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Emergency Nurses' Utilization of Ultrasound Guidance for Placement of Peripheral Intravenous Lines in Difficult-access Patients

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Abstract

Objectives: Emergency nurses (ENs) typically place peripheral intravenous (IV) lines, but if repeated attempts fail, emergency physicians have to obtain peripheral or central access. The authors describe the patient population for which ultrasound (US)-guided peripheral IVs are used and evaluate the success rates for such lines by ENs. **Methods:** This was a prospective observational study of ENs in a Level I trauma center with a census of 75,000, performing US-guided IV line placement on difficult-to-stick patients (repeated blind IV placement failure or established history). ENs were trained on an inanimate model after a 45-minute lecture. Surveys were filled out after each US-guided IV attempt on a patient. ENs could decline to fill out surveys, which recorded the reason for use of US, type of patient, and success. Successful cannulation was confirmed by drawing blood and flushing fluids. Descriptive statistics were used to evaluate data. **Results:** A total of 321 surveys were

collected in a five-month period no ENs declined to participate. There were 280 (87%) successful attempts. Twelve (29%) of the 41 failure patients required central lines, 9 (22%) received external jugular IVs, and 20 (49%) had peripheral IV access placed under US guidance by another nurse or physician. Twenty-eight percent (90) of all patients were obese, 18% (57) had sickle cell anemia, 10% (31) were renal dialysis patients, 12% (40) were IV drug abusers, and 19% (61) had unspecified chronic illness. The remainder had no reason for difficult access given. There were four arterial punctures. **Conclusions:** ENs had a high success rate and few complications with use of US guidance for vascular access in a variety of difficult-access patients. **Key words:** emergency ultrasound; emergency nurse education; ultrasound education; ultrasound-assisted line placement; emergency medicine; ultrasound. *ACADEMIC EMERGENCY MEDICINE* 2004; 11:1361-1363.

Acquiring intravenous access in the emergency department (ED) is a common task that is usually performed by the nursing staff. However, some patients such as those who are obese, chronically ill, hypovolemic, intravenous drug users, or those with vascular pathology may prove exceedingly difficult for peripheral intravenous (IV) placement. Several studies have evaluated the use of ultrasound (US) guidance for central venous access by physicians in the ED.¹⁻⁵ Recently, this technique has been applied to peripheral venous access as well. US guidance for brachial and basilic vein cannulation by physicians in ED patients has shown considerable utility.⁶ In addition, one recent study assessed the training of emergency nurses (ENs) in this technology.⁷ However, to date we are unaware of any studies that have evaluated the effectiveness of nurses using US in

difficult-IV-access patients. The purpose of this study was to describe the types of patients and success rates for US-guided peripheral IV access by ENs.

METHODS

Study Design. This was a prospective, observational study with convenience sampling of ENs in our ED performing US-guided IV line placement. The study was approved by the Institutional Review Board with each subject providing written informed consent.

Study Setting and Population. The study was conducted at a Level I trauma center with an EM residency program. The department is staffed by certified ENs and acts as a training site for nursing students from several accredited nursing schools. An active US education program exists in the department with hospital-based credentialing in emergency US available. Nurses were introduced to US guidance for peripheral venous access during one of three classes before the initiation of this study. The classes consisted of a 45-minute lecture that included still images, video segments, and US physics and technique explanation, followed by hands-on practice on an inanimate model simulating a deep peripheral arm

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vein. Nurses performed US-guided line placement using standard aseptic technique according to hospital policy.

Study Protocol. Nurses were asked to fill out a one-page survey after attempting an US-guided line placement on a patient. These forms were available on the US machine (iLook 25; Sonosite, Bothell, WA) dedicated for this purpose in the ED. Nurses were asked the reason that US-guided access was required. The survey form also asked for the number of blind placement attempts (traditional or non-US-guided) made prior to US use. Blind IV attempts were not required before US use if the patient had a significant history of poor venous access or no potential vein cannulation sites were located by the nurse on physical examination.

Nurses were asked to select what they thought was the one main reason contributing to difficulty with blind access and they chose among obesity, IV drug abuse, renal failure, sickle cell anemia, or "other." Lines that failed rapidly (e.g., on initial blood draw, or on initial infusion of fluids, such as a fluid bolus or IV medication drips) were counted as failures. IV lines that failed during the patient's stay in the ED, but after successful infusion of IV medication or IV fluid boluses were not counted as failures.

Measures. Outcome measures were EN documentation of patient characteristics creating the need to use US-guided IV placement, and their subsequent success rate.

Data Analysis. Data analysis used descriptive statistics utilizing statistical calculators from a commercially available software package, StatsDirect. (StatsDirect Software Inc., Ashwell, UK).

