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ORIGINAL RESEARCH

Cardio-Oncologic Knowledge of Nurses in the Oncology Service: A Multi-Center Survey in China

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Purpose: Elucidation of the cardio-oncologic knowledge among the oncology nurses of tertiary hospitals in Shanxi Province to provide better insights and directions for management by nursing managers.

Background: China's National Health and Wellness Commission issued the Action Plan for Further Improving Nursing Services in June 2023, which requires nurses to provide patients with physical and mental holistic nursing services, such as medical care, condition observation, assistance with treatment, and health guidance. Most oncology patients are treated with chemotherapy, but the modality can cause greater harm to patients, especially cardiotoxicity. How to provide precise care for chemotherapy patients is a problem for nursing managers.

Methods: In order to investigate the level of cardio-oncologic knowledge among the oncology nurses of tertiary care hospitals in Shanxi Province, China, a questionnaire was created based on the relevant literature and the provided instructions on cardio-oncology. The chi-squared test was performed for multiple comparisons of the level of knowledge of disease observation, health guidance, and implementation of treatment. Spearman correlation analysis was performed to analyze the correlation between the levels of cardio-oncologic knowledge and general information of hospitals and nurses.

Results: Cardio-oncology awareness among the oncology nurses was 0.1%–44.7%, the awareness rate of single dimension was 0 to 3.9%, and overall awareness rate was 0. A partially significant difference was revealed in the two-by-two comparisons of the awareness rates of the three dimensions of disease observation, health guidance, and implementation of treatment ($P < 0.05$). A correlation was observed between the cardio-oncologic knowledge and some of the hospital and the nurses' general information data ($P < 0.05$).

Conclusion: Oncology nurses exhibited a low rate of awareness related to cardio-oncology. Hospitals could establish oncology nursing teams to train the oncology nurses to promote their cardio-oncologic knowledge and ensure the quality of daily care provided by these nurses.

Keywords: oncology nurse, cardio-oncology, cardiotoxicity, awareness, precision nursing care, nursing management

Introduction

Tumors rank first among the diseases that are a major threat to human health, and chemotherapy is one of the main treatment modalities adopted for tumor patients. In certain cases, chemotherapy might be the only feasible treatment option.[1,2] However, most chemotherapy drugs are cardiotoxic and cause certain heart conditions, such as arrhythmia and heart failure, which are collectively referred to as cardio-oncology.[3] With rapid advances in the treatment options for tumors, most patients with tumors achieve a complete cure. However, mortality does occur, not due to the tumor, and

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rather because of cardiotoxicity.[4,5] Fortunately, cardiotoxicity, which is the most serious complication in patients who receive chemotherapy, is preventable.[3,6] Nurses are the implementers of chemotherapy and preventive measures against cardiotoxicity, and their awareness of disease-related issues directly affects the implementation of nursing interventions.[7–9]

In June 2023, the National Health and Wellness Commission of China issued the Action Plan for Further Improving Nursing Services. The action plan was implemented with the theme of "strengthening the foundation, improving quality, and promoting development". According to this action plan, nurses are required to provide holistic physical and mental care services, such as medical care, disease observation, assisted treatment, health guidance, to their patients to strengthen patrol observation and conduct well in continuous nursing.[10] However, most tumour patients are now treated with chemotherapy, reducing the cardiotoxicity due to chemotherapy among these tumor patients and providing precision nursing for all chemotherapy patients remains a challenge for nursing managers.

In the last 5 years, several guidelines and expert consensus on cardio-oncology have been published in China as well as abroad to guide the work of clinical personnel.[11–13] However, a study reported that nurses do not possess adequate cardio-oncologic knowledge.[14] This inspired the present investigation on the awareness level of oncology nurses regarding cardio-oncology in Shanxi Province, which would serve as a reference for nursing managers to manage the patients receiving chemotherapy suitably.

