p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

CURRENT STATUS OF PERIPHERAL INTRAVENOUS CATHETER (PIVC) INSERTION AND MANAGEMENT IN PEDIATRIC PATIENTS AND RELATED FACTORS AT THE PEDIATRICS CENTER, THAI NGUYEN NATIONAL HOSPITAL

Tran Le Thu✉, Nguyen Thi Tu Ngoc,
Nguyen Ngoc Huyen, Nguyen Thi Oanh
Thai Nguyen University of Medicine and Pharmacy

ABSTRACT

***Objective**: To assess the current status of peripheral intravenous catheter (PIVC) insertion, maintenance, and management in pediatric patients, and to identify associated factors.*

***Subjects and methods**: A prospective study was conducted comprising 323 observations of PIVC insertion and care in children at the Pediatric Center, Thai Nguyen National Hospital.*

***Results:** 52.4% of cases were classified as having difficult venous access, and only 20.7% were rated as "good" for venous access. In 98.8% of observations, nursing performance in the PIVC insertion protocol was rated "good"; 1.2% were "fair," and none were "poor." Mild pain or slight erythema at the insertion site occurred in 52.9% of children. The mean PIVC dwell time was 3 days. Child age, nursing experience, management of difficulties encountered, and procedure duration were each significantly associated with venous access quality ($p < 0.05$). Phlebitis was significantly associated with child age, nursing experience, troubleshooting, and dressing tubing condition ($p < 0.05$).*

***Conclusions:** Despite high protocol adherence, achieving venous access in children remains challenging; child age, nursing experience, procedure time, difficulty management are key correlates. Strengthen technical training in PIVC for clinical nurses and standardize with rigorous monitoring of insertion and care processes. Integrate routine Visual Infusion Phlebitis (VIP) scoring into nursing records to enable early complication alerts and catheter replacement at predefined thresholds.*

***Keywords**: PIVC insertion, peripheral intravenous catheter, phlebitis, children.*

Chịu trách nhiệm: Trần Lệ Thu, Đại học Y Dược Thái Nguyên
Email: tranlethu@tnmc.edu.vn
Ngày gửi bài: 27/10/2025; Ngày nhận xét: 02/11/2025; Ngày duyệt bài: 26/11/2025
https://doi.org/10.54804

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

1. INTRODUCTION

Peripheral intravenous catheters (PIVCs) are a common invasive intervention among inpatients, used for the administration of intravenous fluids, medications, parenteral nutrition, and blood products, with nurses playing a central role and bearing a substantial procedural workload [1]. In children, anatomical characteristics and limited cooperation make venous access challenging: first-attempt failure can be as high as approximately 47%, about 9% require ≥ 4 attempts, and even with ultrasound guidance repeat attempts are still needed in approximately 15% of cases; in pediatric emergency departments, first-attempt success is only around 67.8% [2 - 4]. Repeated attempts increase pain and stress and the risk of conflict, and are associated with infiltration/extravasation, phlebitis, and a heightened risk of bloodstream infection; PIVC dwell times in children are often shorter than the recommended 72 - 96 hours (mean approximately 51.3 hours in older children) [4,5].

In Viet Nam, available evidence indicates that complications remain substantial (e.g., complications in neonates approximately 20.8%; infiltration/extravasation 15.7%; phlebitis 3.2%), and outcomes are linked to nurses' experience and knowledge and practice [6 - 8]. However, standardized evaluations of the entire care process (venous access catheter insertion securement maintenance management of complications) and associated factors are limited, particularly at tertiary hospitals. The Pediatrics Center, Thai Nguyen National Hospital admits more than 7,000 inpatients annually; PIVC placement is routine, and local data are needed to inform quality improvement. Therefore, this study aimed to (1) describe the current status of PIVC insertion and maintenance in pediatric patients and (2) identify associated factors at the Pediatrics Center, Thai Nguyen National Hospital in 2025.

2. OBJECTIVES METHODS

2.1. Study Design

Prospective cohort study.

- Sample Size and Sampling Method: Applied the single-proportion formula

$$n = \frac{Z^2_{(1-\alpha/2)}(p \times q)}{d^2}$$

$Z^2_{(1-\alpha/2)} = 1{,}96^2$ (p = 0.3 based on Tran Quoc Khanh, 2024 [7]); n = 323 observations.

