WEP Warwick Evans Publishing

International Journal of Public Health and Medical Research

ISSN: 3006-7707 (Print), ISSN: 3006-3752 (Online) | Volume 2, Number 1, Year 2024
DOI: https://doi.org/10.62051/ijphmr.v2n1.01
Journal homepage: https://wepub.org/index.php/IJPHMR/index

Knowledge, Attitudes, and Practices of Oncology Nurses in the Maintenance of Peripherally Inserted Central Catheter (PICC) in Selected Hospitals in Shandong Province China

Feifei Chang, Alfredo Z. Feliciano

Graduate School, Angeles University Foundation, Angeles City 2009, Philippines

ABSTRACT

Background: Standardized catheter maintenance by nurses can reduce complications. Understanding the knowledge, attitude and practice status of clinical nurses in PICC maintenance is of great practical significance for medical and health development. Objective: To describe the current knowledge, attitude and practice (KAP) of nurses on peripheral central catheterization (PICC) maintenance. Methods: The knowledge, attitude and behavior of PICC maintenance of 317 oncology nurses in Shandong Province were analyzed by questionnaires. The counting data were described by frequency and percentage. The influence factors of PICC maintenance knowledge, attitude and behavior were determined by independent sample t test and one-way analysis of variance. Results Gender, age, professional title, education level, work experience, PICC training experience and PICC certificate are all significant factors affecting PICC maintenance knowledge, attitude and behavior. In the dimension of PICC maintenance knowledge, 212 nurses (mean = 10.00, SD=1.26) were proficient in PICC maintenance knowledge, while 105 nurses (mean = 16.60, SD=1.34) were obviously lacking in PICC maintenance knowledge. In the dimension of PICC maintenance attitude, the average score of nurses' PICC maintenance attitude was 52.92+10.34 points, and 228 nurses (mean = 58.86, SD=4.67) had a positive attitude towards PICC maintenance. The average score of nurses' PICC maintenance practice was 62.03+13.00, 64% of nurses had good PICC maintenance practice ability, and 203 nurses (mean =71.33, SD=4.76) had good PICC maintenance practice ability. Discussion In conclusion, the knowledge, attitude and practice of PICC maintenance of oncology nurses in Shandong Province were all at a moderate level. The role of demographic factors on PICC maintenance was paid attention to, and the training on PICC maintenance was emphasized, and the knowledge level, attitude cognition and practical ability of nurses on PICC maintenance were improved through diversified training methods.

KEYWORDS

Nurses; Knowledge; Attitudes; and Practices (KAP); Peripherally Inserted Central Catheter (PICC)

1. INTRODUCTION

A Peripherally Inserted Central Catheter (PICC) is a thin tube that is inserted through peripheral veins (e.g., basilic, median elbow, cephalic, brachial, and external jugular veins) so that the tip of the catheter is located in the superior vena cava or inferior vena cava. Peripheral catheterized central catheter (PICC) has been widely used since it was introduced into China because of its clinical advantages such as long indentation time, small vascular damage, convenient placement and removal [1]. In the United States, more than 1 million patients use PICC to meet their treatment needs every year [2]. Compared with general superficial venipuncture, PICC has a deeper position and a longer indwelling time, so follow-up catheter maintenance has become an important clinical issue. And PICC is considered as the best vascular access device for tumor treatment at present [3].

Complications arising from the use of PICC lines are serious issues. Timely and standardized PICC maintenance is of great clinical significance to prevent catheter-related complications. At present, the overall incidence of PICC-related complications is between 12% and 37% [4, 5] such as thrombosis roughly around 0.3% to 28.3% [6], bloodstream infection around 1.4% to 6.9% [7], phlebitis at 0.6% to 22.12% [7, 8] and skin injury at 13% to 19.7% [9, 10]. The occurrence of these complications adversely increases the rate of second intubation, affects the treatment effect and prognosis, prolongs the hospitalization time of patients, increase medical-related expenses, induces negative emotions such as anxiety and depression, and reduces the quality of life and medical satisfaction of patients [11]. Therefore, timely and standardized maintenance of PICC is of great clinical significance for preventing catheter-related complications.

Infusion Nursing Society (INS) means that transparent semipermeable membrane dressing should be changed regularly every 5 ~ 7 day, and gauze dressing should be changed every 2 days. If PICC catheter is not correctly and regularly maintained in time, it leads to a series of problems, such as shortening the safe indwelling time of catheter, increasing the incidence of catheter-related complications and unplanned extubation rate, and aggravating the pain of patients [12]. The clinical practice guidelines issued by the British Hematology Standards Committee defined the classification of central venous access, advantages and disadvantages of clinical application, complications and preventive measures; The Nursing Practice Standard for Infusion Therapy formulated by American Society of Intravenous Infusion Nursing puts forward relevant requirements in the aspects of operation technology, training and assessment, infection prevention and safety compliance, complications related to infusion, and professional ability of nurses, and establishes a strict INS qualification assessment and certification system to ensure the quality of infusion treatment. Improper nursing or negligence is the leading cause of complications [13]. Scholars believe that paying attention to maintenance after catheterization and strengthening nurses' training can effectively reduce complications [14]. Studies have shown that nursing after subclavian vein catheterization in strict accordance with the norms and strengthening prevention, monitoring, and treatment can reduce the occurrence of complications, prolong the safe time of subclavian vein catheterization, improve the effect of venous catheterization and reduce the economic burden of patients [15]. Cluster nursing intervention can significantly reduce the incidence of catheter blockage, catheter shedding, and CRBSI in patients with central venous catheterization [16]. Nurses' standardized catheter maintenance can reduce complications, prolong the service life of catheters, and reduce the economic burden of patients, which is of great significance in the whole process of intravenous treatment. Therefore, it is urgent to understand clinical nurses' knowledge, attitude, and practice in PICC maintenance and to carry out targeted and efficient knowledge training.

Despite recommendations for standardized practices of PICC maintenance, serious complications continually arise in both national and international settings. With an increasing number of cancer patients that require chemotherapy and insertion of PICC, more is required among oncology nurses who maintain these invasive lines. The study aims to understand the oncology nurses' knowledge, attitudes, and practices regarding PICC maintenance.

1.1. Study Objectives

(1) General Objective

The study described the knowledge, attitude, and practices of nurses, along with their influencing factors, regarding PICC maintenance in selected hospitals in Shandong Province, China.

(2) Specific Objectives

To describe the respondents' profile, as to demographic (Gender, Age, Position, Educational Attainment) and work profile (Unit Assignment, Work Experience, Trainings on PICC Maintenance; PICC Maintenance Certificates; PICC Patients Treated Per Shift)

a. To assess the respondents' knowledge on PICC maintenance;

b. To assess the respondents' attitude on PICC maintenance;

c. To assess the respondents' practices on PICC maintenance; and

d. To determine the difference of knowledge, attitude and practices on PICC maintenance of the respondents when grouped according to respondents' demographic and work profile.

1.2. Conceptual Framework

A descriptive conceptual framework is used in this study to illustrate the process of how the study is going to be conducted. A literature review starts the study to understand the main purpose and provide a direction for the research. Specifically, more information is gathered to understand PICC in general and the required maintenance for oncology nurses. Identified inclusion and exclusion criteria leads to preparing for the data collection process to answer the main research question and objective. With the three (3) main variables for the study, the overall aim is to understand the oncology nurses' knowledge, attitude, and practices toward the maintenance of PICC.

