

Original Article

The influential factors and intervention strategies that engage malignant cancer patients in health-promoting behaviors during PICC line maintenance

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Abstract: Objective: To analyze the influential factors and intervention strategies involved in engaging health-promoting behaviors (EHPD) during peripheral central venous catheter (PICC) line maintenance in malignant tumor patients. Methods: 120 patients with malignant tumors who underwent PICC line maintenance in our hospital were prospectively analyzed. They were divided into a low and moderate level group (HPLP-II score ≤ 137) and a high level group (HPLP-II score > 137) according to their Health Promoting Lifestyle Profile II (HPLP-II) questionnaire scores. Single-factor and multifactor analyses were performed to identify the factors influencing the patients' engagement in self-health-promoting behaviors. The one hundred and twenty patients with malignant tumors were randomly divided into two groups ($n=60$ in each group). The control group and the intervention group underwent routine nursing care and patient education. The two groups were compared in terms of the changes in their HPLP-II scores, their Cancer Patients PICC Self-management Scale (CPPSM) scores, their SAS and their SDS scores before and after the intervention, as well as their maintenance compliance rates, their complication rates during catheter placement, and their lack of PICC maintenance. Results: Literacy, place of residence, duration of catheter use, self-management abilities of PICCs, social support, and anxiety were risk factors ($OR > 1$, $P < 0.05$). Compared with their pre-intervention scores, the HPLP-II and CPPSM scores were increased in both groups ($P < 0.05$), and the SAS and SDS scores were decreased in both groups after the intervention ($P < 0.05$), and the intervention group had higher scores than the control group ($P < 0.05$). The intervention group exhibited a higher maintenance compliance rate than the control group ($P < 0.05$). The incidence of complications and the lack of PICC maintenance in the intervention group were lower than they were in the control group ($P < 0.05$). Conclusion: The influential factors during PICC maintenance for EHPD in malignant cancer patients include literacy, place of residence, duration of PICC use, etc. Patient education can promote patients' EHPD and self-management abilities, relieve their anxiety and depression, reduce their complications, and improve their compliance.

Keywords: Malignant cancer patients, PICC, engagement in health-promoting behaviors, influential factors, health education

Introduction

Chemotherapy is a common option for treating malignant tumors, and the establishment of an effective channel for intravenous chemotherapy is a prerequisite for ensuring the therapeutic effect [1]. Traditional intravenous che-

motherapy is injected through a puncture in a peripheral vein, but repeated punctures increase the workload and pain levels [2]. Transperipheral central venous catheter (PICC) is a safe and reliable intravenous chemotherapy channel for malignant tumor patients, enabling the direct infusion of chemotherapy drugs into

the vein. PICC has the advantages of easy operation, long-term use, and a high puncture success rate, and it helps avoid vascular damage due to irritant agents [3, 4]. Although PICC placement has obvious advantages over other venous access methods, with its widespread application, catheter-related complications such as phlebitis, catheter blockage, and catheter dislodgement have become increasingly common [5]. Evidence has shown that PICC-related complications are not significantly associated with the duration of catheter placement but are closely related to patients' self-management abilities, health-promoting lifestyles, and caregiving techniques [6].

Health promotion behaviors are defined as the process of enabling people to improve their health by increasing control over their health and its determinants [7, 8]. It was found [9] that self-care abilities rely on healthy lifestyles, which can enhance patients' daily activities, and gradually strengthen the patients' attention towards self-care, thus effectively improving their self-care abilities [9]. Currently, there are clinical studies on the self-management abilities of PICC placement in patients with malignant tumors, but there is a lack of discussion on health-promoting lifestyles. The present study analyzed the influential factors and intervention strategies for EHPD during PICC line maintenance in malignant tumor patients.