2.2. Study Subjects

New peripheral intravenous catheter (PIVC) insertions in inpatients at the Pediatric Center, Thai Nguyen National Hospital, performed by nurses during the study period; each insertion was followed from placement until removal or discharge.

+ Inclusion criteria: Inpatients under 16 years old (Under 1 year old, 1 - 3 years old, over 3 years old) with an indication for PIVC; parent/guardian/caregiver provides consent.

+ Exclusion criteria: Central catheters (PICC), umbilical venous catheters (UVC), arterial lines, and PIVCs already in place before study initiation.

- Setting and Period: Pediatric Center, Thai Nguyen National Hospital, from January to December 2025.

- Variables: Demographic characteristics of nurses and pediatric patients observed; current practices in venous access, PIVC

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

insertion, securement, and management; factors associated with PIVC insertion and management in children.

- ***Standards and Assessments:***

• Venous access difficulty: Yan Ya-Min scale (5 items: age, site, visibility, palpability, patency), each item scored 0 - 2; total 0 - 10, categorized as grade 0 (0 - 2), 1 (3 - 4), 2 (5 - 7), 3 (8 - 10).

• PIVC insertion technique: 34-step checklist; each step scored 2/1/0; total 0 - 68, converted to a 10 - point scale: < 7 = average; 7-< 8 = good; 8 -< 9 = very good; ≥ 9 = excellent.

• PIVC securement: 5-item checklist; "Pass" when all 5/5 are achieved (with photo documentation).

• Procedure outcomes: success, number of attempts, and time from skin puncture to securement.

• Catheter management: date/time of insertion, patency checks, monitoring and prevention of complications, dwell time, and reason for removal.

• Complications: Phlebitis graded by the Visual Infusion Phlebitis (VIP) score 0 - 5 (per INS recommendations; previously validated in Vietnam) was monitored and evaluated using a checklist every 8 hours and after 3 days of catheter dwell time.

2.3. Data Analysis

SPSS 23.0. Descriptive statistics (frequency, %, mean ± SD or median). Group comparisons by Chi-square test. Multivariable logistic regression for first-attempt failure using pediatric demographic variables and initial insertion outcomes; report adjusted ORs (95% CI), with $p < 0.05$. Results presented in tables/figures.

2.4. Research Ethics

Approved by the Institutional Ethics Committee of Thai Nguyen University of Medicine and Pharmacy, Thai Nguyen University.

3. RESULTS

Among 323 observations, most nurses had over 10 years of experience (57.6%) and a college-level qualification (72.1%). 100% nurses agreed that training is necessary. When encountering PIVC-related problems, nurses were nearly evenly split between consulting colleagues (50.2%) and resolving issues independently (49.8%). The primary patients undergoing venous access were children under 1 year of age (44.9%), followed by those aged 1-3 years (26.9%); the remaining 28.2% were children. Most children had hard-to-identify veins with poor visibility (52.3%), were non-palpable (74.6%), and had poor patency (57%), indicating a high level of difficulty for venous access procedures. First-attempt success was 47.7%, whereas 30.3% required three or more attempts, and over half (53.3%) needed more than 5 minutes to complete. Nearly 47% achieved successful PIVC placement within ≤5 minutes.

Table 1. Classification of venous access difficulty in pediatric patients

No.	Classification	n	%
1	Level 0 - Good	67	20.7
2	Level 1 - Fairly good	0	0
3	Level 2 - Average	87	26.9
4	Level 3 - Difficult access	169	52.4

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

52.4% were in the “difficult access” group, 26.9% in the “average access” group, and only 20.7% were rated “good.”

