

Construction and evaluation of a cloud follow-up platform for gynecological chemotherapy patients

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Abstract

Purpose Patient follow-up is an essential part of hospital management. With the advent of the information age, patient follow-up is expected to be replaced by Internet technology. This study constructed a gynecological chemotherapy patient cloud follow-up platform to evaluate its cost-effectiveness and patient feedback effect.

Methods A total of 2538 patients were followed up using a cloud follow-up system between January and October 2021. Prior to this, 690 patients were followed up manually over telephonic calls. The patient characteristics, follow-up rate, patient satisfaction, and session duration in the cloud follow-up group and manual follow-up group were compared. In addition, the read rate of health education materials in the cloud follow-up group was analyzed.

Results The general information (age, cancer stage, and disease category) and follow-up rate (cloud: 6957/7614, 91.4%; manual: 1869/2070, 90.3%; $P=0.13$) did not significantly differ between the two groups. The follow-up satisfaction of the cloud follow-up patients was significantly better than that of the manual follow-up group (cloud: 7192/7614, 94.5%; manual: 1532/2070, 74.0%; $P 0.001$). The time spent on the follow-up of 100 patients in the cloud follow-up group was approximately 1.2 hours compared to 10.5 hours in the manual follow-up group. The read rate of health education materials in the cloud follow-up group was 72.9%.

Conclusions The follow-up effect of the cloud follow-up group was not inferior to that of the manual follow-up group, and the cloud follow-up group was more in line with the prevention and control requirements of the post-epidemic era. Cloud follow-up can save medical resources, improve cost-effectiveness, provide sufficient health education resources for patients, and improve patient satisfaction.

Introduction

Gynecological malignant tumors occur in the female reproductive organs. The most common gynecological cancers are cervical, endometrial, ovarian, fallopian tube, and vulvar cancer, accounting for 19% of new female cancer cases, which seriously threaten women's health [1]. Chemotherapy is one of the primary means of cancer treatment [2]. It plays an essential role in improving the cure rate of cancer and prolonging the long-term survival of cancer patients; however, chemotherapy is also associated with several adverse effects [3]. Up to 75% of chemotherapy patients experience chemotherapy-induced nausea and vomiting (CINV) [4]. Even if antiemetics, such as 5-HT₃-receptor antagonist, are used prophylactically, more than 50% of patients still have acute (within 24 hours of receiving chemotherapy) or delayed (between 2 and 5 days following treatment) CINV symptoms [5]. In addition, the incidence of other adverse effects caused by chemotherapy such as chemotherapy-induced constipation (CIC), sleep disturbance, chemotherapy-induced peripheral neuropathy (CIPN), and cancer-related fatigue (CRF) was 16–48% [6], 65% [7], 30–40% [8], and 78%, respectively [9]. These adverse effects usually do not occur

simultaneously, and some of them occur or worsen after discharge [10]. Therefore, providing regular follow-up and professional health guidance to chemotherapy patients is particularly important.

A cloud follow-up is a new follow-up mode that uses mobile information technology to implement continuous nursing; it integrates information technology and medical services. Medical staff sends illustrated medical information to patients through the Internet platform and conducts two-way communication with patients. It has the advantages of convenience, intelligence, and personalization [11]. Traditional follow-up methods, such as telephone, email, outpatient follow-up, family visit, and community follow-up, require a lot of human resources and time. Cloud follow-up can make up for these deficiencies and can realize patient information digital management, data processing, and sharing through information technology to save medical resources and improve the work efficiency of medical staff [12].

Follow-up is an essential part of gynecological chemotherapy patients' routine. In this study, we constructed a cloud follow-up platform for gynecological chemotherapy patients aiming to compare its cost-effectiveness and patient feedback with the traditional method.

Methods

Setting and participants

The research was conducted in a leading maternity and children's hospital in China. The cloud follow-up platform was introduced into the gynecological tumor chemotherapy ward in 2019 and was associated with the hospital information system. We enrolled a total of 2538 patients who had undergone gynecological chemotherapy between January and October 2021; this group of patients was defined as the cloud follow-up group since all patients' follow-ups were completed by the cloud follow-up system. In addition, 690 patients receiving gynecological chemotherapy between April and September 2020 were included in the manual follow-up group; this group of patients was followed up by nurses over the telephone.

