Review

Use of Ultrasound-Guided Nurse Technique for the Placement of Peripheral Venous Access in the Emergency Room Versus the Standard "Blind" Technique: a Systematic Review

Citation: Tersigni S, Brusini A. "Use of Ultrasound-Guided Nurse Technique for the Placement of Peripheral Venous Access in the Emergency Room Versus the Standard "Blind" Technique: a Systematic Review" (2025) *Infermieristica Journal* 4(2): 113-122. DOI: http://doi.org/10.36253/if-3207

Received: December 22, 2024

Revised: June 10, 2025

Just accepted online: June 30, 2025

Published: June 30, 2025

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Data Availability Statement: All relevant data are within the paper and its Supporting Information files. This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination, and proofreading process, which may lead to differences between this version and the Version of Record.

Competing Interests: The author(s) declare(s) no conflict of interest.

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Abstract

Introduction. In the Emergency Department, it is increasingly necessary to be able to find stable venous access when managing acute patients. This study aims to investigate the effectiveness of ultrasound-guided nursing compared to the standard "blind" technique.

Methods. A comprehensive literature search was undertaken using PubMed, Cochrane, and EMBASE. The results were then evaluated according to the JBI checklists.

Results. 9 studies are considered for this review. This review showed the effectiveness of the ultrasound-guided cannulation procedure (53-91.75%) compared to the standard blind technique. It also indicated a reduction in adverse events, a decrease in the number of attempts needed for successful cannulation (1-2.2 punctures), an increase in success on the first attempt (78.9-83%), greater user satisfaction with the ultrasound-guided technique, and reduced pain perception.

Discussions. The effectiveness of the ultrasound-guided cannulation procedure compared to the standard blind technique is aligned with the literature. The innovation of this review is the evaluation of nurse execution, time analysis, user satisfaction, reported pain, and the technique's success.

Keywords: Ultrasound, Emergency Room, Intravenous, Vascular Access, Peripheral

Introduction

In the emergency room setting, due to the urgency and complexity of care, establishing stable venous access is often a critical component in the management of acutely ill patients.[1] According to the literature, more than 50% of patients who present to the emergency department require peripheral venous access for purposes such as blood sampling, medication administration, or diagnostic procedures.[2] This is one of the most frequently performed procedures by emergency room nurses. However, despite its routine nature, peripheral venous cannulation is not always straightforward. Certain patient populations—such as those with obesity, a history of intravenous drug use, end-stage renal disease, or sickle cell anaemia—often present with poor venous access.[3] These patients are classified as having Difficult Intravenous Access (DIVA).[4] In emergency settings, patients with DIVA may undergo multiple percutaneous attempts before successful cannulation is achieved. In some cases, this leads to the use of central venous catheters, which carry higher risks and should ideally be avoided. Although ultrasound guidance can enhance the safety and efficacy of peripheral access, it is not without its own set of challenges and risks.[5-7] Over the past decade, numerous studies have supported the use of ultrasound-guided techniques over blind or more invasive alternatives. For central venous catheter placement, the use of ultrasound guidance by physicians is now widely recommended due to increased success rates and reduced complications.[8-10] More recently, this approach has also been applied to peripheral venous access. A study by Keyes et al. reported a 91% success rate in patients with two previous failed cannulation attempts using ultrasound guidance.[11] Another study found that ultrasound-guided peripheral cannulation by physicians resulted in greater success, shorter procedure times, fewer attempts, and higher patient satisfaction compared to the blind technique in patients with DIVA.[12] Several studies have also explored training emergency room nurses to perform ultrasound-guided peripheral cannulation, reporting encouraging outcomes such as reduced treatment time, lower complication rates, improved patient satisfaction, and increased professional autonomy.[13,14] Despite this, the literature lacks direct comparisons between ultrasound-guided cannulation and the traditional blind technique specifically in nursing practice for patients with DIVA. This review aims to analyze current evidence on this topic, focusing on emergency room nurses who typically rely on the blind technique.

Methods

On June 9, 2025, a search was conducted on the leading international databases ("PubMed", "EMBASE", and "Cochrane CENTRAL") for a systematic review. Table 1 outlines the PICOS framework (Population, Intervention, Comparison, Outcome, Study Design) used for study selection. The search strategy is summarized in Table 2. The first author conducted the initial literature search, while the second was responsible for quality assessment.

Table 1. The PICO question.

