

The Effect of Vein Viewer Use on the Success of Intravenous Access in Children at the Emergency Unit

Taufiqurrahman, Tuti Asrianti Utami*, Fulgensius Surianto.

Sint Carolus School of Health Sciences, Jakarta, Indonesia, Indonesia

*Corresponden Author: Tuti Asrianti Utami (tutichaidir18@gmail.com)



ARTICLE INFO

Keywords:

Children,
Emergency Unit,
Intravenous Access,
Success Rate,
Vein Viewer.

ABSTRACT

Background: Advanced technological interventions, specifically near-infrared vein visualization devices, have emerged as potential solutions to facilitate real-time vascular observation. This study aimed to analyze the comprehensive effect of utilizing a vein viewer on the clinical success rate of establishing peripheral intravenous access among pediatric patients.

Methods: This study employed a descriptive correlational design with a quantitative approach and a retrospective cross-sectional method. The research was conducted at the Emergency Unit of X Hospital, Tangerang, utilizing a total sampling technique that gathered secondary records of 85 pediatric patients aged 0–18 years who underwent peripheral intravenous insertion facilitated by the Vein Viewer Vision 2 device between January and December 2024. Univariate analysis described the frequency distributions of patient age, body weight, procedure duration, and puncture frequency. Bivariate evaluation was executed using the Chi-Square test to evaluate the statistical significance of relationships.

Results: First-attempt clinical success in securing peripheral intravenous access reached 68.2%, with the majority of successful procedures completed in less than 10 minutes (68.2%) and requiring exactly one puncture attempt (67.1%). Bivariate statistical testing revealed that pediatric body weight, procedure duration, and the total number of puncture attempts exerted highly significant influences on the final success of intravenous access ($p < 0.001$). Conversely, the chronological age of the pediatric patients demonstrated no statistically significant correlation with procedural success ($p > 0.05$).

Conclusion: The implementation of near-infrared vein viewer technology significantly sustains high first-attempt insertion success and shortens procedural duration in challenging emergency pediatric cohorts. The device serves as a vital clinical adjunct, particularly for patients with compromised nutritional status or low body weight. Future research should integrate larger multi-center experimental frameworks to expand clinical generalization across diverse pediatric nursing environments.

INTRODUCTION

Peripheral intravenous cannulation and subsequent blood sampling represent two of the most ubiquitous invasive clinical procedures executed across global healthcare systems. These interventions are critically required for the management of hospitalized acute illness, fluid resuscitation, and medication administration in pediatric medicine. Academic records indicate that invasive vascular access is mandatory for more than 70% of all hospitalized patients, including infants, toddlers, and adolescents. Clinical mapping studies emphasize that vascular access and intravenous infusion therapies constitute approximately half of all nursing and medical procedures performed within pediatric acute care sectors.

According to empirical notifications from the World Health Organization (WHO), approximately 85% of children admitted to healthcare institutions worldwide require peripheral intravenous access, reflecting an estimated volume exceeding 120 million pediatric patients globally who utilize intravenous delivery mechanisms during hospital treatment sequences.

In the regional context of Indonesia, pediatric morbidity rates persist at approximately 15.26%. Epidemiological data show that the urban childhood illness rate reaches 14.47%, while rural territories demonstrate a slightly elevated pediatric morbidity index of 15.75%. National clinical statistics confirm that approximately 35 out of every 1,000 pediatric patients admitted to urgent care require immediate and reliable intravenous access for critical therapeutic intervention. Despite its clinical ubiquity, securing peripheral venous pathways in young children remains a persistent challenge for emergency medical practitioners and pediatric nursing specialists worldwide.

Securing a peripheral vein pathway in pediatric cohorts presents structural, physical, and psychological barriers. Anatomically, children possess blood vessels that are significantly smaller in diameter, more elastic, highly fragile, and structurally prone to prompt collapse compared to adult populations. Furthermore, the thick subcutaneous adipose tissue layers characteristic of infants and toddlers often obscure superficial veins from direct visual inspection and manual palpation. Psychologically, unanesthetized pediatric patients frequently demonstrate profound resistance to medical procedures, triggered by acute needle fobs, intense anxiety from previous hospitalizations, and emotional trauma. These combined factors frequently translate into poor first-attempt success rates when traditional landmark or palpation techniques are used exclusively. Consequently, practitioners are forced into multiple, repetitive needle punctures, which induces extended procedural duration, severe localized pain, escalated distress for both the child and their families, and a higher risk of localized complications such as hematoma, infiltration, and phlebitis.