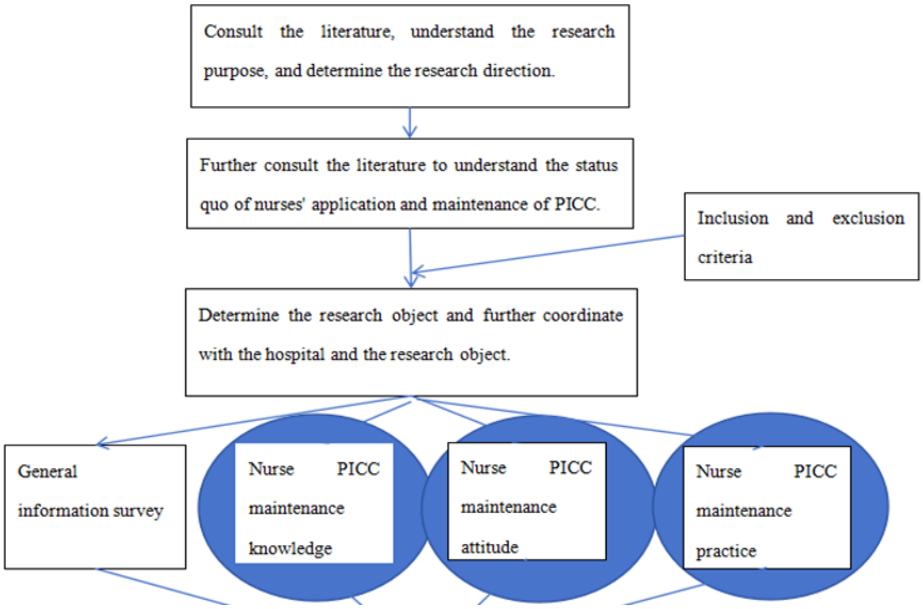

Figure 1. Conceptual Framework

2. REVIEW OF RELATED LITERATURE

2.1. Practice of PICC

Peripherally inserted central venous catheter refers to a catheter placed through the peripheral vein of the upper limb or neck of adults and children (scalp or lower limb vein for infants), and the catheter tip is located in the inferior vena cava or superior vena cava. It mainly provides patients with medium to long-term intravenous infusion therapy ([17]). However, the course of malignant tumor patients is relatively long, and patients need to receive intravenous infusion and chemotherapy for a long time. For patients with advanced cancer, PICC can largely avoid the damage of chemotherapy drugs and intravenous infusion drugs to patients' blood vessels.

2.2. PICC Application at Home and Abroad

PICC can greatly reduce the pain caused by frequent venipuncture, protect patients' peripheral veins, reduce complications, and has the advantages that the liquid flow rate is not affected by the patient's

body position, it is not easy to escape, the indwelling time is extended, nurses' bedside can intubate it, and there is no need for anesthesia and needle fixation. Since its clinical application, it has been widely used in chemotherapy, total parenteral nutrition, nursing care of patients with extensive burns, rescue of critically ill patients, and determination of central venous pressure at home and abroad. It is reported that about 14 million patients in the world are using central venous catheters, including about 3.3 million PICC [18].

2.3. The Role of Nurses in the Maintenance of PICC Catheter

PICC catheter placement is the only operation authorized by nurses independently at present. Because of its professional knowledge, new technology, and new concepts, clinical practice requires a more comprehensive ability of PICC nurses. It is difficult to insert, maintain, and pull out PICC, which requires high technical requirements for operators and requires specialized nurses to implement professional and high-quality nursing operations. Studies have shown that the success rate of PICC catheterization and the incidence of complications after catheterization are closely related to the comprehensive professional ability of PICC nurses. Older nurses, who have longer working experience and have more distribution units may have more experience in PICC maintenance, and nurses with higher education levels may have more maintenance knowledge. Different genders may also have an impact on the importance of catheter maintenance [19].

2.4 Nurses' Knowledge, Attitudes, and Practice of PICC Maintenance

The maintenance of PICC in the United States is mainly based on the 2016 edition of Practice Standard for Infusion Therapy, compiled by the Infusion Nursing Society. However, the current clinical practice and corresponding guidelines are not uniform. The main basis of catheter maintenance in China is the "Technical Operation Standard for Intravenous Therapy and Nursing" issued by the Health and Health Commission and the "Practice Standard for Infusion Therapy" formulated by the American Intravenous Infusion Nursing Association (INS). China's venous catheter maintenance standards are constantly improving, but irregular catheter maintenance is still widespread in clinical practice.

2.4.1. Knowledge

Nurses need to gain better knowledge of catheter maintenance. A survey of hospitals above the second level in Shandong shows that 12.75% have never received the standard of static therapy training, and 75.29% think they need to continue systematic training [20]. Studies have shown that some hospitals in ten provinces/autonomous regions and one city in the western region have practiced the standard of static therapy. However, nurses have a poor grasp of the standard of static therapy, with an average correct rate of 41.1% [21]. Some studies suggest that nurses' basic knowledge about intravenous therapy is poor, so there is a need to strengthen the explanation and training of the content of static therapy standard and promote its implementation [22]. Yu et al. pointed out that the score of pediatric nurses' PICC maintenance knowledge was (61.73±11.98), and further training was needed for PICC maintenance knowledge [23]; Tao et al. pointed out that the score rate of nurses' knowledge of PICC maintenance in the medical association was 66.18%, and 53.15% (59/111) were qualified or above, among which the nurses with grade 2 or below had poor knowledge of PICC maintenance in specialized hospitals [24]. Oncology department, as a department with frequent use of PICC, can better assist the implementation of the next training by understanding the situation of catheter maintenance of oncology nurses, thus ensuring the safety of patients.

2.4.2. Attitudes

Nurses have a poor attitude towards catheter maintenance. Giovanni and other researchers selected 70 nurses for analysis, involving a total of 171 maintenance operations, including catheter flushing (24%), dressing replacement (34%), needle-free infusion joint disinfection and replacement, which

were inconsistent with the guidelines [25]. Xin selected 686 nurses from 12 tertiary general hospitals in Shaanxi Province as the research object, and the results showed that the average score of nurses' PICC was (8.88±7.52), and there was a positive correlation between their knowledge, attitude and behavior [26]. The reason may be that nurses have poor knowledge of catheter maintenance, so they can't maintain it correctly, or it may be that some nurses are busy with clinical work to simplify their work.

2.4.3. Practices

Nurses have poor practice in catheter maintenance. In a survey of nurses in secondary and tertiary hospitals in Guizhou Province, it was found that nurses' PICC maintenance practice was not ideal, and the average score of nurses' PICC maintenance practice was 79.77±12.13. Nurses' practice was influenced by the availability of PICC guidelines, whether they had received training and their attitude towards PICC maintenance [27].

2.5. Future Research Perspectives

Due to the apparent advantages of operability, safety, and fewer complications, PICC has been widely used in tumors, critical patients, and family parenteral nutrition and is regarded as the most potential central venous access in the future. However, due to the unbalanced development of information, medical care, education, and other resources in different regions, nurses' PICC maintenance skills, the ability to deal with complications, and the level of health education may be insufficient, thus increasing the incidence of the catheter complications, shortening the length of catheter, and increasing the economic burden of patients. Therefore, it is necessary to understand the status quo of nurses' knowledge, attitude, and behavior towards PICC maintenance so as to guide the problems existing in PICC maintenance.

3. METHODS

3.1. Study Design and Locale

The descriptive correlational study determines the knowledge, attitude, and practices of oncology nurses in the maintenance of PICC. The study will be conducted in the tertiary hospitals in Shandong, China. The development of PICC technology in hospitals in Shandong Province is different, and their respective hospitals or departments usually formulate the practical scheme followed by nurses in PICC clinical practice. So, this study is convenient to extract oncology departments from 20 tertiary hospitals in Shandong Province, China, which mainly includes three departments: the tumor chemotherapy department, tumor radiotherapy department, and tumor minimally invasive department.

