Journal

Journal of Pediatric Nursing, 90

ISSN

0882-5963

Authors

Bauernsmith, Ian

Davidson, Judy

Burnett, Lindsey

Publication Date

2026-09-01

DOI

10.1016/j.pedn.2026.07.058

Journal of Pediatric Nursing 90 (2026) 797–801

Contents lists available at ScienceDirect

Journal of Pediatric Nursing

journal homepage: www.pediatricnursing.org

Effect of updated best practices on ultrasound-guided peripheral IV dwell time in children

Ian Bauernsmith [a,b,*], Judy Davidson [b,c], Lindsey Burnett [b]

[a] Rady Children's Hospital, San Diego, CA, United States of America
[b] University of California San Diego Health, San Diego, CA, United States of America
[c] Ohio State University, Columbus, OH, United States of America

ARTICLE INFO

Article history:
Received 29 August 2025
Revised 10 June 2026
Accepted 24 July 2026
Available online xxxx

Keywords:
Nursing pediatric
Peripheral venous catheterization
Pediatric ultrasound guided IV
Intravenous catheterization

ABSTRACT

Importance: Placement of intravenous access is challenging in pediatric patients. Complications and replacement of IV access is a common occurrence in pediatric patients.
Objective: This project evaluated a new training program for placement of pediatric USGIV lines.
Design: Quality improvement: pre-post cohort.
Setting: A tertiary pediatric hospital in the southwest United States.
Participants: The pre-intervention cohort included 400 IV lines identified through retrospective chart review. A subset of 68 lines placed in the three months prior to the intervention were specific to the nurses undergoing training. The post-intervention cohort consisted of 359 lines obtained via convenience sampling. Lines were excluded if documentation lacked insertion/removal dates or reasons for removal.
Methods: The educational intervention was based on best practices, including appropriate catheter-to-vessel diameter ratios and optimal catheter length within the vessel. Training was delivered through asynchronous PowerPoint presentations, one-on-one clinical rounding, and badge card distribution. Mean dwell time and complication rates were assessed through chart review. A sample size of 353 lines was calculated to detect a 25% increase in dwell time; 359 lines were reviewed post-intervention.
Results: The average patient age was similar between groups (pre: 11.22 years; post: 11.28 years). A statistically significant increase in dwell time was observed post-intervention (mean 2.17 vs. 1.72 days, $p = 0.0015$). While overall complication rates remained stable, a significant reduction in early complications (within 0–1 day) was noted ($p = 0.01778$).
Conclusions: These findings support integration of measurement-based decision-making in pediatric vascular access. Further multi-site studies are needed to confirm generalizability.

Introduction

Every year in the United States over 300 million peripheral intravenous catheters are used (Ullman et al., 2020). This common invasive procedure is a key component for gathering laboratory samples to evaluate a patient's condition and as a route for providing treatment. Prompt establishment and maintenance of vascular access is key, and delay or loss of access can result in delayed diagnosis or an interruption in treatment, prolonging hospital stays. Due to venous access being an invasive procedure each attempt includes risk for injury or infection (Nickel, 2020).

In pediatrics, establishment and maintenance intravenous access is made more difficult by many factors, including patient lack of compliance, complex medical history, smaller vein size compared to adults, or a more pronounced layer of subcutaneous tissue (Mitchell et al., 2022; Ullman et al., 2020). Traditional intravenous access for pediatric non-medically complex patients on average requires two attempts for every successful intravenous access placement (Ullman et al., 2020). In medically complex patients, on average, six attempts are required for every successful intravenous access (Ullman et al., 2020). At most each intravenous line is expected to last two days (Ullman et al., 2020). For pediatrics, especially medically complex or fragile pediatrics, these numbers represent potentially multiple painful attempts each day of their hospital stay, and every attempt carries a risk for injury or infection. Ultrasound guided intravenous access (USGIV) in pediatrics has demonstrated an increased first attempt success rate (Kleidon et al., 2025; Mitchell et al., 2022).

