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Nurses' practice of peripherally inserted central catheter maintenance and its influencing factors in Guizhou province, China: a cross-sectional study

Li Hu ![ORCID],[1] Yaling Li,[2] Hong Li,[1] Wenjing Ling,[2] Chaoting Zheng,[2] Mingfei Ran,[2] Binbin Xu[3]

[Check for updates]

[1]Breast Surgical Department, The Affiliated Hospital of Guizhou Medical University, Guiyang, Guizhou, China
[2]Department of Nursing, The Affiliated Hospital of Guizhou Medical University, Guiyang, Guizhou, China
[3]The Nethersole School of Nursing, The Chinese University of Hong Kong, Hong Kong SAR, China

Correspondence to
Binbin Xu;
xubinbin@link.cuhk.edu.hk

ABSTRACT

Objectives The aim of this study was to investigate the level of practice of peripherally inserted central catheter (PICC) maintenance among nurses in Guizhou province, China, and to explore its influencing factors.

Design Cross-sectional study.

Setting 11 tertiary and 26 secondary hospitals of Guizhou province, China.

Participants A total of 832 nurses engaged in clinical work of PICC maintenance participated in the present study.

Primary outcome measures PICC maintenance knowledge questionnaire, PICC maintenance attitude questionnaire and PICC maintenance practice questionnaire were administrated online for measuring participants' knowledge, attitude and practice of PICC maintenance, respectively.

Results The mean score of nurses' practice of PICC maintenance was 79.77 ± 12.13 and 60.8% of participants reported acceptable practices of PICC maintenance. The availability of PICC guidelines ($\beta=0.10$, p=0.002), previous training on PICC maintenance ($\beta=0.18$, p<0.001) and attitudes toward PICC maintenance ($\beta=0.48$, p<0.001) were significant factors predicting nurses' practices of PICC maintenance. These factors account for 33% of the variance in the practice of PICC maintenance.

Conclusion Nurses' practice of PICC maintenance in Guizhou province was unsatisfactory. Their practice was influenced by the availability of PICC guidelines, whether or not they received training and their attitudes toward PICC maintenance. A province-level PICC maintenance alliance is recommended to be established to improve the quality of PICC maintenance in Guizhou, which can develop or update PICC guidelines, and provide training on PICC maintenance regularly for nurses engaging in PICC maintenance.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ A large sample size of nurses from secondary and tertiary hospitals participated in the study.
⇒ Convenience sampling method was used to recruit the participants, which may threaten the representativeness of the sample and the generalisability of study findings.
⇒ Self-reported questionnaire was applied to assess nurses' practices of peripherally inserted central catheter maintenance, which may not accurately reflect the actual situation because of social desirability.

parenteral nutrition since it was introduced to China.[4–6] It is a reliable form of intravenous access with high patient satisfaction due to some advantages, such as easy operation, long-term use, avoidance of repeated punctures and reduced vascular damage.[5 7–9]

With the widespread use of PICC, PICC maintenance is of concern during treatment intermission for patients. According to the expert consensus on venous catheter maintenance of the Chinese Nursing Association, PICC should be maintained using an aseptic technique at least once a week; the maintenance content includes PICC function evaluation, infusion connectors and dressings replacement, PICC flushing and sealing and health education.[10] Patients are at risk for PICC-associated complications, including venous thrombosis, catheter-related bloodstream infection, phlebitis and mechanical complications such as occlusion and migration if the PICC maintenance is not timely and adequate. Any complications may result in unplanned extubation, delaying patients' therapy and impacting their physical and mental health.[8 11]

In China, PICC is maintained by nurses. Therefore, nurses' adherence to evidence-based PICC maintenance is essential to

INTRODUCTION

A peripherally inserted central catheter (PICC) indicates that the catheter is inserted via the peripheral veins (eg, the basilic vein, cephalic vein and median cubital vein) into the lower third of the superior vena cava or subclavian.[1–3] PICC has been widely used for long-term transfusion, chemotherapy and

