ORIGINAL ARTICLE

Competency of Oncology Nurses in the Safe Handling of Chemotherapeutic Drugs

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ABSTRACT

Background. With the increasing cancer burden in the country, nurses' exposure to chemotherapy is inevitable as they belong to the workforce responsible for its preparation, administration, and disposal. These drugs are hazardous and necessitate special precautions to avoid direct exposure. Essentially, their competency must be aligned with the recommended safety guidelines to maintain quality patient outcomes while ensuring their safety.

Objective. The primary aim was to determine the competency level of Oncology nurses in terms of knowledge, skills, and attitude. The results were used to develop a training program framework for competency enhancement.

Methods. A descriptive correlational quantitative study was utilized. The study was conducted from December 2023 to February 2024 across three regions in Luzon, Philippines. The study included 203 Oncology nurses who fit the inclusion criteria. Data were collected via a four-part online questionnaire. Data were analyzed using frequency distribution, mean, standard deviation, and Pearson and Spearman correlation coefficients.

Results. Oncology nurses exhibited excellent knowledge ($\bar{x}$ = 16.18) and skills ($\bar{x}$ = 3.86) but only fair attitudes ($\bar{x}$ = 2.92). Knowledge correlated negatively with skills (ρs = -0.45, $p<0.001$) and positively with attitude (ρs = 0.71, $p<0.001$), while skills negatively correlated with attitude (ρs = -0.70, $p<0.001$). Higher education levels strongly correlated with knowledge (χ^2 = 213.28, $p<0.001$) and attitude (χ^2 = 214.08, $p<0.001$) but not skills (χ^2 = 25.48, $p>0.001$). Training in chemotherapy showed significant correlations with knowledge (χ^2 = 241.77, $p<0.001$), skills (χ^2 = 106.93, $p<0.001$), and attitude (χ^2 = 276.51, $p<0.001$). The practice environment had strong positive correlations with all competency dimensions as knowledge (χ^2 = 368.60, $p<0.001$), skills (χ^2 = 2850.87, $p<0.001$), and attitude (χ^2 = 1020.64, $p<0.001$).

Conclusions. Oncology nurses demonstrate comprehensive knowledge and accurate and efficient skills but maintain a neutral attitude toward handling chemotherapeutic drugs. These results relate to the complex interplay between the competency dimensions. There are still gaps and areas needing improvement that should be addressed and supported to align their competencies, especially along the skills and attitude dimensions. Training programs anchored on evidence-based practices and regulatory standards, and promoting a favorable practice environment are vital for their competency development.

Keywords: oncology nurse, chemotherapy, competency, nurse's knowledge, nurse's skills, nurse's attitude

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INTRODUCTION

Cancer remains one of the leading causes of death worldwide despite being a non-communicable disease. Several treatment options are now available for cancer patients, including surgery, radiotherapy, hormone therapy, immunotherapy, targeted therapy, stem cell transplant, and chemotherapy, among others.

While chemotherapy provides therapeutic repose to cancer patients, it has its fair share of adverse effects both for the patient and healthcare providers responsible for their preparation and administration. These drugs are hazardous and necessitate special precautions to avoid direct exposure, through needlestick injury, inhalation, and drug ingestion or absorption. A study mentioned that an estimated 8 million healthcare workers are unnecessarily exposed to chemotherapeutic agents.[1]

Literature pointed out inconsistencies among healthcare workers, including nurses, in complying with and adopting the safety practices identified by the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH).[1-4] Non-compliance with safety standards can expose healthcare workers to health risks from chemotherapy during preparation, administration, and disposal, ranging from dizziness, nausea, and dermatitis to severe conditions like organ damage, fetal loss, reproductive toxicity, leukemia, and melanoma.[2,5]

A study found that the use of personal protective equipment (PPE) remained subpar as none of the nurses who responded to the survey used all the required PPE, and over 69% of nurses claimed that there was no training program on handling chemotherapeutic drugs at their workplaces.[6] Similarly, a study concluded that many of their samples practiced poor handling where improper and inadequate use of gowns, gloves, and other PPE when handling patients and cleaning up spills have been identified.[7] In the Philippines, no public health policy exists about the preparation of chemotherapeutic drugs in restricted areas and the use of PPE by healthcare workers preparing the drugs. Most healthcare workers only use gloves during the preparation and administration due to the unavailability of PPE, insufficient time to look for and don PPE, and ignorance of potential risks associated with exposure.[8]

Non-compliance to the safety guidelines reflects nurses' competencies. As defined by Benner in her theory, competency is the nurse's ability to understand and manage patient care with efficiency, coordination, and confidence.[9] In nursing practice, nurses must apply their learned information (K), skills (S), and intrinsic individual attributes (A) to each situation and be able to tailor that knowledge and those skills to diverse settings.[10]

Several studies reveal that the nurses' KSA level toward handling chemotherapeutic drugs was not satisfactory after being evaluated.[11-13] Further, relationships among these competency dimensions were also identified in some literature. The negative attitudes of Oncology nurses were linked to their limited knowledge about its use, importance, and management of side effects.[14] Relatively, healthcare workers' knowledge and attitude on exposure to chemotherapeutic drugs may affect their adherence to safety measures as a study revealed that only 38% of the respondents had a high level of attitude.[15] This low result in attitude translates directly to the poor behavior of their respondents, especially when observing proper protocols in handling chemotherapeutic drugs.