Description	Scope
Population	Nurses
Intervention	Use of ultrasound-guided nurse technique for the placement of peripheral venous access.
Comparison	Standard "blind" technique.
Outcomes	Success with ultrasound-guided technique, Adverse Events Number of percutaneous puncture attempts (average), Time of procedures or access to the procedure (average), User Satisfaction Pain perception, Success on the first try.
Study design	Only primary studies were considered.

Table 2. Summary of search strings.

Cochrane Library CENTRAL	"vascular access" in Title Abstract Keyword AND "ultrasound" in Title Abstract Keyword OR "echography" in Title Abstract Keyword AND "emergency department" in Title Abstract Keyword AND nurs* in Title Abstract Keyword	735 results
PubMed	(("nurs*"[All Fields] AND ("echography"[All Fields] OR "ultrasonography"[MeSH Terms] OR "ultrasonography"[All Fields] OR "echographies"[All Fields])) OR "ultrasound-guided"[All Fields]) AND (("vascular access" OR "vascular"[All Fields] OR "vascular device"[All Fields] OR "cannulation"[All Fields]) AND ("access"[All Fields])) AND ("emergency"[All Fields] OR "emergence"[All Fields] OR "emergences"[All Fields] OR "emergencies"[MeSH Terms] OR "emergencies"[All Fields] OR "emergency room"[All Fields] OR "first aid"[All Fields] OR "E&A"[All Fields] OR "ED"[All Fields])	256 results
Embase	('vascular access') AND ('echography) AND ('nurse') AND ('emergency')	29 results

Inclusion criteria

- Patients aged over 18 years who presented to the emergency department requiring peripheral venous access.
- Studies conducted in emergency or pre-hospital settings where ultrasound-guided cannulation was performed exclusively by nursing staff.
- Studies reporting on at least one of the following outcomes: cannulation success rate, number of percutaneous attempts, procedure time, incidence of adverse events, patient satisfaction, or pain perception.

Exclusion criteria

- Reviews or non-primary research articles.
- Studies not published in English or Italian.
- Studies involving patients under 18 years or those not requiring peripheral venous access.
- Studies conducted outside the emergency setting (e.g., ICU or medical wards), or where ultrasound was performed by non-nursing personnel such as physicians or paramedics.
- Studies assessing only training efficacy or operator comfort, without direct clinical outcome measures

Data extraction included: first author, year of publication, study design, training methods, participant demographics (number, sex, profession, country, and age range or median), and key outcomes. The second author conducted the quality assessment using the JBI Critical Appraisal Tools (https://jbi.global/critical-appraisal-tools). Five articles used RCT checklists,[15] and four observational studies used prevalence checklists.[16,17]

Results

According to the inclusion criteria, eight studies were selected for this review (Figure 1). Table 3 presents a summary of the results, while Table 4 provides a comparison of the primary outcomes.

In the article by Salleras-Duran et al., the success of insertion using the ultrasound-guided technique was greater than the conventional procedure (91.75% versus 89.9%; p = 0.04).[18] The number of attempts was fewer with the US-guided technique (1,29 vs 1.81 with the "blind" technique), the pain was similar between groups (NRS 4,5), and satisfaction was higher in DIVA patients with the US-guided technique (7,59 vs 6,69 with the standard technique).

In the study by Weiner et al., key findings are presented.[21] The authors confirm that, on average, approximately two puncture attempts

