Efficacy of a Near-Infrared Light Device in Pediatric Intravenous Cannulation

A Randomized Controlled Trial

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Objectives: To determine whether the use of a near-infrared light venipuncture aid (VeinViewer; Luminetx Corporation, Memphis, Tenn) would improve the rate of successful first-attempt placement of intravenous (IV) catheters in a high-volume pediatric emergency department (ED).

Methods: Patients younger than 20 years with standard clinical indications for IV access were randomized to have IV placement by ED nurses (in 3 groups stratified by 5-year blocks of nursing experience) using traditional methods (standard group) or with the aid of the near-infrared light source (device group). If a vein could not be cannulated after 3 attempts, patients crossed over from one study arm to the other, and study nurses attempted placement with the alternative technique. The primary end point was first-attempt success rate for IV catheter placement. After completion of patient enrollment, a questionnaire was completed by study nurses as a qualitative assessment of the device.

Results: A total of 123 patients (median age, 3 years) were included in the study: 62 in the standard group and 61 in the device group. There was no significant difference in first-attempt success rate between the standard (79.0%, 95% confidence interval [CI], 66.8%Y88.3%) and device (72.1%, 95% CI, 59.2%Y82.9%) groups. Of the 19 study nurses, 14 completed the questionnaire of whom 70% expressed neutral or unfavorable assessments of the device in nondehydrated patients without chronic underlying medical conditions and 90% found the device a helpful tool for patients in whom IV access was difficult.

Conclusions: First-attempt success rate for IV placement was nonsignificantly higher without than with the assistance of a near-infrared light device in a high-volume pediatric ED. Nurses placing IVs did report several benefits to use of the device with specific patient groups, and future research should be conducted to demonstrate the role of the device in these patients.

Key Words: intravenous cannulation, vascular access, near-infrared light

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One of the recognized challenges of pediatrics, especially pediatric emergency medicine, is venipuncture for cannulation and phlebotomy. This very common yet painful procedure is all the more difficult with small patients and small veins.[1] Studies have examined the role of topical anesthetics, distraction, and teaching techniques to minimize the discomfort associated with intravenous (IV) catheter placement.[2Y12] Likewise, studies of placement technique have investigated simple light transillumination, local warming, vein-entry indicator devices, and imaging modalities such as ultrasonography for vein identification, but none have looked at a bedside adjunct that uses near-infrared light as a contrast-enhancing illuminator to identify the course of veins noninvasively.[13Y26]

Without ionizing radiation, the device (VeinViewer; Luminetx Corporation, Memphis, Tenn) illuminates skin with polarized 760-nm near-infrared light from a ring of light-emitting diodes that penetrate the skin and subcutaneous fat (because these tissues do not absorb near-infrared light well). In contrast to these surrounding tissues that scatter near-infrared light in all directions, blood in the vein absorbs or scatters forward near-infrared light. The machine can thus generate a 2-dimensional (flat) image of blood-filled structures such as veins and project that image back onto the skin outlined in visible, green-colored light that can be used by the operator to guide and determine accurate needle placement into venous structures. There is no ionizing radiation associated with its use. It does not produce heat sufficient to burn skin, nor is its light harmful to the eyes of patients or its operators (VeinViewer specifications, Luminetx Corporation documents, 2005).

In this randomized controlled trial, we sought to compare the first-attempt success rate for the insertion of peripheral IV catheters between those placed with and without the assistance of the device in a high-volume pediatric emergency department (ED). We hypothesized that use of the device would lead to an improved first-attempt success rate for placement of the catheters by ED nurses, with a clinically important difference of at least 20% between groups.

METHODS

We conducted a nonblinded, randomized controlled trial of a convenience sample of patients between 0 and 20 years of age with a clinical condition requiring IV access for diagnosis and treatment as determined by the treating ED physician. Written informed consent was obtained from each patient's parent or legal guardian before patient enrollment in the study. Similarly, study nurses whose IV placement techniques were studied also gave written informed consent to participate. The protocol received approval from the Baylor College of Medicine Institutional Review Board.

