



Application of intravenous indwelling needles versus peripherally inserted central catheters in the maintenance treatment of acute leukemia

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Highlights

- Although the cost of peripherally inserted central catheters (PICC) is relatively high, it significantly extends the duration of maintenance treatment and therapeutic outcomes of acute leukemia patients.
- PICC placement can effectively relieve patients' anxiety, enhance treatment compliance, and increased overall satisfaction.
- Compared with peripheral indwelling needles, PICC reduces the incidence of venous - related complications, which is conducive to patients' recovery.

Abstract

Objective: To evaluate the therapeutic effects of intravenous infusion using intravenous indwelling needles (IIN) versus peripherally inserted central catheters (PICC) in patients with acute leukemia during maintenance treatment. **Methods:** Eighty-six patients with acute leukemia admitted to the First Affiliated Hospital of Baotou Medical College from July 2022 to March 2023 were randomly divided into the IIN group and the PICC group, with 43 patients in each group. **Results:** Significant differences were observed between the two groups in terms of the number of punctures and puncture time ($P < 0.05$). Although the intubation cost was lower in the IIN group than in the PICC group, the maintenance treatment duration was shorter in the IIN group ($P < 0.05$). There were no significant differences between the two groups in terms of disease symptoms, treatment-related toxicity, and side effects ($P > 0.05$). However, anxiety, treatment compliance, and patient satisfaction were significantly lower in IIN group compared to the PICC group ($P < 0.05$). Additionally, the incidence of vein-related complications in the IIN group was higher than in the PICC group ($P < 0.05$). **Conclusion:** Compared with intravenous indwelling needles, PICCs demonstrate superior application outcomes. Although the cost of PICC placement is relatively high, its ability to prolong maintenance treatment, alleviate patient anxiety, reduce vein-related complications, and improve treatment compliance makes it a valuable method worth promoting.

Keywords: Acute leukemia, nursing staff, intravenous indwelling needles, peripherally inserted central venous catheter, maintenance of treatment time

Introduction

Acute leukemia (AL) is a malignant tumor characterized by abnormal hematopoietic cell

proliferation and is classified into acute lymphocytic leukemia (ALL) and acute myeloid leukemia based on the types of malignant cells [1, 2]. The disease has a poor prognosis

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and high mortality rate, significantly impairing normal hematopoietic function, thereby posing a great threat to patients' health and safety. Chemotherapy, a primary treatment option, can delay disease progression and extend survival time. However, most chemotherapy drugs require intravenous administration [3]. Due to the unique properties of chemotherapy drugs and long-term treatment duration, factors such as safety, convenience, and cost must be carefully considered when selecting the appropriate intravenous access method [4]. Previous reports indicate that the peripheral vein is the most commonly used intravenous access for inpatients, with intravenous indwelling needles (IIN) and peripherally inserted central catheters (PICC) utilized in 51.14% and 8.90% of cases, respectively [5]. Each of these two intravenous methods has distinct advantages and disadvantages. IINs are advantageous for their short indwelling time, low blood flow rate, and few severe complications; however, they require multiple punctures, which negatively impact patient experience and increase the risk of drug extravasation [6]. In contrast, PICC offers fewer punctures, is safe, simple to perform, and can remain in place for extended periods. However, its use is still limited in some settings, and challenges persist in its application for dialysis and hematology patients [7, 8]. As an essential part of nursing work, intravenous therapy should prioritize safety management and the advancement of specialized practices [9, 10]. This study aims to compare the effects of two intravenous therapy methods, IIN and PICC, administered by nurses with operational authority, in AL patients.

Methods

Eighty-six AL patients admitted to the First Affiliated Hospital of Baotou Medical College of Inner Mongolia University of Science and Technology from June 2022 to March 2023 were randomly divided into the IIN group or the PICC group using a random number table method, with 43 patients in each group. Before grouping, all patients were informed in detail about the two venous access methods, including the operation process, costs, and potential risks.

Regarding costs, the hospital covered the difference in puncture costs between PICC and IIN for patients in the PICC group. Regarding risks, patients were fully informed and signed informed consent forms. They were also made aware that they could withdraw from the study at any time if they were unwilling to assume the corresponding risks. After randomization, patients were promptly informed of their group al-

location and the corresponding treatment plan.