* Corresponding author at: UC San Diego Health, 200 W. Arbor Drive #8929, San Diego, CA 92103, United States of America.
E-mail address: ibauernsmith@health.ucsd.edu (I. Bauernsmith).

https://doi.org/10.1016/j.pedn.2026.07.058
0882-5963/

The unique feature of ultrasound for ultrasound-guided peripheral intravenous access is the ability to transform what was previously a qualitative process into a quantitative process. Vessels can be identified, measured, traced, and marked. As practitioners, nurses can apply this information in a critical thinking manner and truly evaluate the available vasculature of a patient to a level of detail that is much greater than what is possible through traditional techniques. This level of detailed information, combined with known dimensions of the available catheters and the potential needs based on expected plan of care can all be combined to inform catheter and vessel selection with the goal of creating a more stable, effective PIV that needs to be replaced less frequently and is established in fewer attempts.

Research on adult subjects has demonstrated some correlation between quantifiable traits on ultrasound such as the depth or diameter of the target vessel and the relationship between those measurements and the length or diameter of the catheter selected can inform the probability of successful placement or potential for early line failure (Badger, 2019; Fabiani et al., 2023; Gottlieb et al., 2017; Keogh et al., 2024; Pandurangadu et al., 2018). Indicators of success include a "moderate depth" and a vessel inner diameter greater than or equal to 0.4 cm (Fabiani et al., 2023; Sabado & Pittiruti, 2019; van Loon et al., 2021). Other studies have described an inverse relationship between depth and rate of successful cannulation, and a direct relationship between vessel diameter and successful cannulation rate (van Loon et al., 2021). Indicators of early line failure include depth of vessel or location the USGPIV is inserted (Fabiani et al., 2023; van Loon et al., 2021), catheter to vein ratio (van Loon et al., 2021), or length of catheter (Badger, 2019; Bahl et al., 2019; Pandurangadu et al., 2018).

A risk benefit analysis was conducted to evaluate the potential to translate adult USGIV practices to the pediatric population. Key components evaluated included current traditional PIV techniques for adult and pediatrics, current known structure of both adult and pediatric veins, and current standard teaching for USGIV. Current practice for adult and pediatric PIV training is the same except for the size of catheters used and vessels accessed. For USGIV there is no noted difference in the standard training between adult and pediatric patients. It was determined that there was no plausible reason to believe pediatric patients would incur extra risk from this practice change.

The purpose of this project is to evaluate a new training program for placement of pediatric USGIV lines utilizing measurements to inform decision making and increase overall dwell time and decrease complication rates.

Materials and methods

Study design

A quality improvement: pre-post cohort design was used.

Setting and population

This quality improvement project was conducted at a single tertiary-care urban pediatric hospital in the southwestern United States.

Data collection procedure

Baseline data was obtained through retrospective chart review completed by the Informatics Department. Intervention data was obtained through chart review based on reporting forms from staff.

Data from this retrospective analysis was used for sample size calculation to determine the number of lines needed in the post-training analysis to detect a 25% increase in dwell time, with a significance level (α) of 0.05 and power ($1-\beta$) of 0.80. This power analysis indicated that 353 lines were needed. Ultimately, 359 lines were included, as data was tabulated monthly.

Three months prior to the training intervention, USGPIV reporting forms were introduced and incorporated into the clinical workflow. These forms included the following data fields: Patient medical record number (for later chart review and data extraction), vessel depth, vessel diameter, catheter gauge, catheter length, and location of ultrasound-guided access placement.

Pre-intervention training standard

Baseline instruction in effect prior to January 2019 for Emergency Department nurses involved an USGPIV training program consisting of a one-hour didactic session delivered via synchronous virtual format, a one-hour hands-on simulation using a task trainer completed in a 1 on 1 fashion with an instructor in person to establish basic skill, and a competency requirement of successfully placing 10 USGPIVs in pediatric patients culminating in demonstration of independent practice. Demonstration of independent practice was defined as the learner being able to complete all aspects of the skill without intervention or direction from the instructor. This training focused on image acquisition, vein identification, and cannulation technique but did not include formal instruction on quantitative vessel assessment or catheter selection based on ultrasound measurements.

Ethical considerations

This project was reviewed by the UC San Diego Institutional Review Board and received a Not Human Subjects research designation (#200701QI).