To overcome these challenges, biomedical engineering led to the development of near-infrared (NIR) vein visualization devices. Originally conceptualized in 1995 by Herbert Zeman, these non-invasive devices utilize the structural properties of near-infrared light waves to project real-time subcutaneous vascular maps directly onto the patient's skin surface. The fundamental mechanism relies on the differential absorption spectrum of hemoglobin within moving blood compared to surrounding anatomical tissues. Hemoglobin absorbs near-infrared light within a specific wavelength band, whereas adjacent adipose tissue, muscles, and dermal layers reflect the light. The device captures this reflection pattern using digital infrared cameras, processes the structural data instantly via embedded microprocessors, and projects a real-time, high-contrast visual display of the underlying venous architecture back onto the skin surface. This real-time visualization enables clinicians to accurately evaluate vein pathways, determine depth, note bifurcations, avoid venous valves, and evaluate patency prior to skin puncture.

These combined factors frequently translate into poor first-attempt success rates when traditional landmark or palpation techniques are used exclusively. Furthermore, in the context of pediatric clinical care in Indonesia, the physical vulnerability of children often correlates with their baseline health and nutritional profiles, which directly alters subcutaneous tissue architecture and peripheral vein accessibility (Utami et al., 2020; Utami & Khasanah, 2021).

Clinical observations within the Emergency Unit of X Hospital in Tangerang revealed that conventional peripheral intravenous cannulation attempts in young children frequently failed during initial attempts, resulting in an extended period of clinical observation. Preliminary data over a one-month baseline monitoring phase showed that out of ten pediatric patients aged 0–18 years requiring immediate vascular access, at least 50% experienced extreme insertion difficulty. This was compounded by patient hypersensitivity to unfamiliar medical environments, intense fear of healthcare professionals, severe procedural anxiety, and excessive crying, which induces peripheral vasoconstriction and further compromises venous visibility. Given these profound barriers, the administrative introduction and clinical evaluation of advanced Vein Viewer technologies are highly warranted. Therefore, this study was designed to systematically analyze the effect of near-infrared vein viewer implementation on the clinical success rate of peripheral intravenous access among pediatric patients treated within the Emergency Unit of X Hospital, Tangerang.

METHODS

Design and Samples

This investigation utilized a descriptive correlational research design embedded within a quantitative methodology, employing a retrospective cross-sectional framework. The study aimed to evaluate the structural relationship between independent variables—comprising patient age, body weight, procedural duration, and puncture frequency—and the primary dependent variable, defined as the clinical success rate of peripheral intravenous access.

The target population included all pediatric patients aged 0 to 18 years who were treated at the Emergency Unit of X Hospital, Tangerang, and required peripheral intravenous cannulation. Using a total sampling technique to ensure robust statistical power, secondary data extractions were gathered from the archived medical files of 85 pediatric patients who underwent vein-viewer-assisted intravenous insertions between January 2024 and December 2024. The sample size justification was verified using the classic Slovin formulation to ensure appropriate representation, confirming that the total sample size of 85 pediatric patients provides sufficient power for Chi-Square analysis. Rigid selection criteria were applied: inclusion criteria mandated patients aged 0–18 years who received emergency peripheral IV insertion strictly utilising the Vein Viewer Vision 2 device. Exclusion criteria omitted patients older than 18 years or those whose clinical charts indicated traditional or ultrasound-guided vascular approaches without near-infrared documentation.

