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Ultrasound in Emergency Medicine

Predictors of Technical Difficulty in Emergency Department Ultrasound-Guided Nerve Blocks: A Multicenter NURVE Registry Analysis

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□ **Abstract—Background: Ultrasound-guided nerve blocks (UGNBs) are increasingly used in emergency departments (EDs), but factors associated with technical difficulty remain poorly characterized. Objectives: To characterize the frequency of technical difficulty during ED UGNBs and explore patient-, provider-, and block-level factors associated with difficult procedures. Methods: We performed a retrospective analysis of the multicenter National Ultrasound-guided neRVE (NURVE) Registry, including UGNBs performed at 11 U.S. EDs from January 2022 through December 2023. This interval was selected to capture the complete initial two-year period of NURVE Registry data collection. Technical difficulty was defined by operator self-report using a standardized registry question. Mixed-effects logistic regression with institution as a random intercept was used to evaluate factors associated with technical difficulty. Results: Among 1725 UGNBs included in the analysis, 82 (4.8%) were reported as technically difficult. In unadjusted analyses, technical difficulty was more common among patients with obesity and differed by block group. In mixed-effects regression, body mass index (BMI) ≥ 30 kg/m² was independently associated with increased odds of technical difficulty compared with BMI 18.5–24.9 kg/m² (odds ratio [OR] 2.94, 95% confidence intervals [CI] 1.58–5.47). Compared with fascia iliaca/femoral region blocks, truncal plane blocks (OR 0.20, 95% CI 0.05–0.87), distal upper-extremity blocks (OR 0.12, 95% CI 0.02–0.94), and distal lower-extremity blocks (OR 0.32, 95% CI 0.10–0.99) were associated with lower odds of technical difficulty. Provider role and prior procedural experience were not significantly associated with difficulty in unadjusted analyses. Conclusions: Technical difficulty during ED UGNBs was uncommon. Obesity was the most consistent predictor of procedural difficulty, while block-group associations were more modest and influenced by site-level factors. These findings may help inform procedural planning and UGNB training initiatives. © 2026 Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.**

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□ **Keywords—point-of-care ultrasound; ultrasound-guided nerve block; regional anesthesia; obesity; emergency medicine; procedural difficulty**

Introduction

Ultrasound-guided nerve blocks (UGNBs) are increasingly used in emergency departments (EDs) as effective, opioid-sparing analgesic interventions for traumatic and nontraumatic pain control (1–4). As ED ultrasound expertise has expanded, the range of nerve blocks performed has grown to include both superficial and deep targets with varying levels of technical complexity (1,2). While prior studies have demonstrated the safety and analgesic efficacy of UGNBs (5), comparatively little is known about the frequency of technical difficulty during block performance or the factors that contribute to procedural challenges in routine ED practice (2). Technical difficulty may reflect procedural complexity and could influence procedural efficiency, learner supervision requirements, operator confidence, and potentially procedural success, although these relationships remain incompletely understood.

Identifying which blocks and patient characteristics are associated with increased difficulty may help clinicians anticipate challenges, guide block selection, and inform training priorities. However, technical difficulty has not been well described as a discrete outcome in the ED literature, and existing studies are limited by small sample sizes, single-center designs, or a focus on complications rather than procedural complexity (2,6). Technical difficulty during regional anesthesia has been studied more extensively in the anesthesiology literature, although most prior work has focused on neuraxial techniques or block failure rather than operator-reported technical difficulty (7). Prior studies have identified factors such as body habitus, poor anatomic landmarks, and patient positioning as contributors to procedural difficulty. In peripheral nerve blocks, higher body mass index (BMI) has also been associated with longer block placement times and increased risk of block failure (8,9). However, these findings may not directly translate to the broad range of ultrasound-guided peripheral nerve blocks performed in the ED, where block type, operator experience, and clinical setting differ.