Cloud follow-up group

Establishment of a multidisciplinary treatment (MDT) team for cloud follow-up

A multidisciplinary treatment (MDT) team consisting of eight members was organized, which included one department director, one head nurse, three tumor nurses, one doctor, and two cloud follow-up information technicians. The department director was primarily responsible for constructing and coordinating the cloud follow-up platform. The head nurse was mainly responsible for formulating a cloud follow-up-related management system and implementing project training. Doctors and nurses answered the medical questions of patients or their families online from 14:00 to 16:00 every day. Tumor nurses were responsible for establishing disease publicity and education knowledge base, follow-up form

base, follow-up rules, etc. The cloud follow-up information technicians were responsible for providing technical support for the information needs of the follow-up of gynecological chemotherapy patients.

Construction of the cloud follow-up platform

The hospital's cloud follow-up platform was constructed and implemented by a third-party company, jointly managed by the technicians of the third-party company and the information technicians of the hospital. The cloud follow-up platform was mainly developed in Java language and adopted the Apsara technology platform, integrating elastic computing, data storage, CDN storage, and large-scale computing technology to provide storage resources and computing resources to users on the Internet in the form of public services. The cloud follow-up platform included PC-based doctor-patient collaboration, medical App, patient app, and WeChat official account. Since July 2020, the cloud follow-up platform has expanded the modules and functions related to the follow-up of gynecological chemotherapy patients as shown in Table 1.

Implementation of the cloud follow-up platform

After obtaining the informed consent of the patient or primary caregiver, the patient was instructed to scan the quick response code, follow the hospital's WeChat official account, download the patient app, and fill in the personal information; the patient was taught how to use the App. After the doctor issued the discharge order, the cloud follow-up system automatically added the patient to the follow-up list and collected the patient's basic information, such as age, diagnosis, registration number, cancer stage, and chemotherapy course. Because most of the chemotherapy patients in the intervention department were discharged the day after infusion of chemotherapy drugs, the MDT team set a specific follow-up time (2 days, 1 week, and 2 weeks after discharge) to investigate the occurrence of acute CINV, delayed CINV, and other chemotherapy complications, and the follow-up contents were consulted by experts. The contents of the follow-up form mainly included the investigation of adverse reactions after chemotherapy, such as CINV, constipation, diarrhea, fatigue, and sleep disorders. Each symptom contained hidden subquestions, which popped up automatically only when the patient chose to select the symptom. In addition, the system automatically pushed the corresponding health education materials according to the answers selected by the patient. The forms of health education materials included video, PowerPoint, and health education text. Furthermore, the system reminded patients to seek medical treatment as soon as possible. Subsequently, a report was generated and automatically uploaded to the cloud as shown in Table 2. Medical staff could view the answers filled in by the patients through the medical App and provide feedback to them if necessary.

Textbox 1 Transcription of a sample dialogue.

System: Dear gynecological chemotherapy patients, in order to timely understand your situation at home and provide you with guidance and help, can you spend a few minutes on a follow-up survey?

Patient: Ok.

System: Have you experienced nausea in the past 24 hours?

Patient: Yes.

The system will automatically pop up related sub questions about nausea.

System: Please select the degree of nausea you have experienced in the past 24 hours.

- Loss of appetite, but not accompanied by reduced food intake
- Reduced food intake without significant weight loss and no malnutrition
- Eating decreased significantly and physical weakness

If the patient selects the third case, the system will automatically pop up the red words "please see a doctor as soon as possible"

System: Have you vomited in the past 24 hours?

Patient: No.

If the patient selects no, the system will automatically pop up the next question.

System: Have you had constipation in the past week?

Patient: No.

System: Have you had diarrhea in the past 24 hours? (feces are thin and more than 3 times / day)

Patient: No.

System: Have you felt tired and weak in the past 24 hours?

Patient: No.

System: Are you satisfied with the quality of your sleep in the last week?

Patient: Yes

System: Have you had the following symptoms in the past 24 hours, such as limb swelling, pain, numbness, chest tightness or tightness?

Patient: No.

System: Can you correctly carry out finger exercises and ankle pump exercise training to prevent thrombosis?

Patient: No.