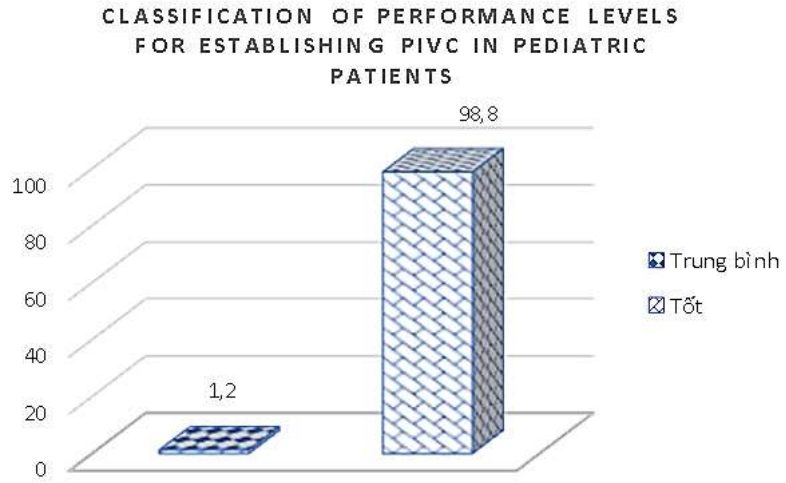

Figure 1. Classification of performance levels for establishing PIVC

Results show that 98.8% of nurses were rated “good” in the peripheral intravenous catheter (PIVC) insertion procedure for children. Only 1.2% were “average,” and none were “poor.”

Table 2. Compliance check for PIVC securement standards

No.	Contents	Pass		Not pass	
		n	**%**	**n**	**%**
1	Skin allowed to air-dry naturally after antisepsis	146	45.2	177	54.8
2	Dressing secured using standard technique	146	45.2	177	54.8
3	PIVC hub/connector secured with the Ω (omega) technique	135	41.8	188	58.2
4	Supportive device used correctly (e.g., splint/ armboard)	320	99.1	3	0.9
5	Health education provided	323	100	0	0
	Total	186	57.6	137	42.4

The compliance rate with PIVC securement techniques remains low: only about 45% correctly performed skin air-drying and dressing securement, and 41.8% correctly secured the hub/connector using the Ω technique. In contrast, the use of supportive devices (99.1%) and the provision of health education (100%) were carried out very well, highlighting strengths in support and patient education.

Table 3. PIVC evaluation using the VIP Score

No.	**Contents**	**n**	**%**
1	No redness, no swelling, no pain *(~VIP 0)*	152	47.1
2	Mild pain / mild redness *(~VIP 1)*	171	52.9
	Total	323	100

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

Over half (52.9%) showed mild signs consistent with VIP≈1; 47.1% had no signs of phlebitis (VIP≈0).

Table 4. Factors related with pediatric venous access difficulty

Factors \ Level		Easy access (Level 0)		Moderate (Level 2)		Difficult (Level 3)		p
		n	%	n	%	n	%	
Child's age	< 1 year old	9	6.2	15	10.6	121	83.4	0.000*
	1 - 3 years old	0	0	72	82.8	15	17.2	
	> 3 years old	58	63.7	0	0	33	36.3	
Nurse's years of experience	< 5 years	0	0	0	0	32	100	0.000*
	5 - 10 years	0	0	14	13.3	91	86.7	
	> 10 years	67	36.0	73	39.2	46	24.8	
Nurse's educational level	College	51	21.9	64	27.5	118	50.6	0.587
	Bachelor/Postgraduate	16	17.7	23	25.6	51	56.7	
How issues with PIVC were handled	Consult colleagues	40	24.7	62	38.3	60	37	0.000
	Self-resolve	27	16.8	25	15.5	109	67.7	
Procedure time	≤ 5 minutes	67	44.4	84	55.6	0	0	0.000*
	> 5 minutes	0	0	3	1.7	169	98.3	

** Fisher's exact test*

Child age, nurse experience, response to difficulties, and procedure time were all significantly associated with venous access difficulty ($p < 0.05$), whereas nurse educational level was not.

Table 5. Factors related with phlebitis severity (VIP score)

Factors \ Level		VIP 0		VIP 1		p
		n	%	n	%	
Child's age	< 1 year	62	4.8	83	57.2	0.001
	1-3 years	56	64.4	31	35.6	
	> 3 years	34	37.4	57	62.6	
Nurse's years of experience	< 5 years	13	40.6	19	59.4	0.000
	5-10 years	32	30.5	73	69.5	
	> 10 years	107	57.5	79	42.5	
How issues were handled	Consult colleagues	90	55.6	72	44.4	0.002
	Self-resolve	62	38.5	99	61.5	
Blood present in catheter lumen	No	152	100	0	0	0.000*
	Yes	0	0	171	100	
Dressing condition	Wet/soiled	0	0	171	100	0.000*
	Dry/clean	152	100	0	0	

** Fisher's exact test*

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

Phlebitis (VIP 1) was significantly associated with child age, nurse experience, problem-solving approach, and dressing/tubing status ($p < 0.05$).