3.2. Study Participants

3.2.1. Sample Size and Sampling

The sample is computed based on a 5% margin of error, a confidence interval of 95%, and a 50% response distribution. The study includes more than the required sample size to achieve generalizable findings. According to the proportion range in the sample estimation table provided by the Social Investigation Research Method, it is determined by combining experience and practice. There are 122 tertiary hospitals in Shandong Province, and the total number of oncology nurses is about 2,000. Taking the proportion of 10%-30%, plus the loss of 20% of the total sample size, considering the actual situation, the sample size is finally set at 317. The participants will come from 20 tertiary hospitals in Shandong Province and will be selected using a convenient sampling technique.

3.2.2. Inclusion and Exclusion Criteria

Inclusion Criteria:

(1) Full-time nurse in the oncology department;

(2) Working experience is over 6 months;

(4) Nurses with or without PICC certification or training will be included;

(5) Those with experience of doing PlCC maintenance in the current workplace.

Exclusion Criteria:

(1) Nurses who refused to cooperate with this study;

(2) Those absent during data collection.

3.3. Research Instrument

The research instrument is divided into two (2) major sections: a general information survey to collect the respondents' socio-demographic statistics and work characteristics and a second part of the questionnaire to measure the nurses' knowledge, attitudes, and practices of PICC care. The internal consistency of the questionnaire Cronbach's α is 0.996, and its reliability and validity are good [28].

Nurses' knowledge of PICC maintenance: PICC maintenance knowledge questionnaire was applied to measure participants' knowledge of PICC maintenance [19].The scale consisted of 19 items each, it includes five answers: always, often, sometimes, rarely, and never, which are recorded as 5, 4, 3, 2, and 1respectively.

Nurses' attitude towards PICC maintenance: Nurses' attitudes toward PICC maintenance was determined by PICC maintenance attitude questionnaire [19]. Likert's 5-level scoring method is adopted, it includes five answers: always, often, sometimes, rarely, and never, which are recorded as 5, 4, 3, 2, and 1respectively. Show all scores by average. The higher the score, the better the nurses' attitude towards PICC maintenance.

Nurses' PICC maintenance practice: Nurses' practice of PICC maintenance was measured by PICC maintenance practice questionnaire [19]. and the Likert 5-level scoring method is adopted, including five answers: always, often, sometimes, rarely, and never, which are recorded as 5, 4, 3, 2, and 1 respectively. The higher the score, the higher the nurse's PICC maintenance practice.

3.4. Specific Procedures Based on Study Objectives

3.4.1. Communication Letters

The study applied to the director of the hospital's nursing department, for the conduct of the investigation to obtain the permission to conduct a questionnaire survey on PICC maintenance-related issues. Ethical approval was sought. The study underwent an extensive review process by the Angeles University Foundation -Ethics Review Committee and was granted approval to conduct the study.

3.4.2. Floating of Questionnaire

After coordinating with all the head nurses in the oncology department, the study proceeded by informing every respondent about the purpose of the study and how they can participate. They filled in the form free of charge according to their wishes and investigate the relevant data through an on-site questionnaire survey. The researcher explained the items that the respondents do not understand and the matters needing attention in filling in the questionnaire in time to assist the smooth progress of the questionnaire survey, and the questionnaire was recovered on the spot. It was also checked whether there was any omission or unsatisfactory filling in of the questionnaire.

3.4.3. Follow-up of Responses

All data was entered and double checked. If there were any questions or differences in the entry process, it was communicated / reconciled with the research object to eliminate the deviation and ensure that the entered data is not wrong.

3.5. Ethical Considerations

3.5.1. Informed Consent Process, Duration of Participation, and Withdrawal Criteria

Before the investigation, explain the research purpose, process and confidentiality principle to nurses, allow them to refuse to participate, and assure them that not participating will not affect their work, and sign an informed consent form after obtaining their consent. The whole process of participants' participation in the questionnaire survey is voluntary; that is, participants can decide to stop the questionnaire survey at any time without any adverse effects on them. It takes 15-20 minutes to complete the questionnaire.

3.5.2. Risks and Inconveniences

This study uses the form of a questionnaire survey, and there is of negligible risk. After two years, the collected data will be deleted to avoid information leakage of the participants.

3.5.3. Benefits of the Study

By understanding the knowledge, attitude, and behavior of nurses in the selected hospital for PICC maintenance, master the situation and existing problems of nurses in PICC maintenance, and then provide suggestions for training maintenance knowledge.

3.5.4. Privacy, Confidentiality, and Data Management

In the whole process of the study, the respondents and their personal data are confidential, and the collected data do not involve privacy issues such as names, but are only represented by code names. In the process of writing a paper, names will never be involved, and all research results are only for research purposes. All data are protected by passwords and stored for two years.

3.5.5. Conflict of Interest

There is no conflict of interest in this study. The researcher is assuring the integrity and impartiality of the research process. A conflict of interest arises when external influences or personal considerations could potentially compromise the objectivity, validity, or reliability of the study's findings. By affirming the absence of such conflicts, we are declaring that the researchers involved have acted with transparency, honesty, and ethical integrity throughout the entire research endeavor.

3.6. Statistical Analysis of Data

SPSS 29 utilized in this study. Demographic profile and work characteristics; and knowledge, attitude and practice of the respondents was calculated using descriptive statistics (frequency, percentage distribution, average and mean).

The distribution of nurses in the survey will be presented in a table, and the knowledge, attitude, and practice of PICC will be illustrated using tables also. The difference in the variables according to the demographic profile and work characteristics of the respondents will be analyzed using ANOVA and t-test. However, if the data is not normally distributed, Kruskal-Wallis analysis and Mann-Whitney analysis were used.

4. RESULTS

4.1. Demographic and Work of Nurses

Table 1 shows the demographic profile of the 317 participants, which reveals a predominantly female representation, comprising 89.6% of the sample, while males constitute 10.4%. Regarding age distribution, the majority falls within the 30–39 age range, accounting for 50.2%, followed by those aged 20–29 at 30.0%, indicating a relatively young workforce. In terms of position, the largest proportion are supervisor nurses (40.1%), followed closely by senior nurses (33.4%), highlighting a diverse hierarchy within the nursing staff. Educational attainment shows a significant majority of participants holding undergraduate degrees (64.7%), with junior college (26.2%) and graduate students (9.1%) representing smaller proportions. When referring to educational levels such as junior, undergraduate, and graduate in the context of this study, they typically represent different stages of academic achievement and preparation. Oncology nurses in the context of this study, are healthcare professionals who specialize in providing care to patients diagnosed with cancer. They work in healthcare settings, cancer treatment, oncology clinics, and palliative care facilities.

Table 1. Demographic Profile (N=317)

Demographic Profile	n	%
Gender		
Female	284	89.6
Men	33	10.4
Age		
20–29	95	30.0
30–39	159	50.2
40–49	50	15.8
50–59	13	4.1
Position		
Junior nurse	40	12.6
Senior nurse	106	33.4
Supervisor nurse	127	40.1
Head nurse	44	13.9
Educational Attainment		
Junior college	83	26.2
College	205	64.7
Graduate Student	29	9.1
Work Experience		
<2	24	7.6
2–5	80	25.2
6-10	104	32.8
>10	109	34.4
Training on PICC Maintenance		
Yes	307	96.8
No	10	3.2
PICC Maintenance Certificates		
Yes	114	36.0
No	203	64.0

Overall, the demographic makeup suggests a predominantly female, relatively young nursing workforce, with a diverse range of positions and educational backgrounds contributing to the study.