Practice patterns and adoption also vary, which underscores the value of registry data to characterize procedural challenges (10). Because UGNB performance depends on adequate target visualization and needle tracking, factors such as patient body habitus may potentially influence procedural difficulty. Using data from a large, multicenter registry, we sought to characterize the frequency of technical difficulty during ED UGNBs and explore patient-, block-, and provider-level factors associated with difficult UGNB performance.

Materials and Methods

Study Design and Setting

We conducted a retrospective analysis of the National Ultrasound-guided neRVE (NURVE) Block Registry, a multicenter registry that captured data on over 2700 UGNBs performed in 11 U.S. EDs. Further details regarding registry characteristics, including race/ethnicity, have been reported previously by Goldsmith et al. (5) Participating sites included both academic and community EDs, with data entered by treating clinicians using standardized registry fields. For this analysis, we included UGNBs performed between January 2022 and December 2023. This interval represents the complete initial two-year period of NURVE Registry data collection and corresponds to the registry cohort previously described by Goldsmith et al. (5).

Outcome

The primary outcome was technical difficulty during UGNB performance, defined by operator response to the standardized registry question, "Was the procedure technically difficult?" and recorded as a binary yes/no variable.

Covariates

Candidate covariates were obtained from standardized fields entered into the NURVE Registry by treating clinicians at the time of registry data entry. These included block type, patient BMI, provider role, provider experience, and patient gender. Patient gender was included as a candidate covariate in accordance with sex and gender equity in research (SAGER) guidelines.

Block types were grouped *a priori* into eight anatomically and technically related categories (Table 1) to support meaningful comparisons, as several individual block types were infrequently performed but shared similar technical characteristics. BMI was categorized as <18.5, 18.5–24.9, 25.0–29.9, and ≥ 30 kg/m^2. The provider role was classified as ultrasound-trained attending physician, nonultrasound-trained attending physician, resident physician, ultrasound fellow, or advanced practice provider. Provider experience was defined by self-reported number of prior UGNBs performed. Because prior work suggests ultrasound-guided regional anesthesia learning curves may begin to plateau after approximately 10–15 procedures, we performed an exploratory

Table 1. Nerve Block Groupings Used in Analysis.

Group	Included Block Types	Blocks, n (%)	Rationale
Proximal upper extremity/ shoulder/neck	• Axillary brachial plexus. • Infraclavicular brachial plexus. • Interscalene brachial plexus. • Retroclavicular approach to the infraclavicular region (RAPTIR). • Superficial cervical plexus. • Superior trunk. • Supraclavicular brachial plexus. • Suprascapular.	243 (14.1%)	Grouped based on shared proximal upper-extremity, shoulder, and cervical anatomy and similar procedural approaches
Distal upper extremity	• Median. • Radial. • Ulnar.	126 (7.3%)	Grouped based on superficial peripheral nerve targets and similar procedural approaches
Truncal plane blocks	• Clavipectoral fascial plane. • Ilioinguinal. • Intercostal. • Parasternal. • Pectoralis. • Rectus sheath. • Serratus. • Transversus abdominis plane (TAP).	166 (9.6%)	Grouped based on shared truncal fascial plane anatomy and similar procedural approaches
Erector spinae	• Erector spinae block.	326 (18.9%)	Kept separate because of distinct depth, landmarks, positioning, and needle trajectory
Fascia iliaca/ femoral region	• Fascia iliaca/femoral. • Lateral femoral cutaneous.	562 (32.6%)	Grouped based on shared anterior hip/proximal thigh anatomy and similar procedural approaches
PENG	• Pericapsular nerve group (PENG) block.	73 (4.2%)	Kept separate because of its distinct target anatomy and technical profile
Transgluteal sciatic	• Transgluteal sciatic nerve block.	96 (5.6%)	Kept separate because of its posterior approach, target depth, and positioning requirements
Distal lower extremity	• Genicular. • Popliteal sciatic. • Saphenous at adductor canal. • Superficial peroneal. • Sural. • Tibial.	133 (7.7%)	Grouped based on distal lower-extremity targets and similar procedural approaches

Note: Block types were grouped a priori into anatomically and technically related categories to balance clinical interpretability with statistical stability. Individual block types with low event counts were not analyzed separately.

