Effect of Preventive Measures on Oncology Nurses' Performance Regarding Tumor Lysis Syndrome

Amira Sabry Mohammed Mohammed [(1)], Samah Mahmoud Mohamed [(2)], Naglaa Abd Elkareem Moghazy Basuony [(3)]

(1) Lecturer of Medical Surgical Nursing, Faculty of Nursing, Zagazig University, Egypt,
(2) Lecturer of Medical Surgical Nursing, Faculty of Nursing, Zagazig University, Egypt
(3) Assistant Prof. of Medical Surgical Nursing, Faculty of Nursing, Zagazig University, Egypt

Abstract

Background: Tumor Lysis Syndrome (TLS) is a serious oncology emergency that happens following cancer treatment. The oncology nurses have an important role in the prevention of TLS. Insufficient nurses' knowledge and practice about preventive measures regarding TLS lead to life-threatening situations for patients. Without preventive measures, this condition will occur as a complication. So, prevention is better than treatment. ***Study aim:*** Evaluate the effect of preventive measures on oncology nurses' performance regarding tumor lysis syndrome. ***Design:*** A quasi-experimental design. ***Setting:*** Oncology department at Zagazig University Hospitals in the Al Sharkia governorate of Egypt. ***Subject:*** A convenience sample of available nurses (40), who work in the previously mentioned setting. ***Tools:*** A self-administered questionnaire to assess demographic characteristics of nurses and their knowledge about TLS and its preventive measures; observational checklists to assess nurses' practice of TLS preventive measures. ***Results:*** All nurses' knowledge and practice dimensions were improved post implementing the preventive measures program in addition to the presence of a statistically significant difference and improvement in total nurses' knowledge and practices, with the percent of improvement equal to 81.8% and 42%, respectively. ***Conclusions:*** The intervention of the preventive measures program of the nurses has a positive effect and effective role in improving their performance (knowledge and practice) regarding TLS. ***Recommendations:*** More research should be conducted with a large sample size and in different contexts to assess the impact of the program on nurses' performance and make generalizations.

Keywords: Preventive measures, Nurses' performance, Tumor Lysis Syndrome

Introduction:

In clinical practice, tumor lysis syndrome (TLS) is a common metabolic and oncologic emergency. According to **Adeyinka and Bashir (2022)**, this syndrome is common in adult cancer patients after chemotherapy. TLS usually happens shortly after chemotherapy begins, although it can also happen on its own before treatment or in conjunction with radiation therapy **(Durani & Hogan, 2020).** TLS is brought on by the breakdown (lysis) of tumor cells, which releases intracellular components into the bloodstream, including potassium, phosphate, and nucleic acids. Electrolyte abnormalities are the hallmark of this potentially fatal illness, which can result in multiple organ failure, arrhythmias, seizures, and acute kidney damage **(Rivera-Gamma & Davis, 2023).** Hyperkalaemia, hyperphosphatemia, hypocalcaemia, and hyperuricemia are all brought on by TLS. As previously indicated, these laboratory abnormalities may result in neuromuscular instability and potentially harmful repercussions **(Durfee, 2022).**

It's critical to identify tumor lysis syndrome symptoms as soon as possible. Although they may appear later, symptoms usually appear within 72 hours after beginning chemotherapy treatment **(Williams & Killeen, 2019).** Electrolyte abnormalities are the cause of a number of tumour lysis syndrome symptoms. Due to the potentially fatal cardiac arrhythmias it causes, hyperkalaemia is the most urgent worry. When hyperkalaemia is present, electrocardiogram (ECG) alterations frequently exhibit a distinctive pattern. A peaked, narrow-based T wave may be the first ECG alteration observed when potassium levels are higher than 5.5 mEq/L **(Gupta et al., 2022; Varga et al., 2019).**

Prevention is the primary line of treatment and is crucial to the management of TLS. Before beginning cytotoxic therapy, it starts with identifying the patients who are at risk and putting

preventative measures in place. Maintaining a urine output of at least three liters per day by rigorous hydration is a first preventative measure. It seems to reason that no more potassium or phosphorus should be supplied. In outpatient and inpatient settings, patients and their family members should be informed about the dangers, symptoms, and indicators of tumor lysis syndrome as well as the significance of alerting medical professionals about the illness. Encourage patients to eat a diet low in potassium and phosphate. It may be necessary to prescribe oral phosphate binders, like calcium acetate **(Webster & Kaplow, 2021).**

Additionally, prophylactic use of hypouricemic and diuretic medications. Urate oxidase and allopurinol both work well to lower serum uric acid levels. In low-risk situations, allopurinol should be administered as a preventative measure; in intermediate- to high-risk cases, urate oxidase should be used as a therapy. When treating TLS, electrolyte correction and renal replacement therapy may also be necessary **(Cheung et al., 2020).** Urine analysis is used to detect electrolyte abnormalities, namely those involving potassium, phosphate, and uric acid, in order to diagnose tumor lysis syndrome. Electrolyte replacement may be necessary for individuals based on serum blood testing. For symptomatic hypophosphatemia, some people may require ongoing renal replacement treatment **(Nelan & Prepetit, 2023).**

TLS is managed with strong fluid hydration to enhance renal function (urine output 100 mL/m2/h), phosphate binders (such as aluminium hydroxide) to treat hyperphosphatemia, and rasburicase (which oxidises uric acid) to regulate uric acid (> 450 mmol/L). As normal, hyperkalaemia should be addressed. Calcium should be used to treat hypocalcemia-related seizures or arrhythmias. Usually, a symptomatic hypocalcaemia doesn't need to be treated. Dialysis might be necessary according to **Grewal, Herrity, and Pasic (2023)**. In order to prevent further complications, intervention should be started as soon as tumor lysis syndrome is suspected. This is because spontaneous tumor lysis syndrome may be more severe than treatment-related tumor lysis syndrome, which is typically treated with antihyperuricemic medications to prevent an increase in uric acid **(Menakuru et al., 2022).**

It is recommended that nurses support patients who are capable of increasing their daily oral fluid intake to 1.5 to 2 L; usually IV hydration is given to hospitalized patients. Adults should aim to maintain a urine production of at least 3 L per day or more than 100 mL per hour in order to stay hydrated **(Matuszkiewicz- Rowinska & Malyszko, 2020).** If the patient's potassium level is low (less than 3.5 mEq/L), potassium is typically not added to the hydration. To avoid volume overload, it is essential to monitor fluid status (intake and outflow), particularly in patients with compromised cardiac or renal function **(Williams & Killeen, 2019).**

In addition, nurses should check uric acid, creatinine, and electrolytes every 6 to 8 hours subsequent to the start of cancer treatment. According to **Cheung et al. (2020),** preventive measures should also involve monitoring patient status, laboratory results, renal function, and response to prescribed medications every eight to twelve hours for intermediate-risk patients, every six to eight hours for high-risk patients, and every four to six hours for patients who present with tumor lysis syndrome.