ensure the care quality of PICC. Previous studies have focused on nurses' knowledge of PICC maintenance.[12–19] However, little was known about their practice. In 2016, a survey was conducted to investigate PICC maintenance practice among nurses from three tertiary hospitals in Beijing. The results revealed that nurses' practice of PICC maintenance was acceptable.[20] While these results cannot be generalised to other places in China due to different situations. In some provinces, a province-level PICC maintenance network was established to ensure the quality of PICC maintenance.[21–23] The PICC maintenance network applies unified PICC maintenance quality standards and provides unified training and assessment to nurses at all maintenance sites.[22] While in some provinces such as Guizhou province, a province-level PICC maintenance network had not been established. Therefore, whether all nurses engaging in PICC maintenance are trained well and adhere to standard PICC maintenance remains unknown. Considering the importance of PICC maintenance and the different situation of PICC maintenance in Guizhou province, it is imperative to investigate PICC maintenance practice among nurses in Guizhou province. Thus, the present study aimed to (1) investigate nurses' practice of PICC maintenance in Guizhou province and (2) explore its predictors, which may provide evidence for improving the quality of PICC care.

METHODS

Study design

A web-based cross-sectional study was conducted in secondary and tertiary hospitals in Guizhou province of China from 1 July 2022 to 30 July 2022.

Participants

Participants for this study were identified by the following criteria: (1) registered nurses (RNs) working in hospitals across Guizhou province; (2) RNs engaging in intravenous therapy-related clinical work; (3) RNs having experience in PICC maintenance; (4) RNs were willing to participate in this study. RNs were excluded if they were on leave during the data collection period.

Sample size and sampling method

We applied G*Power V.3.1.9.7 to calculate the sample size. According to Cohen,[24] a sample size of 787 nurses was required for multiple linear regression if we estimate a small effect size ($f^2=0.01$) with the power of 0.80 at 5% level of significance. The participants were recruited through convenience sampling.

Variables and measures

The variables for the present study were nurses' knowledge, attitudes and practice regarding PICC maintenance.

Demographic questionnaire

A researcher-developed questionnaire was used to measure nurses' general characteristics, including age, work years, professional title, educational level, hospital type, the availability of PICC maintenance guidelines and previous experience with PICC maintenance.

PICC maintenance knowledge questionnaire

PICC maintenance knowledge questionnaire was applied to measure participants' knowledge of PICC maintenance.[25] The questionnaire consists of 19 items, and all items are single-choice questions. A correct answer was scored 1 point, and a wrong answer was 0. The total score ranged from 0 to 19. The original total score was converted using a 100-mark system with the following formula: Convert total score=original total score/19×100. A cut-off point of 60 was set to interpret whether nurses pass or fail the examination.[20]

PICC maintenance attitude questionnaire

Nurses' attitudes toward PICC maintenance was determined by PICC maintenance attitude questionnaire.[25] It includes 17 items and a 4-level Likert scale scores for each item (1=strongly disagree, 2=disagree, 3=agree and 4=strongly agree). The total score ranges from 17 to 68. The attitude score was also converted using a 100-mark system to present the result. The converted score was categorised into two levels: ≥80 represented that nurses' attitudes toward PICC maintenance were satisfactory, while <80 indicated unsatisfactory attitudes, in accordance with a similar study conducted in China.[20]

PICC maintenance practice questionnaire

Nurses' practice of PICC maintenance was measured by PICC maintenance practice questionnaire.[25] The questionnaire constructs of 16 items, and 5-level Likert scale answers for each item (1=never, 2=seldom, 3=sometime, 4=often and 5=always). The total score ranges from 16 to 80. Again, we converted total scores using a 100-mark system. A cut-off point of 80 was selected to reflect whether nurses' practice of PICC maintenance was acceptable or unacceptable according to a previous study.[20]

Validity and reliability of PICC maintenance knowledge, attitudes and practice questionnaires

PICC maintenance knowledge, attitudes and practice questionnaires were developed by Xu[25] based on Infusion Therapy Standards of Practice[26] released by Infusion Nursing Society and the Nursing Practice Standards for Intravenous Therapy[27] issued by the National Health Commission of the People's Republic of China in 2013. Delphi method was performed to assess the validity of questionnaires. The expert panel consisted of 20 experts in intravenous therapy and nursing management. Experts were asked to assess the importance of each item using a 5-Likert scale (1=very unimportant, 2=unimportant, 3=average, 4=important and 5=very important) and to evaluate the relevance of each item using a 4-Likert scale (1=not relevant, 2=somewhat relevant, 3=relevant and 4=very relevant). In addition, revision suggestions for each item from experts were welcomed, and corresponding changes were made. These questionnaire items with a mean importance score of ≤3.5, a full importance