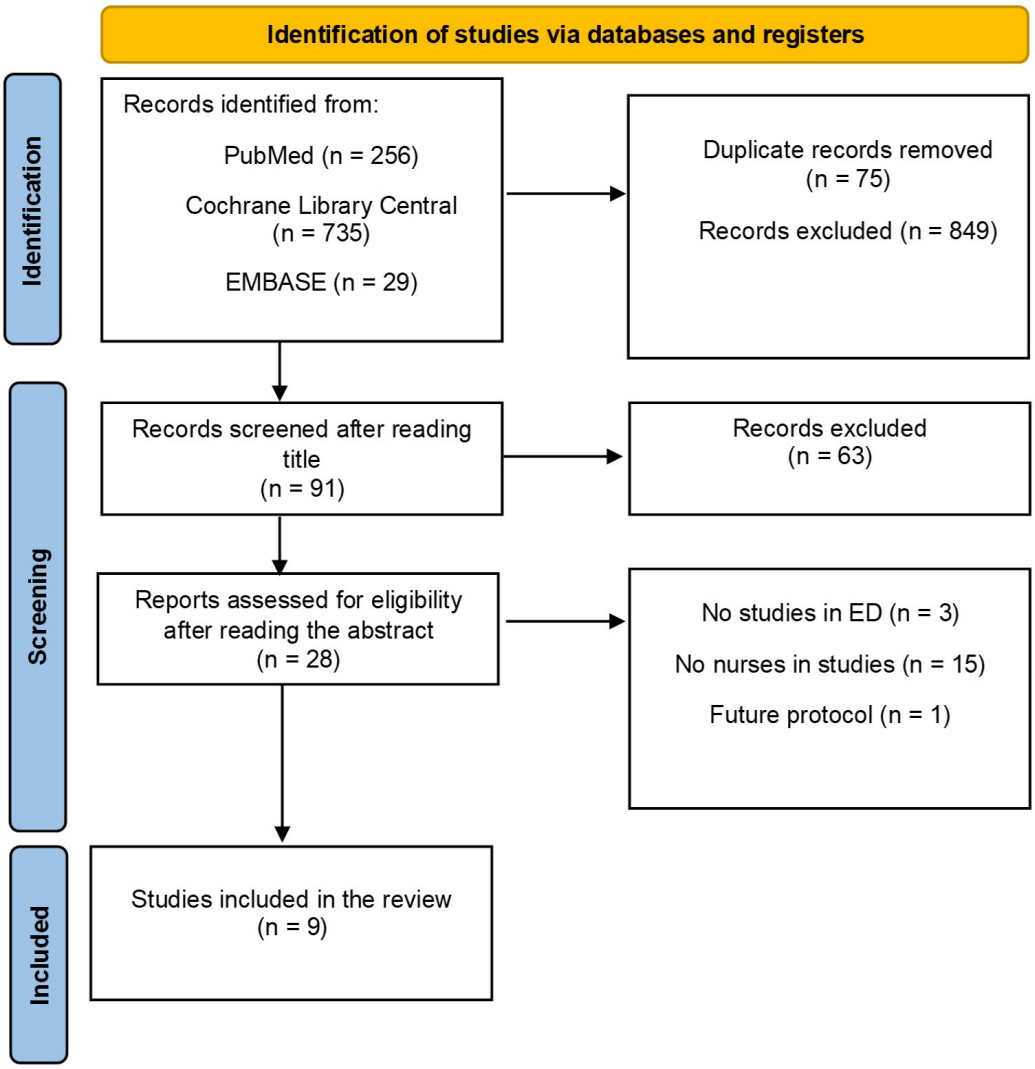

Figure 1. PRISMA flow chart showing the stages of review and item selection.

are made before transitioning to an ultrasound-guided approach. Interestingly, even with ultrasound guidance, the number of puncture attempts remains around two, indicating no significant reduction in the number of attempts between the two techniques. However, the study contributes important secondary outcomes that enhance understanding of clinical applicability. The average duration of the ultrasound-guided procedure was 27.6 minutes (95% CI: 16.0–39.1), compared to 26.4 minutes (95% CI: 16.8–36.0) for the blind technique, suggesting minimal difference in time required. Despite the similar procedure durations, patient satisfaction significantly increased with ultrasound guidance, rising from 63.2% for the blind technique to 86.2% for the ultrasound-guided approach. Additionally, pain perception was slightly lower in the ultrasound group, at 4.9% (95% CI: 3.6–6.1), compared to 5.5% (95% CI: 4.1–6.9) in the blind technique group.21

The study by Davis et al. (2021),[19] one of the most comprehensive to date, analyzed data from 150,710 emergency department patients. It aimed to assess potential delays in care when venous access was obtained using ultrasound guidance by either nurses or physicians. All findings were statistically significant ($p < 0.001$) and highlighted clear benefits of nurse-performed ultrasound-guided cannulation in patients with DIVA. For instance, the average time to establish venous access in DIVA patients was 1.64 hours (IQR: 0.79–3.08) when performed by nurses, compared to 2.51 hours (IQR: 1.46–4.07) when performed by physicians. Similarly, the time to obtain lab results was 1.53 hours (IQR: 0.93–2.78) for nurse-inserted lines and 2.18 hours (IQR: 1.26–3.60) for physician-inserted lines. When the catheter was

Table 3. Summary of search strings.