Materials and methods

General information

A total of 120 patients with malignant tumors, including 64 males and 56 females, aged 27-79 years, who underwent PICC line maintenance in our hospital from March 2018 to December 2019 were recruited as the study cohort. (1) Inclusion criteria: patients with a duration of PICC placement ≥ 2 weeks, patients ≥ 18 years old, patients who were diagnosed with a malignant tumor using imaging, cytology, and pathology tests, and patients who could complete the questionnaires independently or with assistance. (2) Exclusion criteria: patients with concomitant severe organic disease, patients with a complete or partial inability to care for themselves, those with mental disorders, patients with a perceived barrier to communication or cognitive disorders, patients with contraindications to PICC placement such as a skin injury at the puncture site, vascular malformation, aller-

gy or a previous history of severe allergy, or the inability to participate in this study for other reasons. This study was approved by the ethics committee of The First Affiliated Hospital of Hainan Medical University. The patients and their family members voluntarily signed the informed consent forms.

Methods

Factor analysis: The patients were grouped according to HPLP-II [10], which contains six aspects including health responsibility, interpersonal relations, nutrition, physical activity, spiritual growth, and stress management, with 52 items in total, and with the possible scores ranging from 52-208 points. The HPLP-II scores >137 were classified as high level, and scores ≤ 137 were classified as low to moderate level. The demographic information including age, gender, education level, place of residence, and placement duration were compared between the two groups.

Method of care: The 120 patients with malignant tumors were randomly divided into two groups ($n=60$ in each group). The control group received routine care such as dietary intervention, routine patient education, and guidance on catheter placement. The intervention group received the following health education: (1) Before placement. The patients were informed of the long duration of chemotherapy and the need for long-term infusions to reduce the stimulation by chemotherapy agents. Previous patients who had been successfully treated were invited to give lectures. The placement process and the advantages of PICC, its role, and the key points during placement were explained using drawings, pictures and other visual methods. The patients were encouraged to communicate with their families to reduce their psychological pressure. (2) During placement. Optimal vascular access strategies were used with the patients. For pain-sensitive patients, the anesthesia drug doses could be increased within the limit. The physicians listened patiently to each patient's complaints during the operations. (3) After placement. The replacement of the patch as well as the dressing were explained and demonstrated. Patient education cards and brochures were distributed to explain the precautions to be taken after the placement. The risk factors for complications during placement and the prevention of complications were explained to the patients.

using patient education through WeChat groups and telephone follow-up. Educational videos on the maintenance of PICC placement and check-lists were used to supervise the patients and their families to independently carry out the daily catheter maintenance.

Outcome measurement: (1) Self-management abilities. The patients' self-management abilities before the intervention and at 3 months after intervention were assessed using the seven dimensions of the CPPSM [11], including confidence in catheter management, daily life management, and catheter maintenance compliance, and their abilities were classified as good (>144), moderate (108-144), or poor (<108). (2) Psychological status. Before the intervention and at 3 months after the intervention, the patients' psychological states were assessed using the Depression Self-assessment Scale (SDS) [12] and the Anxiety Self-assessment Scale (SAS) [13], with 20 items in each scale. The cut-off scores are 53 and 50, respectively, and exceeding the cut-off indicates depression or anxiety. (3) Catheter maintenance compliance. Strict adherence to the doctor's instructions and the timely and correct flushing, placement, and changing of the PICC catheters were judged as full compliance. Adherence to the doctor's instructions but difficulty in correctly performing the PICC catheter-related maintenance were defined as partial compliance. Non-adherence to the doctor's instructions and the inability to perform the PICC catheter-related maintenance were judged as non-compliance. (4) Lack of PICC maintenance. The occurrences of a loose dressing without maintenance at the puncture site, fluid leakage and blood at the puncture site without maintenance, more than two days using the same sterile gauze dressing without maintenance, 7 days without flushing, and dressing contamination at the puncture site without maintenance were compared between the two groups. (5) Complications during the placement of the catheter. During the placement, the complications such as bleeding at the puncture site, phlebitis, catheter blockage, and catheter dislodgement were recorded and compared.