The unsatisfactory competency levels may be affected by various factors, including personal and the nurse's practice environment.[16-19] Furthermore, researchers identified that inadequate knowledge and skills of nurses in the Oncology unit have been linked to unsafe practices associated with chemotherapy. A study in Iran found that 90.7% of nurses working in the Oncology unit have no education on the methods of protection and safety standards with chemotherapy.[20] Likewise, in the Philippines, opportunities for advanced education are limited; thus, nurses most frequently receive on-the-job training in chemotherapy and the management of complicated and vulnerable cases of cancer patients.[21]

The identified gap in the nurses' competencies in the safe handling of chemotherapeutic drugs has led to the creation of various training programs. Many researchers mentioned an improvement in the nurses' KSA after the introduction of a training program.[18-20] Given its positive impact, they have concluded and recommended that a structured training program on the safe handling of chemotherapy be included as part of the nurses' continuing education.[22,23]

Training programs in chemotherapy have significantly affected the nurses' performance in other countries, but little is known about its effect on Filipino nurses. The literature review revealed that only a few studies relating to chemotherapy have been conducted in the Philippine setting. However, none of these studies have focused on the nurses, their competency in particular, and the training programs available for them. Hence, the study has been conducted to provide information and evidence in these areas. With the increasing cancer burden in the country, nurses' exposure to chemotherapy is inevitable as they belong to the workforce responsible for its preparation, administration, and disposal. Their competency should be at par with the recommended safety guidelines to maintain quality patient outcomes while ensuring their safety.

OBJECTIVES

The study determined the level of competency of Oncology nurses in the safe handling of chemotherapeutic drugs. Specifically, it answered the following questions:

1. What is the Oncology nurses' level of competency in the safe handling of chemotherapeutic drugs along the dimensions, knowledge, skills, and attitude?
2. What is the relationship between knowledge, skills, and attitude as competency dimensions in the safe handling of chemotherapeutic drugs among Oncology nurses?

3. Is there a significant relationship between the Oncology nurses' level of competency in the safe handling of chemotherapeutic drugs and the following variables: educational attainment, training attended, and practice environment?
4. What training program framework can be developed for Oncology nurses on the safe handling of chemotherapeutic drugs based on the results of the study?

MATERIALS AND METHODS

Research Design

A quantitative descriptive correlational design was utilized in the conduct of the study to examine the relationships between variables with manipulation, allowing for the observation of natural associations in the data. Further, it entailed the use of numerical data in the analysis using statistical methods to align with the research objectives.

Locale and Population

The study was conducted from December 2023 to February 2024 in three regions in the Philippines, namely the National Capital Region (NCR), Cordillera Administrative Region (CAR), and Central Luzon. These areas were selected based on the identified health institutions capable of providing chemotherapy among cancer patients as regional cancer centers. Given the vast expanse and the various health institutions within the region, the study aimed to reach out to a broader audience of health professionals.

Respondents for the study were Oncology nurses from various health institutions within NCR, CAR, and Central Luzon. Eligible respondents were (a) nurses assigned to work in the Oncology/Palliative unit or may have been assigned to other hospital units but possess experience in administering chemotherapy, and (b) nurses with at least three months of experience in handling chemotherapy.

The population of Oncology nurses in the three regions was provided by an organization for Oncology nurses. At the time of data collection, there were 411 Oncology nurses as members of the organization. The Taro Yamane formula with a 5% margin of error was used to calculate the appropriate number of respondents, requiring 203 respondents. Quota sampling was utilized to ensure the representation of each specific region within the population. By setting quotas based on the geographic regions, this approach offered an organized yet adaptable framework that simplified gathering a balanced dataset. The study had a 100% response rate as there were no invalidated responses due to missed items, and no respondents expressed refusal.

Data Gathering Tools

The study utilized a four-part online questionnaire. The first part of the research instrument was designed to collect the respondents' demographic information, including their educational attainment, training in chemotherapy, and practice environment. To identify the practice environment of the respondents, the Practice Environment Scale of the Nursing Work Index (PES-NWI) by Lake (2002) was adopted. The PES-NWI is open-access, with no cost or access restrictions for users. It is composed of 31 items categorized into five subscales, including (a) Nurse participation in hospital affairs; (b) Nursing foundations of quality care; (c) Nurse manager, leadership, and support of nurses; (d) Staffing and resource adequacy; and (e) Collegial Nurse-Physician Relations. The PES-NWI is a 4-point Likert scale, (1) = strongly disagree; (2) = disagree; (3) = agree; (4) = strongly agree. The practice environment is deemed favorable if the score is above the set midpoint of 2.5 and unfavorable for scores of 2.5 and below. The tool has a Cronbach's α value of 0.82, corresponding to an acceptable value and confirmed construct validity.

The second part of the questionnaire is a multiple-choice test composed of 20 items to identify the Oncology nurses' level of competency in terms of knowledge. It is divided into five parameters with four items each: (a) knowledge related to the nature of chemotherapeutic drugs, (b) use of PPE, (c) sources of exposure, (d) perceived risks, and (e) health hazards of handling chemotherapeutic drugs. The respondents were given a score of "1" for every correct answer and "0" for each incorrect answer, yielding a total score of 20 points.