The system automatically pops up the health education video of finger manipulation and ankle pump movement

After the patient has answered all the questions, click submit.

System: Thank you for your cooperation. We have recorded your problem. Please handle it according to the system prompt, keep the phone unobstructed, and we will follow you up if necessary.

Household graded management

Patients were able to record the adverse reactions of chemotherapy at home through the patient app, and the medical staff viewed the contents filled in by patients in real-time through the medical App and executed household graded management of patients with abnormal data. In the case of CINV, first-level management included patient self-management. According to the Common Terminology Criteria for Adverse Events v4.0 [13], when the patient's nausea and vomiting symptom was rated as grade 0–2, the medical staff conducted one-to-one online guidance through the cloud follow-up system. In addition, secondary management involved medical specialty outpatient management. When the nausea and vomiting symptom was rated as grade 3–4, the medical staff timely recommended patients to the hospital online and made telephonic confirmation if necessary.

Manual follow-up group

The patients in the control group were investigated by manual follow-up, that is, the nurses called the patients one by one according to the discharge list of patients. The contents of the follow-up form were consistent with those of the cloud follow-up system; however, the uploaded report needed to be filled in manually

Evaluation indicators

The evaluation indexes included follow-up rate, follow-up satisfaction, session duration, and read rate. Following formulae were used: follow-up rate = number of effective follow-ups / (number of effective follow-ups + number of invalid follow-ups) × 100%; follow-up satisfaction = (number of very satisfied + number of satisfied) / number of total actual follow-up cases × 100%; and read rate = number of read times / number of send times × 100%. The number of effective follow-ups was defined as the complete data collection in Table 2 (excluding the number of health education materials pushed parameter). The number of invalid follow-ups was defined as missing or incomplete data in Table 2. Follow-up satisfaction was defined as the patient's satisfaction with the follow-up service, divided into five levels: very satisfied, satisfied, average, dissatisfied, and very dissatisfied. The number of read times was defined as the number of times the patient actively read health education materials. The number of send times was defined as the number of times the cloud follow-up platform automatically pushed health education materials for patients. Session duration was defined as the time required for medical staff to communicate with patients over the telephone.

Statistical analyses

SPSS statistical software (version 22.0, IBM Inc) was used for data analysis. Age, cancer stage, disease category, and read rate of health education materials were conducted by descriptive analysis. Patient

characteristics, follow-up rate, and follow-up satisfaction in both groups were tested by Pearson's chi-square test. All tests were two-sided. $P < 0.05$ indicated a statistically significant difference.

Results

Patient characteristics

The characteristics of patients in the two groups are shown in Table 3. No significant difference in age, cancer stage, and disease category was found between the two groups.

Cost-effectiveness

When the patients in the cloud follow-up group and manual follow-up group completed three follow-ups, the follow-up rate of the two groups was not statistically significant (cloud: 6957/7614, 91.4%; manual: 1869/2070, 90.3%; $P=0.13$). The follow-up satisfaction of cloud follow-up patients was significantly better than that of manual follow-up group patients (cloud: 7192/7614, 94.5%; manual: 1532/2070, 74.0%; $P < 0.001$). We randomly selected 100 patients from the cloud follow-up group to calculate session duration. The total time required to complete one follow-up was 1.2 hours compared with 10.5 hours in the manual follow-up group. Time spent in the manual follow-up group included the time taken by the nurse over the telephone to inquire about the patient follow-up form information and to arrange and upload Table 2, as indicated by interviewing three medical staff members. Table 2 in the cloud follow-up group was automatically generated by the system and hardly took any time. The time spent on the cloud follow-up group by the medical staff was chiefly the time required to give telephonic feedback on any abnormal form submitted by the patient. The cloud follow-up duration was shorter than the manual follow-up duration (Table 4).

Push and reading of thematic health education materials on the cloud follow-up platform

Between January and October 2021, the cloud follow-up platform pushed 170374 thematic health education materials, 124189 of which were read, with a read rate of 72.9%. Among them, the read rate of "Diet, nutrition, and chemotherapy patients" was the highest, followed by "Management of nausea and vomiting in chemotherapy patients" and "Management of constipation in chemotherapy patients." "Guidelines for adolescent gynecological chemotherapy patients" had the lowest read rate (Table 5).