Statistical analysis

The data were processed using SPSS 22.0 software. The measurement data were expressed as ($\bar{x} \pm S$) and compared using *t* tests. The count data were expressed as percentages and

compared using χ^2 tests. The rank data were examined using rank sum tests. $P < 0.05$ indicated a significant difference.

Results

General information

There were no significant differences in the general information such as gender, age, literacy, place of residence, monthly household income, etc. between the control group and the intervention group ($P > 0.05$), so they were comparable (**Table 1**).

Single factor analysis

There were significant differences in terms of literacy, place of residence, monthly household income, duration of catheterization, self-management abilities, social support, and anxiety between the high level group and the low and moderate level group ($P < 0.05$) (**Table 2**).

Multifactor analysis

Our unconditional logistic regression analysis showed that place of residence, literacy, self-management abilities, duration of catheter placement, social support, and anxiety were risk factors affecting engagement in self-health promotion behaviors during PICC line maintenance in malignant tumor patients ($OR > 1$, $P < 0.05$) (**Table 3**).

The HPLP-II and CPPSM scores

Both the HPLP-II and CPPSM scores were elevated after the intervention, and both scale's scores in the intervention group were higher than they were in the control group ($P < 0.05$) (**Figure 1**).

Psychological states

The SAS and SDS scale scores were decreased in both groups after the intervention, and the intervention group showed lower scores than the control group ($P < 0.05$), suggesting that patient education can significantly reduce patients' anxiety and depression during treatment (**Figure 2**).

Catheter maintenance compliance

The catheter maintenance compliance in the intervention group was better than it was in the control group ($P < 0.05$), indicating that patient

Table 1. Comparison of the general information between the two groups

General information		Control group (n=60)	Intervention group (n=60)
Gender	Male	33	31
	Female	27	29
Age		52.9±7.5	53.1±6.8
Literacy	Junior high school and below	20	19
	High school and technical secondary school	23	27
	Junior college and above	17	14
Place of residence	Rural area	19	18
	Cities and towns	25	23
	Urban area	16	19
Monthly household income per capita (Yuan)	<3000	19	15
	3000-5000	32	33
	>5000	9	12
Duration of placement (d)	14-30	20	23
	31-90	27	23
	>90	13	14
Social support	Low level	24	23
	Moderate level	20	19
	High level	16	18
Self-management skills	Good	11	13
	Moderate	25	23
	Poor	24	24
Anxiety		22	18

education can help promote catheter maintenance compliance (**Table 4**).

Lack of PICC maintenance

The occurrence of the lack of PICC maintenance in the intervention group (8.33%) was lower than it was in the control group (23.33%) ($P<0.05$), indicating that patient education can significantly reduce the occurrence of the lack of PICC maintenance (**Table 5**).

The complication rate during placement

The complication rate during the placement in the intervention group (10.00%) was lower than it was in the control group (26.67%) ($P<0.05$), suggesting that patient education can significantly reduce the incidence of complications during placement (**Table 6**).

Discussion

PICC has significant advantages among the methods used for the long-term injection of chemotherapy agents for malignant tumors, such as a simple operation, less traumatic, and long-term use. However, patients will have dif-

ferent degrees of stress reactions and psychological disorders during their catheterization, reducing their self-health-promoting behavior and adversely affecting the effects of the catheterization [14, 15]. Therefore, the factors affecting the engagement of self-health-promoting behaviors during PICC maintenance should be explored in order to formulate targeted interventions to improve their self-care abilities, improve their compliance, and reduce their complications.