We enrolled patients between June 1, 2006 and May 31, 2008, at the study site, Texas Children's Hospital, an urban pediatric ED in Houston with an annual census of more than 85,000 pediatric patients.

Patients presenting for care at a day and time when trained research assistants or study authors (AMP, DCH) were available were included. If their treating nurse was enrolled in the study, consecutive patients were approached for enrollment at the time their treating physician ordered placement of an IV. Standard indications for IV placement included need for fluid therapy, administration of medications, and obtaining blood specimens.

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Children who were previously healthy and with chronic medical conditions were eligible. The exclusion criteria were age greater than 20 years and need for immediate resuscitation obviating the possibility of obtaining study measurements.

Emergency department nurses in 3 groups were recruited by physician study staff not actively involved in their performance appraisals or employment supervision. A nursing education supervisor sent an e-mail describing the study, and interested nurses were able to enroll. In addition, the study was described during nursing sign-out report sessions, and additional nurses enrolled. They were enrolled as the IV placement staff in 3 groups as a surrogate for nursing experience: those working less than 5 years in the nursing profession, those working 5 to less than 10 years, and those working 10 years or more. Neither patients nor nurses received any form of compensation or incentive for participation, and there were no employment or job-role changes or reports made to supervisors for nurses' accepting or declining to participate. Nurses completed a 1-hour training session designed and conducted by the device manufacturer and the study authors to establish proficiency in the operation of the device and in the study protocol. All nurses passed a practical examination demonstrating their proficiency.

Patients were randomized to use of the device for IV access or the traditional technique of palpation of the overlying skin and unaided visualization of peripheral veins for IV access (using only ambient room light). When randomized to the device group, patients had their IV lines placed by a nurse with the aid of near-infrared light generated by the device. The device's light source is mounted as an arm on a rolling platform base, which contains its power supply, fan, and processor.

Nineteen ED nurses volunteered to participate and were stratified by 5-year blocks of nursing experience. These 19 nurses were drawn from a pool of approximately 150 full-time ED nurses. Patients, their families, or participating nurses did not receive compensation for participation.

Trained research staff members conducted enrollments and obtained consent of patients (if 18 years or older or assent for those younger), their parents, or their guardians and collected study data from chart review and parent interviews. The research staff members did not participate in patient care. Group assignment was determined by a sealed opaque envelope contained within the enrollment packet that was opened by the research staff member just before IV start attempts began. The study nurse placing the IV line did not have to be the primary bedside nurse caring for the patient.

TABLE 1. Nursing Survey Results

	0 to G5	5 to G10	Q10
How many years have you worked as a registered nurse?	3	8	3
How many years have you worked at Texas Children's Hospital?	6	7	1

	Yes	No
Before working as a registered nurse, did you work as a licensed vocational nurse or phlebotomist or another job requiring you to start IVs or draw blood?	3	11

Please indicate your level of agreement with the following statements	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	No Opinion/ Cannot Answer	Mean
In patients who did not have dehydration or a chronic illness (ie, the patient who is not an IV nightmare), the VeinViewer helped me find veins I did not see through routine inspection	0	3	7	3	1	0	3.1
In dehydrated patients, the VeinViewer helped me find veins that I did not see through routine inspection	0	0	4	6	4	0	4.0
In patients with chronic medical conditions (ie, the patient who is normally an IV nightmare), the VeinViewer helped me find veins I did not see through routine inspection	0	1	1	4	7	0	4.0
In young infants (younger than 1 year), the VeinViewer helped me find veins I did not see through routine inspection	0	4	1	6	3	0	3.6
The VeinViewer distracted me from my usual IV starting technique	0	6	6	1	1	0	2.8
The VeinViewer saved me time in starting IVs	0	4	7	3	0	0	2.9
I would use the VeinViewer more often if it were smaller or more portable	0	1	1	3	8	1	4.1
The VeinViewer is a helpful tool to use in patients in whom IVs are difficult to obtain	0	0	1	4	8	1	4.2