Nr.	Author(s)	Study Design	Professionals	Intervention/Control (if required)	Setting	JBI Evalution
1	Salleras-Duran et al., 2024[18]	RCT	Nurses	Compare the ultrasound-guided technique versus conventional peripheral intravenous catheterization in patients with difficult intravenous access (DIVA)	Emergency Department, USA	12/13
2	Davis et al., 2021[19]	Retrospective observational study	Nurses and Physicians	Use of the ultrasound-guided technique performed by nurses vs the same technique performed by doctors in the DIVA patient	Emergency Department, USA	9/9
3	Bahl et al., 2016[20]	Single-center-opened RCT study	Nurses	Use of the ultrasound-guided technique vs blind technique in assigned patients with difficult venous access	Emergency Department, USA	8/13
4	Weiner et al., 2013[21]	Multicenter opened RCT study	Nurses	Independent positioning of ultrasound-guided venous access with reduction of medical intervention, such as control of cannulation with blind technique plus evaluation with a questionnaire for users	Emergency Department, USA	5/13
5	Carter et al., 2015[22]	Quasi-randomized, single-center opened study	Nurses	"Non-inferiority" study on the positioning of ultrasound-guided venous access by nurses compared to doctors	Emergency Department, USA	6/13
6	Yalçınlı et al., 2022[23]	Three-arm, single-center, double-blind RCT study	Nurses	Three-arm study with cannulation with standard, ultrasound-guided, and infrared techniques. Evaluate the three variables with statistical associations regarding success and cannulation time	Emergency Department, Turkey	13/13
7	Adhikari et al., 2010[24]	Retrospective observational study	Nurses	Comparison of the frequency of infections and risks secondary to cannulation with standard technique and with ultrasound-guided technique	Emergency Department, USA	8/9
8	Chinnock et al., 2007[25]	Prospective observational study	Nurses and Physicians	Study on the success of ultrasound-guided venous cannulation performed by nurses in DIVA patients	Emergency Department, USA	6/9
9	Brannam, 2004[3]	Prospective observational study	Nurses	Use of the ultrasound-guided technique to evaluate the success of the procedure and any adverse events	Emergency Department, USA	4/9

Table 4. Comparison of the primary outcomes.

First Author	Success with the UGT	Adverse Events	Nr of percutaneous puncture attempts (average)	Time of procedures or access to the procedure (average)	User Satisfaction	Pain perception Evalution	Success on the first try
Salleras-Duran et al., 2024[18]	UGT: 91.75% BT: 89.9%	N/I	UGT: 1.29 BT: 1.81	UGT: 7.89 min BT: 5.1 min	UGT: 7.59 (SD 2.04) BT: 6.69 (SD 2.28)	UGT: 4.66 (SD 2.75) BT: 4.33 (SD 2.91)	N/I
Davis et al., 2021[19]	N/I	N/I	N/I	Time from access to the ER to the UGT performed by nurses: 1.64 hours (IQR 0.79 – 3.08) Time from access to the ER to the UGT performed by physicians: 2.51 hours (IQR 1.46 – 4.07)	N/I	N/I	N/I
Bahl et al., 2016[20]	UGT: 76% BT: 56%	N/I	UGT: 1.52 BT: 1.71	UGT: 20.7 min BT: 15.8 min	N/I	N/I	N/I
Weiner et al., 2013[21]	N/I	N/I	UGT: 2.0 [95% CI 1.5-2.4] BT: 2.1 [95% CI 1.6 – 2.6]	UGT: 27.6 min [95% CI 16.0-39.1] BT: 26.4 min [95% CI 16.8 – 36.0]	UGT: 86.2% BT: 63.2%	UGT: 4.9% [95% CI 3.6 – 6.1] BT: 5.5% [95% CI 4.1 – 6.9]	N/I
Carter et al., 2015[22]	Success Rate Nurses: 86%	5% complications only in the physicians group	N/I	N/I	N/I	N/I	N/I
Yalçınlı et al., 2022[23]	N/I	N/I	UGT: 1 p [IQR 1,25 – 1,64] BT: 1 [IQR 1,35 – 1,74]	UGT: 107 seconds [IQR 69 - 228] BT: 72 seconds [IQR 47 - 134]	N/I	N/I	UGT: 78,9% BT: 62,2%
Adhikari et al., 2010[24]	N/I	UGT: 0.52% BT: 0.78%	N/I	N/I	N/I	N/I	N/I
Chinnock et al., 2007[25]	53% (95% CI= 44 - 62%)	5 (5%)	N/I	N/I	N/I	8%	UGT: 83%
Brannam, 2004[3]	87%	4 (1,2%)	BT: 2.2 (95% CI = 1.9 – 2.4)	N/I	N/I	N/I	N/I

Legend. **UGT**: Ultrasound-Guided Technique; **BT**: Blinded Technique; **N/I**: Not investigated; **ER**: Emergency Room.

intended for analgesia, the time to pain relief was slightly shorter for nurse-performed procedures (3.46 hours, IQR: 1.78–7.23) compared to those performed by physicians (3.49 hours, IQR: 2.15–7.15).[19]