RESULTS

A total of 321 survey forms were collected in a five-month period. Eighty-seven percent of IV attempts using US (280) were successful. Of the 41 (13%) patients in whom US-guided peripheral line placement attempts failed, 12 (29%) went on to have central lines placed. In nine (22%) of the failed attempts, an external jugular line was placed by the attending physician to obtain venous access. In the remainder of cases, venous access was accomplished by another nurse or physician using US guidance.

The mean number of attempted blind IV sticks prior to US use was 2.2 per patient (95% confidence interval [CI] = 1.9 to 2.4). There were 79 (26%) patients in whom a blind attempt at IV placement was not made before US because of their history and lack of palpable veins. Excluding patients who had no blind IV attempts, the average number of attempts was 2.9 (95% CI = 2.7 to 3.2). Twenty-three ENs participated in

the study and submitted surveys. Most patients, 168 (52%), had between one and three blind attempts prior to US utilization. Patient characteristics are listed in Table 1.

There were four (1.2%) complications, all arterial punctures, noted in the ED. The first patient was critically ill and, on arterial puncture, the catheter was placed in the brachial artery and used for continuous arterial blood pressure measurement, which was planned, but not yet placed. The second was also an arterial cannulation from which an arterial blood gas was obtained. Two other arterial punctures were noted. In these cases, the arteries were penetrated with needles only and catheters were not placed. No hematomas or other complications occurred.

DISCUSSION

Several articles and abstracts have been published dating back to the early 1990s relating to central and peripheral access under US guidance.¹⁻⁹ These studies all involve the use of US guidance by emergency physicians. Recently, focus has shifted to peripheral access under US guidance.^{6,9} A study by Keyes et al.⁶ evaluated US-guided peripheral IV line placement in 101 ED patients, the majority of whom were IV drug users or significantly obese. The lines were placed by emergency physicians with a reported success rate of 91%. Another study by Costantino and Fojtik⁹ evaluated the success rate of emergency physicians in placing peripheral lines in 51 patients using US guidance when ENs had not been successful. They reported a success rate of 92%. Both of these studies involved emergency physicians using US to place peripheral lines even though the initial attempts were made by the nursing staff.

To the best of our knowledge, there have been no studies published regarding the application of US guidance to peripheral access in patients by ENs. The type of patient who would benefit from nursing use of US or how nursing practice might be affected has also not been evaluated. In a recent study that compared training nurses obtaining real-time US-guided access on an inanimate model (phantom) with emergency residents using the same model, nurses performed significantly better.⁷

TABLE 1. Characteristic Breakdown for Patients Requiring US-guided IV Access

Characteristic	Percent of Total Population Studied
Obesity	28% (90 patients)
Sickle cell anemia	18% (57 patients)
Renal dialysis	10% (31 patients)
IV drug use history	12% (40 patients)
Chronic illness, unspecified	19% (61 patients)
Unspecified reason	13% (42 patients)

In our study, ENs had a success rate of 87%. Such a success rate is comparable to those found in studies evaluating US-guided peripheral line placement by emergency physicians. An important advantage of the successful use of US by nursing staff is that they are usually the first to attempt line placement, and will be more likely to successfully complete their task if aided by US. Logically, any time that another level of ED staff has to be recruited for line placement, time will be lost. This may result from delays in finding a resident or attending physician and waiting for him or her to free up time to perform the procedure; during quality assurance reviews, we found significant delays in such patients getting laboratory work, antibiotics, and other medications. Expanding the capability of the "first IV provider" to successfully obtain access will result in saving time.

There were only four complications, all involving arterial cannulation. Only 4% of patients in the study required a central line. This is probably a low number for the subgroup of patients who were enrolled in the study. The percentage of difficult-access patients who go on to receive a central line probably varies from one ED to another. Although our study could not detect how many patients would have received central lines without US assistance, it is likely that some patients avoided central line placement.

LIMITATIONS

The possibility of reporting bias is always present. However, nurses had little incentive to misreport results. Informal queries and checks indicated that reporting was accurate. Nurses entered varying numbers of patients into the study. Some patients may have been seen more than once during the study period and thus have more than one entry into the study. Application of such results from one center to another can always be problematic. However, it is likely that our

results can be applied to most busy EDs. Longer-term complications such as infection rates were not compared between US-guided lines and blindly placed IV lines as this was outside of the scope of our study.

CONCLUSIONS

After a brief tutorial, the ENs had a high success rate with few complications when using US for IV access in many different types of difficult-access patients. The need for central venous access and physician involvement in peripheral line placement was low.

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