The work characteristics of respondents, clarify the professional landscape. Work experience is diversified, with the majority (34.4%) having over 10 years of experience, followed by those with 6-10 years (32.8%) and 2–5 years (25.2%), indicating a range of expertise levels among participants. Training on PICC maintenance is widespread, with 96.8% of respondents having received training, underscoring the commitment to professional development. Concerning PICC maintenance certificates, 36.0% of respondents hold certificates, while 64.0% do not, highlighting the variation in certification status among participants. These findings collectively depict a nuanced view of the work characteristics and professional backgrounds of the study participants, contributing to a comprehensive understanding of the nursing workforce under investigation.

Table 2. Number and Proportion of Correct Responses to Items of PICC Maintenance Knowledge (n=317)

Knowledge on PICC Maintenance	Correct (f)	Correct (%)
1. Content of PICC maintenance	317	100
2. Preferred disinfectant and correct disinfection range when replacing dressing	264	83.3
3. Incorrect method of tearing the film when replacing it	139	43.8
4. Wrong time to replace clear dressing infusion joint	274	86.4
5. Incorrect sterilization of the screw part when replacing the infusion joint	284	89.6
6. Type and minimum volume of rinse solution should be used after infusion of blood products and fat milk	294	92.7
7. Maintain the type and volume of sealing fluid for PICC	235	74.1
8. Maintain piping flushing and sealing techniques used in PICC	314	99.1
9. PICC accidentally completely removed from the incorrect intervention	276	87.1
10. Correct intervention of PICC block	301	95.0
11. The preferred auxiliary test for PICC-associated thrombosis	316	99.7
12. Proper precautions for PICC-associated infections	317	100.0
13. Incorrect intervention of PICC rupture in vitro	99	31.2
14. The first intervention for PICC rupture in vivo	256	80.8
15. Incorrect intervention of phlebitis	302	95.3
16. Correct intervention for contact dermatitis	133	42.0
17. Incorrect health education for discharged PICC patients	90	28.4
18. Incorrect operation to remove PICC	211	66.6
19. In the process of PICC removal, the patient suddenly appeared signs and symptoms such as dyspnea, chest pain, hypotension, irritability, sweating, etc., and the intervention operation was not correct	148	46.7

This paper analyzes 19 items of PICC maintenance knowledge dimension (Table 2, 3). Table 2 shows that a large number of nurses are knowledgeable about the content of PICC maintenance (item 1, 317, 100%), correct preventive measure for PICC-related infections (item 12, 317, 100%), the preferred auxiliary test for PICC-associated thrombosis (item 11, 316, 99.7%), maintain piping flushing and sealing techniques used in PICC (item 8, 314, 99.1%), incorrect intervention of phlebitis (item 15, 302, 95.2%), correct intervention of PICC block (item 10, 301, 95%), indicating that the nurses surveyed had a good understanding of the basic operations and infection prevention measures of PICC maintenance and had a certain level of knowledge of PICC maintenance. This table shows that among the items that measured their knowledge of PICC maintenance, only few nurses are knowledgeable about health education for discharged patients with PICC (item 17, 90, 28.4%), intervention for PICC breakage in vitro (item 13, 99, 31.2%), incorrect method of tearing the film when replacing it(item 3, 139, 43.8%), correct intervention for contact dermatitis(item 16, 133, 42%).indicating that nurses lack

knowledge of in vitro PICC rupture intervention and patient health education, and it is necessary to strengthen the learning of PICC rupture intervention knowledge and health education knowledge in the future.

The total score of PICC maintenance knowledge dimension is 19 points, which is divided according to 60% [19] of the total score, that is, a score above 11.4 indicates that the PICC maintenance knowledge is good, and a score below 11.4 indicates that the PICC maintenance knowledge is poor. According to the PICC knowledge dimension scale, the final statistics show that 212 nurses (mean= 10.00, SD=1.26) are proficient in PICC maintenance knowledge, and 105 nurses (mean= 16.60, SD=1.34) have obvious lack of PICC maintenance knowledge, indicating that more than half of nurses have acceptable knowledge of PICC maintenance knowledge, but there are still a large number of nurses who need to strengthen their PICC maintenance knowledge. The knowledge level of nurses is directly related to the life and health of patients, so it is still necessary to pay attention to and regularly evaluate nurses' knowledge of PICC maintenance, and comprehensively improve nurses' knowledge quality of PICC maintenance.

Table 3. PICC maintains knowledge pass to fail ratio

Variable		Totality	Percent (%)	Mean + SD
Knowledge	Not knowledgeable	105	33.1	16.60+1.34
	Knowledgeable	212	66.9	10.00+1.26

The study analyzed 17 items of PICC maintenance attitude (Table 3, 4). The higher the total score of attitude dimension, the more positive nurses' attitude towards PICC maintenance. According to the results in Table (3, 4), most of the entries scored above 3 points, indicating that nurses were able to recognize the importance of PICC maintenance for patient safety, had a positive attitude toward continuous learning and skill improvement, and were willing to participate in PICC maintenance. PICC maintenance attitude includes professional skills, health management, skill training and other contents, which can show that nurses always take patients as the center in PICC maintenance, respect patients, ensure personalized care and improve patient satisfaction. In terms of attitudes towards PICC maintenance, table 3A shows that nurses believe timely and correct PICC maintenance can reduce the occurrence of PICC-related complications (mean= 3.68, SD=0.469). They also believe that PICC maintenance training must be conducted regularly (mean=3.49, SD=0.501). Nurses consider it necessary to master the knowledge of PICC maintenance and the management of complications (mean= 3.44, SD=0.557). Most nurses agreed that Patients with PICC need regular catheter maintenance during both the treatment period and the treatment intermission (mean= 3.42, SD=0.571). Most nurses are willing to attend PICC maintenance training (item 17, I am willing to take an active part in PICC maintenance training, mean=3.42, SD=0.394). Meanwhile, low mean scores that suggest a not so favorable attitude about PICC maintenance concerning mastery of technique to better meet the needs of discharged patients with PICC (mean= 2.22, SD=0.978). The average score of nurses in item 10 was lower, indicating that nurses were less likely to agree that they had the responsibility to educate PICC patients and their caregivers about their daily management of PICC (mean= 2.25, SD=0.882). The average score of item 11 "Nurses can play an important role in catheter maintenance of discharged patients with PICC" was low, that is, most nurses believed that nurses could not play an important role in catheter maintenance with a negative attitude (mean= 2.47, SD=1.129). The use of correct flushing and locking techniques is critical for preventing PICC occlusion (mean= 2.94, SD=1.045) and the selection of appropriate disinfectants and disinfection ranges is critical for preventing Pics associated infections (mean= 2.97, SD=0.898) both scored low.