Significance of the study:

The **National Cancer Institute (2020) predicted** that 606,520 people would die from cancer-related causes and 1,806,590 new cases would be diagnosed in the US that year. Oncologic emergencies are defined as acute occurrences that endanger the life or health of cancer patients, whether they are brought on by the cancer itself or its treatment, are one of the causes of cancer-related mortality. **In 2020, Jafari et al.,** the most frequent and potentially fatal oncologic emergency is TLS. Tumor lysis syndrome is extremely deadly, thus it's critical to identify people who are at high risk and begin early prophylactic treatment. A patient's life can be saved if the renal and metabolic disturbance linked to tumor lysis syndrome is identified quickly and treated. In the treatment of these patients, oncology nurses are essential **(Adeyinka & Bashir, 2022).** Nurses who directly care for patients should be knowledgeable of the risk factors and aftereffects of tumor lysis syndrome. Early intervention and the timely use of evidence-based care are facilitated by attentive and regular

monitoring of risk variables, patient symptoms, and test results. Patients who are at risk of developing tumor lysis syndrome must be identified right away in order to avoid and cure it. Nurses can reduce problems, enhance patient quality of life, and improve patient outcomes by using this knowledge to better manage and monitor therapies **(Rivera-Gamma & Davis, 2023).**

Aim of the study:

The current study aimed to evaluate the effect of preventive measures on oncology nurses' performance regarding tumor lysis syndrome through the following:

- Assess the nurses' level of knowledge regarding TLS preventive measures.
- Assess the nurses' level of practices regarding TLS preventive measures.
- Design and implement a preventive measures program for oncology nurses regarding tumor lysis syndrome.
- Evaluate the effect of the preventive measures program regarding TLS on the knowledge and practices of oncology nurses.

Research hypotheses:

The following research hypotheses were created to reach the study's objective:

H_1: The nurses' mean knowledge scores after intervention of preventive measures program will be higher than that of their before it.

H_2: The nurses' mean practice scores after intervention of preventive measures program will be higher than that of their before it.

H3: There is a positive effect of preventive measures program on oncology nurses' knowledge and practices regarding TLS.

Subjects and Methods:

Research design:

The research design employed in this study was quasi-experimental, involving one group and pre- and post intervention testing. The quasi-experimental study approach looks for a cause-and-effect link between the independent and dependent variables. According to **Loewen and Plonsky (2016),** the dependent variable is the one that is affected, whereas the independent variable is the one that is influencing.

Setting:

The study was conducted in oncology department at Zagazig University Hospitals in the Al Sharkia governorate of Egypt. The oncology department is located in the general internal medicine hospital at fifth floor; it has 5 rooms with 42 beds (20 for male and 22 for female).

Subjects:

A convenience sample included all available nurses (40) working in the above mentioned setting, provided direct patient care, work experience at least one year and acceptance to participate in the study.

Tools of data collection:

There were two tools used for data collection:

I: A Nurses' self-administered questionnaire: It was designed in Arabic language. It was developed by the researcher based on pertinent literature review **(Abdel-Nabey et al., 2022; Rahmani et al., 2019; Howard, Jones & Pui, 2018)**. It consists of 68 questions covered three parts as the following:

- **Part1. Demographic data of nurses:** eight close ended questions that included data on the nurses' age, sex, marital status, qualification, years of experience in oncology department, attendance of training courses about tumor lysis syndrome, hospital policy for prevention tumor lysis syndrome and availability of preventive measures guidance or booklet in their department.
- **Part2. Nurses' knowledge about TLS:** This part was focused on assess nurses' knowledge regarding tumor lysis syndrome. It was contained "25" multiple-choice questions (MCQ) such as definition, incidence rate, causes, signs and symptoms, laboratory tests, risk factors, electrolyte disturbance, fluids, nutrition, methods of treatment, and complications.
- **Part3. Nurses' knowledge about preventive measures:** It included 35 true or false questions concerned with assess nurses' knowledge regarding preventive measures of TLS, as clinical findings and risk assessment, intravenous fluids, serum electrolytes, kidney functions test, weight measurement, intake and output chart, blood tests, ECG monitoring and interpretation, food avoidance, nephrotoxic

drugs and nursing observations, and preventive measures.

Knowledge scoring system: Multiple-choice questions with four possible responses made up each knowledge item. "One" was the score value for each successful response, whereas "Zero" was the score value for the false response. The item scores were totaled, the total was divided by the number of items, and the findings were translated to percentage scores in order to get the area's mean score. Data entry and statistical analysis determined that the test's overall knowledge score was 70. The nurse's knowledge was considered satisfactory if the percent score was greater than 70% and unsatisfactory if it was less than 70%.

II: Nurses' practices observational checklists:

Eight observational checklists were used to assess the satisfactory of nurse's practical skills toward tumor lysis syndrome preventive measures such as leg measurement for swelling (8 steps), estimate jugular venous pressure (4 steps), measuring vital signs (45 steps), inserting urinary catheterization (24 steps), intravenous infusion (27 steps), electrocardiogram doing, monitoring and interpretation (20 steps), withdrawal blood sample (26 steps) and measure and record urinary output (10 steps). They adopted from **(NETTINA, 2014; Lynn & LeBon, 2011; Roberts& Hedges, 2010).**

Practice scoring system: consisted of assigning a "One" to each practice item that was observed to be correctly completed and a "Zero" to those that were not. The area's mean score was calculated by adding together the item scores for each practice area, dividing the total by the number of items. These scores were converted to percentage scores. A practice's percent score was considered satisfactory if it was above or equal to 80% and unsatisfactory if it was below 80%, according to data entry and statistical analysis. A high threshold was set because of the critical circumstance the nurse is in, which requires a very high level of experience and expertise.

III: Preventive measures program:

The researchers created it during the assessment. It was developed to update and refresh nurses' knowledge about tumor lysis syndrome and its preventive measures, in addition to improve their practice competency for it. A booklet in Arabic language is created based on expert perspectives and a review of pertinent literature (nursing textbooks, periodicals, and online resources) about TLS preventive measures. The effectiveness of the training program was evaluated by comparing the knowledge and practice of nurses before and after program.

Tools validity and reliability:

The content validity of the data collection tools was evaluated after they were presented to a panel of five experts from different nursing and medical specialities. Two medical-surgical nursing professors, two oncology professor, and one ICU specialist from Zagazig University Hospital were on the panel. These experts evaluated the instruments' applicability, thoroughness, clarity, and administration ease. Minor adjustments were made in based on the expert's advice. Using Cronbach's Alpha test, the internal consistency reliability of each tool's items was evaluated. For first tool, which measured nurses' knowledge, it was 0.80; for second tool, which measured nurses' practice for TLS preventive measures, it was 0.92.

Ethical consideration:

Prior to starting the study, a written consent was taken from the research Ethics Committee (REC) in Faculty of Nursing at Zagazig University (ID/ZU.Nur.REC://133-1/10/2023) and the dean of the faculty. Also, the directors of the study settings were consulted for formal clearance. As well, after informing participating nurses about the nature, objective, and methods of the study, an oral agreement was obtained before data collection to ensure the highest degree of collaboration and to prepare for the participants' presence. The participants were also informed that they might withdraw from the study at any time. The study was carried out under stringent confidentiality restrictions, and all nurses were assured that their data would only be used for research.

Pilot study:

A pilot study using four nurses, or 10% of the total study population, was carried out to test the tools' comprehensiveness, clarity, relevance, understanding, applicability, and ease of use. It also aimed to estimate the time needed to complete these forms. In the actual study population, nurses who took part in the pilot study were included because the tool remained unchanged.