Study intervention

Pre-intervention assessment of line duration and outcome was assessed by retrospective electronic chart review of all USGPIV lines placed from January of 2019 through August of 2020. These dates were selected as January 2019 was the earliest available date lines were designated as placed with ultrasound guidance. Lines were excluded if charting did not include any of the following: insertion date and time, removal date and time, and removal reason (including complications). Removal reasons included the following: therapy complete, order for removal, unintentional removal, removal for complication (phlebitis, redness, pain, unable to flush, leaking, infiltrate). Information on the provider type who placed the USGPIV was collected when available. The following patient demographics were abstracted from the electronic medical record: patient age and gender.

The intervention introduced in this study focused specifically on the application of ultrasound-derived vessel depth and diameter measurements to guide catheter selection. Nurses were trained to acquire measurements using the calipers built into the unit specific ultrasound. Nurses were additionally educated in how to incorporate these measurements alongside anticipated clinical needs, such as infusion requirements, to select the smallest appropriate catheter while maintaining adequate functional performance. This represented a shift from primarily technique-based training to a decision-making framework integrating quantitative data into practice. The interventional training for this study was designed to augment existing USGPIV competency rather than replace it. While nurses had previously been trained in ultrasound-guided insertion technique, the intervention emphasized a new cognitive component: the use of vessel measurements and catheter-to-vein ratios to inform device selection and placement strategy. This distinction allowed for evaluation of the incremental impact of measurement-based education on clinical outcomes.

Emergency Department nurses who had either completed or were currently undergoing training in the department's ultrasound-guided peripheral venous access program were included in the training intervention. The training intervention involved three components: 1) an

Table 1
Example of the badge card table provided to staff.
Measurement-based ultrasound-guided peripheral IV catheter selection guidelines.

Catheter	Depth	Diameter
24ga 1.25"	0–1.25 cm	>/= 0.15 cm
22ga 1.75"	0–1.49 cm	>/= 0.2 cm
20ga 1.88"	0–1.54 cm	>/= 0.24 cm
18ga 1.75"	0–1.49 cm	>/= 0.28 cm
16ga 2"	0–1.59 cm	>/= 0.41 cm
14ga 2"	0–1.59 cm	>/= 0.5 cm

Catheter denotes the length and gauge combinations available to staff.
Depth denotes the minimum and maximum depth for the respective catheter for safe cannulation.
Diameter denotes the minimum vessel diameter for the respective catheter for safe cannulation.
These thresholds reflect recommended catheter selection parameters associated with improved catheter survival.

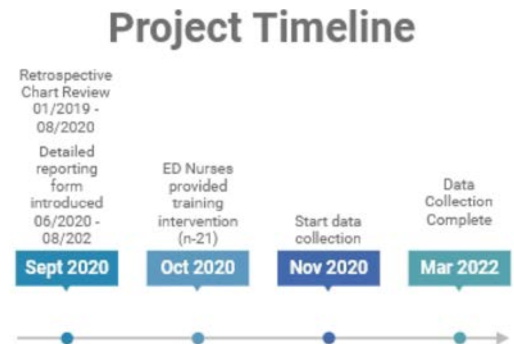

Fig. 1. Project timeline.
Study design and data collection timeline for pre- and post-intervention cohorts.

on-line asynchronous presentation (~ 30 min) 2) individual face-to-face follow-up confirming ability to use ultrasound calipers (~15–30 min) 3) badge card with recommendations for catheter to vein insertion ratio and catheter length printed for reference (Table 1). A one-month period was utilized to complete the training intervention for all practitioners. Data from this training period was excluded from the analysis.