Table 4. Respondents' Attitudes on PICC Maintenance

Attitudes on PICC maintenance	Mean+ SD
1. Patients with PICC need regular catheter maintenance during both the treatment period and the treatment intermission.	3.42+0.571
2 There is a correlation between indwelling time and the timely and correct PICC maintenance.	3.15+1.167
3. Timely and correct PICC maintenance can reduce the occurrence of PICC related complications.	3.68+0.469
4. PICC maintenance needs to be performed according to a standardized process.	3.04+1.021
5. Strict aseptic procedures in the process of PICC maintenance is essential to prevent PICC-related infections.	3.36+0.532
6. Choosing the right disinfectant and disinfection range is important to prevent PICC-related infections.	2.97+0.898
7. Using the correct flushing and locking techniques is essential to prevent PICC occlusion.	2.94+1.045
8. A comprehensive and systematic catheter function assessment contributes to the early identification of PICC-related complications.	3.31+0.904
9. Effective health education for patients with PICC contributes to PICC self-management.	3.38+0.603
10. Nurses are responsible to provide education on PICC daily management for patients with PICC and their caregivers.	2.25+0.882
11. Nurses can play an important role in catheter maintenance for discharged patients with PICC.	2.47+1.129
12. It’s necessary for nurses to master the knowledge of PICC maintenance and complication management.	3.44+0.557
13. Nurses need to master the PICC maintenance technique to better meet the needs of discharged patients with PICC.	2.22+0.978
14. Participation in PICC maintenance training is important for nurses to improve relevant knowledge and skills.	2.95+0.723
15. PICC maintenance training should be conducted regularly.	3.49+0.501
16. I am interested in learning knowledge of PICC maintenance.	3.43+0.496
17. I am willing to take an active part in PICC maintenance training.	3.42+0.494
Total mean score	52.92+10.34

The total score of PICC maintenance attitude dimension is 68 points, which is divided according to 60% of the total score, that is, a score higher than 41 indicates a good PICC maintenance attitude (positive), and a score lower than 41 indicates a poor PICC maintenance attitude (negative). According to the dimension scale of PICC maintenance attitude, the final statistics showed that 228 nurses (mean= 58.86, SD=4.67) had a positive attitude towards PICC maintenance and 89 nurses (mean= 37.71, SD=1.82) had a negative attitude towards PICC maintenance, indicating that most nurses were willing to carry out PICC maintenance, but there were still some nurses who needed to change their negative attitude towards PICC maintenance to better maintain patients' health.

Table 5. Ratio of positive and negative attitudes maintained by PICC

Variable		Totality	Percent (%)	Mean + SD
Attitude	Negative	89	28.1	37.71+1.82
	Positive	228	71.9	58.86+4.67

This study analyzed the dimensions of PICC maintenance practice, including 16 items (Table 5). The higher the score, the higher the practical ability. The practical dimensions include mastering the basic

operations of PICC maintenance, complying with maintenance guidelines and regulations, identifying and managing PICC complications, teamwork and communication, and patient health education. As can be seen from Table 5, nurses can carefully follow the standard PICC maintenance process (mean=4.53, SD=0.536), strictly follow the aseptic principle (mean=4.60, SD=0.491), master the PICC flushing and sealing technology (mean=4.53, SD=0.565), correctly use disinfectants and distinguish disinfection areas (mean=4.58, SD=0.537), and the above items are above 4.50 points. It indicates that the respondents can often or always perform the above practical operations, have good practical skills, and can provide high-quality PICC dimension operations for patients. At the same time, the study also found that the scores of nurses constantly learning PICC maintenance technology innovation technology were lower (mean=2.89, SD=1.517), and the scores of maintenance and management items using electronic resources such as online databases to understand PICC maintenance complications were also lower (mean=2.68, SD=1.325) , both lower than 3 points, indicating that the respondents occasionally or infrequently learned the latest practical skills of PICC maintenance. Low awareness of continuous learning.

Table 6. Respondents' Practices on PICC Maintenance

Respondents' Practices on PICC Maintenance	Mean+ SD
1. I take the initiative to learn the background knowledge and development status of PICC maintenance technology.	3.03+1.663
2. I proactively follow the promotion of PICC maintenance technology.	2.89+1.517
3. I am familiar with the types and specifications of PICC catheters.	3.44+1.376
4. I learn about PICC maintenance and management of complications through electronic resources such as online databases and professional journals	2.68+1.324
5. I take the initiative to participate in the training related to PICC maintenance organized by the department and the hospital.	3.10+1.317
6. I identify risk factors for PICC-related complications for patients with PICC.	3.80+0.938
7. I provide targeted education to patients with PICC on maintenance related knowledge.	3.56+0.675
8. I follow a standardized process for PICC maintenance no matter with or without supervision.	4.53+0.536
9. I strictly follow the principle of asepsis when performing PICC maintenance.	4.60+0.491
10. I master PICC flushing and sealing techniques.	4.53+0.565
11. I can select the correct type and amount of PICC flushing and sealing fluids for patients.	4.29+0.658
12. I can select the correct disinfectant solution and disinfection area when disinfecting the skin.	4.58+0.537
13. I can correctly time the change of transparent dressings and connectors.	4.25+0.468
14. When performing PICC maintenance, I assess the limb inserted with catheter to determine if there are any PICC-related complications.	4.23+0.951
15. I properly manage various PICC-related complications.	3.91+0.806
16. I indicate the date of maintenance and record relevant information in a long-term care booklet after performing PICC maintenance.	4.62+0.493
Total mean score	62.03+13.00

The total score of PICC maintenance practice dimension is 80 points, according to 60% of the total score, that is, higher than 48 points indicates strong PICC maintenance practice ability, and lower than 48 points indicates weak PICC maintenance practice ability. According to the PICC maintenance practice dimension scale, the final statistical results showed that 203 nurses (mean=71.33, SD=4.76) had strong PICC maintenance practice ability and 114 nurses (mean=45.48, SD=1.36) had weak PICC maintenance practice ability, indicating that most nurses had strong PICC practice ability, but some nurses still needed to improve their practice level of PICC maintenance.

Table 7. Ratio of acceptable to unacceptable PICC maintenance practices

Variable		Totality	Percent (%)	Mean + SD
Practice	Poor	114	36	45.48+1.36
	Good	203	64	71.33+4.76

Table 8 shows the statistical analysis results of age, gender, position, education, work experience, PICC maintenance training, PICC maintenance certificate and other variables in three dimensions of knowledge, attitude and practice. The "p-value" column represents the level of statistical significance for each variable related to knowledge, attitude, and practice. The results showed that age, gender, professional title, educational level, work experience, PICC maintenance training experience and PICC maintenance certificate had significant differences in PICC maintenance knowledge, attitude and practice scores. Specifically, nurses of different genders had statistical differences in PICC maintenance knowledge($P<0.05$) and attitude ($P<0.05$) dimension, but not in PICC maintenance practice dimension($P>0.05$). In the dimension of PICC maintenance knowledge, the average score of men was higher (mean=17.061, SD=0.088); In the dimension of PICC maintenance attitude, the average score of men is also higher (mean=60.30, SD=1.015). In terms of professional titles, nurses' professional titles had significant effects on knowledge ($P<0.000$), attitude ($P<0.000$) and behavior ($P<0.000$) of PICC maintenance, indicating that nurses with different professional titles had differences in their ability levels and ways of PICC maintenance. Specifically, in the dimension of PICC maintenance knowledge, Supervisor nurse had the highest average score (mean=16.94, SD=1.125), followed by Head nurse (mean=56.05, SD=1.509); In the dimensions of PICC maintenance attitude and practice, Supervisor nurse had the highest average score, and Head nurse had the second average score. Similarly, education significantly affected nurses' knowledge ($P<0.000$), attitude ($P<0.000$), and behavior ($P<0.000$), and nurses with higher education levels were likely to show higher proficiency and adherence to PICC maintenance programs. Specifically, in terms of PICC maintenance knowledge, Junior college had the highest average score (mean = 16.31, SD=1.189), followed by college (mean=10.48, SD=1.090). In the dimension of PICC maintenance attitude, Junior college has the highest average score (mean=60.46, SD=3.001), followed by college (mean=51.95, SD=+10.349). In terms of PICC maintenance practice, Junior college has the highest average score (mean=68.63, SD=3.196)., followed by college (mean=61.62, SD=14.286). PICC maintenance training experience and PICC maintenance certificate significantly affected nurses' knowledge ($P<0.000$), attitude ($P<0.000$) and behavior ($P<0.05$), indicating that experienced, trained and certified nurses had higher knowledge level, more positive attitude and better behavior towards PICC maintenance. Specifically, nurses without PICC maintenance training experience had higher average scores in PICC maintenance knowledge (mean=16.90, SD=0.316), attitude (mean=59.60, SD=0.843) and practice (mean=64.60, SD=1.506,) than nurses with previous training experience, which may be related to the small number of nurses without PICC maintenance training experience, resulting in higher average scores. At the same time, the average scores of PICC maintenance knowledge (mean=17.06, SD=1.250), attitude (mean=60.03 SD=1.822,) and practice (mean=70.95, SD=10.009) of nurses with PICC maintenance certificate were higher than those of nurses without PICC maintenance certificate, indicating that nurses with certificate had higher PICC maintenance level and stronger comprehensive quality.