Field work:

Three stages were used to perform the study as the following:

(1) The preparatory stage:

- The current study's data was collected from November 1st, 2023, until end of April, 2024. Six months were needed to execute the training program as one month for the preparatory phase, one month for the theoretical portion, three months for the practical portion, and one month for the post-program data gathering. During the planning stage, the researchers received all required licenses from Zagazig University Hospital and the directors of the study setting.
- The researchers visited the study settings, spoke with the directors, and explained the goal of the study and the data collection procedure to them in order to maintain their cooperation throughout the data collection process and to plan the study's schedule so that it does not conflict with the nurses' work. The researchers had already discussed the goal of the study and the data collection procedure with each nurse before inviting them to participate after informing them of their rights.
- The nurses who gave their consent were given instructions on how to complete the self-administered questionnaire, which was designed to ascertain the nurses' true understanding of tumor lysis syndrome and its preventive measures. The researchers were always on hand to answer any queries or clarify any confusion. After that, the filled-out forms were collected and their accuracy verified. This took fifteen to twenty five minute every nurse. Eight observational checklists were used to assess the nurses' practices for preventing tumor lysis syndrome, and each nurse was observed while doing their normal patient care duties.

(2) The implementation stage:

- Following the assessment phase, the researchers transformed the needs they had found into goals and then developed the training curriculum based on the goals of the study, the nurses' educational backgrounds, and their previously assessed proficiency. Its objective was to improve and modernize nurses' understanding of and approach to tumor lysis syndrome prevention.
- According to the most recent and updated guidelines for tumor lysis syndrome preventive measures published by **Memorial Sloan Kettering Cancer Centre (2022) and Jones et al. & British Committee for Standards in Haematology (2015)**, as well as expert recommendations and evaluations and reviews of relevant literature (nursing books, publications, and online resources), the training program was developed as a booklet in an easy-to-understand Arabic language. Each study participant then received a copy of the booklet.
- The researchers worked with nurses to organize the theoretical and practical component of the program's training sessions. The nurses were divided into eight smaller groups, each with five nurses, because it was not possible to gather them all at once. Three days a week, the researchers were available during the morning and afternoon shifts. The training program was carried out by researchers over the course of "16" instructional sessions (six for the theoretical portion and ten for the practical portion), as follows:
- ***The theoretical part*** was implemented over the course of six sessions, which coated two sections, *the first section* covered tumor lysis syndrome (introduction about TLS, definition and its risk assessment, risk factors, signs and symptoms, occurrence, electrolyte imbalances, complications, fluid intake, nutrition, blood tests, indicators for dialysis and ICU admission, methods of treatment, health education and follow up); *The second section* covered preventive measures for TLS (clinical findings and risk assessment, amount of intravenous fluids, serum electrolytes, kidney functions test, weight measurement, intake and output chart, blood tests, ECG monitoring and interpretation, food avoidance, nephrotoxic drugs, prophylaxis drugs and nursing observations, and preventive measures). The duration of each session ranged from 35 to 45 minute.
- ***The practical part*** contained the leg measurement for swelling, jugular venous pressure estimation, measuring vital signs, inserting urinary catheterization, intravenous infusion, electrocardiogram doing, monitoring and interpretation, withdrawal blood sample,

measure and record urinary output. Every practical session lasts 60 minute, and it usually starts with a summary of the topics discussed in the earlier sessions and the objectives of the one that will follow. Praising and/or acknowledging the interested nurses were one way to encourage them during the training program's execution.

- The training program was conducted via a presentation, group discussion, role-playing, demonstration, and re-demonstration of the many prior practical abilities. A variety of instructional resources were included as a brochures, posters, colored handouts, audiovisual materials, and real equipments to help in demonstration the practical part of program.

(3) The evaluation stage:

- The training program's effect on nurses' performance in terms of tumor lysis syndrome prevention measures was evaluated by a post-test that was administered using the identical pretest instruments or forms. To measure a training program's effectiveness or efficacy, it was necessary to find changes between the pre-intervention (assessment) and post-intervention phases.

Statistical analysis of the data:

All information was gathered, tallied, and statistically examined using IBM Corp., which was published in 2015. IBM SPSS Statistics, Version 23.0 for Windows. N.Y. Armonk: IBM Corp. Qualitative data were presented as numbers and percentages, whereas quantitative data were presented as mean ± SD and median (range). In order to compare two normally distributed variables, the paired t test was employed. The Chi square test or, when applicable, the Fisher Exact test were used to compare the percentage of categorical variables. The Pearson's correlation coefficient was computed to evaluate the link between the different study variables; a value close to 1 indicates strong correlation, a value close to 0 indicates weak correlation, and a (+) sign indicates positive direct correlation and a (-) sign indicates inverse correlation. Predictive analysis is what logistic regression is to describe how one or more independent variables and one or more dependent dichotomous variables relate to one another; it was a two-sided test. If the p-value was less than 0.05, it was deemed statistically significant; if it was greater than 0.05, it was deemed statistically insignificant.

Results:

Table 1 clarifies that 55% of studied nurses their age less than thirty years old, 70% were female, and 75% of them married. Regarding qualification, 70% and 67.5%, respectively of studied nurses had nursing institute and having experience less than 10 years. As well, 100% of studied nurses neither attend training courses about TLS preventive measures nor did hospital have policy about it.

Table 2 indicates that all nurses' knowledge dimensions regarding TLS were improved after intervention of preventive measures program as nurses' knowledge about TLS raised from 17.5% to 87.5% with mean difference 8.08 and percent of improvement equal 73.8% as well as nurses' knowledge about preventive measure of TLS raised from 12.5% to 90% with a mean difference 13.03 and percent of improvement equal 87.74%.

Concerning total nurses' knowledge regarding TLS preventive measures, **figure 1** shows that only 15% of studied nurses had satisfactory total knowledge before preventive measures program, which raised up after program to be 80.0% and this improvement was statistically significant ($p<0.001$) with a mean difference equal 21.1 and percent of improvement 81.8%.

Table 3 illustrates that all dimensions of nurses' practice regarding TLS were improved after intervention of preventive measures program with a percentage of improvement ranged from 27.7% related to electrocardiogram monitoring and interpretation by nurses to 60% related to nurses' practice about estimate the jugular venous pressure with statistically significant difference ($p<0.001$).

Figure 2 demonstrates that only 17.5% of the studied nurses had a total satisfactory practice regarding TLS preventive measures before intervention of the program, while 75.0% of nurses become had satisfactory practice after preventive measures program. Additionally, this improvement and difference between both phases was highly statistically significant ($p<0.001$) with a mean difference equal 40.4 and percent of improvement 42%.

Table 4 reveals that there was statistically significant relation between satisfactory nurses' total knowledge level about TLS and sex (p=0.006) before intervention of preventive measures program.

Table5 presents that there was no statistically significant relation between satisfactory nurses' total knowledge about TLS and their demographic characteristics after intervention of program.

Table 6 exhibits that there was statistically significant relation between satisfactory nurses' total practice and their sex (p=0.017) before intervention of preventive measures program.

According to **Table 7**, there was a statistically significant relation between nurses' total practice level and their marital status (p=0.043) after intervention of program

In the light of **Table 8;** there was statistically significant positive correlation between total knowledge score and total practice score before and after intervention of preventive measures program as p<0.05.