Usage of other functions of the cloud follow-up platform

Of 2538 patients, 2212 patients downloaded the patient app and were registered on it. The patients actively recorded 6235 times of diet and nutrition, 4256 times of CINV, 3218 times of constipation, 823 times of diarrhea, 3012 times of sleep disturbance, 1987 times of peripherally inserted central catheters (PICC) home care, 924 times of fatigue, 328 times of numbness of hands and feet, and 1439 times of pain as observed from the automatic data statistics function of the cloud follow-up platform. A medical staff member checked the patients' records through the medical App and provided online feedback in time for abnormal records.

Discussion

Cloud follow-up meets the current needs of coronavirus disease 2019 (COVID-19) prevention and control

The aim of continuous nursing is to extend in-hospital nursing services to communities and families to ensure continuity of nursing services [14]. Due to the limited length of stay, patients with gynecological chemotherapy still have different degrees of demand for out-of-hospital nursing services after discharge, and the implementation of continuous nursing for gynecological chemotherapy patients can improve the quality of life (QoL) of the patients [15]. With the arrival of the information age, "Internet +" deeply integrates the Internet and patient follow-up through the application of information and communication technology and the carrier and actual functions of the Internet platform, forming a modern form of information follow-up, and cloud follow-up is one of the products. Cloud follow-up allows non-contact information exchange with the following functions: timely understanding of patients' adverse reactions to chemotherapy, providing online health guidance, making up for the shortcomings of traditional follow-up, avoiding cross-infection during COVID-19, and meeting the requirements of COVID-19 prevention and control.

Cloud follow-up can improve the cost-effectiveness of follow-up

The cost-effectiveness analysis showed no significant difference in the follow-up rate between the cloud follow-up group and the manual follow-up group, which shows that the follow-up effect of the cloud follow-up group is not inferior to the manual follow-up group and can replace the manual follow-up to a certain extent. In addition, cloud follow-up allows simultaneous follow up of 7–9 patients and automatically generates the follow-up results in contrast to manual follow-up that requires nurses to call patients in turn, fill in the follow-up form, and manually generate the follow-up results; therefore, cloud follow-up saves time and human resources. Patient satisfaction can objectively reflect the quality of medical services offered and is one of the standards to measure quality management of hospitals [16]. Patient satisfaction in the cloud follow-up group was higher than that in the manual follow-up group, and the difference was statistically significant. After the cloud follow-up platform pushes the follow-up form or health education materials to the patients through the WeChat official account, the patients can fill in the form or read the materials in their spare time. In contrast, to the time required to cooperate with the nurses for manual follow-up, the follow-up time of the cloud follow-up group is more flexible. In addition, patients in the cloud follow-up group can obtain health education materials through the platform, consult medical staff online, obtain professional guidance and medication reminders, and receive disease knowledge in a more comprehensive manner than with the manual follow-up.

The cloud follow-up platform can reflect patients' attention to different aspects of disease knowledge

Disease knowledge is closely related to patients' self-care ability, treatment compliance, and [17-19]. In this study, 13 structured health education themes were designed using expert correspondence. The read rate of patients exhibited that patients pay different attention to each theme. Patients paid the highest attention to diet and nutrition as this part had the most active records, which reflected the level of

patients' diet and nutrition knowledge to a certain extent and affected their diet and nutrition treatment compliance, which may be closely related to the prognosis of tumor chemotherapy patients. The 2017 ESPEN guidelines on nutrition in cancer patients recommend enteral nutrition support as a treatment for cancer chemotherapy patients [20]. Therefore, patients pay more attention to diet and nutrition during home care [21]. In addition, patients pay more attention to the management of CINV and constipation, consistent with a previous study [22] since CINV and constipation are the most common adverse reactions of chemotherapy and significantly impact patients' comfort and QoL. Patients pay less attention to fertility-related matters and guidelines for adolescent gynecological chemotherapy patients (read rates were 40.5% and 35.1%, respectively). The reason may be related to the age at which diseases occur. The incidence age of gynecological malignant tumors is mainly 40–65 years [23], which is consistent with the data collected in our study. However, most people in this age group had passed their adolescence and had given birth; therefore, they pay less attention to relevant health education.