The third part of the questionnaire aimed to identify the level of competency of Oncology nurses in terms of skills through a 37-item self-rated 4-point Likert scale, (1) = Never; (2) = Sometimes; (3) = Often; (4) = Always. It involves 11 items for the preparation parameter, eight for the administration, and six for the parameters post-administration, disposal, spills, and excreta handling.

The fourth part is composed of 15 items on a 4-point Likert scale relating to the attitude of Oncology nurses in safely handling chemotherapeutic drugs. The scale for the attitude included seven negative and eight positive statements. Positive statements were scored as (1) = Strongly Disagree; (2) = Disagree; (3) = Agree; (4) = Strongly Agree, contrariwise negative attitude statements were scored as (1) = Strongly Agree; (2) = Agree; (3) = Disagree; (4) = Strongly Disagree.

The three parts of the questionnaire that determined the level of competency were subjected to content validity using the Average Scale Level-Content Validity Index/Ave (S-CVI/Ave). Three Subject Matter Experts (SME) in the field of (a) Oncology Nursing, (b) Quality Improvement and Research, and (c) Statistics were chosen to score each item from the questionnaire for its level of relevance through a 4-point Likert level of relevance scale (1 – not relevant; 2 – somewhat relevant; 3 – relevant; 4 – highly relevant), where scores of 1 and 2 are considered content invalid, and scores of 3 and 4 are content valid.

The questionnaire has been improved and adjusted based on the SMEs' input and evaluation. After their final approval of the modified questionnaire, it was subjected to content validity and reliability testing. S-CVI/Ave scores of 1, 0.98, and 0.96 were obtained for knowledge, skills, and attitude,

respectively, indicating high content validity. Subsequently, a pilot test was conducted utilizing 20 Oncology nurses as respondents. The questionnaire yielded a Cronbach's α of 0.763, surpassing the prescribed threshold of 0.7. This outcome implies that the items comprising the questionnaire exhibit a satisfactory level of reliability. As the questionnaire is deemed valid and reliable, no further modifications were made during the data collection.

Data Gathering Procedure

Approval to proceed with the study was sought from the Institution's Review Ethics Committee (REC), then assistance from the organization. An information material containing the web link, QR code, and password to the online questionnaire was sent to the organization. This material was then forwarded to their database comprising of Oncology nurses.

Before answering the survey questions, respondents were presented with an online self-administered informed consent form. This detailed the nature and purpose of the research, its confidentiality, and the respondent's rights. Respondents acknowledged and agreed to the terms before proceeding. After agreeing to the online informed consent, the respondents were redirected to the online questionnaire created using *Jotform,* an online survey maker tool. The licensed version is equipped with data encryption and spam protection. Instructions on completing the online survey were provided at the beginning of the form. Given the online format, respondents can take the survey at their own pace, ensuring they provide thoughtful and accurate answers.

The online questionnaire was kept accessible to the respondents for almost two months. As soon as the target number of respondents per region was reached, the questionnaire was then closed so as not to receive further responses.

Data were collected through *Jotform,* exported as a spreadsheet file using Microsoft Excel, and saved in a password-secured folder in the researcher's computer. A backup file was also kept in *Jotform* cloud storage and encrypted with a password. Double data entry was employed, and no discrepancies were identified against the original records, and no missing values were identified. No identifying data were collected from the respondents, ensuring their confidentiality. Responses were numbered 1-203 accordingly.

Statistical Treatment

Descriptive statistics were employed in the data analysis to address the study's objectives. Mean and standard deviation were used to identify the Oncology nurses' level of competency in terms of knowledge, skills, and attitude.

The study used Pearson's correlation coefficient and Spearman rank to examine relationships between variables. Spearman rank was applied to ordinal data, specifically oncology nurses' competency in skills and attitudes and their relationships with factors like educational attainment, chemotherapy training, and practice environment. Pearson's correlation was employed as the respondents' test scores generated interval data for the knowledge dimension. The statistical level of significance for the test treatments was set at 0.05.

Ethical Considerations

Ethical principles were applied throughout the research process for data collection, data processing, and research outcome publication. Ethical considerations in internet-based research according to the Philippine Health Research Ethics Board (PHREB) were integrated in the study, including autonomy, anonymity and privacy, transparency, and non-maleficence were observed and maintained for the best interest of the respondents.

The online informed consent assured respondents that declining participation would not impact their employment, affiliation, or similar factors. Participants indicated their consent by selecting the appropriate option in the online form, with a separate option available for those who refused. No personal identifiers, such as names or email addresses, were collected to ensure respondent anonymity. Furthermore, the survey data was encrypted and protected from spam to safeguard against data breaches, making it accessible solely to the researcher.