The present study used a self-prepared questionnaire to evaluate the knowledge of the oncology nurses of tertiary hospitals in Shanxi Province regarding cardio-oncology. The objectives of obtaining information in the questionnaire were as follows: 1. to understand the level of awareness regarding cardio-oncology among the oncology nurses of the tertiary hospitals in Shanxi Province; 2. to elucidate the relevant factors affecting this awareness of these nurses; 3. to provide fresh insights and directions for the management of oncology patients in the Department of Nursing; 4. to provide a reference for the precise management of patients with specialized diseases admitted in the hospital.

Study Data and Methodology

Data

Tertiary hospitals are medical institutions classified by China's current "The measures for the administration of the hospital grade", and are the highest level in the "three levels, six grades" classification of hospitals in mainland China.[15] Tertiary hospitals are classified as Class III A and Class III B, and are rich in medical resources and represent a high level of expertise in China. The subjects of the present study were the oncology nurses in all tertiary hospitals across 11 cities in Shanxi Province, China. The inclusion criteria were as follows: (i) registered Nurse of Shanxi Provincial Health Commission in China; (ii) independent cover. The exclusion criteria were: (i) not engaged in chemotherapy work; (ii) engaged in clinical auxiliary work.

Research Methodology

Questionnaire Preparation

The questionnaire was prepared by following the drug instructions and related guidance documents.[11–13] The questionnaire was reviewed by five experts involved in oncology cardiology and nursing management for more than 10 years, and 30 study participants who met the inclusion criteria were selected to be pre-surveyed. The initial draft was revised based on their feedback to form the final questionnaire. The questionnaire comprised two parts. The first part was aimed at surveying the general information regarding the hospitals and nurses. This part contained 18 questions, including multiple-choice questions and open-ended questions. The second part contained questions to evaluate the nurses' cardio-oncologic knowledge. This part contained 10 questions, all of which were indeterminate multiple-choice questions, divided into the three dimensions of disease observation (4 questions), health guidance (2 questions), and implementation of treatment (4 questions). For details about the questionnaire, please see the Appendix. Each question was credited with 1 point, and a total score of 10 points could be achieved.

The Calculation Formula

It was regarded as knowing if the subject answered correctly to all questions in the questionnaire. The awareness rate of each question, each dimension, and the entire questionnaire was expressed as the single question awareness rate, single dimension awareness rate (disease observation, health guidance and implementation of treatment), and total awareness rate, respectively. The formula used for calculating the awareness rate was as follows:

The single-question awareness rate was calculated by dividing the number of subjects who answered the questions correctly by the number of people who filled out the questionnaire. The awareness rate of a single dimension was calculated by dividing the number of people who correctly answered all the questions in that dimension by the number of people who filled in the questions. The overall awareness rate was calculated by dividing the number of subjects who correct answers to all questions by the number of people who filled the questions out.

Distribution of the Questionnaires

The questionnaire was transformed into a questionnaire star, and the questionnaire star app was then used for data collection. Questionnaire Star is a commonly used electronic questionnaire collection tool in China, which is operated online to facilitate rapid data collection. The specific questionnaire distribution process is shown in Figure 1 below. The questionnaire survey was conducted anonymously, although the purpose and significance of the study were explained in detail to the nurses prior to conducting the survey. The subjects were free to withdraw at any point in time. The completion and submission of the questionnaire were regarded as informed consent to participate in the study.

Statistical Analysis

Data import from Questionnaire Star into Excel 2021. Statistical analysis was performed using SPSS 25.0 software. The characteristics of the hospitals and nurses were expressed as numbers and the composition ratio. The awareness of each topic was expressed as the number of people and the awareness rate. The Chi-squared test was adopted to compare the differences in awareness of disease observation, health guidance, and implementation of treatment. Pairwise multiple comparisons were performed using the a-split method. When all expected counts (expected cell frequencies 100.0%) were >5, Pearson's chi-square test was used. With at least 115. One expected count (expected cell frequencies ≥ 25.0%) < 5 but > 1, continuity correction was used. For the minimum expected count of <1, Fisher's exact probability method was used. Spearman correlation was adopted to determine the correlation between the cardio-oncologic knowledge and the characteristics of the hospitals and nurses, and the correlation coefficient was then used to evaluate the degree of correlation. The correlation coefficient was r, and $r < 0$ indicated a negative correlation, while $r > 0$ indicated a positive correlation. $r<0.4$ indicated weak correlation, 0.4 to 0.7 indicated a moderate correlation, >0.7 indicated a strong correlation. The statistical significance threshold was $P < 0.05$ in all tests.