score (ie, 5 points) ratio of ≤0.8, a coefficient of variation of importance score of ≥0.25, or an item-level Content Validity Index of <0.78 were removed from the item pool. After two rounds of Delphi process, 19 items, 17 items and 16 items that all experts supported were finally retained for PICC maintenance knowledge, attitudes and practice questionnaires, respectively. The Scale Content Validity Index values for PICC maintenance knowledge, attitudes and practice questionnaires were 0.94, 0.98 and 0.99, respectively. The reliability of the PICC maintenance knowledge, attitudes and practice questionnaires was also evaluated among 200 nurses. The Cronbach's α values for PICC maintenance knowledge, attitudes and practice questionnaires were 0.71, 0.95 and 0.96, respectively. The content of the PICC maintenance knowledge, attitudes and practice questionnaires could be accessed from the online supplemental material 1–3.

Data collection procedure

The research team collected data from 1 July 2022 to 30 July 2022. Wen Juan Xing, a widely used electronic data collection tool in China, was applied to collect data online. Initially, we identified a list of hospitals that provide PICC maintenance services in Guizhou province. Second, we contacted the nursing directors of those hospitals, explained the study purpose and asked for their permission and help with data collection. Third, we provided uniform training on participant recruitment and data collection procedure to nursing directors willing to participate in this study. Subsequently, we sent a hyperlink to the online questionnaire, with an e-informed consent and introduction for filling out the questionnaire to those nursing directors. Finally, those nursing directors helped us recruit eligible nurses and instructed them to complete the online survey.

To ensure the quality of data collection, we used some functions of Wen Juan Xing. We limited the terminal and IP address for filling out the questionnaire, which could prevent nurses from out of Guizhou province from filling in the questionnaire and avoid nurses filling in the questionnaire repeatedly. Furthermore, we set the property that incomplete questionnaires cannot be submitted to avoid missing data.

Data analysis

Descriptive statistics were used to analyse participants' characteristics. Univariate and multiple regression analyses were performed to determine how much each variable contributed to PICC practice. Before performing univariate analyses, the normality and homogeneity of variance (HoV) assumptions for PICC maintenance practice scores were checked. The results showed that the data were normally distributed. The assumption of HoV for practice scores categorised by participants' demographic characteristics and PICC-related characteristics were not met except for PICC maintenance practice scores categorised by hospital grade and PICC attitude level. Therefore, an independent t-test was applied to test the difference

in PICC practice scores categorised by hospital grade and PICC attitude level. In contrast, the Mann-Whitney test or Kruskal-Wallis test was used to test the difference in PICC practice scores categorised by the rest demographic characteristics. Significant variables from the univariate analyses were then entered simultaneously into the standard multiple regression analysis. Independent variables, except age, work year, PICC knowledge and PICC attitude, were transformed as dummy variables with codes (gender: 0=male, 1=female; professional title: 0=nurse or senior nurse, 1=supervision nurse or co-chief nurse or chief 1 nurse; educational level: 0=specialised secondary school or junior college, 1=undergraduate or above; hospital type: 0=secondary hospital, 1=tertiary hospital; the availability of PICC maintenance guideline: 0=no, 1=yes; previous experience of training on PICC maintenance: 0=no, 1=yes). The data met normality, linearity, homoscedasticity, multicollinearity and autocorrelation assumptions. All data were analysed by SPSS software V.23 (IBM Corp, Armonk, New York, USA). Significance was set at p<0.05.

Patient and public involvement

Patients and the public were not engaged in the design, implementation and dissemination plans of this study.

RESULTS

Demographic characteristics of participants

Eleven tertiary and 26 secondary hospitals participated in this study. One thousand five hundred and nity-six eligible nurses were invited to participate in the survey, and 832 completed and submitted the questionnaire voluntarily, with a response rate of 52.1%. Table 1 presents the demographic characteristics of the participants. The mean age of the participants was 32.05±6.03 years. Most of them were women (n=772, 92.8%), had a bachelor's and above degree (n=645, 77.5%) and with a professional title of nurse or senior nurse (n=579, 69.6%). In total, 67.1% of the participants had worked for more than 5 years, and 55.6% worked in tertiary hospitals. The majority (n=764, 91.8%) reported that they had guidelines for PICC maintenance in their workplace and 83.9% had experience in PICC maintenance training (table 1).