RESULTS

Table 1 presents the number of Oncology nurses in the three identified regions and their demographic characteristics. Out of the 203 respondents, 127 (62.53%) are from NCR,

Table 1. Demographic Characteristics of the Respondents

Region	Educational Attainment			Trainings attended		Practice Environment		N
	BSN	With units in PGS	Completed PGS	With training	No training	(-)	(+)	
NCR	113	14	0	127	0	1	126	127
CAR	40	3	0	38	5	3	40	43
Central Luzon	30	3	0	32	1	1	32	33
Total	183	20	0	197	6	5	198	203

PGS – Post-graduate studies, (-) – unfavorable, (+) – favorable

Table 2. Level of Competency in Terms of Knowledge

Knowledge Parameters	Min	Max	M	SD	IN
Nature of Chemotherapeutic Drugs	2.00	3.00	2.99	0.09	Good
Personal Protective Equipment (PPE)	1.00	3.00	2.11	0.52	Fair
Perceived Risks	3.00	4.00	3.99	0.07	Excellent
Sources of Exposure	3.00	4.00	3.99	0.07	Excellent
Health Hazard	3.00	4.00	3.09	0.29	Good
Overall Knowledge	14.00	17.00	16.18	0.42	Excellent

Min – lowest score, Max – highest score, $\bar{x}$ – mean, SD – standard deviation, IN – interpretation

43 (21.17%) are from CAR, and the remaining 33 (16.30%) belong to Central Luzon. Of these respondents, only 20 (9.9%) have units in post-graduate studies, and none have completed these studies. Further, a majority of 197 (97%) had already received training in chemotherapy, and 198 (97.54%) deemed their practice environment favorable.

Oncology Nurses' Level of Competency Along the Knowledge Dimension in the Safe Handling of Chemotherapeutic Drugs

The study was able to gather data from 203 Oncology nurses. Of the 203 respondents, 202 (99.51%) possessed excellent knowledge, and one (0.49%) had good knowledge. Generally, the study respondents have excellent competency in their knowledge of the safe handling of chemotherapeutic drugs. Table 2 shows various values, with the highest score being 17 and the lowest being 14 out of 20 questions. The mean score of 16.18 indicates that respondents generally exhibited excellent knowledge. Furthermore, a consistent and strong level of understanding across the sample is shown by the small standard deviation of 0.42, which shows a relatively low dispersion of scores around the mean.

Table 2 also presents that among the five parameters, respondents have excellent knowledge of perceived risks ($\bar{x}$ = 3.99, SD = 0.07) and sources of exposure ($\bar{x}$ = 3.99, SD = 0.07), while fair level of knowledge of PPE ($\bar{x}$ = 2.11, SD = 0.52). Oncology nurses are continually exposed to various threats associated with handling chemotherapeutic agents. Oncology nurses with a high level of knowledge about the risks and sources of exposure from these drugs are likelier to perceive them as hazards to their health and well-being. As corroborated by other literature, the risk appraisal of Oncology nurses is influenced by their increasing awareness of the potential harm posed by these drugs.[23]

On the contrary, among the parameters, the respondents' knowledge of PPE ranked fair, which means they only have basic knowledge of the matter. Respondents were asked questions relating to the importance of having to use PPE and the Occupational Safety and Health Administration (OSHA)-approved specific PPE (i.e., gown and gloves) when handling chemotherapeutic drugs. Based on the results, only 0.49% (n = 1) and 18.72% (n = 38) of the respondents have an accurate knowledge of the safe gowns and gloves, respectively, that are ideal when handling chemotherapeutic drugs. Findings from other literature are consistent with this study's result, emphasizing that this low score in terms of PPE use may have stemmed from insufficient knowledge or awareness of the guidelines themselves.[24]

The current study revealed promising results as Oncology nurses have an overall excellent level of competency in the knowledge dimension. Nevertheless, the focus should be on interventions that can improve their knowledge of using appropriate PPE when handling chemotherapeutic drugs.

Oncology Nurses' Level of Competency Along the Skills Dimension in the Safe Handling of Chemotherapeutic Drugs

The study evaluated the competency of 203 Oncology nurses in the safe handling of chemotherapeutic drugs. From the respondents, 191 (94.04%) had an excellent level of competency along the skills dimension, and 12 (5.91%) were rated as good. Overall, Oncology nurses in the study demonstrated excellent competency in terms of skills when handling chemotherapeutic drugs.

Results reflected in Table 3 show a remarkable mean score of 3.86 with a standard deviation of 0.20, implying an accurate and efficient performance among Oncology Nurses based on set standards to ensure safety in the preparation, administration, post-administration, disposal of equipment, and handling of spills and excreta.

Table 3 also presents that among the parameters, skills in preparation have the highest score ($\bar{x}$ = 3.95; SD = 0.16). In the study, 196 (96.55%) of the Oncology nurses consistently performed the standard procedures before administering

Table 3. Level of Competency in Terms of Skills

Skills Parameters	M	SD	IN
Preparation	3.95	0.16	Excellent
Administration	3.79	0.27	Excellent
Post-Administration	3.88	0.24	Excellent
Disposal of Equipment	3.77	0.24	Excellent
Handling of Spills and Excreta	3.92	0.24	Excellent
Overall Skills	3.86	0.20	Excellent

$\bar{x}$ – mean, SD – standard deviation, IN – interpretation

chemotherapeutic drugs, and the remaining 7 (3.45%) performed them on most occasions rather than at all times. These procedures include reviewing facility protocol, verifying physician's orders, checking patient's current condition, validating patient's chart, preparing necessary equipment, receiving drugs in sealed containers, and locating the spill kit in the station.