Table 8. Nurse Demographic Characteristics and Their Association with PICC Maintenance Knowledge, Attitude and Practice Score (n=317)

Variable	Knowledge		Attitude		Practice	
	M±SD	P value	M±SD	P value	M±SD	P value
Age		< 0.001		< 0.001		< 0.001
20–29	9.89+1.292		38.67+3.410		46.12+3.408	
30–39	16.14+2.014		57.84+5.358		68.84+10.577	
40–49	16.88+0.521		62.48+0.789		69.82+1.870	
50–59	16.92+0.277		59.85+0.899		65.08+1.605	
Gender		< 0.001		< 0.001		0.303
Female	14.11+3.423		52.05+10.624		61.77+13.107	
Men	17.061+0.088		60.30+1.015		64.24+12.202	
Position		< 0.001		< 0.001		< 0.001
Junior nurse	9.72 +1.377		37.58+1.708		44.95+ 1.484	
Senior nurse	12.90+3.643		47.66+10.793		53.78+12.871	
Supervisor nurse	16.94+1.125		61.03+1.795		71.75+4.119	
Head nurse	15.07+0.873		56.05+1.509		69.39+4.013	
Educational Attainment		< 0.001		< 0.001		< 0.001
Junior college	16.31+1.189		60.46+3.001		68.63+3.196	
College	14.20+3.642		51.95+10.349		61.62+14.286	
Graduate Student	10.48+1.090		38.07+1.831		46.03+0.981	
Work Experience		< 0.001		< 0.001		< 0.001
<2	9.83+1.308		42.54+4.075		48.42+5.823	
2–5	10.04+1.267		37.59+1.853		45.42+1.385	
6-10	17.13+1.370		60.25+2.376		70.77+10.714	
>10	16.06+1.208		59.43+3.264		68.88+3.396	
Trainings on PICC Maintenance		0.014		0.426		0.451
Yes	14.34+3.404		52.69+10.466		61.95+13.220	
No	16.90+0.316		59.60+0.843		64.60+1.506	
PICC Maintenance Certificates		< 0.001		< 0.001		< 0.001
Yes	17.06+1.250		60.03+1.822		70.95+10.009	
No	12.93+3.292		48.91+11.034		57.02+11.793	
Note: Kruskal-Wallis and Mann-Whitney were used since the data is not normally distributed						

5. DISCUSSION

5.1. On the Demographic Profile of the Nurses

The demographic profile of the 317 participants offers valuable insights into the nursing workforce under study. With women comprising 89.6% of the sample. The majority falling within the 30–39 age range (50.2%) indicates a relatively young workforce. The distribution of positions reveals a diverse hierarchy, with supervisor nurses (40.1%) and senior nurses (33.4%) prominent, reflecting typical organizational structures. Educational attainment is predominantly undergraduate (64.7%), emphasizing the importance of higher education in nursing [29]. Overall, these findings depict a dynamic and diverse nursing workforce, crucial for addressing evolving challenges.

5.2. On the Work Characteristics of the Nurses

The work characteristics of respondent sheds light on their professional landscape. Work experience varies, with a notable 34.4% having over 10 years, indicative of seasoned professionals. Moreover, widespread training on PICC maintenance (96.8%) underscores commitment to professional development. Variation in PICC maintenance certificates (36.0% holding certificates) suggests differing competencies impacting practice. Overall, these findings offer a comprehensive understanding of the nursing workforce, crucial for improving practice, education, and policy in oncology care.

5.3. On the Nurses' Knowledge, Attitudes, and Practices on PICC Maintenance

As to the knowledge of nurse in PICC maintenance, the study showcases the proficient PICC maintenance skills of respondents, reflecting a strong emphasis on education and training within their healthcare organization. These findings align with prior research, emphasizing the importance of nurses' expertise in reducing complications associated with PICC lines [30]. Furthermore, on nurses' practices in PICC maintenance, the results of the study emphasize their commitment to patient safety and adherence to established protocols. While nurses demonstrate proficiency in various aspects of PICC maintenance, areas for improvement, such as enhancing vigilance in recognizing complications and patient education, are identified, emphasizing the need for ongoing education and training initiatives. Overall, these insights contribute to efforts aimed at enhancing the quality and safety of PICC care practices in healthcare settings.

In addition, the knowledge, attitude and practice of PICC maintenance of oncology nurses in Shandong Province are at a moderate level. We pay attention to the effects of factors such as gender, age and professional title on PICC maintenance, and pay particular attention to PICC maintenance training. Diversified training methods such as lectures and systematic course teaching were adopted, and training guidelines were constantly updated to comprehensively improve nurses' knowledge level, attitude cognition and practical ability of PICC maintenance [31, 32]. At the same time, the study focuses on areas where knowledge, attitude and practice scores are low. In the dimension of PICC maintenance knowledge, we found that the average score of nurses with good knowledge was 10.00, and that of nurses with poor knowledge was 16.60. Specifically, nurses lacked knowledge on health education of discharged patients, intervention of in vitro PICC rupture, intervention of contact dermatitis, etc. Good health education is an important preventive approach to maintain the health of discharged patients [33]. In the future, nurses' health education and training should be emphasized to comprehensively improve their knowledge and literacy. In the dimension of PICC maintenance attitude, the results showed that most nurses' attitude towards PICC maintenance was positive, but some attitudes needed to be changed. Among them, nurses' attitude towards "nurses need to master PICC maintenance technology, in order to better meet the needs ", "nurses are responsible for providing patients with PICC daily management education", "nurses play an important role in catheter maintenance after patients are discharged" and other aspects are more negative. The study found that most nurses believed that they were not the main person in charge of PICC maintenance and did not need to improve the technical level of PICC maintenance. The results showed that the cognition of nurses' professional role was vague, considering that it was related to job burnout, they should pay attention to the psychological and physiological conditions of nurses, reduce the work burden of nurses, provide psychological support to nurses, and improve the working environment and salary. Reduce the occurrence of nurse burnout [34, 35]. In the dimension of PICC maintenance practice, more than half of nurses have strong practice ability, but there are still some aspects to be improved. Specifically, the scores of nurses' initiative and enthusiasm in actively learning PICC maintenance techniques and actively participating in PICC maintenance training were low, indicating that nurses' initiative in learning PICC maintenance knowledge was not strong, and their initiative in continuing medical education was weak, which further led to their weak knowledge, attitude and practical ability

in PICC maintenance, which was considered to be due to excessive occupational pressure. Unable to coordinate work and study [36]. Hospital managers arrange nurses' work reasonably, encourage nurses to participate in training and continue to learn, improve nurses' learning and training enthusiasm, and improve the comprehensive quality of hospital talents.