Level of knowledge, attitudes and practice of PICC maintenance

The results showed that the average scores for knowledge, attitudes and practices of PICC maintenance were 53.57±13.80, 89.93±11.25 and 79.77±12.13, respectively. A total of 29.6% of participants had sufficient understanding of PICC maintenance, 68.5% of participants held positive attitudes toward PICC maintenance and 60.8% of participants reported acceptable practices of PICC maintenance (table 2).

Univariate analysis of practice regarding PICC maintenance by demographic characteristics, PICC maintenance knowledge and PICC maintenance attitudes

As shown in table 3, the univariate analysis revealed a significant difference in the practice of PICC maintenance

Table 1 Demographic characteristics of participants (N=832)

Characteristics	n	%
Gender		
Women	772	92.8
Men	60	7.2
Age (years) (M=32.05, SD=6.03, min–max=20–58)		
20–29	321	38.6
30–39	417	50.1
40–49	78	9.4
50–59	16	1.9
Work year (M=9.28, SD=6.25, min–max=1–36)		
<2	74	8.9
2–5	200	24
5–10 (not include 5)	277	33.3
>10	281	33.8
Professional title		
Nurse or senior nurse	579	69.6
Supervision nurse or co-chief nurse or chief nurse	253	30.4
Educational level		
Specialised secondary school or junior college	187	22.5
Undergraduate or above	645	77.5
Hospital type		
Secondary hospital	369	44.4
Tertiary hospital	463	55.6
The availability of PICC maintenance guideline in the workplace		
Yes	764	91.8
No	68	8.2
Previous experience of training on PICC maintenance		
Yes	698	83.9
No	134	16.1

%, percentage.; M, mean; max, maximum; min, minimum; n, frequency; PICC, peripherally inserted central catheter.

Table 2 Level of knowledge, attitudes and practices of PICC maintenance (N=832)

Level	n	%
Knowledge (M=53.57, SD=13.80, min–max=15.79–94.74)		
Pass (≥60)	246	29.6
Fail (<60)	586	70.4
Attitude (M=89.93, SD=11.25, min–max=33.82–100)		
Positive (≥80)	570	68.5
Negative (<80)	262	31.5
Practice (M=79.77, SD=12.13, min–max=40–100)		
Acceptable (≥80)	506	60.8
Unacceptable (<80)	326	39.2

%, percentage; M, mean; max, maximum.; min, minimum; n, frequency; PICC, peripherally inserted central catheter.

$(R^2=0.33, F(8, 823)=50.51, p<0.001)$. Only the availability of PICC guidelines ($\beta=0.10$, p=0.002), previous training on PICC maintenance ($\beta=0.18$, p<0.001) and attitudes toward PICC maintenance ($\beta=0.48$, p<0.001) were significant determinants of the practices of PICC maintenance (table 4).

DISCUSSION

This study investigated the level of practice of PICC maintenance and explored its influencing factors among nurses in Guizhou province. It revealed that participants' practice of PICC maintenance was unacceptable. The availability of PICC guidelines, previous training on PICC maintenance and attitudes toward PICC maintenance were significant predictors for PICC maintenance practice. These results indicated that nursing managers should pay attention to the quality of PICC maintenance. Strategies to improve nurses' practices of PICC maintenance are essential.

Nurses' practice of PICC maintenance was unacceptable, with a mean score of 79.77±12.13 and only 60.8% of participants reported acceptable practices (ie, more than 80) of PICC maintenance. Compared with the results that all participants had good practices of PICC maintenance from a previous study,[20] the present situation was not satisfactory.

This significant discrepancy may be related to different participants recruited. The previous study only included nurses from tertiary hospitals,[20] while our study involved both nurses from tertiary and secondary hospitals. Nearly 40% of participants performed unsatisfactorily in PICC maintenance, although 83.9% reported receiving PICC maintenance training. This finding suggests that the training effect may be unsatisfactory, and more attention needs to be paid to improve training quality and effectiveness. The nursing managers in Guizhou province should

among nurses of different ages (p<0.05), professional titles (p<0.01) and educational levels (p<0.01). In addition, nurses working in a tertiary hospital, having access to PICC maintenance guidelines in their workplace, having training experience in PICC maintenance, or having better knowledge and attitudes toward PICC maintenance had significantly higher scores of practices regarding PICC maintenance (all p<0.001).