Further analysis of Table 3 reveals that disposal of equipment receives the lowest rate ($\bar{x}$ = 3.77; SD = 0.24). In this parameter, 190 (93.60%) Oncology nurses consistently performed the procedures, 12 (5.91%) followed them on most occasions, while one (<1%) performed the procedures on some occasions only. In the safe handling of chemotherapeutic drugs, disposal of equipment involves the proper wearing of PPE, use of appropriate containers (e.g., sharps in puncture-proof containers and toxic waste containers), not disconnecting IV tubings from IV containers, closing of cytotoxic containers before chemical decomposition, and sealing of waste containers when they are ¾ full. There appears to be a lack of defined guidelines and segregation practices for cytotoxic drug waste, as nurses in their study often disposed of cytotoxic wastes, among other medical wastes.[20] This practice among Oncology nurses raises a concern as chemotherapeutic drugs require careful handling even after their use to inhibit environmental contamination and unwanted exposure of nurses and patients.

Oncology Nurses' Level of Competency Along the Attitude Dimension in the Safe Handling of Chemotherapeutic Drugs

The study involved 203 responses from Oncology nurses. One hundred forty-eight (72.91%) of the 203 Oncology nurses had a fair level of attitude while the remaining 55 (27.09%) scored good. Generally, Oncology nurses involved in the study perceived their attitude as only fair in the safe handling of chemotherapeutic drugs.

Table 4 reveals a mean score of 2.92 and a standard deviation of 0.28, indicating a fair level of attitude among the respondents. This suggests that the respondents possess a neutral mindset and emotions towards the handling of chemotherapeutic drugs. The fair result may be attributed to the overall nurse's experience in handling chemotherapy. With its complexity, the responsibility may be taxing for Oncology nurses and may consume their time in the overall process just to ensure compliance with the protocols.

Table 4. Level of Competency in Terms of Attitude

Dimension	M	SD	IN
Attitude	2.92	0.28	Fair

$\bar{x}$ – mean, SD – standard deviation, IN – interpretation

Relationship Between the Oncology Nurse's Knowledge, Skills, and Attitude as Competency Dimensions

The results in Table 5 demonstrate the correlation coefficient between knowledge, skills, and attitude as competency dimensions in the safe handling of chemotherapeutic drugs. The negative association (high correlation value of -0.45, $p<0.001$) between knowledge and skills. This implies that Oncology nurses with higher knowledge levels can have marginally poorer practical skills when handling chemotherapeutic drugs. The negative correlation between knowledge and skills can be multifaceted. Several studies have discovered that nurses were aware of the safety protocols but were not compliant in the actual clinical practice setting.[20,25] Factors for such discrepancy may be related to nurses' time constraints when complying.[26] The heavy workload, time pressures, and the demands of the nature of the profession may drive nurses to resort to using shortcuts or steer clear of using the equipment entirely.

Second, the investigation reveals a very strong and positive association (correlation coefficient of 0.71, $p<0.001$) between knowledge and attitude. This robust correlation suggests that those with more knowledge typically have more positive attitudes regarding safe handling procedures. This result coincides with other research findings stating that nurses with suboptimal knowledge of chemotherapy handling also exhibited a negative attitude towards it.[27,28] However, a study highlighted that there is no existing relationship between knowledge and attitude,[29] while another finding stated that knowledge is not automatically equated with a positive attitude[30].

Finally, a compelling study finding reveals a substantial and negative correlation between skills and attitude, showing a positive relationship (correlation coefficient of -0.70, $p<0.001$). According to the present study, those with greater skill levels might have less favorable attitudes toward safe handling procedures. This surprising result necessitates further investigation as preceding studies related to the focus of the study reveal otherwise. Other studies pointed out that nurses with a positive attitude are more likely to engage in safer practices and vice versa.[30,31]

Table 5. Correlation Analysis for the Level of Competency

Variable 1	Variable 2	Correlation Coefficient	Qualitative Description	*p*-value	IN
Knowledge	Skills	-0.45	Strong, negative correlation	0.00	Significant
Knowledge	Attitude	0.71	Very strong, positive correlation	0.00	Significant
Skills	Attitude	-0.70	Strong, negative correlation	0.00	Significant

IN – interpretation

Relationship Between the Level of Competency and Oncology Nurse's Education

Table 6 demonstrates the correlation between knowledge, skills, and attitude as competency dimensions and the Oncology nurse's education. First, a correlation coefficient of 213.28 ($p<0.001$) indicates a significant finding of the substantial association between knowledge and education. Education offers Oncology nurses access to information, resources, and learning opportunities that can expand their knowledge base and understanding of handling chemotherapeutic drugs. Similarly, other literature suggests that advancement in education enhances critical thinking skills and may encourage Oncology nurses to challenge and modify their existing knowledge and suppositions about chemotherapeutic drugs.[32]

Similarly, a correlation coefficient of 214.08 ($p<0.001$) indicates a strong positive link between attitude and education in the analysis. It implies that those who have completed higher education are likelier to have optimistic outlooks and a greater feeling of accountability for patient safety and high-quality care. As supported by other studies, with the advanced knowledge and expertise gained through higher education levels, Oncology nurses tend to have a higher self-efficacy, positively influencing their attitude toward their responsibilities as Oncology nurses.[30,32]

Finally, a correlation value of 25.48 ($p>0.001$) shows no significant association between education and skills in the investigation. A majority of 90.1% (n = 183) have finished BS Nursing. Given this data, there is a lack of variation in the education levels among the respondents. With the majority having the same level of education, identifying the influence of education on the Oncology nurses' skills is complicated by the lack of variability to analyze. Therefore, this lack of variability may potentially mask an existing relationship between education degrees and skills.