Wen et al. [16] found that 125 cancer patients with PICC had an average score of (100.70±18.42) for health-promoting lifestyle, which was generally at a medium level, and the scores were related to the patients' education levels and the number of days of catheterization. This study found that the engagement of self-health-promoting behaviors during the PICC maintenance was influenced by factors such as educational level, place of residence, monthly household income, and the duration of catheter placement, which was basically similar to the above research results. The reasons are as follows: (1) Literacy. Patients with higher education levels can actively obtain relevant medical

EHPD influential factors and intervention strategies

Table 2. A single-factor analysis of EHPD in patients with malignant tumors

Factors		Low to moderate level group (n=88)	High level group (n=32)	Statistical value	P
Age (years)		53.6±8.15	52.1±7.88	t=0.887	0.377
Gender	Male	46	18	$\chi^2=0.149$	0.699
	Female	42	14		
Education	Lower secondary and below	36	3	$\chi^2=27.320$	0.000
	High school/junior college	40	10		
	College/undergraduate	12	19 ^{***}		
Place of residence	Rural	32	5	$\chi^2=12.696$	0.002
	Cities and towns	38	10		
	Urban areas	18	17 ^{**}		
Monthly household income per capita (Yuan)	<3000	25	9	$\chi^2=9.339$	0.009
	3000-5000	53	12		
	>5000	10	11 ^{**}		
Duration of placement (d)	14-30	36	7	$\chi^2=6.748$	0.034
	31-90	37	13		
	>90	15	12 [#]		
Number of placements	1	60	23	$\chi^2=0.166$	0.920
	2	18	6		
	≥3 times	10	3		
Timing to placement	First round of chemotherapy	55	17	$\chi^2=1.179$	0.555
	Second round of chemotherapy	24	12		
	Third round of chemotherapy	9	3		
Primary caregiver	Spouse	51	16	$\chi^2=0.778$	0.678
	Parent, brother, sister or child	23	9		
	Other	14	7		
Social support	Low level	42	5	Z=11.805	0.003
	Moderate level	27	12		
	High level	19	15 ^{**}		
Self-management skills	Good	10	14	Z=25.824	0.000
	Moderate	32	16		
	Poor	46	2 ^{***}		
Anxiety	Yes	35	5	$\chi^2=6.158$	0.013
	No	53	27 [#]		
Depression	Yes	9	2	$\chi^2=0.446$	0.504
	No	79	30		

Note: compared with the low to moderate level group, [#]P<0.05, ^{**}P<0.01, ^{***}P<0.001.

Table 3. A multifactorial analysis of EHPD in patients with malignant tumors

Factors	B	Standard error	Wald	P	OR	95% CI
Literacy (lower secondary and below)	2.944	0.705	17.441	0.000	19.000	4.771-75.663
Place of residence (rural)	1.799	0.588	9.365	0.002	6.044	1.910-19.133
Monthly household income (<3000 yuan)	1.117	0.585	3.648	0.056	3.056	0.971-9.614
Duration of placement (14-30 days)	1.414	0.566	6.240	0.012	4.114	1.356-12.482
Social support (low level)	1.892	0.586	10.431	0.001	6.632	2.104-20.903
Self-management abilities (poor)	3.472	0.833	17.391	0.000	2.031	1.019-3.159
Anxiety	1.323	0.371	12.695	0.000	3.754	1.813-7.772

information, fully understand the importance and necessity of PICC placement, and conduct catheter maintenance according to the educa-

tional materials, which is conducive to the development of a health-promoting lifestyle. (2) Place of residence. Due to poor transportation

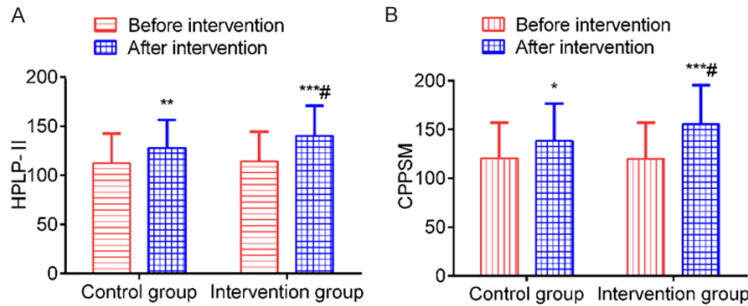


Figure 1. A comparison of the HPLP-II and CPPSM scale scores in the two groups. Note: (A) HPLP-II scores; (B) CPPSM scores. Compared with pre-intervention, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$; compared with post-intervention, # $P < 0.05$.