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The research staff collected patient data on age and race (given the possible roles of vein size and skin color in identification of veins under the skin and in the device's technical performance), chief complaint, chronic medical conditions, reason for IV access, and weight. Chronic medical conditions specifically identified were those often associated with need for frequent venous access, such as sickle-cell disease, recurrent pneumonia, neuromuscular weakness and spasticity conditions, intractable epilepsy, congenital heart disease, solid-organ or stem-cell transplant, and immunodeficiency conditions.

The staff then started to measure time when the nurse began examining the patient for veins suitable for cannulation. Timing ceased and the study ended when a vein was successfully cannulated as demonstrated by easy normal-saline solution flush or removal of a sample of blood for laboratory analysis without signs of infiltration or hematoma formation. Decision as to site of tourniquet placement, the order of extremities examined and selected for venipuncture, and catheter size was left to the nurses according to their training and experience.

After the completion of the study, a follow-up survey of participating nurses was conducted using a web-based survey instrument (SurveyMonkey, http://www.surveymonkey.com) to assess their experience with the device (Table 1).

The primary outcome measure was the first-attempt success rate for insertion of the cannula into a peripheral vein as determined by easy flush with normal saline solution or successful blood return for laboratory analysis.

The nursing survey sought to identify specific patient characteristics for which the device was subjectively helpful or not helpful. In addition, it sought to identify characteristics of the device that were considered most beneficial and most problematic.

Based on the findings of a pilot study of typical IV placement procedures conducted at the same institution with the same patient population, we estimated that a sample size of 122 patients would identify a 20% difference in first-attempt success rate with a 2-tailed > of 0.05 and power of 0.80. It was decided a priori that a 20% difference in success rate would indicate clinical significance.

We performed data analysis using Stata (StataCorp, College Station, Tex) and SAS (SAS Institute, Inc, Cary, NC). We used Stata to estimate frequencies and binomial 95% confidence intervals (CIs). We used SAS to perform the generalized linear mixed model statistical analysis.

Patient demographic characteristics were compared between groups using frequencies and 95% CIs. The primary end point of first-attempt success was compared using a generalized linear mixed model with a random effect to account for the clustering of effects by nurse, where a P G 0.05 was significant. As there were 3 subjects who withdrew before study completion, an intention-to-treat analysis was performed. Comparisons were also made between subgroups of patients, specifically by age, weight, ethnicity, presence of a chronic disease, indication for IV cannulation, and use of topical anesthetics. Responses to the nursing questionnaire were described using frequencies and 95% CIs.

RESULTS

One hundred twenty-seven pediatric patients entered the study and were assigned randomly to the standard or device group. Four of these were excluded because their study group was not indicated on the study form, leaving 123 study subjects. There were 62 subjects in the standard group and 61 subjects in the device group. Each nurse completed a minimum of 1 and a maximum of 13 patient encounters.