Results

General Information

The General Information of Hospitals

A total of 739 oncology nurses working in the tertiary hospitals of 11 prefecture-level cities in Shanxi Province were included as the research subjects in the present study. Three persons were excluded due to incomplete responses to the questionnaire, resulting in a final survey of 736 persons. Of these, 694 were in Class III A hospitals, and 42 in Class III B. 731 were in general hospitals, and 5 were in specialized hospitals. The ward size was 202 for oncology centres, 464 for separate wards, and 70 for medical groups. The basic information about the hospitals where the survey respondents were working is provided in Table 1.

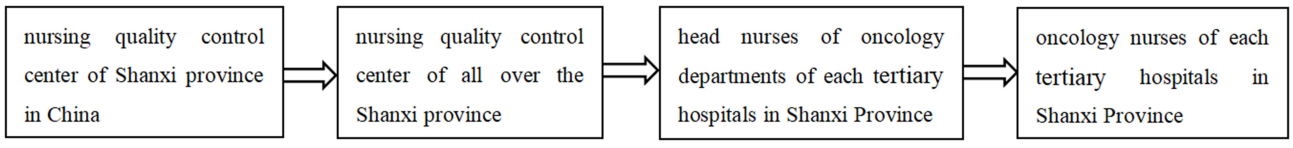

Figure 1 Flow of questionnaire distribution.

Table 1 General Information Regarding the Tertiary Hospitals in Shanxi Province

Item	Quantities (Person)	Component Ratio (%)	Item	Quantities (Person)	Component Ratio (%)
Hospital level			Quarterly	44	5.9
Class III A	694	94.3	Half-yearly	41	5.6
Class III B	42	5.7	Yearly	19	2.6
Type of hospital			Non-scheduled	360	48.9
General hospital	731	99.3	Non-training	101	13.7
Specialized hospital	5	0.7	**Undertake training of personnel**		
Oncology ward size			Head nurse	450	61.1
Oncology center	202	27.5	Doctor	300	40.8
Separate ward	464	63.0	Specialist oncology nurses	465	63.1
Medical group	70	9.5	Nurses take turns.	230	31.3
Oncology nursing specialty group			**Training kits in department**		
Yes	401	54.5	Yes	499	67.8
No	150	20.4	No	237	32.2
Unclear	185	25.1	**Package chemotherapy training materials in department**		
Quality checker of oncology patient care			Yes	515	70.0
Oncology Nursing Specialty Group	475	64.5	No	211	30.0
No team management	233	31.7	**Oncology cardiology training kit in department**		
Other team management	28	3.8	Yes	311	42.3
Departmental training for cardio-oncology			No	425	57.7
Yes	395	53.7	**Revision of systems and standards after training**		
No	341	46.3	Post-training revisions	286	38.9
Frequency of departmental training for cardio-oncology			Revised one year after training	18	2.4
Weekly	55	7.5	Revised with the Nursing Department's revision schedule	357	48.5
Monthly	116	15.8	No revision	75	10.2

General Information of the Subject Nurses

Table 2 presents the general information of the nurses who participated in the survey. There are 8 males and 728 females; 111 nurses, 287 primary nurse, 282 nurse-in-charge, 50 deputy director of the nurse, and 6 chief nurses; 525 chemotherapy drugs are infused daily, 133 weekly, and 78 monthly.