5.4. On the Difference of Knowledge, Attitude and Practices on PICC Maintenance of the Nurses when Grouped According to their Demographic Profile

Different ages had significant effects on nurses' knowledge, attitude and practice of PICC maintenance ($p<0.05$), this indicates that the older the age, the more clinical experience, contact with more patients, and can face a variety of clinical scenarios in a timely and effective manner. Similarly, Different genders had significant effects on nurses' knowledge, attitude and practice of PICC maintenance ($p<0.05$), these results indicate that there are significant differences between different genders in PICC maintenance practices, which may be related to the occupational cognition and occupational attitudes of different genders. Different professional titles had significant effects on nurses' knowledge, attitude and behavior of PICC maintenance, showing that nurses in higher positions demonstrate greater expertise [37]. The significant p-values (0.000) for knowledge, attitude and for practices) confirm this, emphasizing the need for tailored training programs at different hierarchical levels. The findings demonstrates that educational attainment significantly influences nurses' PICC maintenance proficiency, this is consistent with the results of previous studies [37]. The significant p-values (0.000 for knowledge, attitude and practices) support this, highlighting the importance of ongoing education and professional development initiatives in enhancing PICC care skills. These findings collectively emphasize the holistic approach needed to ensure nurses' proficiency in PICC maintenance, considering factors such as age, gender, hierarchical position, and educational attainment. By addressing these diverse influences through tailored training programs and professional development initiatives, healthcare organizations can enhance overall patient safety and quality of care.

5.5. Relationship of PICC maintenance training on nurses' knowledge, attitude and behavior of PICC maintenance

In addition, it underscores the influence of training on nurses' PICC maintenance proficiency. Nurses who master the knowledge of PICC maintenance through standardized training can effectively reduce the occurrence of adverse reactions in patients [38]. The results of this study show that PICC maintenance training has a significant impact on PICC maintenance knowledge, attitude and practice, indicating that clinical nurses who have undergone PICC maintenance training will obtain a higher level of PICC maintenance knowledge, a more positive attitude and a stronger PICC maintenance practice ability. However, at present, due to the limited knowledge level of nurses in PICC operation and maintenance, they have insufficient understanding of PICC complications, insufficient understanding of the importance and necessity of PICC maintenance, lack of necessary prevention knowledge and difficulty in understanding the professional nursing skills required for PICC maintenance, and even some regional nurses are completely unaware of PICC maintenance knowledge [39]. As a result, clinical operation and maintenance of PICC catheterization cannot be performed. According to previous studies, at this stage, nurses in most hospitals, especially primary hospitals, have uneven cognition of PICC maintenance knowledge, and some nurses have poor knowledge of PICC maintenance [32, 40]. Even due to the lack of clinical nurses' knowledge of PICC maintenance, some medical institutions will not provide PICC catheterization services, thus affecting patient treatment [41].Therefore, in the future, efforts should be made to improve the specialized nursing technology of primary hospitals, increase the standardized training of nursing staff, give play to the driving and leading role of the "top-down" medical union, encourage high-level general hospitals to actively help primary medical institutions, provide safe and effective PICC operation and

maintenance technology to primary medical institutions, and provide high-quality medical services for patients in an all-round way.

6. CONCLUSIONS

The study highlights a predominantly female workforce. With a notable youthfulness. There is diverse hierarchy, with supervisor nurses and senior nurses as the majority, reflecting a typical organizational structure.

The study provides insights into the professional landscape showing diverse distributions in work assignments, reflecting specialized oncology nursing, with variation in work experience, and indicating seasoned professionals. Widespread training on PICC maintenance underscores commitment to professional development. PICC patients treated per shift reveals workload distribution disparities, highlighting staffing and resource allocation needs, while variation in PICC maintenance certificates suggests differing competencies impacting practice.

The study underscores nurses' proficiency, dedication to patient safety, and adherence to protocols in PICC maintenance. Their expertise, positive attitudes, and commitment to ongoing education contribute to a culture of safety and quality improvement. While demonstrating proficiency, areas for improvement highlight the need for continued education and vigilance in recognizing complications. These conclusions support efforts to enhance PICC care practices and ensure optimal patient outcomes in healthcare settings.

The study reveals that age and gender do significantly impact nurses' proficiency in PICC maintenance, echoing previous research. Significant differences based on hierarchical position and educational attainment emphasize the need for tailored training programs. These findings underscore the importance of considering diverse factors in ensuring nurses' competency in PICC care, ultimately enhancing patient safety and quality of care.

The study highlights significant disparities in PICC maintenance proficiency based on work experience, training, certification. These findings emphasize the importance of tailored training programs, mentorship, workload management strategies, and ongoing professional development initiatives to optimize PICC care quality and ensure standardized practice across diverse clinical settings.

7. RECOMMENDATIONS

(1) Given the predominantly female workforce and diverse hierarchy, healthcare organizations should develop leadership development programs that promote gender diversity and provide opportunities for career advancement for both male and female nurses.

(2) To address workload distribution disparities and ensure optimal patient care, healthcare institutions should establish workload management protocols that consider factors such as patient acuity levels, staffing ratios, and resource availability.

(3) To build on nurses' proficiency and dedication to patient safety in PICC maintenance, healthcare organizations should implement continuous education and training programs. These programs should focus on enhancing nurses' skills in recognizing complications, critical thinking, and communication, ensuring they remain updated on best practices and protocols.

(4) Recognizing the impact of hierarchical position and educational attainment on PICC maintenance proficiency, healthcare organizations should develop hierarchical-specific training initiatives. These programs should cater to the unique needs and competencies of nurses at different levels, providing targeted education and skill development opportunities to enhance their effectiveness in PICC care.

(5) To address disparities in PICC maintenance proficiency based on work experience, training, certification, healthcare institutions should foster interdisciplinary collaboration and support. This can involve creating platforms for knowledge sharing, establishing mentorship programs, and providing resources to support nurses in diverse clinical settings.

(6) Future Researchers may focus on investigating the long-term patient outcomes associated with different levels of nursing proficiency. This longitudinal study could assess factors such as PICC-related complications, infection rates, and patient satisfaction over an extended period, considering the influence of nurses' demographic characteristics, training, and workload on outcome.

ACKNOWLEDGEMENTS

This study was reviewed and approved for implementation by the Angeles University Foundation - Ethics Review Committee. (ERC code: 2024-MAN-Student-066). Participants gave informed consent to participate in the study before taking part.

REFERENCES

[1] Chen W, He L, Yue L, et al. Spontaneous correction of misplaced peripherally inserted central catheters [J]. Int J Cardiovasc Imaging, 2018, 34(7):1005-1008.

[2] Oza-Gajera B P, Davis J A, Farrington C, et al. PICC line management among patients with chronic kidney disease [J]. J Vasc Access, 2023, 24(2):329-337.

[3] Qingjuan J, Cui W, Yanping Y, et al. The effect of PDCA cycle management on the maintenance of PICC lines in outpatient department:A Meta-analysis [J]. Nursing of Integrated Traditional Chinese and Western Medicine, 2019.

[4] Liu B, Wu Z, Lin C, et al. Applicability of TIVAP versus PICC in non-hematological malignancies patients: A meta-analysis and systematic review [J]. PLoS One, 2021, 16(8):e0255473.

[5] Mielke D, Wittig A, Teichgraber U. Peripherally inserted central venous catheter (PICC) in outpatient and inpatient oncological treatment [J]. Support Care Cancer, 2020, 28(10):4753-4760.

[6] Mavrovounis G, Mermiri M, Chatzis D G, et al. Peripherally Inserted Central Catheter lines for Intensive Care Unit and onco-hematologic patients: A systematic review and meta-analysis [J]. Heart Lung, 2020, 49(6):922-933.

[7] Chopra V, O'Malley M, Horowitz J, et al. Improving peripherally inserted central catheter appropriateness and reducing device-related complications: a quasiexperimental study in 52 Michigan hospitals [J]. BMJ Qual Saf, 2022, 31(1):23-30.