Multiple regression analysis of factors contributing to practice of PICC maintenance

In the multiple regression analysis, age, professional title, educational level, hospital type, the availability of PICC maintenance guidelines in the workplaces, previous experience of training on PICC maintenance, knowledge and attitudes toward PICC maintenance totally accounted for 33.0% of the variance in practices of PICC maintenance

Table 3 Univariate analysis of practice of PICC maintenance by demographic characteristics of participants, knowledge of PICC maintenance and attitudes toward PICC maintenance (N=832)

Characteristics	M±SD (Md±IQR)	Statistics	P value
Gender		1.26[e]	0.84
Women	79.62[a]±12.14[b]		
Men	81.67[a]±11.86[b]		
Age (years)		9.66[f]	0.022[*]
20–29	80.00[c]±18.75[d]		
30–39	80.00[c]±15.00[d]		
40–49	82.50[c]±13.13[d]		
50–59	89.38[c]±13.44[d]		
Work year		3.85[f]	0.278
<2	80.00[c]±19.06[d]		
2–5	80.00[c]±19.69[d]		
5–10	80.00[c]±15.00[d]		
>10	81.25[c]±15.00[d]		
Professional title		−2.74[g]	0.006[**]
Nurse or senior nurse	80.00[c]±17.50[d]		
Supervision nurse or co-chief nurse or chief nurse	81.25[c]±13.75[d]		
Educational level		−3.03[g]	0.002[**]
Specialised secondary school or junior college	80.00[c]±20.00[d]		
Undergraduate or above	80.00[c]±15.63[d]		
Hospital type		−3.69[e]	<0.001
Secondary hospital	78.04[a]±11.88[b]		
Tertiary hospital	81.14[a]±12.17[b]		
The availability of PICC maintenance guideline in the workplace		−4.94[g]	<0.001
Yes	80.00[c]±16.25[d]		
No	73.13[c]±20.94[d]		
Previous experience of training on PICC maintenance		−7.01[g]	<0.001
Yes	81.25[c]±14.06[d]		
No	71.25[c]±20[d]		
Knowledge of PICC maintenance		−4.66[g]	<0.001
Fail (<60)	80.00[c]±17.50[d]		
Pass (≥60)	82.50[c]±12.81[d]		
Attitudes toward PICC maintenance		−14.88[e]	<0.001
Negative (<80)	71.57[a]±10.91[b]		
Positive (≥80)	83.54[a]±10.73[b]		

[a]Mean, [b]SD, [c]median, [d]IQR, [e]t: independent t-test, [f]H: Kruskal-Wallis test, [g]Z: Mann-Whitney test. [*]P value<0.05, [**]p<0.01.
M, mean; Md, median; PICC, peripherally inserted central catheter.

provide more training opportunities to ensure all nurses engaging in PICC maintenance are trained well. At the same time, they are recommended to take strategies to guarantee the effectiveness of PICC training, including dynamic assessment and training and exploration of new training models.

The availability of PICC guidelines was a significant factor in practices of PICC maintenance. Nurses who work in a unit where PICC guidelines are available are more likely to perform well in PICC maintenance. We did not find similar findings in previous studies. This finding could be attributed to the fact that guidelines provide nurses with existing evidence of PICC maintenance, promoting them to provide evidence based PICC maintenance for patients rather than providing nursing care based on personal experience. From this, we

Table 4 Multiple regression analysis of factors contributing to practice of PICC maintenance (N=832)

Predictor variables	Unstandardised coefficient		Standardised coefficient		
	B	SE	β	T	P value
Age	0.07	0.08	0.04	0.95	0.344
Professional title *	−0.89	1.04	−0.03	−0.86	0.391
Educational level *	0.16	0.86	0.01	0.18	0.854
Hospital type *	0.18	0.72	0.05	1.64	0.101
The availability of PICC maintenance guidelines in the workplace *	3.36	1.06	0.10	3.18	0.002†
Previous experience of training on PICC maintenance *	4.20	1.32	0.18	6.15	<0.001
Knowledge of PICC maintenance	0.02	0.03	0.03	0.89	0.377
Attitudes toward PICC maintenance	0.52	0.03	0.48	16.08	<0.001