The cloud follow-up platform provides sufficient health education resources for gynecological chemotherapy patients

Prescott et al. showed that gynecological chemotherapy patients have insufficient health education information, especially in the period of home care [24]. However, lack of knowledge is an independent risk factor for treatment non-compliance [25]. The 13 thematic health education materials pushed through the cloud follow-up platform provided a knowledge guarantee for gynecological chemotherapy patients. The home care function delivered convenient management tools for the patients, and the consultation facilitated a communication bridge between medical staff and patients. The cloud follow-up provided sufficient health education resources for patients' continuous nursing.

Limitations

This study has some limitations. First, in addition to the form of online answers by the medical staff, other forms can be introduced, such as chatbot. A chatbot is an artificial intelligence program that realizes human-computer interaction in the form of dialogue or text with the help of natural language processing and emotion analysis. Currently, it is used in disease diagnosis, treatment, and management [26]. It can also help gynecological tumor patients in solving problems commonly faced during the perioperative period [27]. Therefore, future work can develop chat machine software or reference software suitable for gynecological chemotherapy patients to serve the patients better. Second, the cloud follow-up system used in this study was put through the stages of early software testing, system installation training, and hospital pilot; therefore, clinical operation time was short, and the system was not stable enough. These could be continuously improved in combination with the actual work with a software engineer in later stages of the operation process.

Conclusions

In this study, we found that the follow-up effect of the cloud follow-up group was not inferior to that of the manual follow-up group, and cloud follow-up has the advantages of meeting the needs of COVID-19

prevention and control, improving the cost-effectiveness of follow-up, providing sufficient health education resources for patients, and laterally reflecting patients' attention to disease knowledge; therefore, cloud follow-up can be widely used in clinical practice.

Declarations

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Competing Interests:

The Authors declare that there is no conflict of interest.

Author Contributions:

Yalin Tian and Xin Dan are responsible for study conception and design and analysis and interpretation of data. All authors drafted or revised the manuscript, have read and approved its final version, and are accountable for all aspects of the paper.

Ethics approval:

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of West China Second University Hospital, Sichuan University (approval no. 2019071).

Consent to participate:

Written informed consent was obtained from the parents.

Consent to publish:

The authors affirm that all participants provided informed consent for publication of the information in table 2, 3, 4 and 5.

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Tables

Table 1

Modules and functions of cloud follow-up platform

Category	Functional module	Specific functions	Function description
PC-based doctor-patient collaboration platform	Patient management	Patient grouping	After the doctor issues the discharge order, the cloud follow-up platform automatically adds the patient to the cloud follow-up list
		Personality management	Includes health records (such as basic personal information, medical history information, number maintenance, information entry, lifestyle, and laboratory indicators); business records (such as health education records, follow-up form records, short message records, follow-up records, and abnormal monitoring); health records (such as diet records, chemotherapy complications records)
	Knowledge base management	Health education resources	It contains 13 special health education materials for gynecological chemotherapy patients in the form of video, PowerPoint slides, and text.
		Propaganda rule base	Chemotherapy patients started from the day of discharge, followed by a special health education every week on a total of 13 topics.
		Follow-up form resources	Questionnaire on adverse reactions of chemotherapy (including nausea, vomiting, sleep, constipation, diarrhea, deep venous thrombosis, fatigue)
		Follow-up rule base	Follow-up forms will be pushed 2 days, 1 week, and 2 weeks after discharge.
		Reminder phrase resources	Set phrases to remind patients of precautions
	Follow-up center	Follow-up plan	Make a follow-up plan. Medical staff can view the total follow-up personnel, personnel to be followed up, personnel who have been followed up, and overdue follow-up personnel
	Statistical center	Statistical function	Automatically count the reading of each health education theme and the specific filling of each follow-up form and summarize and export the data
	Medical App	Health information	Health information
Doctor-patient interaction		Doctor-patient interaction	Medical staff can monitor the abnormal health information, inspection results, and follow-up results of patients, communicate and interact with patients in real-time, answer patients' problems in real-time, provide health education and guidance, and realize remote nursing services.
Patient App	Household	Graded	Graded management is carried out according to

	graded management	management of chemotherapy complications	the severity of adverse reactions after chemotherapy.
	Consulting service	Consulting service	Provide online interaction for patients. Patients can leave messages in the form of text, pictures, videos, and voice messages or contact medical staff online to solve the problems existing in home care remotely.
	Medical information	Medical information	Patients can view medical records, examination reports, and laboratory test reports synchronously through the App.
	Personal settings	Personal settings	Patients can set personal information, medication reminders, follow-up reminders, etc.
WeChat official account	Health education and follow-up		The cloud follow-up platform pushes messages through the open interface of the WeChat public platform. After the patients connected with the WeChat official account, the health education materials and follow-up questionnaires were directly pushed to the main interface of the WeChat official account. Patients used this to acquire knowledge about the disease and fill in the follow-up questionnaires at any time during the daily use of WeChat.

