 2015; 13(1):13-22.
- Rossi F, Noren H, Jove R, Beljanski V and Grinnemo KH. Differences and similarities between cancer and somatic stem cells: therapeutic implications. *Stem. Cell Res. Ther.* 2020; 11(1):489.
- Sarita D, Preksha S and Shaminder K. A study to assess the practices regarding safe handling of chemo drugs among nursing personnel. *Int. J. Curr. Res.* 2019; 11(9):6821-6827.
- Schwappach DLB, Taxis K and Pfeiffer Y. Oncology nurses' beliefs and attitudes towards the double-check of chemotherapy medications: a cross-sectional survey study. *BMC Health Serv Res* 2018; 18(1):123.
- Snyder, S., & Stringer, L. (2018). "Anticancer drug". *Encyclopedia Britannica*. Retrieved from <https://www.britannica.com/science/anticancer-drug>. [Accessed in: June, 2021].
- Waheida SM, Abd-ELgaffar SI and Atia G. Evaluation of handling practices of oncology nurses during chemotherapy preparation and administration in Menoufia oncology hospital. *Int. J. Novel Res. Healthc. Nurs.* 2015; 2(3):107-119.
- Wyant T. (2017). *Assessing the Impact of Chemotherapy Education on Practice Change for Error Prevention: A Program Evaluation (Ph.D Thesis)*. Ohio State University.
- Zayed HA, Saied SM, El-Sallamy RM and Shehata WM. Knowledge, attitudes and practices of safe handling of cytotoxic drugs among oncology nurses in tanta university hospitals. *Egypt. J. Occup. Med.* 2019; 43(1):75-92.