Results Regarding the Cardio-Oncologic Knowledge

Awareness Rate of the Cardio-Oncologic Knowledge

Table 3 presents the results regarding the nurses' awareness of cardio-oncology. As clear from the table, the awareness rate of health guidance was 3.9%, the highest among all dimensions. Moreover, the awareness rate of implementing the treatment was the lowest (0) among all dimensions. The awareness rate of an individual topic ranged from 0.1% to 44.7%. No one can answer all the questions correctly and the overall awareness rate was 0. These data demonstrated that

Table 2 General Information Regarding the Nurses in the Oncology Departments of Tertiary Hospitals in Shanxi Province

Item	Quantities (Person)	Component Ratio (%)	Item	Quantities (Person)	Component Ratio (%)
Gender			Chief nurse	6	0.8
Male	8	1.1	**Working years in oncology department**		
Female	728	98.9	<1 year	208	28.3
Age			1–3 year	122	16.6
<25 years old	47	6.4	4–5 year	60	8.1
25–30 years old	209	28.4	6–10 year	147	19.9
31–35 years old	210	28.5	11–15 year	144	19.6
36–40 years old	157	21.3	>15 year	55	7.5
41–45 years old	58	7.9	**Tumor knowledge meets the needs of work**		
46–50 years old	31	4.2	Yes	329	44.7
>50 years old	24	3.3	No	407	55.3
Professional title			**Frequency of use of chemotherapy drugs**		
Nurse	111	15.1	Monthly infusion	78	10.6
Primary nurse	287	39.0	Weekly infusion	133	18.1
Nurse-in-charge	282	38.3	Daily infusion	525	71.3
Deputy director of the nurse	50	6.8			

Table 3 Awareness Rate of Oncology Cardiology Knowledge Among the Nurses in the Oncology Departments at the Tertiary Hospitals in Shanxi Province

Item	Number of People Who Know/Person	Awareness Rate/%
Disease observation	0	0
1.Which of the following antineoplastic treatments do you think cause cardiotoxicity?	297	40.4
2.Which of the following drugs would you consider to have cardiotoxicity as a major side effect?	1	0.1
3.When do you think cardiotoxicity will occur?	92	12.5
4.What are the key observations of nurses regarding the use of cardiotoxic drugs?	30	4.1
Health guidance	29	3.9
1.What are the precautions for cardiotoxicity that nurses can implement?	329	44.7
2.What are the health guidelines for patients who may have heart disease with oncology?	52	7.1
Implementation of treatment	1	0.1
1.Which of the following antineoplastic therapies can be given directly intravenously?	1	0.1
2.Which of the following antineoplastic drugs requires rapid instillation (within half an hour)?	33	4.5
3.Which of the following antineoplastic drugs must be instilled within one hour?	40	5.4
4.Which of the following antineoplastic drugs should be given slowly (at least 3 h)?	1	0.1
Overall awareness	0	0

the nurses pay greater attention to disease health guidance, particularly the preventive measures, and the overall awareness regarding these was poor among the subject nurses.

Comparison of the Awareness Rates in Different Dimensions

Table 4 presents the results of the comparison of the nurses' awareness rates of the cardio-oncologic knowledge among all dimensions. The Chi-squared test revealed a P-value of less than 0.001, ie, the difference was statistically significant, which indicated that differences existed in the awareness rates of at least two dimensions. Table 5 presents the results of the multiple comparisons of nurses' awareness rates among the three dimensions, which were conducted using the a-split method. Two revealed P-value was <0.001, and the test level a was 0.05/3 (0.017), with statistical significance. It showed that significant differences existed between health guidance and disease observation and also between health guidance and implementation of treatment. In contrast, no statistical difference existed between disease observation and implementation of treatment.

Correlation Analyses

Correlation Analysis Between the Awareness of Cardio-Oncologic Knowledge and the General Hospital Information

Table 6 presents the results of the correlation analysis between the awareness of cardio-oncologic knowledge and the general hospital information. Spearman correlation analysis revealed a weak and positive correlation of cardio-oncologic knowledge with the level of the hospital, the type of hospital, the size of the oncology ward, departmental training for oncology cardiology, the personnel undertaking training, training kits in the department, package chemotherapy training materials in the department, and cardio-oncology training kit in department. A moderate and positive correlation was also between the cardio-oncologic knowledge and the oncology nursing specialty group.