Practice recommendations in the training intervention were based on prior research in adult patients undergoing ultrasound-guided venous access, including studies on peripherally inserted central catheters (Badger, 2019; Bahl et al., 2019; Keogh et al., 2024; Pandurangadu et al., 2018; Sabado & Pittiruti, 2019; Sharp et al., 2015). To adapt this guidance for pediatric patients, measurements expressed as percentages or ratios were used to allow for appropriate scaling. The team was instructed to aim for a catheter-to-vein ratio of 45% or less (Sharp et al., 2015; van Loon et al., 2021) and to ensure at least 50% of the catheter length remained within the target vessel (Pandurangadu et al., 2018). A schematic of prior adult measurement-based placements and adapted pediatric measurements is shown in Table 1. Table 1 summarizes the measurement-based guidelines introduced during the intervention, which were used to guide catheter selection and placement. This table was used to generate reference badge cards for staff with specific measurements for approved catheters provided a quick reference during line placement.

Post-intervention assessment

Data for the post-training USGIV lines was collected from USGIV reporting forms previously implemented (vessel depth, vessel diameter, catheter gauge, catheter length, and location of ultrasound-guided access placement) and chart review (insertion date and time, removal date and time, and removal reason). The vessel depth was measured from skin to top vessel wall and vessel diameter was measured as inner vessel diameter from top to bottom of vessel. Post-intervention lines were tracked monthly until sample size was reached.

Results

Pre-training USGIV

A schematic overview of the study design is presented in Fig. 1. Fig. 1 illustrates the timeline of pre-intervention data collection, the training implementation period, and post-intervention data collection used to evaluate changes in dwell time and complication patterns. Overall, data from 400 USGIV lines were assessed in the 20 months prior to the training intervention. This time period was chosen to maximize the sample size and began when ultrasound guidance was first documented in the electronic medical record. Implementation of the reporting form occurred in the last 3 months of this period. 85 attempts for 68 successful placements of the 400 lines were completed utilizing the reporting form. The training intervention took place over 1 month for which USGIV line data was excluded from analysis. Post-training USGIV lines were tabulated monthly by reporting form and chart abstraction until sample size was met (18 months).

For the retrospective analysis of the 400 pre-intervention USGIV lines, an average of 20 USGIV lines/month were placed. The mean age of patients receiving these lines was 11.22 years (SD 5.63) with 45.75% of lines placed in male patients (Table 2). These lines had a mean dwell of 1.72 days (SD 2.23) and median dwell of 0.93 days. The complication rate for these lines was 17%. Of the complications the most common was infiltration at 51% followed by leaking at 18% and difficulty or painful flush at 6%. The average time to complication was 2.144 days. Table 2 demonstrates that patient demographics were similar between groups, while dwell time significantly increased following the intervention.

During the 3-month period prior to the training intervention detailed data was collected on 85 attempts with 68 successful line placements representing 1.25 attempts per line. No statistical difference was noted in the dwell times between the retrospective chart review group and the group utilizing the reporting form ($p = 0.2697$, Difference − 0.4307, CI -0.5472 to 0.05139). These lines were placed in children with mean age of 10.65 years (SD 5.361) with 48.52% being placed in male patients. The complication rate for these lines was 23.5%. Of the complications the most common was infiltration at 50% followed by leaking at 31.25% and broken hub, pain with flush, and phlebitis at 6.25% each. The average time to complication was 2.51 days.

Table 2
Demographics & outcomes.
Patient and catheter characteristics and outcomes before and after intervention.

Variable	Pre-Intervention ($n = 400$)	Post-Intervention ($n = 359$)	*P* value
Patient Demographics			
Age in years, mean (SD)	11.22(5.63)	11.28(6.92)	0.8853*
Gender, male, n (%)	183 (45.75)	187 (52.23)	0.0943#
USGIV Lines Placed during Observed Time Period			
Number of USGIV Lines placed monthly, mean (SD)	20 (9.65)	19.94 (9.59)	
Dwell Time in Days	1.72(2.23)	2.17(2.35)	**0.0013**◇
Overall Complication Rate n, (%)	66(16.50)	70(19.50)	0.5693#
Timing of Complication n, (%)			**0.0299**◇
Days 0–1	19 (4.75)	9 (2.50)	
Days 1–2	13 (3.25)	10 (2.79)	
Days 2–4	19 (4.75)	26 (7.24)	
Days >4	17 (4.25)	22 (6.13)	

Legend: SD = standard deviation, * denotes *t*-test, # denotes Fisher's Exact Test, ◇ denotes Mann Whitney *U* Test.
Values are presented as mean (SD) unless otherwise specified.