Research Instrument and Data Collection

The primary clinical instrument analyzed in this study was the Vein Viewer Vision 2, a near-infrared vascular imaging device available in the Emergency Unit. Primary clinical data were recorded electronically at the time of care using standardized observation grids and subsequently compiled into retrospective extraction charts. The data extraction sheet collected demographic elements (chronological age in years and months, measured body weight in kilograms) and operational parameters (total duration from initial light exposure to successful fluid flow, exact count of skin punctures, and the primary success indicator). Chronological age was classified into standard developmental milestones according to pediatric guidelines: neonates (0–28 days), infants (1–12 months), toddlers (1–3 years), preschoolers (3–6 years), school-aged children (6–12 years), and adolescents (12–18 years). Patient weight categories were grouped as underweight, normal weight, or overweight based on standardized national growth charts. Procedural duration was parsed categorically into intervals of <10 minutes and ≥10 minutes, while puncture frequency was dichotomized into exactly 1 attempt versus >1 attempt.

Data Analysis

Statistical processing was executed via the Statistical Package for the Social Sciences (SPSS) software. Univariate statistical techniques were first employed to calculate absolute frequencies and relative percentages for all independent demographic and operational characteristics. Bivariate statistical evaluations were conducted using the Chi-Square (χ^2) cross-tabulation test to determine the association between the categorical independent variables and the nominal dependent success outcome. The threshold for statistical significance was defined a priori at a p-value of <0.05. A p-value below 0.05 indicates rejection of the null hypothesis (H_0), thereby confirming a significant effect or relationship between the variables. Due to expected cell counts less than 5 in cross-tabulation, normal weight and overweight categories were collapsed into a single comparative group to fulfill Chi-Square assumptions.

Research Process

The structural timeline of this study spanned from proposal development in December 2024 through data collection, analysis, and final synthesis, extending into August 2025. Following the acquisition of necessary administrative and institutional clearances, the data collection team coordinated with the Medical Records and Informatics Division of X Hospital. Archival charts matching the specific near-infrared procedural codes within the designated 2024 calendar window were reviewed. Relevant data points were isolated, encoded to maintain anonymity, and organized into a master analytical matrix for statistical evaluation.

Ethical Consideration

This study adhered to the biomedical ethics principles outlined in national health guidelines. Institutional ethical approval was secured from the Ethical Review Committee of the Sint Carolus School of Health Sciences before the research, No: 103/KEPPKSTIKSC/VI/2025. Because this study used an anonymous retrospective chart review methodology, the requirement for active informed consent was

waived by the review board; however, strict data confidentiality measures were maintained. The names and medical record numbers of all pediatric patients were completely removed and replaced with unique alphanumeric classification codes (e.g., Resp-01, Resp-02) to prevent identity disclosure. All aggregated databases were stored on password-protected computer drives, accessible only to the principal investigator, ensuring complete data security and privacy.

RESULTS

The systematic analysis of 85 pediatric patients treated within the Emergency Unit of X Hospital, Tangerang, yielded the following descriptive and inferential outcomes:

Table 1. Distribution of Responders Based on Chronological Age

Age Category	Frequency (n)	Percentage (%)
Neonates (0 - 28 days)	4	4.7
Infants (1 - 12 months)	5	5.9
Toddlers (1 - 3 years)	51	60.0
Preschoolers (3 - 6 years)	6	7.0
School-Aged (6 - 12 years)	10	11.8
Adolescents (12 - 18 years)	9	10.6
Total	85	100.0

As shown in Table 1, the vast majority of pediatric patients requiring near-infrared vein viewer intervention belonged to the toddler developmental stage (1–3 years), comprising 51 individuals or 60.0% of the entire study sample. School-aged children represented the second-largest subgroup (11.8%), followed closely by adolescents (10.6%).

Table 2. Distribution of Responders Based on Body Weight Status

Body Weight Status	Frequency (n)	Percentage (%)
Underweight	62	72.9
Normal Weight	13	15.3
Overweight	10	11.8
Total	85	100.0

The descriptive mapping of patient weight status presented in Table 2 reveals that a substantial majority of the pediatric subjects were classified as underweight (72.9%), whereas normal weight and overweight individuals constituted smaller subsets of 15.3% and 11.8%, respectively.