Table 4 Comparison of the Differences in the Awareness of Disease Observation, Health Guidance, and Implementation of Treatment

Item	Awareness		X^2 value	*P* value
	Number of People Who Know/%	Number of People Who Do Not Know/%		
Disease observation	0(0)	736(100)	54.947[a]	<0.001
Health guidance	29(2.9)	707(97.1)		
Implementation of treatment	1(0.1)	735(99.9)		

Note: [a]The (0.0%) expected count of 0 cells is less than 5.

Table 5 Multiple-Comparison Analysis of the Awareness Rate of Disease Observation, Health Guidance, and Implementation of Treatment

Item	Awareness		Total	X^2 value	*P* value
	Number of People Who Know/%	Number of People Who Do Not Know/%			
Disease observation	0(0)	736(100)	736	29.583[a]	<0.001
Health guidance	29(2.9)	707(97.1)	736		
Total	29	1443	1472		
Disease observation	0(0)	736(100)	736	N/A[b]	1
Implementation of treatment	1(0.1)	735(99.9)	736		
Total	1	1471	1472		
Health guidance	29(2.9)	707(97.1)	736	26.677[a]	<0.001
Implementation of treatment	1(0.1)	735(99.9)	736		
Total	30	1442	1472		

Notes: [a]The (0.0%) expected count of 0 cells is less than 5. [b]The (50.0%) expected count of 2 cells is less than 1. The data were analyzed using Fisher exact probability test.

Table 6 Spearman Correlation Analysis Between the Awareness of Cardio-Oncology and General Hospital Information

Item	Awareness		Item	Awareness	
	r value	*P* value		*r* value	*P* value
Hospital level	0.170	<0.001	Frequency of departmental training for cardio-oncology	0.001	0.998
Type of hospital	0.085	0.020	Undertake training of personnel	0.142	<0.001
Oncology ward size	−0.051	0.171	Training kits in department	0.092	0.013
Oncology nursing specialty group	0.433	<0.001	Package chemotherapy training materials in department	0.084	0.023
Quality checker of oncology patient care	0.030	0.415	Oncology cardiology training kit in department	0.109	0.003
Departmental training for cardio-oncology	0.247	<0.001	Revision of systems and standards after training	0.007	0.845

Table 7 Spearman Correlation Analysis Between the Awareness of Cardio-Oncologic Knowledge and the General Information of Nurses

Item	Awareness		Item	Awareness	
	r value	*P* value		*r* value	*P* value
Gender	0.014	0.704	Working years in oncology department	0.663	<0.001
Age	−0.067	0.070	Tumor knowledge meets the needs of work	−0.022	0.550
Professional title	−0.012	0.751	Frequency of use of chemotherapy drugs	0.382	<0.001

Correlation Analysis Between the Awareness of Cardio-Oncologic Knowledge and the General Information of the Nurses

Table 7 presents the results of the correlation analysis between the awareness of cardio-oncologic knowledge and the nurses' general information dataset. Spearman correlation analysis revealed that awareness of cardio-oncologic knowledge was moderately positively correlated to the nurses' years of experience working in the oncology department of the hospital and was weakly positively correlated the frequency of chemotherapy drug usage.