Detailed information about vessel depth, vessel diameter, catheter length, and catheter gauge were available for this subset of pre-intervention lines. Pre-interventions attempts had a mean depth of 0.4834 cm (SD 0.2941) and mean diameter of 0.2924 cm (SD 0.1390). The most common catheter used was a 1.75″ 22 ga (78.82%).

Clinical provider training

Training was implemented for Emergency Department nurses who had either completed or were currently undergoing training in the department's ultrasound-guided peripheral venous access program. This included a total of 21 nurses. At the time of training 11 nurses were competent with USGIV placement and had experienced their initial training up to 18 months prior to the training intervention. All nurses in this group received USGIV training prior to independent USGIV placement. 10 additional nurses completed USGIV training that had not previously placed USGIV lines and were receiving training for the first time. All 21 nurses completed the entire training program within one month for which USGIV line data was excluded from analysis.

Post-training

359 post-intervention USGIV lines were analyzed and collected over an 18-month period. An average of 19.94 USGIV lines/month were placed consistent with the number placed prior to the intervention. Also consistent with the pre-intervention population, the post-intervention group had a mean age of 11.28 years (SD 6.92) with 52.23% of lines placed in male patients. These lines had a mean dwell of 2.174 days (SD 2.350) and median dwell of 1.307 days. These lines were placed in children with mean age of 11.29 years (SD 6.915). The complication rate for these lines was 19.50%. The average time to complication was 3.361 days (SD 2.299).

Observed change

While the overall complication rate was not significantly different at 16.50% vs 19.50% ($p = 0.5693$, difference of 0.7840, CI 95% 0.05903 to 1.476) we did note that the **timing** of complications was significantly different. Pre-interventions lines with complications demonstrated a mean dwell of 2.689 days (SD 2.418) with a median dwell of 2.144 days. Post-interventions lines with complications demonstrated a mean dwell of 3.361 days (SD 2.229) with a median dwell of 2.928 days. This increase was noted to be significant ($p = 0.299$, difference of 0.7840, CI 95% 0.5903 to 1.476). Concurrently, overall dwell was significantly higher in the post-intervention group (Table 2).

Table 3
Changes in clinical practice patterns following measurement-based training.
This table represents the 85 USGIV lines that were placed prior to the teaching intervention by the Emergency Department USGIV team compared to the 359 USGIV lines placed after the teaching intervention. These data represent the same practitioners pre and post intervention. Data are derived from the reporting form and clinical chart review.

Variable	Pre-Intervention ($n = 85$)	Post-Intervention (n = 359)	P value
Clinical Factors			
Age in years, mean (SD)	10.65 (5.36)	11.29 (6.91)	0.2451◇
Gender, male, n, (%)	33 (48.52)	187 (52.09)	**0.0302#**
Obesity, yes, n (%)	16 (18.82)	116 (32.31)	**0.0171#**
Complex Medical History, yes, n (%)	54 (63.52)	215 (59.89)	0.6217#
Hold help, yes, n (%)	43 (50.59)	265 (73.82)	**<0.0001#**
Agitated, yes, n (%)	18 (21.18)	93 (25.91)	0.4056#
Fascia, yes, n (%)	32 (37.65)	225 (62.67)	**<0.0001#**
Training Features			
Successful Placement, n, (%)	68 (80)	320 (89.14)	**0.0289#**
>50% Catheter in Vessel, n, (%)	39 (45.88)	284 (79.11)	**<0.0001#**
Verification Method			
Flush, yes, n (%)	25 (29.41)	75 (20.89)	**0.0079#**
Flush and long view, n (%)	43 (50.59)	279 (77.72)	
Unknown	17 (20)	5 (1.39)	
Catheter Features			
Length	N (%)	N (%)	
0.75 in.	2 (2.36)	0	**0.0363#**
1.00 in.	3 (3.53)	1 (0.28)	**0.0235#**
1.25 in.	0	144 (40.11)	**<0.0001#**
1.75 in.	67 (78.82)	186 (51.81)	**<0.0001#**
1.88 in.	8 (9.41)	23 (6.41)	0.3442#
2.00 in.	0	4 (1.11)	>0.9999#
Unknown	5 (5.88)	1 (0.28)	
Gauge	N (%)	N (%)	
24	2 (2.36)	144 (40.11)	**<0.0001#**
22	71 (83.53)	186 (51.81)	**<0.0001#**
20	11 (12.94)	23 (6.41)	0.0658#
18	0	5 (1.39)	0.5885#
Unknown	5 (5.88)	1 (0.28)	
Vessel Features			
Location	N (%)	N (%)	
Upper Arm	31 (36.47)	54 (15.04)	**<0.0001#**
Lower Arm	21 (24.71)	189 (52.65)	**<0.0001#**
Lower Leg	3 (3.53)	12 (3.34)	>0.9999#
Arm	26 (30.59)	80 (22.28)	0.1198#
Unknown	4 (4.71)	24 (6.68)	
Vessel Name	N (%)	N (%)	
Cephalic	36 (42.35)	190 (52.92)	0.0913#
Basilic	11 (12.94)	31 (8.64)	0.2204#
Antecubital	24 (28.24)	83 (23.12)	0.3259#
Saphenous	3 (3.53)	8 (2.23)	0.4476#
Brachial	2 (2.36)	0	**0.0007#**
Other	9 (10.59)	25 (6.96)	
Vessel Measurements	Mean (SD)	Mean (SD)	
Vessel Depth, cm	0.48 (0.29)	0.48 (0.20)	0.9745*
Vessel Diameter, cm	0.29 (0.13)	0.27 (0.11)	0.3559*