Table (1): Frequency and Percentage distribution of demographic characteristics of studied nurses (n=40):

Demographic Characteristics	No.	%
Age per year:		
- <30 years	22	55.0
- ≥30 years	18	45.0
Mean ± SD	28.87±3.45	
Median(range)	28 (24-35)	
Sex:		
- Male	12	30.0
- Female	28	70.0
Marital Status:		
- Married	30	75.0
- Single	10	25.0
Qualifications:		
- Bachelors	12	30.0
- Nursing institute	28	70.0
Experience years:		
- <10 years	27	67.5
- ≥10 years	13	32.5
Mean ± SD	8.15±3.58	
Median(range)	7 (4-15)	
Training about TLS		
- No	40	100.0
Hospital policy for preventive measures about TLS		
- No	40	100.0

Table (2): Frequency and percentage distribution of studied nurses' knowledge dimensions regarding TLS preventive measures throughout program phases (n= 40):

Nurses' knowledge dimensions	Program Intervention phases				^{M}p
	Before		After		
	No.	%	No.	%	
Nurses' knowledge about TLS:					
- Satisfactory	7	17.5	35	87.5	<0.001
- Unsatisfactory	33	82.5	5	12.5	
Mean ±SD Median(range)	10.95±4.73 10(6-22)		19.03±2.19 18.5(14-24)		
mean difference	8.08				
% of improvement	73.8%				
Nursing Knowledge about TLS preventive measures:					
- Satisfactory	5	12.5	36	90.0	<0.001
- Unsatisfactory	35	87.5	4	10.0	
Mean ±SD Median(range)	14.85±5.2 13(9-28)		27.88±2.66 28(22-31)		
mean difference	13.03				
% of improvement	87.74%				

M: McNemar Test **p<0.05: significant**

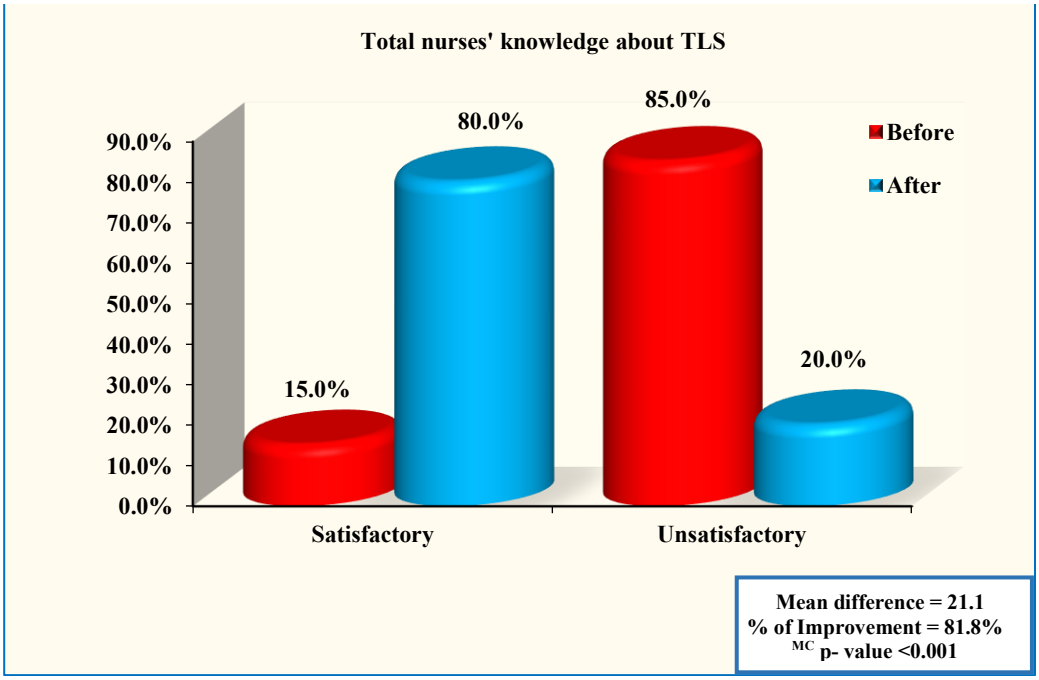

Figure 1: Total studied nurses' knowledge about TLS preventive measures throughout program phases (n= 40)

Table (3): Frequency and percentage distribution of studied nurses' practice dimensions regarding TLS preventive measures throughout program phases (n= 40):

Nurses' practice dimensions	Program Intervention phases						Mean difference	% of improvement	^{M}p
	Before		After		Before	After			
	No.	%	No.	%	Mean ±SD	Mean ±SD			
Leg measurements for swelling:									
- Satisfactory	8	20.0	16	40.0	3.92±1.91	5.4±1.43	1.48	37.8 %	0.033*
- Un satisfactory	32	80.0	24	60.0					
Jugular Venous Pressure estimation:									
- Satisfactory	1	2.5	24	60.0	2.25±0.95	3.6±0.496	1.35	60%	<0.001
- Un satisfactory	39	97.5	16	40.0					
Measuring vital signs:									
- Satisfactory	3	7.5	30	75.0	23.65±7.095	36.83±6.47	13.18	55.7%	<0.001
- Un satisfactory	37	92.5	10	25.0					
Urinary catheterization:									
- Satisfactory	4	10.0	29	72.5	14.7±3.26	20.13±2.07	5.43	36.9%	<0.001
- Unsatisfactory	36	90.0	11	27.5					
Intravenous infusion:									
- Satisfactory	2	5.0	28	70.0	15.88±3.98	22.83±2.52	6.95	43.8%	<0.001
- Unsatisfactory	38	95.0	12	30.0					
ECG monitoring and interpretation:									
- Satisfactory	19	47.5	38	95.0	13.83±3.47	17.63±1.13	3.8	27.7%	<0.001
- Unsatisfactory	21	52.5	2	5.0					
Withdrawing blood sample:									
- Satisfactory	21	52.5	37	92.5	17.05±6.36	23.7±1.42	6.65	39.0%	0.001
- Unsatisfactory	19	47.5	3	7.5					
Measure and Record Urinary Output:									
- Satisfactory	13	32.5	23	57.5	4.95±2.79	6.97±1.3	2.02	40.8%	0.046
- Unsatisfactory	27	67.5	17	43.5					

M: McNemar Test **p<0.05: significant**

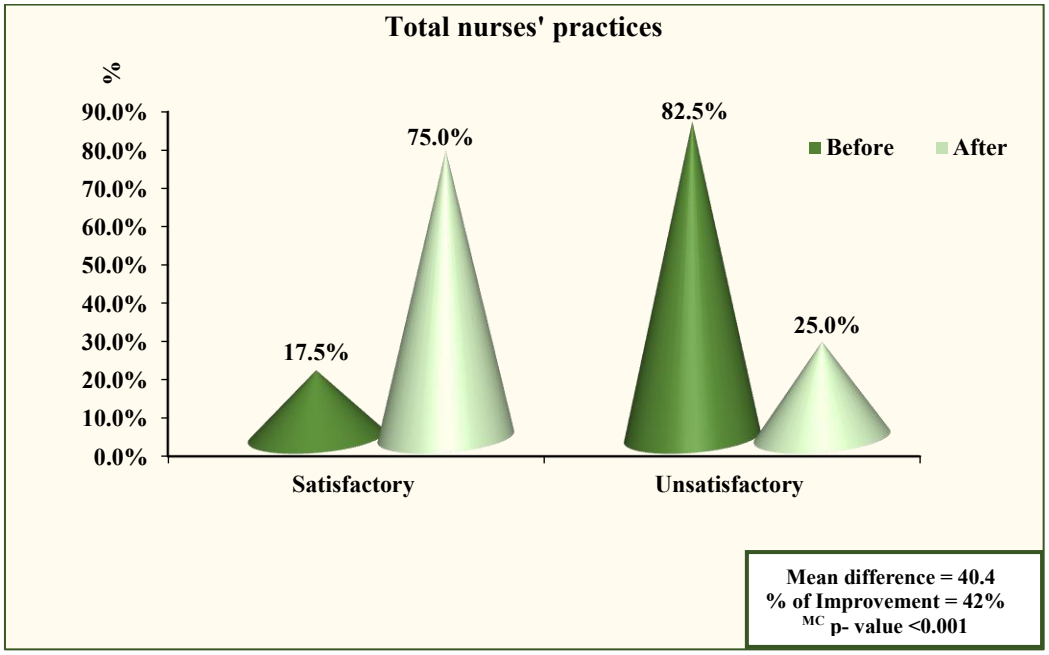

Figure 2: Total studied nurses' practice about TLS preventive measures throughout program phases (n= 40)