Discussion

Nurses in the Oncology Units of Tertiary Hospitals in Shanxi Province Have a Low Awareness Rate of the Cardio-Oncologic Knowledge

According to results presented in Table 3, the single-question rate of awareness of cardio-oncologic knowledge among the oncology department nurses ranged between 0.1% and 44.7%, and no one answered all the questions correctly. While this result was consistent with the findings of Jingjing Jia,[16] who reported insufficient cardio-oncologic knowledge among the healthcare personnel, the lower awareness rate observed in the present study could be related to the large number of respondents who have worked in the oncology department for less than one year and the question type, the judgment criteria of the awareness rate, and the setting of the calculation formula. All questions used in the present study were non-directional multiple-choice questions; each question might have one or more answers. Only when all answers are correctly answered is a single question judged correctly known; multiple or fewer choices are incorrect. All questions in each dimension were answered correctly to be judged to be single-dimensional correctly known. Taking the disease observation as an example, all the answers to the four questions are correct, which means that this dimension is known. When all the questions are answered correctly, the nurse knows the whole knowledge. Because nursing work is facing life issues, nurses are required to choose the best nursing care from a wide range of nursing measures to care for patients in their daily work, and this setting fits the actual nursing situation. This setting of examination questions requires nurses to know all the common knowledge of cardio-oncology and to choose accurately which meets the high-level requirements of tertiary hospitals. In China, the concept of cardio-oncology was proposed in 2016.[17] Therefore, the nurses' low awareness of cardio-oncologic knowledge could be related to the fact that education on this concept has not been included in the nursing school study material to date. Table 4 and Table 5 revealed differences in the single-dimension

knowledge rates, with health guidance having the highest knowledge rate of 3.9%, which was attributable to China's strong promotion of health education in the "Healthy China 2030 Planning Outline".[18] The awareness rate of disease observation was 0, indicating that the nurses had poor knowledge of the patient's condition observation, and they could not fully observe the patient's condition and provide precision nursing for the patient. In China, nursing is identified as a first-level discipline since 2011,[19] which requires nurses to master a broad range of specialist data on basic nursing knowledge and reflect precise professionalism in their work to promote the development of the nursing discipline.[20] The observation of a patient's illness is a factor that reflects the professionalism of nurses. In addition, the accountability system for holistic care has been continuously advocated since 2011, which requires nurses to observe the patient's condition, undertake therapeutic and nursing measures, and provide health guidance.[10] While nurses have, since then, gradually paid greater attention to the observation of a disease, a huge gap remains, as revealed by the results of this study. Shijuan Gao and others,[21] in their study on the risk assessment of safe chemotherapy failure, also reported concerns over the implementation of abnormal infusion of chemotherapy drugs due to the lack of disease observation. According to this study, the awareness rate of treatment implementation was 0.1%, which was inconsistent with the 53.4% awareness rate of implementation of correct management strategies to reduce the incidence of cardiovascular disease reported by Jingjing Jia.[16] This could be related to the fact that only the drip rate of chemotherapy drugs was investigated in this study. Since the drip rate requirements for drugs are detailed in the drug insert, it is possible that nurses are not habituated to reading drug instructions. Nursing managers would, therefore, have to begin with multiple approaches to promote cardio-oncologic knowledge among their subordinate nurses. The first could be to assist the nurses in fully understanding the concept of holistic nursing with responsibility to stimulate their interest in the all-round management of patients and undertake the required initiatives for mastering the relevant knowledge. The second approach would be to improve the nurses' awareness of the necessity of mastering the relevant knowledge by emphasizing to the nurses that they have to perform well in terms of patient observation, health guidance, implementation of treatment, and the other requirements. The third approach could involve encouraging the nurses to read the drug instructions, which contain detailed explanations on the requirements for drug usage and the drug instructions have legal effect.[22] The fourth approach would be adopting a variety of strategies, such as strengthening the training and quality supervision to promote the nurses' mastery of the relevant knowledge.

Hospitals Should Implement Precise Care for Cancer Patients by Improving the Nurses' Cardio-Oncologic Knowledge