Legend: ◇ Denotes Mann Whitney U Test, # Denotes Fisher's Exact Test, * Denotes T Test.

Discussion

The use of intravenous therapy for any patient is a cornerstone of treatment in current medical practice for hospitalized patients (Keogh et al., 2024; Ullman et al., 2020). Loss of access during hospitalization from events such as phlebitis, infiltration, or infection represent interruption in treatment with potential for prolongation of hospital stays (Ullman et al., 2020). Research and literature focus primarily on longer term access options such as peripherally inserted central catheters (PICC), multi-lumen central lines, and surgically implanted ports or tunneled catheters (Keogh et al., 2024; López Álvarez et al., 2018; Otani et al., 2018). Additionally, national focus is on the sequelae and subsequent costs of central line associated bloodstream infections resulting in updated national practice guidelines, formation of facility specific nursing bundles, and national benchmarks for care (Keogh et al., 2024). In contrast, the body of literature for peripheral access technique is limited and without the same robust level of benchmarks, bundles, and taskforces compared to longer term IV access options however, literature is demonstrating the role for USGIV in various settings such as the emergency department or the intensive care setting (Anderson et al., 2022; Cochrane et al., 2020; Fabiani et al., 2023; Listed, 2019; López Álvarez et al., 2018; Mitchell et al., 2022; Otani et al., 2018; Sabado & Pittiruti, 2019; van Loon et al., 2021).

Both adult long-term peripheral IV access and pediatric peripheral IV access are performed using ultrasound guided technology (Anderson et al., 2022; Fabiani et al., 2023; van Loon et al., 2021). Both populations have proportionally different yet structurally similar venous structures (Fabiani et al., 2023). This project demonstrates how practices can be translated safely from adult long-term access options to pediatric ultrasound guided peripheral access options.

The pre-post comparison demonstrated a significant change in the average dwell time and a shift in the time point that most complications occur. These results suggest that considering vein depth and diameter in relation to catheter length and gauge during pediatric peripheral ultrasound guided IV insertion improves average dwell time and delays complications for pediatric patients. These findings are consistent with previous literature in adult populations (Badger, 2019; Bahl et al., 2019; Currie & Huecker, 2019; Pandurangadu et al., 2018; Sharp et al., 2015; van Loon et al., 2021). These results are significant as they represent an improvement in multiple factors. With a longer average dwell time, a larger percentage of patients have the potential to only need a single PIV for their hospital stay. In addition, a longer average dwell time translates to fewer re-access attempts which can improve patient and family satisfaction and reduce interruptions in care. Fewer interruptions in care can reduce overall length of stay, reducing healthcare costs.