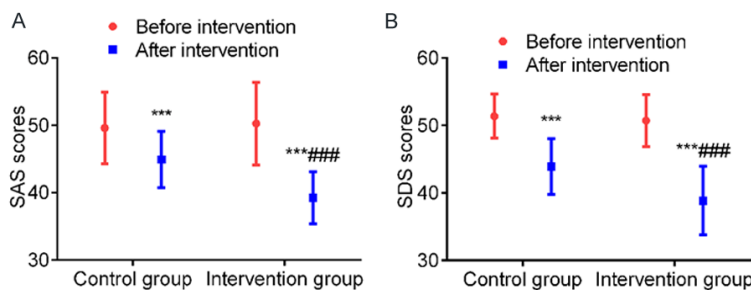


Figure 2. Comparison of the SAS and SDS scores in the two groups. Note: (A) SAS scores; (B) SDS scores. Compared with pre-intervention, *** $P < 0.001$; compared with post-intervention, ### $P < 0.001$.

Table 4. A comparison of the catheter maintenance compliance between the two groups n (%)

Group	Complete compliance	Partial compliance	Non-compliance
Control group (n=60)	20 (33.33)	30 (50.00)	10 (16.67)
Intervention group (n=60)	39 (65.00)	18 (30.00)	3 (5.00)***
Z		3.574	
P		0.000	

Note: compared with the control group, *** $P < 0.001$.

and insufficient medical resources in rural areas, the rural patients failed to perform their maintenance on time, so their catheter maintenance compliance rates were low [17]. (3) Patients with longer placement durations have higher self-management abilities, which may be related to the repeated education and health guidance they receive during their hospital visits. (4) Self-management abilities and psychological states are factors that play a facilitating role in the development of healthy behaviors, which may reduce the impact of negative emotions on the disease and help patients build confidence [18]. (5) Society is an impor-

tant source of support for patients during their rehabilitation, providing the patients with relevant information and various needed resources, and increasing social support can reduce the resistance encountered during the treatment and rehabilitation, so it is conducive to the development of patients' self-health-promoting behavior [19].

In this study, the HPLP-II and CPPSM scale scores of the intervention group were higher than the corresponding scores in the control group, and the SAS and SDS scores and the occurrences of a lack of PICC maintenance and complications of the intervention group were lower than they were in the control group, and the catheter maintenance compliance rate in the intervention group was better than it was in the control group. Therefore, it is evident that the implementation of patient education can improve the self-management abilities and the self-health-promoting behaviors, alleviate adverse psychological states, improve catheter maintenance compliance, and reduce the occurrence of the lack of PICC maintenance and the complications. Huang [20] found that the HPLP-II scores of the health education group were higher

than that the scores in the traditional group, and the incidence of complications was lower than it was in the traditional group, which further confirms that health education can help promote the healthy behavior of malignant tumor patients with PICC and reduce their complications. The reason may be that by distributing educational materials regarding the procedures of PICC placement, including the precautions and measures to deal with the complications, the patients' resistance to catheter placement were relieved. They realized the importance of catheter maintenance, resulting in fewer negative coping styles and fewer nega-

Table 5. A comparison of the lack of PICC maintenance between the two groups n (%)

Group	Loose dressing at puncture site	Oozing and bleeding at puncture site	Sterile gauze dressing over 2 days	Not flushed for more than 7 days	Dressing contamination at puncture site	Totals
Control group (n=60)	3 (5.00)	4 (6.67)	4 (6.67)	1 (1.67)	2 (3.33)	14 (23.33)
Intervention group (n=60)	1 (1.67)	1 (1.67)	2 (3.33)	0 (0.00)	1 (1.67)	5 (8.33)*
χ^2	1.034	1.878	0.702	1.008	0.342	5.065
<i>P</i>	0.309	0.171	0.402	0.315	0.559	0.024

Note: compared with the control group, **P*<0.05.