Oncology patients are a special group of individuals with a low resistance to the effects of the disease and the treatment they are receiving, which results in physiological and psychological debilitation.[23] Chemotherapeutic drugs are a special kind of medication that is lethal also to normal tissue cells[24] and, therefore, require strict control of the drip rate and close observation of the patient's reaction to the drug.[25] The nurses should, therefore, be more precise in the nursing measures they undertake for the oncology patients who are infused with cardiotoxic drugs. In the present study, all questions were judged to be correct only when all the correct answers were provided, which is consistent with the concept of precision nursing. Precision nursing is the embodiment of specialty nursing[26] and necessitates developing high-quality nursing.[27] According to the results presented in Table 3, the awareness rates associated with these four questions of disease observation were 40.4%, 0.2%, 12.5%, and 4.1%, respectively, indicating the lack of relevant knowledge in the respective fields. This lack of knowledge would render it impossible to observe precisely during infusion while also influencing the accuracy of notification to the patients at discharge and a precise follow-up after discharge. The correct answer rate for "implementation of treatment" dimension was just 0.1%, which was consistent with the finding of Shijuan Gao,[21] who also reported an infusion speed error in the safe administration of intravenous chemotherapy drugs among nurses. The health guidance dimension included two questions on the knowledge of preventive measures for cardiotoxicity and discharge guidance. Only 44.7% and 7.1% of the nurses were answered correctly, respectively, which was consistent with the report of Jingjing Jia[16] on low awareness rate of preventive strategies against cardiovascular risks and dietary guidance to reduce cardiovascular risks. Indeed, from the perspective of knowledge, belief, and practice,[28] mastering relevant knowledge is the basis of precise nursing. This is attributable to various reasons. First, mastering the

main points related to illness observation would enable the nurses to observe patients precisely and timely identify the changes in the illness, thereby facilitating the doctors in providing accurate diagnosis and treatment. Second, the accurate patrol determined according to the characteristics of drugs would be useful indirectly in terms of the efficient utilization of the nursing human resource in the event of a relative shortage of this resource.[29] Third, mastering the illness observation-related points during different periods would enable accurate communication and reassure the patients, reflecting humanistic care. Fourth, the accurate infusion achieved after mastering the requirements of drug infusion speed would prevent the medication errors due to the use of improper infusion speed.[30] This would also prevent the nurses from becoming the second victim of the occurrence of infusion speed errors.

The Hospital Should Provide Efficient Training on Precise Nursing for the Nurses in Their Respective Oncology Departments to Promote the Mastery of Cardio-Oncologic Knowledge

The results in Table 6 show that cardio-oncologic knowledge was better in Class III A hospitals, general hospitals, hospitals with an oncology center, multiple trainers, a oncology nursing specialty group, the presence of training for cardio-oncology, the availability of training packages in the department, the availability of chemotherapy training packages in the department, and the availability of cardio-oncology training packages in the department. According to the results presented in Table 7, the nurses' cardio-oncologic knowledge was positively correlated to their years of experience working in the oncology department and the frequency of chemotherapy drug usage. This indicated that the longer the time spent in the oncology department, the more frequent the use of chemotherapeutic drugs, and the better the cardio-oncologic knowledge. In the present study, 55.3% of the nurses felt that their current knowledge level did not meet the requirements of oncology nursing. In the past five years, several organizations in China as well as internationally have issued guidelines and expert consensus on oncology cardiology,[31,32] which mention the management of oncology patients. In addition, 10.2% of the nurses in the present study stated that their hospitals had not incorporated relevant training on this knowledge into the hospital's standards and other norms. Hospital norms form the basis for nurses' implementation, while the guidelines and consensus guide the clinical work, although they cannot be applied directly.[33] Both should be refined, summarized, and implanted into the hospital's systems, standards, procedures, and other specifications. For instance, the "2021 ICOS Consensus Statement: Definition of Cardiovascular Toxicity in Cancer Treatment[12]" as well as the "2022 ESC/EHA/ESTRO/IC-OS Guidelines: Cardio Oncology[13]", describe vascular toxicity, although the former is detailed and further comprehensive compared to the latter, and reading multiple guidelines is not convenient. Indeed, the content in the same guide does not have to be implanted within the same specification and could also be implanted in multiple aspects of the nursing work and reflected in multiple trainings. For instance, both shift and patrol nurses should observe the condition of the patient and examine the infusion speed. As a nursing manager, multiple points could be considered in providing training on precision nursing. First, the training of nurses should, in addition to relying on the unified training organized by the nursing department, include training in specialized knowledge. Second, the training must be conducted by professionals. Third, the latest releases must be immediately incorporated into the training content through updation. Fourth, the system, standards, and processes must be revised at different points and the training content should be strengthened. Fifth, comprehensive knowledge points should be focused on when preparing the training content. Sixth, key points should be highlighted and increase the assessment of knowledge that is easy to ignore. Seventh, the training must be conducted based on the daily findings.