In the study by Carter et al., outcomes related to success and complications in ultrasound-guided venous access were evaluated among nurses and physicians. The success rate was 86% for nurses and 85% for physicians, with no statistically significant difference. However, complications occurred only in the physician group (5%), while no adverse events were reported in the nurse group.[23]

Bahl et al. studied patients with difficult intravenous access (DIVA), reporting a 76% success rate for ultrasound-guided cannulation compared to 56% with the blind technique. The average number of attempts was lower with ultrasound (1.52) than with the blind method (1.71). Procedure times, including preparation, were 20.7 minutes for ultrasound-guided cannulation and 15.8 minutes for the blind technique.[20]

In a study published in 2007 by Chinnock et al., conducted when ultrasound use was not yet widespread among emergency physicians, nurses achieved a 53% success rate (95% CI: 44–62%) using ultrasound guidance. Notably, 5% of cases involved arterial puncture, and 8% of patients reported pain during the procedure. Impressively, 83% of successful cannulations with ultrasound occurred on the first attempt, a significant improvement over the blind technique.[25]

Yalçınlı et al. investigated ultrasound and blind techniques, as well as infrared guidance (the latter not included in this review). Their study found a first-attempt success rate of 78.9% for the ultrasound-guided group, compared to 62.2% for the blind technique ($p = 0.010$). However, ultrasound-guided procedures took longer—107 seconds vs. 72 seconds for the blind method. Notably, both techniques required only one puncture attempt on average in this study.[23]

Lastly, in a study by Adhikari et al., infection rates were assessed between catheters inserted using ultrasound-guided and blind techniques. The infection rate was 0.52% for ultrasound-guided insertions, compared to 0.78% for the blind technique.[24]

Discussion

The effectiveness of the ultrasound-guided cannulation procedure ranges from 53 to 91.75%, compared to the standard blind technique. It also indicated a reduction in adverse events, a decrease in the number of attempts required for successful cannulation (from 1 to 2.2 punctures), an increase in success on the first attempt (ranging from 78.9% to 83%), greater user satisfaction with the ultrasound-guided technique, and reduced pain perception.

This systematic review highlights the effectiveness of the ultrasound-guided cannulation procedure compared to the standard blind technique. These findings align with another systematic review that found the efficacy of the ultrasound-guided peripheral intravenous cannulation procedure in comparison to the standard of care (the landmark and palpation method): the ultrasound-guided cannulation had a two-times higher likelihood of first successful cannulation, fewer attempts, and greater patient satisfaction.[26] Another meta-analysis examined ultrasonographical guided peripheral intravenous cannulation in children and adults across various settings. Ultrasound guidance reduced the number of attempts and the risk of failure on the first attempt execution.[27]

The evidence from this review carries substantial implications for emergency care, where time-sensitive vascular access is critical for administering fluids, medications, and resuscitative therapies.[28] Integrating the ultrasound-guided cannulation procedure in both adult and paediatric populations is essential.[26,27]

This review innovates by evaluating nurse execution, time analysis, user satisfaction, reported pain, and the technique's success. The ultrasound-guided technique requires more execution time but increases user satisfaction rates. However, only a few selected studies investigate user satisfaction and pain perception.

The need for nurse training deserves careful consideration, as several studies have demonstrated higher success rates in vascular access placement in DIVA patients by adequately trained nurses.[29,30] Specifically, Burton et al. conducted a systematic review that objectively highlighted the positive impact of training allied health professionals in ultrasound-guided vascular access placement within hospital settings.[30]

Limits of the study

The study's limitations are represented by the potential for poor sample selection and notable heterogeneity, which may occur due to inaccurate sampling in some cases, and the possibility of bias. Using only a few international databases and a single source of gray literature may have significantly reduced the number of selectable studies. The small sample size of some studies and the limitation that most studies are conducted in a single location, which is therefore monocentric, reduces the generalizability of the results. Only some studies have a high quality.

Conclusions

It is therefore clear how the use of the ultrasound-guided technique performed by Emergency Room Nurses for patients with DIVA is decisive and effective in terms of safety for the patient, with a reduction in adverse events, a consequent increase in user satisfaction, and a decrease in perceived pain. Furthermore, the literature shows the efficacy of training among nurses. However, the main limitation of the ultrasound-guided procedure is the increased time required for procedure execution. However, there is still a limited presence of research studies in this area. At the end, conducting further studies to confirm or refute some results would be helpful and necessary.

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