Table 3 highlights shifts in clinical practice following the intervention, including increased use of distal placement sites and smaller catheter sizes. Secondary findings included significant trends in the use of "hold help" during placement, the identification of fascia prior to placement, increased overall success rate, change in the use of 1.25 in. 24 gauge catheters and 1.75 in. 22 gauge catheters, as well as significant increase in the placement of lines in the lower arm (Table 3). This constellation of findings is consistent with recommendations from the Infusion Nurses Society to use the smallest available catheter in a distal location away from areas of flexion (Keogh et al., 2024).

There were some additional anecdotal findings that came up during rounding with the team or during spontaneous conversations. These findings included the following concepts: how the measurement-based training resulted in a change in the USGIV nurse's traditional IV attempts, how the use of measurements allowed the USGIV nurse to manage their own technique progression by giving them a data point, specifically vessel diameter, to determine their own relative level of skill, and a sense of being empowered to advocate for a different modality when no vessel that met the measurements could be identified potentially saving the patient an uncounted number of futile PIV attempts. The team also had several discussions about identifiable features on ultrasound such as presence or absence of fascia around the vessel, proximity to bone, or surrounding tissue and their impact on the USGIV attempt. These qualitative findings suggest the need for additional research into the role of measurement-based education on the perceptions, attitudes, and decision-making of staff receiving this style of education.

Limitations

This project was completed on a single site with a convenience sampling of patients in a non-randomized design. Limited demographic data was collected.

Conclusions

This single-center quality improvement project demonstrates that a measurement-based educational intervention for ultrasound-guided peripheral intravenous access is feasible and associated with a clinically meaningful increase in dwell time (26%) in pediatric patients. By incorporating vessel depth and diameter into catheter selection decisions, nurses were able to improve catheter performance and delay the onset of complications. These findings support the integration of quantitative, ultrasound-informed decision-making into standard pediatric vascular access training. Future multi-site studies are needed to evaluate generalizability, assess long-term outcomes, and further define best practices for measurement-based USGPIV insertion in children.

CRediT authorship contribution statement

Ian Bauernsmith: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Judy Davidson:** Writing – review & editing, Resources. **Lindsey Burnett:** Writing – review & editing, Writing – original draft, Supervision, Resources, Formal analysis.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Anderson, A. P., Taroc, A. M., Wang, X., Beardsley, E., Solari, P., & Klein, E. J. (2022). Ultrasound guided peripheral IV placement: An observational study of the learning curve in pediatric patients. *Journal of Vascular Access*, *23*(2), 250–256. https://doi.org/10.1177/1129729820987958.

Badger, J. (2019). Long peripheral catheters for deep arm vein venous access: A systematic review of complications. *Heart & Lung : the journal of critical care, 48(3), 222–225*. https://doi.org/10.1016/j.hrtlng.2019.01.002.

Bahl, A., Hang, B., Brackney, A., Joseph, S., Karabon, P., Mohammad, A., ... Shotkin, P. (2019). Standard long IV catheters versus extended dwell catheters: A randomized comparison of ultrasound-guided catheter survival. *The American Journal of Emergency Medicine, 37(4), 715–721*. https://doi.org/10.1016/j.ajem.2018.07.031.

Cochrane, H. K., Henwood, P. C., Platz, E., Koskenoja, V., Landry, A., Frasure, S. E., ... Kimberly, H. H. (2020). A randomized trial of ultrasound-guided peripheral IV catheter placement in difficult access patients using a guidewire approach. *The American Journal of Emergency Medicine, 38(1), 122–126*. https://doi.org/10.1016/j.ajem.2019.07.022.

Currie, M., & Huecker, M. R. (2019). *Ultrasound intravascular access*. StatPearls.

Fabiani, A., Santoro, M., & Sanson, G. (2023). The catheter-to-vein ratio at the tip level, not the catheter type, as a risk factor for a catheter failure. A retrospective comparative study of polyurethane midline and long peripheral catheters. *Heart & Lung*, *60*, 39–44. https://doi.org/10.1016/j.hrtlng.2023.02.027.