Hospitals Should Establish a Professional Group of Oncology Nurses to Ensure the Quality of Nursing Provided to Cancer Patients

All hospitals included in the present study were tertiary hospitals, representing a high level of domestic hospitals.[34] In these hospitals, nurses undergo standardized training and assessment prior to receiving/joining their posts.[35] However, the overall awareness rate of cardio-oncologic knowledge among the evaluated nursing staff in the oncology departments of these hospitals was determined to be zero, which indicated that the awareness rate might not be a problem on its own and could rather be related to inadequate management. The daily work of the hospital is heavy, with the various tasks intricately intertwined, thereby requiring a rigorous design for benign operation. The results presented in Table 6 revealed

that the nurses' cardio-oncologic knowledge was related to several factors, which could all be improved by establishing a specialty group for oncology nursing. This is consistent with the report of Michael,[36] who believed that multi-disciplinary professional teams comprising cardiologists, oncologists, nurses, with rich and diverse knowledge on the relevant topics, could provide training to the trainee nurses to assist them in enhancing and clarifying their knowledge. Since the 14th Five-Year Plan of China, the nation has witnessed vigorous development in the specialties,[37] with the nursing professional groups playing a great role in improving the quality of specialized nursing and improving the overall nursing experience of patients.[38] Hospitals should, nonetheless, consider a few points when establishing specialty groups for oncology nursing. First, the professional group of oncology nursing should establish a seamless connection with the work-related content of the other professional groups at the hospital to ensure that everyone has something to do and everything is managed properly. Second, the members of the oncology professional group should include the head nurse of the oncology specialty or the oncology specialist nurse who has obtained the qualification certificate. Third, when organizing training, these professional groups should consider the training frequency and the nurses who would undertake this training and whether preparing the training brochures. Fourth, the corresponding quality assessment standards should be formulated and also updated according to the latest training content at different points in time. Fifth, when setting the score, the quality assessment standard should increase the score of important and easily ignored content. Sixth, daily quality control must do well and set frequency of quality control.

Limitations

The present study had the following limitations. First, the study considered only the general information of the hospital and the general information of the nurses, while the nurses' cardio-oncologic knowledge could have been affected by various other factors. Therefore, further studies based on detailed interviews must be conducted to increase the content of general information for a further detailed analysis, which would improve the relevant factors. Second, the cardio-oncologic knowledge investigated in the present study was evaluated based on the relevant literature and the drug inserts, which implies that only the current level of knowledge has been considered in the study, while in real, the repertoire of this knowledge is ever-increasing as the field of medicine progresses. The treatments are being improved and updated.

Conclusion

The present study focused on the cardio-oncologic knowledge among the nurses of the tertiary hospitals in Shanxi Province. The study included the analysis of the correlation between the knowledge and the general information of hospitals and nurses. It was revealed that tertiary A hospitals, larger tumor wards, diversified trainers, organizing training related to cardio-oncology, having a special training brochure, establishment of a professional oncology group, frequent use of chemotherapy drugs, timely revision of the existing systems and standards according to the training content, could promote the nurses' mastery of the knowledge related to cardio-oncology. Finally, feasible suggestions for enhancing precision nursing, such as precision training for nurses and the establishment of professional oncology nursing groups for cancer patients, were provided.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethical Approval

This study was approved by the Institutional Review Board of Shanxi Bethune Hospital of China (YXLL-2023–171) and conducted in accordance with the Declaration of Helsinki. All nurses provided informed consent.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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