Relationship Between the Level of Competency and Oncology Nurse's Training in Chemotherapy

A strong correlation coefficient of 241.77 ($p<0.001$) indicates that training in chemotherapy and knowledge are significantly correlated, according to the analysis presented in Table 7. This robust correlation highlights the transformative power of training initiatives in providing people with the essential knowledge and comprehension of safety regulations, best practices, and chemotherapeutic procedures. These results are consistent with other studies highlighting a notable rise in nurses' knowledge levels once training programs are finished, as evidenced by a significant difference in their respondents' pre-and post-test scores.[11,13,22]

Comparably, a correlation value of 106.93 ($p<0.001$) shows a significant association between skills and chemotherapy training. Several pieces of literature also revealed similar results.[22,30,31,33] This emphasizes the complex nature of skill learning and raises the possibility that training programs will result in actual competency with chemotherapeutic drugs.

Finally, a correlation coefficient of 276.51 ($p<0.001$) indicates a robust favorable relationship between attitude and chemotherapy training. This implies that those who receive in-depth training are likelier to have optimistic outlooks and a greater feeling of accountability for patient safety and high-quality treatment. Supporting the abovementioned result are studies highlighting the beneficial impacts of training interventions on the attitudes of healthcare personnel about chemotherapy management. They have featured the value of organized educational programs in raising the competency of medical personnel and developing a culture of excellence and safety in the administration of chemotherapy.[18-20,23-34]

An exhaustive literature review revealed no antithesis to the strong relationship between participating in training programs and the Oncology nurses' competency along the three dimensions, knowledge, skills, and attitude, in the safe handling of chemotherapeutic drugs.

Table 6. Correlation Analysis for the Level of Competency and Oncology Nurse's Education

Variable 1	Variable 2	Correlation Coefficient	Qualitative Description	*p*-value	IN
Education	Knowledge	213.28	Strong, positive correlation	0.00	Significant
Education	Skills	25.48	No relationship	0.27	Not Significant
Education	Attitude	214.08	Strong, positive correlation	0.00	Significant

IN – interpretation

Table 7. Correlation Analysis for the Level of Competency and Oncology Nurse's Training in Chemotherapy

Variable 1	Variable 2	Correlation Coefficient	Qualitative Description	*p*-value	IN
Training	Knowledge	241.77	Strong, positive correlation	0.00	Significant
Training	Skills	106.93	Strong, positive correlation	0.00	Significant
Training	Attitude	276.51	Strong, positive correlation	0.00	Significant

IN – interpretation

Table 8. Correlation Analysis for the Level of Competency and Oncology Nurse's Practice Environment

Variable 1	Variable 2	Correlation Coefficient	Qualitative Description	*p*-value	IN
Practice environment	Knowledge	368.60	Strong, positive correlation	0.00	Significant
Practice environment	Skills	2850.87	Strong, positive correlation	0.00	Significant
Practice environment	Attitude	1020.64	Strong, positive correlation	0.00	Significant

IN – interpretation

Relationship Between the Level of Competency and Oncology Nurse's Practice Environment

Table 8 presents an analysis of the correlation between the practice environment and the respondents' knowledge, skills, and attitude competency levels. It can be inferred from the table that with a correlation coefficient of 368.60 ($p<0.001$), 2850.87 ($p<0.001$), and 1020.64 ($p<0.001$) for knowledge, skills, and attitude, respectively, the competency dimensions have a strong and positive correlation to the practice environment. As previously stated, the practice environment of the respondents appears to be favorable, which could have positively affected their competencies.

This implies that Oncology nurses employed in supportive practice settings are more likely to have access to tools, training, and chances for professional growth, which will increase their knowledge of safe handling procedures. This corroborates with literature indicating the pivotal role that the practice environment plays in terms of improving nurses' knowledge.[6,35,36] Knowledge gaps can be bridged if healthcare settings initiate and support continuous education and training programs among nurses.[35,36]

Likewise, in support of other literature,[20,37,38] the study's result revealed that skill development practices and practice settings directly impact Oncology nurses' practical competency in safe handling techniques. Adherence to safety protocols is significantly facilitated by resource allocation, managerial support, and infrastructure.[38] However, a study found no association between the practice environment and skill competency among nurses, specifically on PPE use.[39] Their study indicates that although nurses perceived a favorable work environment, it did not always result in consistently utilizing PPE.

Moreover, this research shows the significance of practice environments in influencing patient safety and quality care attitudes. It implies that nurses employed in settings with a safety-focused and supportive culture are likelier to have positive outlooks and a greater sense of accountability for following safe handling procedures. As indicated in another study, feelings of stress and burnout likely influence the nurses' attitudes toward the handling of chemotherapy.[38]

DISCUSSION

An excellent level in the knowledge dimension signifies that Oncology nurses demonstrate a comprehensive grasp, awareness, and familiarity with handling chemotherapeutic drugs, including their nature, the use of PPE, source of exposure, perceived risks, and associated health hazards. The present study reported that a significant proportion of the respondents are members of an organization and had received training about chemotherapy, which may have contributed to the high base knowledge. These results may be attributed to nurses' advanced education and specialized training. The latest protocols, drug regimens, and safety measures are shared with Oncology nurses through training. Furthermore, specialized training may involve simulations and hands-on practice that help solidify the learning and prepare Oncology nurses to manage the complexities of handling chemotherapeutic drugs.[32]

Nurses play a crucial role in handling chemotherapeutic drugs; hence, being equipped with good practice skills is important, which is demonstrated by the study's results. With the present study, since most respondents have had chemotherapy-related training, it might have fostered good practices. Similarly, a study mentioned that there was a high compliance rate among nurses[40] and a study in Pakistan reported that a majority of 56% of the nurses have good practices in terms of the safe handling of chemotherapy[41]. These progressive results among different studies may be a product of numerous factors, including training and education programs, availability of PPE, institutional policies, presence of safety guidelines, and adherence to safety protocols.