Inclusion criteria

- (1) Diagnosis meeting the criteria for China Adult Acute Lymphoblastic Leukemia or Acute Myeloid Leukemia [11, 12];
- (2) Age 18–70 years, with a life expectancy of more than 6 months;
- (3) Tolerated chemotherapy and provided informed consent;
- (4) Condition adaptation: Long-term intravenous infusion or drug infusion requirements exceeded than 7 days;
- (5) Vascular conditions: The veins should be unobstructed with larger diameter. There is no obvious abnormality in the blood vessels, such as deep vein thrombosis. It is recommended to choose upper limb veins. If there are no suitable upper limb veins, head and neck and lower limb veins can be selected;
- (6) Skin conditions: There is no obvious infection, ulcer or other skin lesions at the catheterization site.

Exclusion criteria

- (1) Severe cognitive dysfunction or complete lack of cooperation;
- (2) Presence of malignant tumors, blood system disorders, liver or kidney failure or other serious comorbid diseases;
- (3) Known allergy to catheter materials (such as silicone, polyurethane, etc.);
- (4) Severe coagulopathy: Patients with bleeding tendency or abnormal coagulation function may experience uncontrolled bleeding during catheterization or catheter blockage after catheterization;
- (5) Local infection or inflammation (such as infections, inflammation, or skin damage at the catheterization site);
- (6) Abnormal anatomical structure (such as vascular stenosis and distortion that can cause difficult catheter placement or catheter dislocation);
- (7) Poor cooperation or tolerance during the catheterization.

Both groups were treated by specially trained nursing staff, and all procedures were completed in accordance with the Operation Specification for Intravenous Therapy Nursing Technology [13]. The patients were informed about the catheterization process. All patients received the same chemotherapy regimen.

Acute myeloid leukemia protocol: Days 1–3: Intravenous infusion of daunorubicin (Manufacturer: Hanhui Pharmaceutical Co., Ltd., National Drug Approval No.: H33020925) at a dose of 45–60 mg/m² per day. Days 1–7: Intravenous infusion of cytarabine (Manufacturer: Pfizer Pharmaceuticals Wuxi Co., Ltd., National Drug Approval No.: H20205027) in two divided doses, 100–150 mg/m².

ALL protocol: Days 1, 8, 15, 22: Intravenous push of vincristine (Manufacturer: Guangzhou Baiyunshan Hanfang Modern Pharmaceutical Co., Ltd., National Drug Approval No.: H44023474) at a dose of 1.5 mg/m². Days 1–3: Intravenous infusion of daunorubicin (Manufacturer: Hanhui Pharmaceutical Co., Ltd., National Drug Approval No.: H33020925) at a dose of 30–45 mg/m² per day. Vincristine was administered as an intravenous injection on Day 1 and Day 8. Days 1–14: Oral administration of prednisone (Manufacturer: Shanghai Shangyao Xinyi Pharmaceutical Co., Ltd., (H31020605)) at a dose of 60 mg. Days 15–28: Gradual tapering and discontinuation of prednisone.

In the IIN group, an indwelling needle was used with the following procedure: the basilic vein or median elbow vein was chosen, and the smallest indwelling needle that met the therapeutic blood flow criteria was used. After successful puncture, 3 M adhesive tape was used for fixation; if the catheter remained intact, the dressing and heparin cap were replaced every 72 h.

In PICC group, a 4Fr safe PICC (purchased from BD, USA) was used. The operation was as follows: the patient was positioned supine with the arm extended at a 90-degree angle, and the head was tilted to one side to fully expose the puncture site. Among the 43 patients, 31 were treated via the cephalic vein approach, 12 via the basilic vein approach, and the forearm elbow was used as the puncture point. A 10 cm spiral disinfection was performed around the puncture site, both above and below, to ensure maximum sterility. The Seldinger technique was adopted, and the central venous catheter was advanced into the superior vena cava using a guide wire. The puncture site and exposed

portion of the catheter were secured with 3 M adhesive tape. The dressing was changed every week, and the catheter was flushed with 100 U/24 ml heparin solution 24 hours post-insertion.

Observation outcomes

Clinical outcome: The clinical outcome scale for AL patients, as reported by Lin et al. [14]. This scale includes 15 items covering physiology (7 items related to disease symptoms, 4 items related to treatment toxicity and side effects, and 4 items related to activities of daily living), psychology (5 items related to anxiety, 5 items related to depression, and 3 items related to feelings of inferiority), social factors (5 items related to social support), and treatment (5 items related to compliance and 4 items related to patient satisfaction). The scale includes four domains, nine clinical outcomes, and 42 items. The Cronbach's α coefficient was 0.796, and the content validity was 0.907. Each item was rated on a scale from 1 to 5, with 17 positive items scored positively, and 25 negative items scored negatively. The total score range for each domain was: 15–75 points (physiology), 13–45 points (psychology), 5–25 points (social factors), and 9–45 points (treatment), respectively. Higher scores indicate better clinical outcomes.