Table (4): Relation between studied nurses' total knowledge and their demographic characteristics before preventive measures program (n= 40):

Demographic Characteristics	Nurses' total knowledge before program intervention				no.	fp-value
	Satisfactory ≥70%		Unsatisfactory <70%			
	No.	%	No.	%		
Age:						
- <30 years	3	13.6	19	86.4	22	0.99
- ≥30 years	3	16.7	15	83.3	18	
Sex:						
- Male	5	41.7	7	58.3	12	0.006*
- Female	1	3.6	27	96.4	28	
Marital Status:						
- Married	3	10.0	27	90.0	30	0.153
- Single	3	30.0	7	70.0	10	
Qualifications:						
- Bachelors	3	25.0	9	75.0	12	0.341
- Nursing institute	3	10.7	25	89.3	28	
Experience years:						
- <10 years	4	14.8	23	85.2	27	0.99
- ≥10 years	2	15.4	11	84.6	13	

f= Fisher exact test **(*) Significant p<0.05** **Insignificant p>0.05**

Table (5): Relation between studied nurses' total knowledge and their demographic characteristics after preventive measures program (n= 40):

Demographic Characteristics	Nurses' total knowledge after program intervention				no.	fp-value
	Satisfactory ≥70%		Unsatisfactory <70%			
	No.	%	No.	%		
Age:						
- <30 years	18	81.8	4	18.2	22	0.99
- ≥30 years	14	77.8	4	22.2	18	
Sex:						
- Male	10	83.3	2	16.7	12	0.99
- Female	22	78.6	6	21.4	28	
Marital Status:						
- Married	23	76.7	7	23.3	30	0.653
- Single	9	90.0	1	10.0	10	
Qualifications:						
- Bachelors	9	75.0	3	25.0	12	0.68
- Nursing institute	23	82.1	5	17.9	28	
Experience years:						
- <10 years	22	81.5	5	18.5	27	0.99
- ≥10 years	10	76.9	3	23.1	13	

f= Fisher exact test **(*) Significant p<0.05** **Insignificant p>0.05**

Table (6): Relation between studied nurses' total practice and their demographic characteristics before preventive measures program (n= 40):

Demographic Characteristics	Nurses' total practice before program intervention				no.	p-value
	Satisfactory ≥80%		Unsatisfactory <80%			
	No.	%	No.	%		
Age:						
- <30 years	4	18.2	18	81.8	22	0.99
- ≥30 years	3	16.7	15	83.3	18	
Sex:						
- Male	5	41.7	7	58.3	12	0.017*
- Female	2	7.1	26	92.9	28	
Marital Status:						
- Married	4	13.3	26	86.7	30	0.34
- Single	3	30.0	7	70.0	10	
Qualifications:						
- Bachelors	3	25.0	9	75.0	12	0.41
- Nursing institute	4	14.3	24	85.7	28	
Experience years:						
- <10 years	5	18.5	22	81.5	27	0.99
- ≥10 years	2	15.4	11	84.6	13	

f= Fisher exact test **(*) Significant p<0.05** **Insignificant p>0.05**

Table (7): Relation between studied nurses' total practice and their demographic characteristics after preventive measures program (n= 40):

Demographic Characteristics	Nurses' total practice after program intervention				no.	fp-value
	Satisfactory ≥80%		Unsatisfactory <80%			
	No.	%	No.	%		
Age:						
- <30 years	16	72.7	6	27.3	22	0.99
- ≥30 years	14	77.8	4	22.2	18	
Sex:						
- Male	11	91.7	1	8.3	12	0.231
- Female	19	67.9	9	32.1	28	
Marital Status:						
- Married	20	66.7	10	33.3	30	0.043*
- Single	10	100.0	0	.0	10	
Qualifications:						
- Bachelors	10	83.3	2	16.7	12	0.693
- Nursing institute	20	71.4	8	28.6	28	
Experience years:						
- <10 years	21	77.8	6	22.2	27	0.7
- ≥10 years	9	69.2	4	30.8	13	

f= Fisher exact test **(*) Significant p<0.05** **Insignificant p>0.05**

Table (8): Correlation between studied nurses' knowledge and practice score regarding tumor lysis syndrome preventive measures throughout program phases (n= 40):

Items	Program Intervention phases			
	Before		After	
	Knowledge score		Knowledge score	
	r	P	r	P
Practice score	0.48	0.001	0.5	0.0001

Pearson' correlation coefficient (r) **p<0.05 consider significant**

Discussion:

Prevention is better than treatment for tumor lysis syndrome **(Adeyinka & Bashir, 2022).** Rapid identification of patients at risk for tumor lysis syndrome is necessary for both prevention and treatment. Nurses can minimize problems and improve patient outcomes by using their knowledge to better manage and monitor therapies **(Rivera-Gamma & Davis, 2023).** Nurses are in a unique position to take prompt action to avoid long-term negative responses because they are probably the first to recognize TLS symptoms. This collection of treatment orders enables nurses to respond promptly to the earliest indications of TLS. Long-term organ damage is less likely to occur in patients who get early treatments **(Lassiter, 2018).** Through a range of prevention and treatment interventions, the oncology nurse can maximize outcomes for patients who are at risk or who have been diagnosed with TLS **(Li et al., 2015).**

Healthcare professionals need to be aware of this syndrome in order to prevent its emergence and to manage it promptly to prevent serious effects. So, understanding its physiological effects, underlying risk factors, and current therapeutic strategies are prerequisites **(Cheung et al., 2020).** Therefore, the ability of nurses on prevention adverse events and problems that arise from tumor lysis syndrome in clinical practice will be improved by their understanding of risk factors and clinical findings. The degree of surveillance and intervention required for affected patients can be ascertained by acute and critical care nurses using clinical presentations linked to these test derangements and disease-related risk factors **(Durfee, 2022).**

Oncology care necessitates ongoing development since nursing professionals must possess both technical and psychosocial abilities. Continuous educational interventions have been successful in filling in the educational gaps that have been identified in cancer nursing staff **(Solera-Gómez et al., 2022).**

One of the best ways to lower stress levels and enhance self-efficacy and work performance for cancer nurses is to provide them with sufficient education **(Bozorgnejad et al., 2021; Penagos & Vargas, 2020; Fuoto & Turner, 2019).** Thus, the aim of this study was to evaluate the effect of preventive measures on oncology nurses' performance regarding tumor lysis syndrome. Four main topics will be covered in a discussion of the existing findings, in the following order:

Firstly, the Demographic characteristics of studied nurses:

According to the current study's analysis of the demographic characteristics of the nurses under study, more than half of studied nurses' age less than thirty years old and more than two thirds female and three quarters of them married. Regarding qualification, more than two thirds of studied nurses had nursing institute and having experience less than 10 years. As well, all of studied nurses neither attend training courses about TLS preventive measures nor did hospital have policy about it.