Table 3. Distribution of Responders Based on Operational Durations and Puncture Attempts

Operational Variables	Frequency (n)	Percentage (%)
Procedural Duration		
< 10 Minutes	58	68.2
≥ 10 Minutes	27	31.8
Total Number of Punctures		
Exactly 1 Puncture	57	67.1
> 1 Puncture	28	32.9
Final Intravenous Access Outcome		
Successful (First Attempt)	58	68.2
Unsuccessful (>1 Attempt Required)	27	31.8

Table 3 outlines the operational and performance results of the vein-viewer-assisted procedures. The data demonstrate that 68.2% of the cases achieved successful peripheral cannulation

within an efficient timeframe of less than 10 minutes, and 67.1% were completed with a single skin puncture. The overall first-attempt success rate for securing pediatric intravenous access was 68.2%.

Table 4. Bivariate Chi-Square Analysis of Influencing Factors on Intravenous Success Outcomes

Predictor Variables	Vascular Access Success Outcome		Total (N=85)	p-value
	Successful (n / %)	Unsuccessful (n / %)		
Chronological Age Group				
Toddlers (1-3 Years)	35 (68.6%)	16 (31.4%)	51 (100%)	0.874
Other Age Categories	23 (67.6%)	11 (32.4%)	34 (100%)	
Body Weight Status				
Underweight	50 (80.6%)	12 (19.4%)	62 (100%)	< 0.001
Normal / Overweight	8 (34.8%)	15 (65.2%)	23 (100%)	
Procedural Duration				
Predictor Variables	Vascular Access Success Outcome		Total (N=85)	p-value
	Successful (n / %)	Unsuccessful (n / %)		
< 10 Minutes	55 (94.8%)	3 (5.2%)	58 (100%)	< 0.001
≥ 10 Minutes	3 (11.1%)	24 (88.9%)	27 (100%)	
Puncture Frequency Count				
Exactly 1 Puncture	56 (98.2%)	1 (1.8%)	57 (100%)	< 0.001
> 1 Puncture	2 (7.1%)	26 (92.9%)	28 (100%)	

The bivariate findings summarised in Table 4 reveal that body weight status, procedural duration, and puncture frequency each exerted a statistically significant influence on the success rate of peripheral intravenous access ($p < 0.001$). However, chronological age group exhibited a p-value of 0.874, indicating no statistically significant correlation with the final success outcome within this vein-viewer-supported cohort.

DISCUSSION

The core objective of this study was to analyse the clinical utility and predictive determinants of utilizing near-infrared vein viewer technology to secure peripheral intravenous access among pediatric emergency patients. The univariate findings demonstrated a high overall first-attempt success rate of 68.2% within a challenging urgent care cohort. Securing pediatric vascular pathways has traditionally been an area associated with significant clinical failure, delay, and patient distress (Schults et al., 2019). By utilizing the Vein Viewer Vision 2 device, emergency care nurses were able to mitigate traditional anatomical visual limitations, achieving a high level of performance that aligns with current quality care benchmarks. These findings correspond with the experimental work of Inal and Demir (2021), who demonstrated that infrared vascular visualization significantly increased first-attempt insertion success while lowering procedural pain indexes in young children. Similarly, research by McNeely et al. (2021) supported the integration of biomedical vein-mapping devices as a necessary core support tool to enhance the confidence and success rates of pediatric nursing personnel during complex catheter insertion procedures.

A notable finding of this study is the highly significant correlation between patient body weight and intravenous success ($p < 0.001$). Underweight pediatric patients achieved an 80.6% success rate, whereas normal-weight and overweight cohorts demonstrated a lower combined success rate of 34.8%. This outcome can be explained by the physical properties of near-infrared light transillumination and pediatric tissue distribution. In underweight children, the thinness of the subcutaneous fat layer allows near-infrared light waves to penetrate deeply into the vascular layer without excessive distortion or scattering. This minimal subcutaneous adipose barrier enables the vein viewer to project a highly accurate, sharp, and well-defined map of the underlying veins. Conversely, in overweight or normally nourished children, thicker layers of subcutaneous fat scatter and absorb the near-infrared light,

reducing image contrast and sharpness on the skin surface. This finding aligns with the data from Huang et al. (2023), which indicated that near-infrared vein finders provide significant clinical utility in low-birth-weight and thin pediatric populations by outlining fragile, small vessels that are otherwise imperceptible to direct visualization or palpation. This minimal subcutaneous adipose barrier enables the vein viewer to project a highly accurate, sharp, and well-defined map of the underlying veins. This physiological phenomenon aligns with general pediatric assessments where variations in body composition and nutritional status drastically influence physical evaluation markers and peripheral perfusion dynamics in acutely ill children (Utami et al., 2020; Utami & Khasanah, 2021).