TABLE 2. Demographic and Clinical Characteristics of 123 Study Participants

	Standard, % (95% CI, %), n = 62	Device, % (95% CI, %), n = 61
Sex		
Male	54.8 (41.7Y67.5)	65.6 (52.3Y77.3)
Female	45.2 (32.5Y58.3)	32.8 (21.3Y46.0)
Missing	0 (NA)	1.6 (0.0Y8.8)
Age, yr		
0Y1	22.6 (12.9Y35.0)	11.5 (4.7Y22.2)
1Y3	33.9 (22.3Y47.0)	32.7 (21.3Y46.0)
4Y8	12.9 (5.7Y23.9)	18.0 (9.4Y30.0)
8+	30.6 (19.6Y43.7)	34.4 (22.7Y47.7)
Missing	0 (NA)	3.3 (4.0Y11.3)
Weight, kg		
0Y10	29.0 (18.2Y41.9)	19.7 (10.6Y31.8)
910Y20	30.6 (19.6Y43.7)	37.7 (25.6Y51.0)
920Y30	14.5 (6.9Y25.8)	6.6 (1.8Y15.9)
930	22.5 (12.9Y35.0)	33.3 (21.3Y46.0)
Missing	3.2 (0.4Y11.2)	3.2 (0.4Y11.3)
Ethnicity		
Hispanic	45.2 (32.5Y58.3)	50.8 (37.7Y63.9)
African American	22.6 (12.9Y35.0)	26.2 (15.8Y39.1)
White	27.4 (16.9Y40.2)	19.7 (10.6Y31.8)
Chronic disease		
Yes	14.5 (6.9Y25.8)	26.2 (15.8Y39.1)
No	85.5 (74.2Y93.1)	73.8 (60.9Y84.2)
Reason for IV		
Blood specimen	24.2 (14.2Y36.7)	41.0 (28.6Y54.3)
IV medications	27.4 (16.8Y40.2)	32.8 (21.3Y46.0)
IV fluids	14.5 (6.9Y25.8)	8.2 (2.7Y18.1)
Missing	33.9 (22.3Y47.0)	18.0 (9.4Y30.0)
Topical anesthetic		
Yes	48.4 (35.5Y61.4)	39.3 (27.1Y52.7)
No	51.6 (38.6Y64.5)	60.7 (47.3Y72.9)
Nursing years		
G5 yr	14.5 (6.9Y25.8)	13.1 (5.8Y24.2)
5Y10 yr	43.5 (31.0Y56.7)	44.3 (31.5Y57.6)
10+ yr	29.0 (18.2Y41.9)	26.2 (15.8Y39.1)
Missing	12.9 (5.7Y23.9)	16.4 (8.2Y28.1)

NA indicates not applicable.

Overall, demographic and medical-history characteristics were similar between the groups (Table 2). The median age of the 123 subjects was 3 years (interquartile range, 2Y11 years), and the median weight was 16 kg (interquartile range, 10Y34 kg).

In the standard group, the overall first-attempt success rate; was 79.0% (95% CI, 66.8%Y88.3%) compared with 72.1% (95% CI, 59.2%Y82.9%) in the device group. Adjusting for clustering of effects by nurse, there was no statistically significant difference between the groups (P = 0.361). Given the sample size of 123, the study was powered at 79% to detect a 20% improvement from the standard technique. The study was underpowered (14.7% power) to detect the 7% decrease in efficacy found between the standard and device groups.

Three patients withdrew from the study: 1 in the standard group and 2 in the device group. The most common reason for

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TABLE 3. Success of First IV Cannulation Attempt by Patient Age, Weight, Ethnicity, Chronic Disease, Reason for IV, Use of Topical Anesthetic, and Years of Nursing Experience