Gottlieb, M., Sundaram, T., Holladay, D., & Nakitende, D. (2017). Ultrasound-guided peripheral intravenous line placement: A narrative review of evidence-based best practices. *The Western Journal of Emergency Medicine*, *18*(6), 1047–1054. https://doi.org/10.5811/westjem.2017.7.34610.

Keogh, S., Britt Meyer, F., Mary Jo Sarver, N., Rachael Crickman, V., Jenny Ong, R., Simon Clare, P., & Mary Hagle, R. E. (2024). Infusion Therapy Standards of Practice. www.ins1.org.

Kleidon, T. M., Schults, J. A., Royle, R. H., Gibson, V., Ware, R. S., Andresen, E., ... Ullman, A. J. (2025). First-attempt success in ultrasound-guided vs standard peripheral intravenous catheter insertion: The EPIC superiority randomized clinical trial. *JAMA Pediatrics*, *179*(3), 255–263. https://doi.org/10.1001/jamapediatrics.2024.5581.

Listed, N. A. (2019). AIUM practice parameter for the use of ultrasound to guide vascular access procedures. *Journal of Ultrasound in Medicine*, *38*(3), E4–E18. https://doi.org/10.1002/jum.14954.

van Loon, F. H. J., Korsten, H. H. M., Dierick–van Daele, A. T. M., & Bouwman, A. R. A. (2021). The impact of the catheter to vein ratio on peripheral intravenous cannulation success, a post-hoc analyses. *PLoS One*, *16*(5 May). https://doi.org/10.1371/journal.pone.0252166.

López Álvarez, J. M., Quevedo, O. P., Lorenzo, T. R., Limiñana Cañal, J. M., & Loro Ferrer, J. F. (2018). Ultrasound-guided vascular cannulation. Experience in critically-ill pediatric patients. *Archivos Argentinos de Pediatría*, *116*(3), 204–209. https://doi.org/10.5546/aap.2018.eng.204.

Mitchell, E. O., Jones, P., & Snelling, P. J. (2022). Ultrasound for pediatric peripheral intravenous catheter insertion: A systematic review. *Pediatrics*, *149*(5) American Academy of Pediatrics. https://doi.org/10.1542/peds.2021-055523.

Nickel, B. (2020). Hiding in plain sight: Peripheral intravenous catheter infections. *Critical Care Nurse*, *40*(5), 57–66. https://doi.org/10.4037/ccn2020439.

Otani, T., Morikawa, Y., Hayakawa, I., Atsumi, Y., Tomari, K., Tomobe, Y., ... Hataya, H. (2018). Ultrasound-guided peripheral intravenous access placement for children in the emergency department. *European Journal of Pediatrics, 177(10), 1443–1449*. https://doi.org/10.1007/s00431-018-3201-3.

Pandurangadu, A. V., Tucker, J., Brackney, A. R., & Bahl, A. (2018). Ultrasound-guided intravenous catheter survival impacted by amount of catheter residing in the vein. *Emergency Medicine Journal, 35(9), 550–555*. https://doi.org/10.1136/emermed-2017-206803.

Sabado, J., & Pittiruti, M. M. (2019). Principles of ultrasound-guided venous access. . UpToDate. https://www.uptodate.com/contents/principles-of-ultrasound-guided-venous-access.

Sharp, R., Cummings, M., Fielder, A., Mikocka-Walus, A., Grech, C., & Esterman, A. (2015). The catheter to vein ratio and rates of symptomatic venous thromboembolism in patients with a peripherally inserted central catheter (PICC): A prospective cohort study. *International Journal of Nursing Studies*, *52*(3), 677–685. https://doi.org/10.1016/j.ijnurstu.2014.12.002.

Ullman, A. J., Bernstein, S. J., Brown, E., Aiyagari, R., Doellman, D., Faustino, V. E. S., ... Chopra, V. (2020). The Michigan appropriateness guide for intravenous catheters in pediatrics. *MiniMAGIC. Pediatrics*, *145*(Suppl 3), S269–S284. https://doi.org/10.1542/peds.2019-3474I.