In the field of Oncology, where patients face significant psychological concerns, the attitude of nurses plays a significant role in their total patient experience[14] and in ensuring their welfare along the process. Having inadequate knowledge and skills renders nurses feeling incompetent and insecure, leading to medical errors, potentially endangering their welfare and compromising their patient's safety. However, the study's previous results demonstrated an excellent level of competency in terms of knowledge and skills, refuting the factors presented by the mentioned studies. While the attitude score is fair, there may be room for improvement in this competency area as the respondents neither have a positive nor negative attitude.

The negative correlation between knowledge and skills can be multifaceted. A significant element for such discrepancy might potentially be the time constraints nurses face in complying with the safety protocols.[26] As previously stated, the heavy workload, time pressures, and the demands of the nature of the profession may drive nurses to resort to using shortcuts or steer clear of using the equipment entirely. Another vital factor to consider with the inconsistency presented is the limitation in terms of infrastructure and

supplies. Even with optimal knowledge, Oncology nurses are unable to put their skills into practice if the necessary required equipment is not available.

Another negative correlation exists between the competency dimensions. Those with greater skill levels might have somewhat less positive attitudes toward safe handling procedures. This surprising result necessitates further investigation as preceding studies related to the focus of the study reveal otherwise. In this particular setting, given the emotional and mental challenges of handling chemotherapy, nurses with higher skill levels may nevertheless experience a negative attitude towards the work. They may struggle to keep a positive disposition amid these challenges, even when they are skilled in the technical aspects of handling chemotherapeutic drugs.

Knowledge offers the cognitive framework for the formation and development of attitudes. Results of the study emphasize how necessary theoretical knowledge and awareness are in influencing nurses' mindsets and emotions, and creating a safe environment in healthcare settings. Factors leading to this result can vary from educational programs and training to institutional support. Educational interventions such as training and programs can provide a base of knowledge that influences how nurses view and respond to clinical situations. Thus, gaining more knowledge is equivalent to being more confident in one's ability to carry out practices, realizing the significance of following safety protocols, and appreciating how their actions affect patient outcomes.

Advancements in education enhance critical thinking skills and may encourage Oncology nurses to challenge and modify their existing knowledge and suppositions about chemotherapy. The strong correlation emphasizes that education is important in providing nurses with the foundational knowledge needed to handle chemotherapeutic drugs safely. It emphasizes the significance of formal education and ongoing learning to improve expertise and guarantee safe practice. Similarly, the results of the study emphasize how education can significantly change nurses' mindsets and emotions about safe handling procedures. It implies that those who have completed more education are likelier to have optimistic outlooks and a greater feeling of accountability for patient safety and high-quality care.

In summary, handling chemotherapeutic drugs is a complex process encompassing the various dimensions of competency, including knowledge, skills, and attitude. These dimensions have an intricate relationship affected by several factors, such as the Oncology nurses' level of educational attainment, training programs, and practice environment. Determining how each dimension relates to one another and identifying how the variables influence these competencies are pivotal in shaping a competent Oncology nurse. This implies that more than feeding into the competency of nurses through training and activities, equal attention should be given to the availability of resources and support mechanisms.

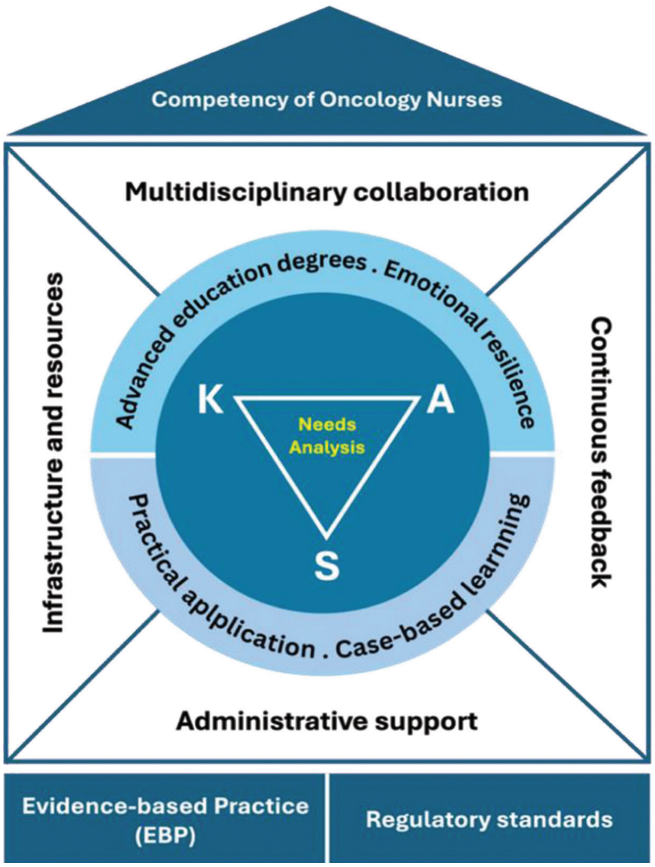

Figure 1. Proposed competency training framework based on the results.