Nursing-related parameters: The number of punctures, cost of intubation, duration of maintenance treatment, and duration of puncture were recorded.

Vein-related complications: The incidence of complications was recorded, including bleeding (active bleeding present at the dressing site after 24 hours), thrombosis (confirmed by color Doppler ultrasound, with symptoms such as arm swelling), phlebitis (redness, swelling, heat, and pain at the puncture site), catheter-related bloodstream infection (symptoms such as skin redness, swelling, and pain at the insertion site, along with positive bacterial culture from the catheter), catheter obstruction, and other events. The total occurrence rate of these complications was calculated.

Statistics methods

Data were analyzed using SPSS 23.0 software. Measurement data ($\bar{x} \pm s$) (clinical outcomes, nursing-related parameters) were compared using a t-test. Count data (n, %) (vein-related complications) were analyzed using χ^2 tests. A P-value of <0.05 was considered statistically significant.

Table 1. Comparison of nursing-related parameters between the two groups ($\bar{x} \pm s$)

	IIN group	PICC group	t	P
General data	50	50		
Number of cases	43	43		
Puncture times (Times)	1.13±0.25	1.02±0.27	1.069	<0.050
One-time catheterization fee (Yuan)	74.26±14.25	2100.45±134.68	98.106	<0.001
Maintenance treatment time (d)	14.84±1.25	22.17±3.45	13.099	<0.001
Puncture time (min)	5.41±1.35	20.56±1.37	0.511	<0.050

Note: IIN, intravenous indwelling needles; PICC, peripherally inserted central catheters.

Table 2. Comparison of clinical outcomes between the two groups ($\bar{x} \pm s$)

	IIN group	PICC group	t	P
General data	50	50		
Number of cases	43	43		
Symptoms of disease	24.78±3.64	24.33±3.75	0.565	0.574
Toxic and side effects of treatment	12.15±3.23	12.26±3.18	0.159	0.874
Activity of daily living	14.25±2.37	14.18±2.45	0.135	0.893
Anxiety	17.34±2.03	20.39±2.18	6.714	<0.001
Depression	18.44±2.65	18.93±2.34	0.909	0.366
Inferiority complex	10.14±2.19	10.21±2.03	0.154	0.878
Social support	16.47±2.34	16.25±2.40	0.430	0.668
Compliance	17.68±2.38	20.34±2.67	4.877	<0.001
Satisfaction	15.43±2.06	17.31±2.15	4.140	<0.001

Note: IIN, intravenous indwelling needles; PICC, peripherally inserted central catheters.

Results

Comparison of nursing-related parameters between the two groups

There were no significant differences between the two groups in terms of the number of punctures or puncture time ($P>0.05$). The cost of catheter indwelling in IIN group was significantly lower than that in PICC group, but the maintenance treatment duration was significantly shorter in the IIN group ($P<0.05$, Table 1).

Comparison of clinical outcomes between the two groups

No significant differences were found between the two groups regarding clinical outcomes such as disease symptoms, toxicity and side effects, activities of daily living, depression, feeling of inferiority, or social support ($P>0.05$). However, anxiety, treatment compliance, and satisfaction were significantly lower in the IIN group compared to the PICC group ($P<0.05$, Table 2).

Complications between the two groups

The incidence of vein-related complications in the IIN group (25.58%) was significantly higher than that in the PICC group (6.98%) ($P<0.05$, Table 3).

Discussion

Chemotherapy, the primary treatment for AL,

often reduces white blood cell counts. Intravenous infusion is the main route of drug administration. As the drug dosage increases, it not only raises the risk of toxicity and side effects but can also cause significant stimulation and damage to blood vessel walls, which in turn affects treatment compliance and patient satisfaction [15, 16]. Clinically, patients with hematologic malignancies should choose more reliable vascular access methods [17].

Indwelling needles, a traditional intravenous infusion method, offer advantages such as simple operation and low cost. However, they have a short indwelling time, requiring frequent re-punctures. Repeated punctures of the thin-walled peripheral veins increase the risk of mechanical phlebitis and drug extravasation, leading to irritation. Mild extravasation can cause local redness, swelling, heat, and pain, while severe extravasation can result in skin and tissue damage, including necrosis. These complications elevate the physical, mental, and economic burdens on patients and can reduce their trust in and recognition with nursing, which hinders the overall treatment process [18].