Table 2

Automatically generated table for the dialogue in Textbox 1.

Parameter	Information
Basic information	Patient name, age, diagnosis, registration number, cancer stage, chemotherapy course, and discharge date ^a
Dialogue result	The patient completed the follow-up form
Follow-up form duration (s)	221
Question 1 score	5
Question 2 score	0
Question 3 score	0
Question 4 score	0
Question 5 score	0
Question 6 score	0
Question 7 score	0
Question 8 score	5
Total score	10
Number of options abnormal	2
Number of times of medical treatment reminded	1
Number of health education materials pushed	1
Follow-up date	2021/5/4

^a Basic information is automatically extracted from the hospital information management system

Table 3

Comparison of basic information in cloud and manual follow-up group.

Characteristics	Cloud follow-up group, n (%)	Manual follow-up group, n (%)	Chi-square (df)	<i>P</i> value
Number of patients	2538(100)	690(100)		
Age (years)			0.54(3)	0.91
40	337 (13.3)	96(13.9)		
40–49	769 (30.3)	215(31.2)		
50–59	898 (35.4)	236(34.2)		
≥60	534 (20.0)	143(20.7)		
Cancer stage			3.50(3)	0.32
I	302(11.9)	90(13.0)		
II	783(30.9)	196(28.4)		
III	822(32.4)	214(31.0)		
IV	631(24.9)	190(27.6)		
Disease category			2.90(5)	0.72
Cervical carcinoma	822(32.4)	235(34.1)		
Ovarian cancer	655(25.8)	181(26.2)		
Endometrial cancer	700(27.6)	173(25.1)		
Gestational trophoblastic tumor	122(4.8)	39(5.6)		
Vulvar carcinoma	107(4.2)	30(4.4)		
Other	132(5.2)	32(4.6)		

Table 4

Comparison of cloud and manual follow-up group indicators.

Indicators	Cloud follow-up	Manual follow-up	Chi-square (df)	<i>P</i> value
Follow-up			2.36 (1)	0.13
Number of effective follow-ups	6957	1869		
number of invalid follow-ups	657	201		
Follow-up rate, %	91.4	90.3		
Satisfaction			764.31(2)	0.001
number of very satisfied	4327	887		
number of satisfied	2865	645		
number of total actual follow-up cases	7614	2070		
follow-up service satisfaction, %	94.5	74.0		
Time spent, hours per 100 patients	1.2	10.5	N/A ^a	N/A

a N/A: not applicable

Table 5

Push and reading of thematic health education materials on cloud follow-up platform.

Health education theme	Sending times	Read times	Read rate (%)
Diet, nutrition, and chemotherapy patients	10152	9827	96.8
Management of nausea and vomiting in chemotherapy patients	20137	17357	86.2
Management of constipation in chemotherapy patients	19827	16778	84.6
Drug treatment and adverse reactions in patients with gynecological tumors	10152	8558	84.3
Sleep management of chemotherapy patients	17998	15056	83.7
Home care in PICC and infusion port	10152	7956	78.4
Fatigue management of chemotherapy patients	18267	14224	77.9
Management of diarrhea in chemotherapy patients	11298	7657	67.8
Prevention of thrombosis in chemotherapy patients	10998	7213	65.6
Diagnosis and management of gynecological tumors	10672	6987	64.5
Prevention and management of CIPN	11267	6134	54.4
Fertility related matters of chemotherapy patients	9628	3897	40.5
Guidelines for adolescent gynecological chemotherapy patients	9826	3445	35.1
Total	170374	124189	72.9

Note: PICC: peripherally inserted central catheters; CIPN: chemotherapy induced peripheral neuropathy