Table 6. A comparison of the complications during placement between the two groups n (%)

Group	Phlebitis	Bleeding	Clogged catheter	Dislodgement	Allergic dermatitis	Totals
Control group (n=60)	4 (6.67)	2 (3.33)	4 (6.67)	3 (5.00)	3 (5.00)	16 (26.67)
Intervention group (n=60)	2 (3.33)	0 (0.00)	1 (1.67)	1 (1.67)	2 (3.33)	6 (10.00)*
χ^2	0.702	2.034	1.878	1.034	0.209	4.381
<i>P</i>	0.402	0.154	0.171	0.309	0.648	0.036

Note: compared with the control group, **P*<0.05.

tive emotions such as anxiety and depression [21]. This can not only reduce the lack of PICC maintenance and complications, but it can also save time and costs for patients who live far away from home, thereby improving their health-promoting behaviors and compliance [22-25].

In summary, we identified the influential factors of the engagement of self-health-promoting behaviors in PICC pipeline maintenance in malignant tumor patients. Implementing targeted patient education can promote healthy behavior and self-management abilities, reduce complications, alleviate negative emotions, and improve compliance. Although the study analyzed the relationship among the socio-demographic factors, the self-management abilities, the social support, and the self-health promotion behaviors, the analysis was not thorough enough; the sample size was small, the scope was relatively narrow, and there was a lack of comparability, which may lead to some bias in the results. All these shortcomings will be improved in future studies.

Disclosure of conflict of interest

None.

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References

- [1] Wang J, Li N, Qi YX and Yan R. Comparison of application of peripherally inserted central catheterization and conventional subclavian vein catheterization or femoral vein catheterization in intravenous chemotherapy for patients with blood diseases. *Hebei Med* 2019; 41: 798-800.
- [2] Johansson E, Hammarskjöld F, Lundberg D and Arnlin M. Advantages and disadvantages of peripherally inserted central venous catheters (PICC) compared to other central venous lines: a systematic review of the literature. *Acta Oncol* 2013; 52: 886-892.
- [3] Al-Asadi O, Almusarhed M and Eldeeb H. Predictive risk factors of venous thromboembolism (VTE) associated with peripherally inserted central catheters (PICC) in ambulant solid cancer patients: retrospective single Centre cohort study. *Thromb J* 2019; 17: 2.
- [4] Swaminathan L, Flanders S, Rogers M, Calleja Y, Snyder A, Thyagarajan R, Bercea P and Chopra V. Improving PICC use and outcomes in hospitalised patients: an interrupted time series study using MAGIC criteria. *BMJ Qual Saf* 2018; 27: 271-278.
- [5] Chasseigne V, Larbi A, Goupil J, Bouassida I, Buisson M, Beregi JP and Frandon J. PICC management led by technicians: establishment of a cooperation program with radiologists and evaluation of complications. *Diagn Interv Imaging* 2020; 101: 7-14.