[8] Yu X, Yue S, Wang M, et al. Risk Factors Related to Peripherally Inserted Central Venous Catheter Nonselective Removal in Neonates [J]. Biomed Res Int, 2018, 2018:3769376.

[9] Liu Jing, Liu Chunfang, Li Xiuchuan, et al. Summary of the best evidence for prevention of PICC catheter-related skin injury [J]. Chinese Journal of Nursing, 202, 57(16):8. (in Chinese.

[10] Zhao, Huihan, Yu, et al. Medical Adhesive-Related Skin Injury Prevalence at the Peripherally Inserted Central Catheter Insertion Site: A Cross-sectional, Multiple-Center Study [J]. Journal of wound, ostomy, and continence nursing: official publication of The Wound, Ostomy and Continence Nurses Society, 2018, 45(1):22-25.

[11] Swaminathan L, Flanders S, Horowitz J, et al. Safety and Outcomes of Midline Catheters vs Peripherally Inserted Central Catheters for Patients With Short-term Indications: A Multicenter Study [J]. JAMA Intern Med, 2022, 182(1):50-58.

[12] Ray-Barruel G, Xu H, Marsh N, et al. Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: A systematic review [J]. Infect Dis Health, 2019, 24(3):152-168.

[13] Li W, Li-Hua S, Hong-Mei W. Retrospective Analysis of Common Complications of Deep Vein Catheterization and Its Guiding Signi?cance for Nursing [J]. World Latest Medicine Information, 2019.

[14] Xu B, Zhang J, Hou J, et al. Nurses' knowledge of peripherally inserted central catheter maintenance and its influencing factors in Hunan province, China: a cross-sectional survey [J]. BMJ Open, 2020, 10(5):e033804.

[15] Chen Aizhu, Lin Min, Li Xuefan, et al. Effect of intravenous therapy nursing technical operation standard on the effect of subclavian vein catheterization [J]. Fujian Journal of Medicine, 2018, 40(4):2.

[16] Wei Chunling, Wen Chunyan. Application of cluster nursing concept in infection prevention and control of central vein catheterization [J]. Harbin Medicine, 2023, 43(02):143-144.

[17] Gorski L A, Hadaway L, Hagle M E, et al. Infusion Therapy Standards of Practice, 8th Edition [J]. J Infus Nurs, 2021, 44(1S Suppl 1):S1-S224.

[18] Oza-Gajera B P, Davis J A, Farrington C, et al. PICC line management among patients with chronic kidney disease [J]. J Vasc Access, 2023, 24(2):329-337.

[19] Xu Binbin, ZHANG Jinghui, HOU Jianmei, et al. Current situation and Influencing factors of PICC maintenance knowledge of nurses in primary hospitals of Hunan Province [J]. China Nursing Management, 2018, 18(10):1357-1361.

[20] Ma Mengying, Kong Dong, Li Changan, et al. Investigation on the status quo of Health industry standard training of Nursing staff in secondary and above medical institutions of Shandong Province [J]. PLA nursing journal, 2018, 35(07):14-19.

[21] Zhang Min, Li Wuping, Cheng Yijuan, et al. Investigation and analysis of the practice of "Technical Operation Standard of Intravenous Therapy Nursing" in Western Hospital [J]. Nursing Management in China, 2018, 18(5):4.

[22] Xu B, Zhang J, Hou J, et al. Nurses' knowledge of peripherally inserted central catheter maintenance and its influencing factors in Hunan province, China: a cross-sectional survey [J]. BMJ Open, 2020, 10(5):e033804.

[23] Yu X, Yue S, Wang M, et al. Risk Factors Related to Peripherally Inserted Central Venous Catheter Nonselective Removal in Neonates [J]. Biomed Res Int, 2018, 2018:3769376.

[24] Huang Qiongshan, CAI Yingying, Chen Mengyun, et al. Current situation and influencing factors of PICC maintenance knowledge of nurses in medical union [J]. Modern clinical nursing, 2020, 19(08):1-6.

[25] Di Fine G, Centini G, Gavetti D, et al. Best Practices in the Management of Central Vascular Access Devices: An Observational Study in Areas With a High Prevalence of Trained Nurses [J]. J Infus Nurs, 2018, 41(5):319-325.

[26] Xin Aili, Liu Xiaoran, Tian Yujie. Research on PICC related knowledge, attitude and behavior of nurses in general hospital [J]. Journal of Contemporary Clinical Medicine, 2020, 33(02):191-195.

[27] Hu L, Li Y, Li H, et al. Nurses' practice of peripherally inserted central catheter maintenance and its influencing factors in Guizhou province, China: a cross-sectional study [J]. BMJ Open, 2023, 13(3):e068656.

[28] Cheng Feng. Study on reliability and validity of the questionnaire on Knowledge and practice of ICU nurse Central venous catheter maintenance [D]. Anhui Medical University, 2021.

[29] Chen Jin, WANG Qin, Wei Li, et al. Current situation of knowledge, practice and Influencing factors of clinical nurses in prevention of PICC catheter-related infection [J]. Tianjin Nursing, 2021, 29(06):662-666.

[30] Zhou Qin, SHEN Xuhui, WU Wenjin. Current situation and coping strategies of clinical nurses on PICC-related knowledge [J]. Contemporary Nurses (last ten days), 2023, 30(02):35-38.

[31] Chen Lifen, Li Jinyan, Yang Yuhong, et al. Training and effectiveness of PICC maintenance for primary nurses in Guangdong Province [J]. Chinese Nursing Education, 2023, 20(02):194-199.

[32] Tao Shiqi, Huang Guiyun, Qian Yangfeng, et al. Cognition and influencing factors of PICC maintenance knowledge of clinical nurses in all levels of medical institutions in Yunnan Province [J]. Journal of Kunming Medical University, 2020, 41(11):158-164.

[33] Shao Jie, Xiong Yu, Ma Dan, et al. Meta-integration of qualitative studies on fear in patients with PICC catheterization [J]. Journal of Nursing Science, 2022, 37(17):80-82.

[34] Chen Teng, Chen Changying. The Relationship between role cognition, occupational commitment and occupational burnout of internal medicine nurses [J]. General Nursing, 2019, 17(27):3369-3371.

[35] Tong Dan, Tong Lei, Kang Xing-Yu, et al. Effect of job burnout on role cognition, sleep quality and Job satisfaction of pediatric surgery nurses [J]. Journal of Clinical Nursing, 2021, 20(04):73-76.

[36] Bai Linru, Ye Mei, He Huan, et al. Investigation and analysis of the status quo of continuing medical education in a certain hospital [J]. Chinese Medical Science, 2024, 14(12):43-46.

[37] Xu B, Zhang J, Hou J, et al. Original research: Nurses' knowledge of peripherally inserted central catheter maintenance and its influencing factors in Hunan province, China: a cross-sectional survey[J]. BMJ Open, 2020, 10(5).

[38] Tang Huaying, Zhang Lili, Chen Yunxiang, et al. Application of multidisciplinary cooperation led by specialist nurses in PICC quality control [J]. Integrated Nursing (Chinese and Western Medicine), 2020, 6(05):22-25.

[39] Qian Wei, Chen Mingxia. Investigation and analysis of knowledge and cognition of venous catheter maintenance in community nurse center [J]. Medical higher vocational education and modern nursing, 2020, 3(06):422-425.

[40] Chen Yun, Xu Lili. Investigation and analysis of PICC-related knowledge cognition of clinical nurses [J]. Gansu Medicine, 2018, 37(6):4.

[41] Sun Tingting, Tan Jianghong, HU Lingli, et al. Analysis of the status quo and constraints of PICC continuous care service [J]. Journal of Nursing Science, 2019, 34(10):91-94.