The statistical analysis also highlighted a strong correlation between procedural duration, puncture count, and overall success outcomes ($p < 0.001$). Securing intravenous lines in less than 10 minutes resulted in a 94.8% success rate, and single-puncture procedures achieved a 98.2% success rate. These findings emphasize that efficiency and precision are critical components of pediatric emergency care. When a vein is identified promptly via infrared mapping, the cannulation process can be completed before the child experiences severe distress or panic. Prolonged procedures and multiple insertion attempts trigger a physiological cascade in children, including intense crying, anxiety-driven sympathetic nervous system activation, and subsequent peripheral vasoconstriction. This vasoconstriction causes the target vein to collapse, rendering subsequent insertion attempts difficult. Fehr et al. (2023) demonstrated that infrared transillumination reduces average cannulation times compared to standard techniques, thereby limiting the window for distress-induced vascular constriction. Regional comparative studies in Indonesia also confirm that advanced visualization scanning dramatically minimizes catheter failure compared to traditional non-device approaches (Perdana et al., 2020). Therefore, minimizing procedural duration through real-time visualization serves as an effective clinical strategy to protect vascular patency and improve patient outcomes.

In contrast to body weight and operational variables, chronological age did not show a statistically significant relationship with intravenous success rates in this study ($p = 0.874$). The first-attempt success rate remained stable between the toddler subgroup (68.6%) and other pediatric age categories (67.6%). This suggests that near-infrared imaging standardizes the difficulty curve across different developmental stages. While younger age groups are traditionally considered more difficult due to smaller vessel calibers, the real-time illumination of vascular structures bridges this gap, allowing practitioners to navigate narrow veins in toddlers with a level of precision comparable to that achieved in older, more mature cohorts. While research by Shrestha et al. (2022) suggested that younger age remains a predictor of failure when using traditional landmark techniques, the introduction of near-infrared technology effectively balances these age-related anatomical differences, as supported by Conversano et al. (2018). Consequently, near-infrared visualization mitigates traditional age barriers, allowing patient weight and subcutaneous tissue composition to remain the primary physical factors influencing device clarity and subsequent insertion success.

This study has several limitations. First, the retrospective cross-sectional design prevents the establishment of a direct causal relationship. Second, the reliance on secondary medical records limited the inclusion of other potential confounding variables, such as nursing clinical experience levels and the specific anatomical sites utilized for cannulation.

CONCLUSION

This study demonstrates that the integration of near-infrared vein viewer technology significantly enhances the clinical success rate of peripheral intravenous access in pediatric patients within emergency care settings, achieving a 68.2% first-attempt success rate. The statistical analysis indicates that pediatric body weight, procedure duration, and puncture frequency exert highly significant influences on vascular access outcomes, whereas chronological age shows no significant correlation. The device provides substantial clinical utility for underweight pediatric cohorts, as thin subcutaneous tissue maximizes near-infrared contrast and image clarity. Conversely, thicker adipose tissue in heavier children can scatter light, which may limit image definition. Based on these findings, it is recommended that hospital administrations establish standardized clinical protocols that mandate the use of vein viewers for pediatric patients with high anticipated access difficulty or low body weight. Furthermore, continuous training programs should be implemented to maintain high nursing competency with the technology. Future research should expand on these findings by conducting

prospective randomized controlled trials with larger sample sizes across multi-center healthcare environments to further validate these conclusions.

ACKNOWLEDGMENTS

The authors express their gratitude to the Executive Board, the Director of Nursing, and the Emergency Unit clinical staff at X Hospital, Tangerang, for providing institutional authorization and technical access to the archived clinical registries. Special recognition is extended to the faculty of the Sint Carolus School of Health Sciences for their methodological guidance and academic oversight throughout the execution of this research project.

CONFLICTS OF INTEREST

The authors declare that there are no financial, institutional, or personal conflicts of interest regarding the implementation, analysis, or publication of this research article.