- [6] Scrivens N, Sabri E, Bredeson C and McDiarmid S. Comparison of complication rates and incidences associated with different peripherally inserted central catheters (PICC) in patients with hematological malignancies: a retrospective cohort study. *Leuk Lymphoma* 2020; 61: 156-164.
- [7] Ma D, Cheng K, Ding P, Li H and Wang P. Self-management of peripherally inserted central catheters after patient discharge via the We-Chat smartphone application: a systematic review and meta-analysis. *PLoS One* 2018; 13: e0202326.
- [8] Broadhurst D, Moureau N and Ullman AJ. Management of central venous access device-associated skin impairment: an evidence-based algorithm. *J Wound Ostomy Continence Nurs* 2017; 44: 211-220.
- [9] Chen J, Zhao H, Xia Z, Zhang Y, Lv X, Zhou X, Dong X, Li J, Jiang H, Huang Y and Huang H. Knowledge, attitude, and practice toward the daily management of PICC in critically ill cancer patients discharged from intensive care units. *Cancer Manag Res* 2018; 10: 1565-1574.
- [10] Walker SN, Sechrist KR and Pender NJ. The Health-Promoting Lifestyle Profile: development and psychometric characteristics. *Nurs Res* 1987; 36: 76-81.
- [11] Liu CL, Yan MQ and Lu ZQ. Development and validation of the cancer patients PICC self-management scale. *J Nurs Sci* 2012; 12: 1-4.
- [12] Jokelainen J, Timonen M, Keinänen-Kiukaanniemi S, Härkönen P, Jurvelin H and Suija K. Validation of the Zung self-rating depression scale (SDS) in older adults. *Scand J Prim Health Care* 2019; 37: 353-357.
- [13] Samakouri M, Bouhos G, Kadoglou M, Giantzelidou A, Tsolaki K and Livaditis M. Standardization of the Greek version of Zung's self-rating anxiety scale (SAS). *Psychiatriki* 2012; 23: 212-220.
- [14] Rainey SC, Deshpande G, Boehm H, Camp K, Fehr A, Horack K and Hanson K. Development of a pediatric PICC team under an existing sedation service: a 5-year experience. *Clin Med Insights Pediatr* 2019; 13: 117955651988-4040.
- [15] Veyrier M, Henry C, Decottignies A, Laouini T, Maitre S, Marthey L, Begue T, Rieutord A, Barthier S and Roy S. Design and assessment of a outpatient living with PICC-line support program: a pilot study. *Ann Pharm Fr* 2019; 77: 62-73.
- [16] Wen JH, Gu CF and Shan YY. The status and related factors of health promotion behavior of cancer patients with PICC during tube indwelling period. *J Clin Med Pract* 2018; 22: 58-61.
- [17] Santacruz E, Mateo-Lobo R, Vega-Piñero B, Riveiro J, Lomba G, Sabido R, Carabaña F and Botella Carretero JL. Intracavitary electrocardiogram (IC-ECG) guidance for peripherally inserted central catheter (PICC) placement. *Nutr Hosp* 2018; 35: 1005-1008.
- [18] Lee H, Mansouri M, Tajmir S, Lev MH and Do S. A deep-learning system for fully-automated peripherally inserted central catheter (PICC) tip detection. *J Digit Imaging* 2018; 31: 393-402.
- [19] Harrod M, Montoya A, Mody L, McGuirk H, Winter S and Chopra V. Challenges for nurses caring for individuals with peripherally inserted central catheters in skilled nursing facilities. *J Am Geriatr Soc* 2016; 64: 2059-2064.
- [20] Huang YC. Effects of graphic and health education on PICC catheter complications in patients with cancer. *Hebei Med* 2017; 23: 1552-1557.
- [21] Bertani L, Carone M, Caricati L, Demaria S, Fantuzzi S, Guarasci A and Pirazzoli L. Using the Theory of Planned Behavior to explore hospital-based nurses' intention to use peripherally inserted central catheter (PICC): a survey study. *Acta Biomed* 2016; 87: 23-29.
- [22] Ishiyama N and Sudo E. Progress report on cases of peripherally inserted central catheter (PICC) management in our hospital, including elderly patients. *Nihon Ronen Igakkai Zasshi* 2020; 57: 173-181.
- [23] Pan M, Meng A, Yin R, Zhi X, Du S, Shi R, Zhu P, Cheng F, Sun M, Li C and Fang H. Nursing interventions to reduce peripherally inserted central catheter occlusion for cancer patients: a systematic review of literature. *Cancer Nurs* 2019; 42: E49-E58.
- [24] Bertoglio S, Faccini B, Lalli L, Cafiero F and Bruzzi P. Peripherally inserted central catheters (PICCs) in cancer patients under chemotherapy: a prospective study on the incidence of complications and overall failures. *J Surg Oncol* 2016; 113: 708-714.
- [25] Xiang M, Li N, Yi L and Liu B. Causes and nursing countermeasures in pediatric PICC catheter complications. *Pak J Pharm Sci* 2016; 29: 335-337.