Full model: R^2=0.33; $F_{(8, 823)}$=50.51; p<0.001; constant=19.81.
*Dummy coded variables: (gender: 0=male, 1=female; professional title: 0=nurse or senior nurse, 1=supervision nurse or co-chief nurse or chief nurse; educational level: 0=specialised secondary school or junior college, 1=undergraduate or above; hospital type: 0=secondary hospital, 1=tertiary hospital; the availability of PICC maintenance guideline in the workplace: 0=no, 1=yes; previous experience of training on PICC maintenance: 0=no, 1=yes).
†P value<0.01.
PICC, peripherally inserted central catheter.

recommended nursing managers take strategies to make it easy for nurses to access PICC guidelines, which allows them to perform PICC maintenance under guidance.

The previous training experience in PICC maintenance was also identified as the factor predicting nurses' practice of PICC maintenance. This finding indicates that nurses who have received training on PICC maintenance had better performance in PICC maintenance than those who had not received training on PICC maintenance. This finding was inconsistent with that of the previous study, which revealed that nurses' practices of PICC maintenance were not affected by the experience of PICC training.[20] We believe that training could provide nurses with first-hand information on PICC maintenance, enhancing their cognition and capability of PICC maintenance. The findings from a previous study confirmed the importance of training, highlighting that training could improve nurses' practice of PICC maintenance.[28]

Attitudes toward PICC maintenance were also the factor influencing nurses' practices of PICC maintenance. Participants who hold more positive attitudes toward PICC maintenance had higher scores on PICC maintenance practices. This finding was consistent with that of a previous study, which revealed that attitudes toward PICC maintenance were a predictor in practices of PICC maintenance.[25] The positive attitudes toward an issue motivate positive behaviour regarding the matter.[29] Only when nurses realise the importance of PICC maintenance for patients, the consequences of improper PICC maintenance and their role in PICC maintenance, can they make the best use of their knowledge to improve their PICC maintenance practices level.

One unexpected finding of our study was that knowledge was not a significant predictor in nurses' practices of PICC maintenance. Theoretically, knowledge is the basis and prerequisite for forming optimal behaviour.[29] This unexpected finding may be affected by some barrier factors that prevent nurses from accurately applying the knowledge they have acquired to practice, such as workforce shortage, heavy workload and PICC maintenance relevant resources shortage. These factors might lead nurses to simplify the practice process even though they have sufficient knowledge. Future research should further explore the barriers to nursing practice at the organisational level in order to better predict and improve the quality of care.

In summary, the practice of PICC maintenance among nurses in Guizhou province was not acceptable. Its predictors, including guidelines, training and nurses' attitudes should be considered when developing interventions to improve the quality of PICC maintenance. The present study contributed to the understanding of the practice of PICC maintenance and its influencing factors. The findings could provide information for developing tailored interventions to improve the quality of PICC maintenance. However, there were some limitations. First, we applied a convenience sampling method to recruit the participants, which may lead to selection bias, threatening the representativeness of the sample and the generalisability of study findings. Second, a self-reported questionnaire was used to assess nurses' practices of PICC maintenance; thus, the results might be affected by social desirability. Future studies should measure nurses' practice in a more accurate form, such as using the observation method. Third, all participants were recruited from Guizhou province, China; the finding may not apply to nurses in other regions. Finally, the present study failed to consider potential factors of PICC maintenance practice at the organisational level, such as workforce shortage, workload and relevant resources shortage. Further studies are needed to explore other predictors of PICC maintenance practice.

CONCLUSION

In conclusion, the situation of PICC maintenance in Guizhou province was unsatisfactory. Only 60.8% of nurses' performance in PICC maintenance was acceptable. Nurses' practices of PICC maintenance were mainly affected by the availability of PICC guidelines, the training on PICC maintenance and nurses' attitudes toward PICC maintenance. Based on these findings, we have some recommendations for improving the quality of PICC maintenance in Guizhou province. We recommended that the government, nursing associations and large-scale hospitals of Guizhou province establish a province-level PICC maintenance alliance, covering all hospitals introducing PICC technology or engaging in PICC maintenance. The alliance should take responsibility for developing or updating PICC guidelines, providing training on PICC maintenance regularly and developing programmes to enhance nurses' attitudes toward PICC maintenance, improving nurses' practices of PICC maintenance and ensuring the quality of PICC maintenance.

ORCID iD
Li Hu http://orcid.org/0000-0002-8413-8757

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