4. DISCUSSION

This study shows that venous access and PIVC care in pediatric patients remain highly challenging despite an experienced nursing workforce. All nurses stated that they need formal and regular training on pediatric PIVC. The high rate of difficult venous access (52.4%), the low first-attempt success (47.7%), frequent need for ≥ 3 attempts (30.3%), and prolonged procedure times (9.7 minutes) - particularly pronounced in infants < 12 months, whose veins are small, hard to visualize, and prone to collapse. Although a large proportion of nurses had substantial clinical experience (57.6% with ≥ 10 years), problem-solving was evenly split between self-management (49.8%) and consulting colleagues (50.2%). Together, these findings indicate substantial gaps in training, practice conditions, and on-site professional support.

Venous access in children - especially those < 1 year (44.9%) - remained difficult: 74.6% of cases had non-palpable veins and 57% had poor patency; first-attempt success was 47.7%, ≥3 attempts were required in 30.3%, and mean procedure time was 9.7 minutes (exceeding the ideal). The difficulty classification showed 52.4% “difficult” and 20.7% “easy,” with no cases rated as “fairly good,” suggesting the current grading scale may lack discriminatory resolution. While several core technical steps were performed at very high rates (up to 100%), key safety elements were suboptimal (gloving 24.1%, correct skin antisepsis 65.3%, correctly positioned tourniquet 60.1%, and end-of-procedure documentation < 60%). This finding is consistent with the report of Tran Thi Ly (2023), which recorded a compliance rate of 43.4% based on patients and 45.2% based on observation rounds. A total of 144 PIVC insertion procedures were evaluated, with a mean score of 9.52 ± 0.3. Among these, 130 procedures (90.3%) achieved an excellent rating, and 14 procedures (7.7%) were rated as good [8].

At 24 hours post-insertion, only 47.1% had complete records of date/time/operator; 52.9% had blood remaining in the catheter lumen, only about half of dressings met standards, and 52.9% of children had mild VIP scores. According to CDC and INS guidance, PIVC sites should be assessed at least every 8 hours, with complete documentation required to ensure continuity and safety of care [4, 7, 9]. The dwell time of 3.03 ± 1.06 days was consistent with the recommended 72 - 96 hours [2, 6, 10]. However, 21.4% of catheters were removed due to failure, which was associated with the aforementioned shortcomings as well as difficulties in post-insertion care, such as small and fragile veins prone to collapse or rupture, poor cooperation, and frequent movement. Factors significantly associated with venous access difficulty ($p < 0.05$) included child age, nurse experience, approach to troubleshooting, and procedure duration. Phlebitis was more frequent in children < 1 year and > 3 years, among nurses with < 10 years’ experience. The trend of ‘higher risk in younger children’ is consistent with the study by Malraj Sai Rohit (2025) on 237 children aged 1 month to 12 years, which used the VIP score and reported that phlebitis occurred more frequently in those ≤ 3 years compared to older children ($p < 0.05$) [11]. This finding also aligns with the study of Tegegne (2025) involving 423 nurses in Ethiopia, showing that nurses with <5 years of experience had a 52% lower likelihood of good PIVC care practices compared with those with ≥5 years of experience (AOR = 0.48; $p = 0.023$), whereas experience in surgical or pediatric wards significantly improved correct practice

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

[12]. These results highlight the need for regular training, standardization of procedures and improved post-insertion care and documentation to reduce failures and complications.

5. CONCLUSION

Among 323 PIVC insertions, 52.4% of children were classified as difficult venous access, with a first-attempt success rate of 47.7%, and 30.3% requiring ≥ 3 attempts; more than 50% of procedures took > 5 minutes to perform. Although 98.8% of procedures were rated as 'good,' adherence to fixation standards remained low (≈45% with dry tape/skin; 41.8% with correctly applied Ω-shaped securement). VIP scores indicated 52.9% mild phlebitis.

Statistically significant associated factors ($p < 0.05$) included age, nursing experience, management strategies during difficult insertions, and the condition of the dressing - tubing. Phlebitis and difficult access were more frequent in children < 1 year and > 3 years, in nurses with <10 years of experience, and when the dressing tubing did not meet quality standards.

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