According to the researchers, the majority of nurses working in Zagazig University hospitals are female, and this conclusion may be related to the fact that nursing education used to be exclusively for women. This is supported by **Zakaria, Alaa and Desoky, (2022)**, who found that there are more female nurses globally than male nurses, not just in Egypt. Furthermore, the fact that the smallest percentage of nurses at Zagazig University Hospital held a bachelor's degree in nursing might be related to the hospital's ongoing administrative burden, which contributes to its persistent shortage of highly skilled nurses. Regarding the lack of training, this conclusion may be the result of an increasing workload, a lack of training motivation, or the absence of a hospital in-service training department.

The present findings concur with those of **Abo El-Fadl (2020),** who conducted a study titled "Effect of Educational Program on Nurses' Performance Regarding Prevention and Management of Intravenous Extravasation Chemotherapy" and found that over two-fifths of the nurses in the study were female, married, and between the ages of 20 and 30. Three-quarters of the nurses in the study did not attend any chemotherapy-related training courses, two-fifths had years of experience ranging from one to five years, and less than two-thirds had a technical institute of nursing degree.

In a study titled "Effect of Educational Program for Nurses on Clinical Outcomes of Cancer patients with Metastatic Spinal Cord

Compression," **Khalil et al. (2022)** found that nearly two-thirds of the nurses in the study had an intermediate level of education, and the majority was married women. In terms of the sample's participation in prior educational programs, none of the nurses under study had previously attended any educational program. On the other hand, this study found that almost two-thirds of the nurses who participated had between 10 and 20 years of experience in the oncology department.

These findings also align with those of **Ali et al. (2022),** who found that, in terms of educational attainment, the majority of nurses in his study "Effect of Implementing an Educational Program on Knowledge and Performance of Nurses Caring for Patients with Stem Cell Transplantation" were nursing technicians; Regarding training workshops, the least number of nurses who were studied attended only one training session, while the majority of nurses none attended any at all. In contrast to the current study, over half of the nurses were between the ages of 20 and 30.

Furthermore, the present findings were consistent with those of **Elpasiony et al. (2022),** who explained that in his study titled "Influence of Antineoplastic Safe Handling Guidelines on Enhancing Nurses' Performance," half of the nurses were graduates of the nursing institute and more than two thirds of the nurses were female. Additionally, around one-third of the nurses had two to less than three years of experience. Two-thirds of the nurses did not receive any training, while only one-third of them participated in courses on the proper handling of antitumor medications.

While, the current findings contradicted those of **Sharour (2020),** who described in his study "Oncology nurses' knowledge about exploring chemotherapy-related extravasation care" that the majority of participants had a bachelor's degree in nursing and that nearly two thirds of participants were male with a mean age of 26.4 years. Additionally, this study differed from **Admass et al. (2020),** who noted that most participants in his study "Knowledge and Attitude of Ethiopian Oncology Nurses about Cancer Pain Management" held a bachelor's degree in nursing. Also, the current study was different from that of **Abdullah & Rasheed (2018),** who discovered that over half of the nurses in his study, "Nursing Staff Knowledge regarding Safe Chemotherapy Administration at Oncology Centre in Kirkuk City," had completed nursing school.

Secondly, nurses' knowledge regarding TLS preventive measures throughout the program intervention phases:

On the light of the current study, the results indicated that less than one fifth of studied nurses had satisfactory total knowledge regarding TLS before intervention of the program**,** while the majority of nurses became had satisfactory total knowledge after program and this improvement was statistically significant. Too, all nurses' knowledge dimensions regarding TLS were improved after intervention of preventive measures program as majority of studied nurses became had knowledge about TLS and most of them had knowledge about preventive measure of TLS with percent of improvement equal 87.74%. These results may be reflect the efficacy of the program's content, which was created with nurses' skill levels in mind and was clear, easy to understand, and frequently repeated to help nurses retain what they had learnt.

The present findings agreed with **Khalil et al. (2022),** who illustrated that the majority of the nurses in their study had low levels of knowledge prior to the assessment period. However, all of them had high levels of knowledge immediately following the assessment period, and the difference was determined to be extremely statistically significant.

The results of this study are consistent with those of **Ali et al. (2022),** who found that most of the nurses in the study knew very little about stem cell transplantation prior to an educational intervention. Following the implementation of educational intervention, the majority of them gained complete understanding regarding stem cell transplantation, resulting in a complete change in their level of knowledge.

Furthermore, the current results are consistent with **Abo El-Fadl's (2020)** study, which found that over three-quarters of nurses had inadequate knowledge scores prior to program implementation. Conversely, the majority of nurses' knowledge scores were satisfactory right after the educational program was put into place. The knowledge of the nurses in the study about chemotherapy extravasation before, during, and

three months after the program's implementation varies statistically significantly.

Too, this result was in line with **Aziz et al. (2019),** who found that nurses' knowledge of how to prevent, identify, and manage chemotherapy extravasations through ongoing education sessions significantly improved in their study titled "Audit on incidents and knowledge of nurses regarding chemotherapy extravasations at day care oncology of a tertiary care hospital in Karachi, Pakistan."

On the same hand, this finding concurred with **Dawood et al. (2017),** who noted a significant improvement in nursing staff knowledge concerning prevention and management of chemotherapy extravasation post intervention guidelines. These results similar to **Taj et al (2020),** who reported in the study about "Oncology nursing training: A blended teaching approach in resource-limited countries" that there was a significant improvement in knowledge. The post-tests after course completion and again at the 6-month interval showed mean values of 88.28% and 89.30%, respectively.

Thirdly, nurses' practices regarding TLS preventive measures throughout the program intervention phases:

It is clear from the results of the present study that only less than one fifth of studied nurses had satisfactory total practice regarding TLS preventive measures before intervention of the, program while three quarters of nurses became had satisfactory total practice of preventive measures after program intervention and this improvement and difference between both phases was highly statistically significant with a percent of improvement equal 42%. Also, all dimensions of nurses' practice regarding TLS were improved after intervention of preventive measures program with a percentage of improvement ranged from 27.7% related to ECG monitoring and interpretation by nurses to 60% related to nurses' practice about the jugular venous pressure estimation with statistically significant difference.

This finding may be explained by inadequate knowledge, a lack of education and training, inadequate equipment, a scarcity of nursing staff on the oncology unit, a lack of supervision, and a failure to continuously evaluate the stated standards of patient care.

According to **Khalil et al. (2022),** there was a highly statistically significant difference between the total practice scores before and immediately after implementing the program, as well as between the total practice scores before and after a month. These findings are consistent with those of the current study. Additionally, **Ali et al. (2022)** verified that the implementation of an educational program resulted in extremely significant increases in the nurses' performance with regard to the management of patients receiving stem cell transplantation.

Additionally, the current study's results align with those of **Elpasiony et al. (2022),** who found a statistically significant difference in nurses' knowledge and satisfactory development between the pre and post-program periods. A study by **Abd El-Salaheen et al. (2022)** examined the "Effect of an educational program for nurses on prevention and management of chemotherapy extravasation" and found a statistically significant difference between the nurses' pre- and post-program practices. These findings are consistent with that study. Moreover, the results of **Nouri et al.'s** study, "Improving nurses' performance in the safe handling of antineoplastic agents: A quasi-experimental study," from 2021 are consistent with this one.