	Standard, % (95% CI, %), n = 62	Device, % (95% CI, %), n = 61
Age, yr		
0Y1 (n = 21)	71.4 (41.9Y91.6)	28.6 (3.7Y71.0)
2Y3 (n = 41)	81.0 (58.1Y94.6)	80.0 (56.3Y94.3)
4Y8 (n = 19)	87.5 (47.3Y99.7)	72.7 (39.0Y94.0)
8+ (n = 40)	78.9 (54.4Y93.9)	76.2 (52.8Y91.8)
Weight, kg		
0Y10 (n = 30)	72.2 (46.5Y90.3)	58.3 (27.7Y84.8)
910Y20 (n = 42)	73.7 (48.8Y90.9)	82.6 (61.2Y95.0)
920Y30 (n = 13)	88.9 (51.8Y99.7)	50.0 (6.8Y93.2)
930 (n = 34)	85.7 (57.2Y98.2)	80.0 (56.3Y94.3)
Ethnicity		
Hispanic (n = 59)	85.7 (67.3Y96.0)	80.6 (62.5Y92.5)
African American (n = 30)	64.3 (35.1Y87.2)	62.5 (35.4Y84.8)
White (n = 29)	82.4 (56.6Y96.2)	58.3 (27.7Y84.8)
Other (n = 5)	66.7 (9.4Y99.2)	1.00 (15.8Y1.00)*
Chronic disease		
Yes (n = 25)	77.8 (40.0Y97.2)	62.5 (35.4Y84.8)
No (n = 98)	79.2 (65.9Y89.2)	75.6 (60.5Y87.1)
Reason for IV		
Blood specimen (n = 40)	93.3 (68.1Y99.8)	68.0 (46.5Y85.1)
IV medications (n = 37)	64.7 (38.3Y85.8)	75.0 (50.9Y91.3)
IV fluids (n = 14)	66.7 (29.9Y92.5)	60.0 (14.7Y94.8)
Topical anesthetic		
Yes (n = 54)	90.0 (73.5Y97.9)	75.0 (53.3Y90.2)
No (n = 69)	68.8 (50.0Y83.9)	70.3 (53.0Y84.1)
Nursing years		
G5 yr (n = 17)	88.9 (51.8Y99.7)	62.5 (24.5Y91.5)
5Y10 yr (n = 54)	66.7 (46.0Y83.5)	59.3 (38.8Y77.6)
10+ yr (n = 34)	88.9 (65.3Y98.6)	87.5 (61.7Y98.4)

*One-sided, 97.5% CI.

withdrawal of consent was parental dissatisfaction with the number of attempts required for IV placement.

Seven subjects crossed over after 3 attempts at IV cannulation by the method to which they were originally randomized. Of the 62 in the standard group, 4 crossed over to the device group, and 1 was successful in the first attempt. Of the 61 in the device group, 3 crossed over to the standard group, and 2 were successful in the first attempt. After crossover, all IV cannulations were successful in at least 3 attempts.

Use of the device was associated with lower first-attempt success rates in patients aged 0 to 1 year, those weighing less than 10 kg, patients with an underlying chronic disease, those undergoing cannulation for a laboratory draw, or those receiving topical anesthetic before cannulation (Table 3). The study was not powered to detect subgroup differences, and the 95% CIs overlapped between the standard and device groups for all subgroups.

Of the 19 study nurses, 14 (74%) completed the questionnaire. Their responses are shown in Table 1.

DISCUSSION

Use of a near-infrared light device did not show a benefit in first-attempt success rate in IV placement among pediatric patients in a large children's hospital ED. It is possible that its use may benefit a subset of patients such as those significantly dehydrated with subsequently less visible or palpable veins, those with chronic medical conditions affecting the skin or necessitating multiple past IV placements, and those who have high weight for age or are obese with adipose tissue overlying or interposed with their veins.

Since the start of this trial, a systematic attempt to delineate pediatric venous-access difficulty has emerged in the difficult intravenous access (DIVA) score.[20] The score assigns points for prematurity, age younger than 1 year or 2 years, inability to palpate vein, and inability to visualize vein. It can predict first-attempt failure rate. This score and subsequent similar attempts will likely facilitate research into the role of venipuncture aids, with more precision in separating their role in all patients, for whom this study was designed and powered, from their role in chronically ill, small, dehydrated, or other potentially more challenging patients.

Previous studies of adjuncts to pediatric IV cannulation generally fall into 2 groups: those examining techniques for pain reduction and distraction and those examining the role of adjuncts to vein identification and catheter insertion. In fact, a successful IV placement program both minimizes pain and distress and maximizes the likelihood of successful insertion. The 2 are not entirely separate: a patient with adequate pain control is less likely to move and vigorously resist a needle stick.