PICC is an intravenous therapy performed through peripheral venous catheterization, with the catheter tip positioned in central veins such as the superior vena cava or subclavian vein [19, 20]. This technique has the advantages of simple operation, low cost, less vein puncture, and minimal drug stimulation on blood vessels. In addition, PICC provides medium- and long-

Table 3. Comparison of vein-related complications between the two groups [n (%)]

	IIN group	PICC group	χ^2	P
General data	50	50		
Number of cases	43	43		
Oozing blood	1 (2.33)	0 (0.00)		
Thrombosis	2 (4.65)	1 (2.33)		
Phlebitis	4 (9.30)	1 (2.33)		
Catheter-related bloodstream infection	3 (6.98)	0 (0.00)		
Catheter obstruction	1 (2.33)	1 (2.33)		
Incidence	11 (25.58)	3 (6.98)	5.460	0.019

Note: IIN, intravenous indwelling needles; PICC, peripherally inserted central catheters.

term intravenous infusion therapy, allowing patients to continue their normal activities even during chemotherapy's intermittent phases [21]. As the primary operators of intravenous infusion therapy, nurses should carefully select appropriate infusion tools and establish safe, effective vascular access for AL patients [22, 23].

The results of this study revealed no significant differences between the two groups in terms of the number of punctures. However, the cost of catheterization in the IIN group was significantly lower than that in PICC group, but the duration of maintenance treatment was significantly shorter than that in PICC group. These findings suggest that while PICC placement costs more, it has a longer. PICC catheters offer a wide range of applications, with long-term retention and extended maintenance time, making them ideal for AL patients with long-term chemotherapy needs. By enabling patients to leave the hospital with a PICC when their condition stabilizes, this method reduces the frequency of repeated punctures, thereby alleviating both pain and the economic burden on patients.

There were no significant differences between the two groups in terms of clinical outcomes, including disease symptoms, treatment-related toxicity and side effects, activities of daily living, depression, feelings of inferiority, or social support. However, anxiety, treatment compliance, and satisfaction in IIN group were significantly lower than those in PICC group. This finding highlights the significant effect of PICC in reducing anxiety and improving treatment compliance and satisfaction. Repeated punctures with intravenous indwelling needles not only increase patients' negative experiences and anxiety but also lead to a series of complications, such as limb vascular injury and muscle pain at the injection side due to irritation caused by drug extravasation. This results in psychological pressure on patients, undermining their confidence in treatment and rehabilitation, which in turn reduces patient compliance and satisfaction. However, PICC placement avoids drug-in-

duced vascular damage, protects peripheral veins, reduces puncture-related pain, and minimizes complication risks, thereby improving patient comfort and satisfaction, which is conducive to better treatment compliance [24, 25]. The incidence of vein-related complications in the IIN group (25.58%) was significantly higher than that in the PICC group (6.98%). This suggests that PICC placement is more effective in preventing vein-related complications. The intravenous indwelling needle tends to float within the vein, and long-term indwelling can cause mechanical rubbing of the vessel wall, increasing the risk of complications. In contrast, the PICC catheter is typically inserted in the upper arm, which is more accessible for maintenance and far from the respiratory tract, reducing the likelihood of catheter-related complications. In addition, the catheter tip is positioned deep in the vein, where blood flow is faster in the large vein, diluting chemical drugs and reducing friction against the vessel wall. This setup minimizes the risk of drug extravasation and damage to surrounding tissues or organs, making the procedure relatively safe. However, AL patients are at risk of PICC-related infections, and nursing staff should strictly adhere to PICC procedures and aseptic operation to minimize the risk of complications.

Conclusion

Compared to the intravenous indwelling needle, the use of a PICC in AL patients demonstrates more favorable outcomes. Although the cost of PICC catheters is higher, the extended maintenance treatment time effectively alleviates patient anxiety, reduces the risk of vein-related complications, and improves patient compliance and satisfaction. Therefore, PICC is worthy of clinical promotion.

However, this study has some limitations. The research primarily focuses on hematological patients, which limits the generalizability of the findings. Additionally, the treatment outcomes during hospitalization may be influenced by subjective factors, such as social factors, psy-

chological status, climate, and environmental factors, family circumstances, and economic status.

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