Likewise, present results also support those of **Abo El-Fadl, (2020)**, who demonstrated that prior to program implementation, the overall score of over half of nurses' practice was insufficient. High statistically significant variations existed in the practice of the nurses under study before, during, and three months after the program's implementation with relation to extravasation management and preventive techniques. Too, this outcome was consistent with that of **Dawood et al. (2017),** who noted a notable improvement in nursing staff performance with regard to managing and preventing chemotherapy problems.

Fourthly, the relations and correlation between the study variables:

Regarding the relation between studied nurses' total knowledge about TLS and their demographic characteristics after program intervention, the present study showed that there

was no statistically significant relation between satisfactory nurses' knowledge level about TLS and their demographic characteristics after intervention program. It is clear that the program is easy and suitable to improve the knowledge of all nurses without limitation by sociodemographic characteristics as sex, age, qualification or experience.

Al-Atiyyat and Banifawaz (2018) found a positive correlation between nurses' knowledge and higher education in their study named "Oncology nurses' knowledge practice, and confidence towards chemotherapy-induced peripheral neuropathy in Jordan." This result was in contrast to their findings.

Concerning the relation between studied nurses' total practice about TLS and their demographic characteristics after program intervention, the current study reported that there was a statistically significant relation between nurses' total practice level and marital status of nurses after intervention program. Compared to other nurses, it seems that nurses who were single had a good level of practice after preventive measures program intervention.

These findings differed from **Al- ashour & Watheeq, (2022)**, in her study about "Nurse's Practice toward Oncology Patients during Chemotherapy Management" who noted that the majority of nurses practice at a fair level, and there is a strong correlation between practice and years of experience and education only.

Regarding the correlation between nurses' total knowledge and practice score regarding TLS through preventive measures program intervention phases, this study illustrated that there was significant positive association between knowledge and practice score before and after intervention program. From the researcher's point of view, this could be because practice requires knowledge, which highlights the necessity for ongoing supportive education.

These findings concur with **Ali et al., (2022)**, who revealed that there was statistical significant positive correlation among nurses' knowledge and their practice level. Moreover, **Elpasiony et al., (2022)**, discovered that a correlation between the nurses' knowledge and practices in the pre-and post-program periods. As well, this outcome is consistent with research by **Asefa et al. (2021) and Mansour (2019),** which showed that nurses with greater knowledge points were more likely to manage extravasation vesicant IV chemotherapy and handle antineoplastic medications safely.

Furthermore, **Abo El-Fadl, (2020)**, noted that, a statistically significant positive correlation between the overall practice of the studied nurses and their overall knowledge before, throughout, and after three months from program implementation. Additionally, this finding is in line with a study conducted by **Ali (2019)** at Assuit University titled "Effect of Teaching Program on Nurses' Knowledge and Performance Regarding Patients Undergoing Bone Marrow Transplantation." They found that there were a highly positive correlation between nurses' knowledge and their practice improved after application of educational intervention.

Further, this result was consistent with that of **Qalawa et al. (2017),** who found a statistically significant positive correlation between nurses' knowledge and practice in their study titled "the relation between oncology nurses' practice behaviors, knowledge, and confidence regards chemotherapy-induced peripheral neuropathy." This, however, runs counter to the results of a study by **Esmail et al. (2016)** on "Safe handling knowledge and practices of chemotherapy among oncology nurses in Erbil City," which indicated a strong negative association between oncology nurses' knowledge and behaviours.

Conclusion:

Based on the results of this research, all nurses' knowledge and practice dimensions regarding TLS were improved after program intervention with a statistical significant difference, which reflects the positive effect of intervention the preventive measures program in improving nurses' performance regarding tumor lysis syndrome prevention, which supports the study's hypotheses.

Recommendation:

According to the results of the present study the following recommendations are suggested:

- A specific booklets and information materials about TLS in Arabic language should be available.

- Periodic training and intervention programs regarding TLS to refreshing and enhance knowledge and practice of nurses.
- Continuous assessment of nurses' knowledge and practice with apply the principle of reward and punishment
- More research should be conducted with a large sample size and in different contexts to assess the impact of the program on nurses' performance and make generalizations.

References:

Abd El-Salaheen M., Hegazy H., Mahmoud M. &Omran E., (2022): Effect of an educational program for nurses on prevention and management of chemotherapy extravasation. Journal of Nursing Science Benha University; 3(2): 126-142

Abdel-Nabey M., Chaba A., Serre J., Lengline E., Azoulay E., Darmon M. & Zafrani L., (2022): Tumor lysis syndrome, acute kidney injury and disease-free survival in critically ill patients requiring urgent chemotherapy. Ann. Intensive Care; 12(1):15

Abdullah D. & Rasheed O., (2018): Nursing Staff Knowledge regarding Safe Chemotherapy Administration at Oncology Center in Kirkuk City. Journal Scientific Studies; 13(1): 144-155

Abo El-Fadl N.M., (2020): Effect of Educational Program on Nurses' Performance Regarding Prevention and Management of Intravenous Extravasation Chemotherapy. Evidence-Based Nursing Research; 2 (3):1-12

Adeyinka A. & Bashir K., (2022): Tumor Lysis Syndrome. National library for medicine and National Center for biotechnology information

Admass B., Endalew N., Tawuye H. & Mersha A., (2019; 2020): Knowledge and Attitude of Ethiopian Oncology Nurses About Cancer Pain Management: National Survey. 2020; 12(1): Jordan. International Journal of Nursing Sciences; 6(3):283-7

Al- ashour I. & Watheeq H.H., (2022): Nurse's Practice toward Oncology Patients during Chemotherapy Management. The journal of positive psychology; 6(6): 7769-7779

Al-Atiyyat N. & Banifawaz A., (2018): Oncology nurses' knowledge, practice, and confidence toward chemotherapyinduced peripheral neuropathy in Jordan, Saudi Medical Journal; 39(11): 1158– 1163.

Ali A., (2019): Effect of Teaching Program on Nurse's Performance Regarding Bone Marrow Transplantation. Assiut Scientific Nursing Journal, 7(18):12-21.

Ali E.F.M., El shamy K.F., Nabih M.H. & Mabed M.N., (2022): Effect of Implementing an Educational Program on Knowledge and Performance of Nurses Caring for Patients with Stem Cell Transplantation. Mansoura Nursing Journal (MNJ); 9 (2): 2735 – 4121

Asefa S., Aga F., Dinegde N. G. &Demie T. G., (2021): Knowledge and practices on the safe handling of cytotoxic drugs among oncology nurses working at tertiary teaching hospitals in Addis Ababa, Ethiopia. Drug, healthcare and patient safety; 13: 71-80

Aziz A., Samoon Z., Shaheen Z., Feroz A., Khurshid M., Ayoub N. & Sawani S., (2019): Audit on incidents and knowledge of nurses regarding chemotherapy extravasations at daycare oncology of a tertiary care hospital in Karachi, Pakistan. Journal of Oncology and Cancer Research; 3 (1):8 -9

Bozorgnejad M., Ghezeljeh T.N., Haghani H. & Iri A., (2021): The impact of social network-based nursing care training on oncology nurses' occupational stress and self-efficacy: Non-randomized clinical trial. Nursing Practice Today; 8:79–87.