Proposed Competency Training Framework

Designing a training program to develop Oncology nurses' competency in safely handling chemotherapeutic drugs further requires an in-depth and comprehensive approach. The main objective of the proposed training framework in Figure 1 is to strengthen the overall competency of Oncology nurses. The said framework can aid in guaranteeing that Oncology nurses are well prepared to face the demands and difficulties of handling chemotherapy by systematically addressing knowledge, attitudes, and skills within a supportive structure guided by needs analysis, evidence-based practices, and regulatory standards.

Limitations

The current study's results should be considered in light of these various limitations. A fundamental limitation of this study is that it is based exclusively on online data gathering. Although this approach enabled wide access to the population, it is necessary to consider the limitations of using online platforms. Self-selection bias, response bias, and insufficient representation due to a chosen organization, and the digital divide may contribute to the potential imbalance of the collected data and the incomplete representation of the desired population.

Specifically, in terms of sampling, quota method was used in the present study. As it offered an advantage to the online platform of the study, one of its primary limitations is its non-random nature, leading to a selection bias, where portions of the population may be overrepresented or underrepresented. Subsequently, the findings may not be fully generalizable to the broader population beyond the defined subgroups. Due to the potential that the results might not fairly represent the perceptions of the entire population, this constraint undermines the study's external validity. Therefore, the findings should be approached and analyzed within the specified limitations.

Additionally, the respondents are members of the same organization that initiated the invitation to participate in the study. This circumstance raises the potential for induced participation, where respondents may feel pressure to take part due in part of their affiliation with the organization. As such, several steps were employed by the researcher to mitigate the impact of induced participation. These include emphasizing the voluntary nature of participation, assuring anonymity and confidentiality during the data collection and analysis process, and using neutral language in the online survey. This has been therefore recognized in the study and the results were interpreted within this context. Finally, this study utilized a self-reported or self-administered tool to measure the Oncology nurses' skill competency.

CONCLUSIONS

Oncology nurses involved in the study possess a comprehensive grasp, awareness, and familiarity with handling chemotherapeutic drugs and demonstrate accurate and efficient performance to ensure safe handling based on set standards. However, they have a neutral mindset and emotions towards the handling of these drugs. A complex interplay exists between knowledge, skills, and attitude as competency dimensions. Oncology nurses who possess a higher level of knowledge also have a more positive attitude but may have lower skill levels. Attaining higher educational degrees is significant in advancing Oncology nurses' knowledge and attitude but has no apparent impact on their skill in handling chemotherapeutic drugs safely. Training programs are vital in developing the nurses' competency in safely handling chemotherapeutic drugs. Finally, the practice environment is imperative in promoting Oncology nurses' knowledge, skills, and attitudes. Establishing a positive practice environment for nurses across Oncology settings is paramount if patient safety is to be ensured.

Recommendations

Based on the results gathered in the study, attention can be directed towards developing and implementing targeted training courses and support initiatives by healthcare institutions and organizations to improve the emotional resilience of Oncology nurses. These programs may include modules on stress management, communication techniques, and empathy-building activities designed to meet the distinctive challenges associated with the safe handling of chemotherapeutic drugs. Additionally, healthcare institutions and training providers can continue investing in comprehensive and interdisciplinary (e.g., educators, pharmacists, physicians, and safety specialists) training programs for Oncology nurses. These providers should constantly evaluate and enhance training curricula to keep pace with the latest regulatory standards and technological advancements in handling chemotherapeutic drugs.

Due to the positive impact of the Oncology nurses' practice environment, nursing management should consider promoting a positive work environment for Oncology nurses through safe staffing, enhanced collaboration among disciplines, open communication, continuous feedback, and improved job resources. Nursing administrators and managers directly working in the oncology setting should proactively seek input from bedside nurses to meet their specific training and competency needs, eventually improving professional nursing outcomes and quality patient care, and they should place a high priority on and assist Oncology nurses in their pursuit of higher educational degrees.

Further recommendations are highlighted for future research. Training providers and other researchers can validate the proposed training framework to assess its functionality, usability, and suitability for the intended purpose. Longitudinal studies can be undertaken to evaluate the long-term effects of advanced educational degrees on nurses' career progression, job satisfaction, health exposure, and patient outcomes. Such research endeavors can yield significant insights for establishing the structure of future workforce strategies in Oncology nursing. Also, an observational checklist is necessary to evaluate the skill competency of Oncology nurses, and future research can explore utilizing qualitative or mixed method designs, to describe the experiences and perceptions of Oncology nurses in handling chemotherapeutic drugs to inform the quantitative data of the study. Additionally, a more significant number of respondents with greater variation in demographics, specifically educational attainment and training programs attended to offer more representativeness of the population, can also be explored. Finally, considering the financial and resource implications of providing an optimal environment for Oncology nurses to handle chemotherapy safely, additional research can be conducted to evaluate its cost-effectiveness.

Statement of Authorship

Both authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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