Pain-control projects have demonstrated the efficacy of various topical anesthetics. A eutectic mixture of local anesthetics prepared as a topical cream then applied to the skin has demonstrated efficacy, as has another topical lidocaine product, LMX.[2,4Y11] Distraction techniques studied include music and games of concentration, such as finding hidden figures in picture books.[10,12]

Visible-light transillumination is perhaps the longest-established visualization technique, preceding ultrasonography and near-infrared modalities, although early models were limited by the heat produced by the light source. The technique is based on the relative translucency of smaller pediatric extremities. The light source can highlight the course of veins and is readily portable for use at the bedside.[14Y17] Newer models using fiber-optic light sources do not seem to cause burns, and one study found a significant benefit to first-attempt success using a new model, the Veinlite.[16]

Stein et al[21] recently reported no benefit to bedside ultrasonography in a group of adult patients who met study-defined criteria for Bdifficult intravenous access.[Costantino et al,[24] in contrast, also considered patients with a history of difficult access and demonstrated significantly improved time to successful cannulation and number of punctures required for success. This study placed the ultrasound device in the hands of emergency physicians experienced in bedside vascular access with ultrasonography. One study of emergency nurses' use of ultrasonography reported favorable results from voluntary questionnaires with self-reported success rates. No independent confirmation of success was reported.[23]

Recently, ultrasonongraphy has found a home in pediatric IV cannulation. Included in the only randomized pediatric trial were patients with a history of difficult access or 2 unsuccessful attempts during the current ED visit. Although the overall success rate did not significantly differ between ultrasound and control, those in the ultrasound group had fewer attempts and less time devoted to their IV attempts.[26] Given the inherent importance of operator skill in ultrasonography, future larger studies may demonstrate even more success.

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A final emerging aid is the vein entry indicator device, studied and available in Israel. It uses a pressure sensor and processing unit to signal entry into a low-pressure vein. A small recent trial found a highly significant improvement in first-attempt cannulation.[19]

Given the mixed results of other imaging modalities even in loosely defined difficult-access populations, the lack of demonstrated efficacy for the near-infrared light device in an ED with an overall largely young, nonchronically ill patient population, albeit a pediatric one, is not surprising. The nurses in this study, despite a systematic training session in the use of the device, still faced a learning curve in implementing its use. Nurses participating in this study had a trial period before the start of patient enrollment during which they could practice with the machine, but undoubtedly, they were still relatively new users of the machine. Perhaps, the technology is better suited to a study documenting its role over a longer implementation period that investigates whether its long-term use leads to clinical benefits. Though not feasible with the present design, an analysis for trend toward improvement with longer use would be an additional important future measure.

One limitation of this study is that it was performed in a clinical setting in which nurses, even relatively new nurses, place IVs in infants and children in large numbers on a daily basis. Although our hypothesis was that a device like the VeinViewer would improve cannulation success in a broad population, it is conceivable that additional studies would show a benefit if conducted in settings in which pediatric IV cannulation is less commonly performed.

Study subjects were randomized to standard or device groups to balance important confounders between groups. Despite randomization, there were more chronically ill children in the device group. The number of possible other surrogates for IV difficulty is endless, with our study attempting to include such variables as race and ethnicity, weight, and age. Other important details that were not included in data gathering include site of IV attempts on the body and the presence of additional helpers or holders in the patient encounter. Yen et al[20] recently published one of the first systematized attempts at a clinical-prediction rule in pediatric IV cannulation that categorized age of patient, history of premature birth, visibility of a vein, and ability to palpate a vein as predictors of difficult access. Such a rubric would have been helpful if available at the time of our study design and could have helped to ensure more equal vascular access difficulty in each group.

While weight for age was easily obtained using the data collected, a potentially more precise surrogate for body fat (which can obscure peripheral veins) would be body mass index. Height, a measure needed to calculate body mass index, is not routinely measured in the ED.