Cheung W.L., Hon K.L., Fung C.M. & Alexander K.C., (2020): Tumor lysis syndrome in childhood malignancies. Drugs Context; 9:2019-8-2

Dawoud B., Bahgat R., Marie A., & El Sayed S., (2017): Effect of intervention

guidelines on nurses' performance regarding prevention and management of intravenous extravasation chemotherapy for children, Tanta Scientific Nursing Journal; 12 (1): 28-29

Durani U. & Hogan W.J., (2020): Emergencies in haematology: tumor lysis syndrome. Br J Haematol; 188 (4):494-500

Durfee E.M., (2022): Tumor Lysis Syndrome. American Association of Critical-Care Nurses; 42(3):9-25

Elpasiony N.M., Abdelhady F.S.G., Hafez A.A. & Ahmed S.R., (2022): Influence of Antineoplastic Safe Handling Guidelines on Enhancing Nurses' Performance. Egyptian Journal of Health Care; 13(4):1293-1307

Esmail D. H., Qadir C. S., Mahmood E. K., Osman G. A. & Omar Y. B., (2016): Safe handling knowledge and practices of chemotherapy among oncology nurses in Erbil City. kufa J. for Nursing sciences; 6(1): 84-90

Fuoto A.& Turner K.M., (2019): Palliative Care Nursing Communication: An Evaluation of the COMFORT Model. J. Hosp. Palliat. Nurs.; 21(2):124–130

Grewal K., Herrity E. & Pasic I., (2023): Tumour lysis syndrome. CMA Journal; 195 (14):E515.

Gupta A.A., Self M., Mueller M., Wardi G.& Tainer C., (2022): Dispelling myths and misconceptions about the treatment of acute hyperkalemia. Am J Emerg Med; 52:85–91

Howard S.C., Jones D.P. & Pui C.H., (2018): The tumor lysis syndrome. N Engl J Med. 13; 379(11):1094.

Jafari A., Rezaei-Tavirani M., Salimi M., Tavakkol R.& Jafari Z., (2020): Oncological emergencies from pathophysiology and diagnosis to treatment: a narrative review. Soc Work Public Health; 35(8):689–709.

Jones G., Will A., Jackson G.H., Webb N.J.A., Rule S. & British Committee for Standards in Haematology, (2015): Guidelines for the management of tumour lysis syndrome in adults and children with haematological malignancies on behalf of the British Committee for Standards in Haematology. British Journal of Haematology; 169(1): 661-67

Khalil S.A., Diab S.M., Alam ElDin M.A. & El-Melegy O.E.A., (2022): Effect of Educational Program for Nurses on Clinical Outcomes of Cancer patients with Metastatic Spinal Cord Compression**.** Tanta Scientific Nursing Journal; 24 (1):172-199

Lassiter M., (2018): What Oncology Nurses Need to Know About Tumor Lysis Syndrome. Oncology nursing society. Available at: https://www.ons.org/publications-research/voice/news-view

Li H.C., Chung O.K., Tam C.J. & Chiu S.Y., (2015): Effective Prevention and Management of Tumor Lysis Syndrome in Children With Cancer: The Important Contributions of Pediatric Oncology Nurses. J Pediatr Oncol Nurs; 32(4):209-18.

Loewen S. & Plonsky L., (2016): An A-Z of applied linguistics research methods. London: Palgrave Macmillan: pp.1-205. DOI:10.1007/978-1-137-40322-3

Lynn P. & LeBon M., (2011): Skill Checklists for Taylor's Clinical Nursing Skills: A Nursing Process Approach. 3rd (Ed.). Wolters Kluwer Health | Lippincott Williams & Wilkins

Mansour K.A., (2019): Effectiveness of an educational program on nurses' knowledge regarding management of extravasation vesicant intravenous chemotherapy at oncology centers in Baghdad city. Iragi national journal of nursing specialities; 32(3):75-86.

Matuszkiewicz-Rowinska J.& Malyszko J., (2020): Prevention and treatment of tumor lysis syndrome in the era of onco-nephrology progress. Kidney Blood Press Res*;* 45(5):645–60.

Memorial Sloan Kettering Cancer Center, (2022): About Tumor Lysis Syndrome (TLS)

Menakuru S.R., Priscu A., Khan I. & Beirat A., (2022): Spontaneous tumor lysis syndrome in a patient with bulky chronic lymphocytic leukemia diagnosed after resolution of symptoms. Case Rep Oncol; 15(1):442–6.

National Cancer Institute, (2020): Cancer statistics. Available at: https://www.cancer.gov/about-cancer/understanding/statistics. Accessed on 10/4/2024: 1:00am

Nelan P. & Prepetit J., (2023): Recognizing oncologic emergencies. American Nurse Journal; 18(8):06-11

Nettina S.M., (2014): Lippincott manual of nursing practice, (10th Ed.). Wolters Kluwer Health, Lippincott Williams &Wilkins, China, Ch.14, P.P. 439- 445

Nouri A., Javadi M. S., Iranijam E. & Aghamohammadi M., (2021): Improving nurses' performance in the safe handling of antineoplastic agents: A quasi-experimental study. BMC nursing; 20(1): 1-5.

Penagos R.V.& Vargas L., (2020): Efectividad de una intervención de enfermería para modificar la autoeficacia y la sobrecarga del cuidador del paciente hemato- oncológico. Rev Cuid.; 11:1–18

Qalawa S., Sobeh D., & Hafez F., (2017): The relation between oncology nurses' practice behaviors, knowledge, and confidence regarding chemotherapy-induced peripheral neuropathy," Port Said scientific journal of nursing; 4(1): 1-17

Rahmani B., Patel S., Seyam O., Gandhi J., Reid I., Smith N. & Khan S.A., (2019): Current understanding of tumor lysis syndrome. Hematological oncology; 37(5):537-547

Rivera-Gamma S. & Davis M. E., (2023): Tumor Lysis Syndrome: An Oncologic Emergency. AJN, American Journal of Nursing; 123(3): 30-35.

Roberts J.R. & Hedges J.R., (2010): clinical procedures in emergency medicine. (5TH ed.) Saunders, Elsevier Inc.

Sharour L., (2020): Oncology nurses' knowledge about exploring chemotherapy-related extravasation care: A cross-sectional study, Clinical Epidemiology, and Global Health journal; 8(3): 780- 784

Solera-Gómez S., Benedito-Monleón A., LLinares-Insa L.I., Sancho-Cantus D. & Navarro-Illana E., (2022): Educational Needs in Oncology Nursing: A Scoping Review. Healthcare (Basel); 10(12): 2494

Taj M., Lalani B., Madhani N., Ouma C., Njumwa L., Ukani H.& Oluoch M., (2020): Oncology nursing training: A blended teaching approach in resource-limited countries. Journal of Clinical Oncology; 38(15):189-99.

Varga C., Kalman Z., Szakall A., Drubits K., Koch M., Banhegyi R., Olah T., Pozsgai E., Fulop N.& Betlehem J., (2019): ECG alterations suggestive of hyperkalemia in normokalemic versus hyperkalemic patients. BMC Emergency Med; 19(1):33.

Webster J.S. & Kaplow R., (2021): Tumor lysis syndrome: implications for oncology nursing practice. Seminar Oncology Nurs; 37(2):151136

Williams S.M. & Killeen A.A., (2019): Tumor lysis syndrome. Arch Pathol Lab Med; 143(3):386–93.

Zakaria M. M., Alaa S. M., &Desoky G. M. (2022): Oncology nurses' knowledge and practices regarding safe administration of intravenous chemotherapy. Egyptian Journal of Health Care; 13(1): 1218-1231.