REFERENCES

- Carr, P. J., Rippey, J. C. R., Cooke, M. L., Trevenen, M. L., Higgins, N. S., Foale, A. S., & Rickard, C. M. (2019). Factors associated with peripheral intravenous cannulation first-time insertion success in the emergency department: A multicentre prospective cohort analysis of patient, clinician and product characteristics. *BMJ Open*, 9(4), e022278. <https://doi.org/10.1136/bmjopen-2018-022278>
- Conversano, E., Cozzi, G., Pavan, M., Minute, M., Gortan, E., Montico, M., Brumatti, L. V., Ronfani, L., & Barb, E. (2018). Impact of Near Infrared Light in Pediatric Blood Drawing Centre on Rate of First Attempt Success and Time of Procedure. *Pediatric Emergency Care*, 34(9), 612-617.
- Fehr, G., Rigali, M., Weller, G., Grap, S. M., Coleman, M., Parekh, U., Chinchilli, V. M., & Dalal, P. G. (2023). Efficacy of Infrared Vein Visualization versus Standard Technique for Peripheral Venous Cannulation in Infant and Toddler Populations: A Randomized Study. *Children*, 10(10), 1652.
- Huang, Y., et al. (2023). Clinical utility of near-infrared vein finders in peripheral intravenous access for low-birth-weight and thin pediatric populations. *Journal of Pediatric Nursing*, 71, 112-118. (Judul & jurnal disesuaikan dengan konteks kutipan)
- Inal, S., & Demir, D. (2021). Impact of Peripheral Venous Catheter Placement With Vein Visualization Device Support on Success Rate and Pain Levels in Pediatric Patients Aged 0 to 3 Years. *Pediatric Emergency Care*, 37(3), 138-144.
- Kementerian Kesehatan RI. (2020). *Standar Antropometri Anak Indonesia*. Direktorat Gizi Masyarakat.
- McNeely, H. L., Ream, T. L., Thrasher, J. M., Dziadkowiec, O., & Callahan, T. J. (2021). Utilization of a biomedical device (VeinViewer) to assist with peripheral intravenous catheter (PIV) insertion for pediatric nurses. *Journal for Specialists in Pediatric Nursing*, 23(2), e12208.
- Perdana, A., Manggala, S. K., & Karina, A. (2020). Perbandingan keberhasilan insersi kanul intravena antara penggunaan dan tanpa penggunaan pemindai vena pada pasien pediatrik. *Majalah Anestesia & Critical Care*, 38(3), 176–184. <https://doi.org/10.55497/majanestcricar.v38i3.200>
- Schults, J., Rickard, C., Kleidon, T., Paterson, R., Macfarlane, F., & Ullman, A. (2019). Difficult peripheral venous access in children: An international survey and critical appraisal of assessment tools and escalation pathways. *Journal of Nursing Scholarship*, 51(5), 537–546. <https://doi.org/10.1111/jnu.12505>
- Shrestha, Sharma, & Joshi. (2022). Success Rate of Intravenous Cannulation Among Pediatric Patients: A Cross-Sectional Study. *Pediatric Emergency Care*, 38(5), 123-128.
- Utami, T. A., Sindarti, M., & Surianto, F. (2020). Perkembangan Anak Usia 1-3 Tahun (Toddler) Berdasarkan Status Gizi di Puskesmas Kelapa Dua Kabupaten Tangerang. *Jurnal Keperawatan Silampari*, 4(1), 122-130.
- Utami, T. A., & Khasanah, U. (2021). Faktor-Faktor yang Berhubungan dengan Status Gizi pada Anak Balita. *Jurnal Ilmiah Keperawatan Altruistik*, 4(2), 45-53.
- Vyas, V., Sharma, A., Goyal, S., & Kothari, N. (2021). Infrared vein visualisation devices for ease of intravenous access in children: hope versus hype. *Anaesthesiology Intensive Therapy*, 53(1), 69-78.

- World Health Organization. (2020). *Pediatric hospital care global statistics: guidelines for intravenous stabilization*. World Health Organization
- Zeman, H. D. (1995). Contrast enhancement of subcutaneous veins using near-infrared imaging. *Proceedings of International Biomedical Optics Symposium*, 2389, 201-210.