Nurses were stratified by skill level using the surrogate of years of experience in nursing and in pediatric care settings. There are nevertheless multiple uncollected differences in nurse skill level in venous cannulation for which the number of years of experience does not account. Some nurses may have worked in settings in which IV placement is uncommon. Thus, years as a nurse does not necessarily equate to IV skill level.

The study sought to represent a real ED setting by including a large panel of nurses. This large number, however, may lead to a wide splay of individual skills and limitations. Because several nurses required a number of months to complete their time in the study, it is possible as well that their skills in using the device varied over time. Periodic quality assurance and retraining in a formal session would have possibly aided these nurses. Similarly, difficulties in consistent timing of IV start sessions could have been mitigated by more frequent training and quality assurance sessions or by use of video-based timing.

In addition, within the last 6 months, the device manufacturer discovered a magnification effect of the back-projected vein image, making veins appear 50% to 100% larger than the actual vein width. Although this effect has been corrected in the next version of VeinViewer, it had not been recognized at the time of this study. This may account for some results, particularly with the smaller patients, causing clinicians to attempt to access veins too small to accept even a 24-gauge IV catheter. Even so, the basic mechanics and design of the device is the same in both versions. In both versions, the vein image gives no information regarding depth of the vessel. It is interesting to speculate whether the knowledge of and compensation for the vein-magnification effect would have improved the results.

A survey of the participating nurses suggested that the device may benefit dehydrated patients and those with a history of difficult access, and its role should be evaluated in a prospective study. Of those who completed the questionnaire, 90% found the device a helpful tool for patients in whom an IV is difficult to obtain. Similarly, 70% found it a useful adjunct in dehydrated patients, and 80% found it useful in chronically ill patients and those with IV access problems. By comparison, 70% were neutral or unfavorable in their opinions of the device's role in otherwise healthy, nondehydrated patients. They reported concerns over the large size of the device, with 80% reporting that they would use it more if it were more portable and smaller. None of the nurses reported that using the device saved time in starting IVs. The survey, however, contains subjective impressions of IV access difficulty (young age, dehydration, and chronic illness), rather than the more recently published DIVA scoreYbased measures.

The study was not powered to detect differences in these subgroups of patients, and a study powered for these difference could reveal a role for these patients, as has been shown in a trial of ultrasound-guided technique.[26] Similarly, a study powered to detect differences among nursing skill or experience level would potentially reveal another role for the device.

Our study initially set out to compare time with successful cannulation between the groups as a secondary outcome. The difficulty of measuring a start and stop time consistently over varying nurse techniques led to data that were not usable. A secondary study could evaluate time to successful cannulation as an outcome measure.

The possibility that a vascular-access adjunct might benefit subgroups of patients has been examined with other techniques. Modalities such as ultrasonography have documented efficacy when applied to a specific subgroup such as patients with acutely recognized or a longstanding history of difficult access.[26] Given the emergence of data such as the DIVA score providing more useful definitions of difficult-access pediatric patient characteristics, the study device should be examined in a trial powered for this subgroup.

Similarly, nurses of different experience levels participated in this study. It is conceivable that IV placers with fewer years of experience or who treat fewer pediatric patients might benefit more from an adjunct such as the VeinViewer device. More experienced nurses in turn may be more comfortable in their techniques, and a new technology may in fact prove initially burdensome to them during a study period. Further studies powered to detect these subgroup differences should follow this study that included all patients and all nursing skill levels.

Though not demonstrating a benefit in the aggregate of patients, this study documents the need for a more focused look at a new form of vascular imaging. A survey of participating

nurses documented responses that argue for a possible role of the device in dehydrated and chronically ill patients. Further research powered for the particular clinical settings and patients in which the near-infrared light technology might add a distinct benefit should be conducted for this potentially promising technology. Future studies, using the next-generation device, may be better able to evaluate the usefulness of near-infrared light in obtaining vascular access.

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