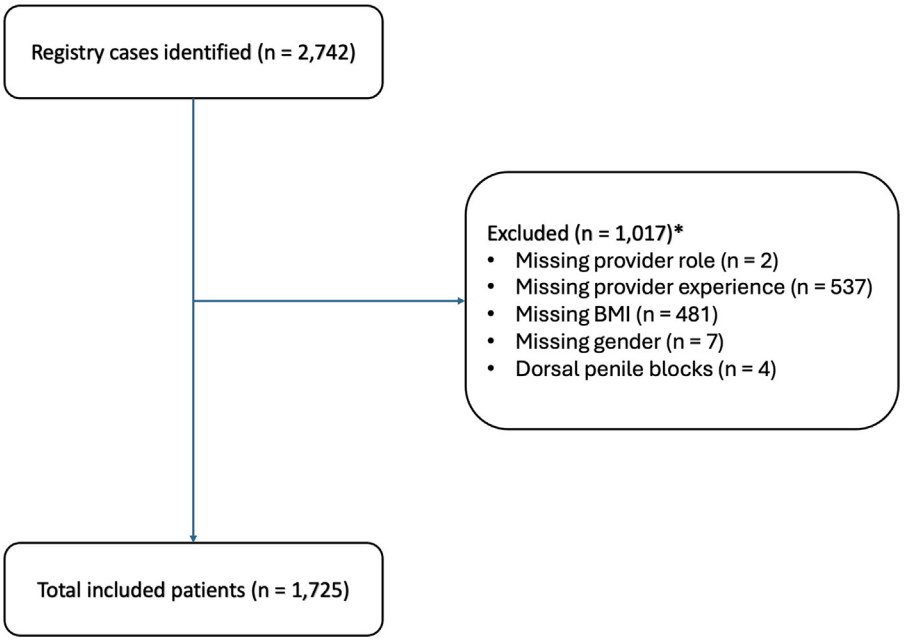


Figure 1. Study flow diagram. Of 2742 registry cases, 1013 were excluded because of missing or unknown covariate data, and four additional dorsal penile block cases were excluded because of sparse outcome counts and resultant model instability, leaving 1725 cases in the final analytic sample. Missing-covariate categories are not mutually exclusive.

dichotomization of provider experience at 10 prior procedures ($\leq$10 vs. $\geq$11) (11).

Cases with missing or unknown covariate data were excluded from the complete-case analysis. Provider experience was an optional registry field and accounted for the majority of missing observations. Individual block types with sparse outcome counts were not modeled separately to avoid unstable estimates.

Statistical Analysis

Continuous variables were assessed for normality using histograms and Q-Q plots. Age was not normally distributed and was therefore reported as median (IQR) and compared using the Wilcoxon rank-sum test. Categorical variables were compared using chi-square or Fisher exact tests, as appropriate. Bidirectional stepwise logistic regression based on Akaike Information Criterion (AIC) was used for variable selection among candidate fixed effects. Candidate covariates were selected a priori based on clinical relevance and availability within the registry and included block group, BMI category, provider role, provider experience, and patient gender. Block group was specified and retained *a priori* as the primary variable of interest. At each iteration, candidate models were compared using AIC, with lower values indicating a more favorable balance between model fit and complexity. Covariates were retained or removed according to whether their inclusion improved AIC. Collinearity among candidate covariates was assessed using generalized variance inflation factors. Institution was modeled as a random intercept to account for clustering by site. Because technical difficulty was infrequent and some subgroups had relatively few events, we performed a sensitivity analysis using Firth penalized logistic regression to assess the robustness of the primary findings to small-sample and separation bias. The sensitivity model included the same fixed-effect predictors as the final mixed-effects model. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) are reported. Analyses were performed using R (12). This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. This study was approved by site-specific institutional review boards at each participating institution.

Results

Of 2742 total registry entries, 1013 were excluded because of missing or unknown covariate data. An additional four dorsal penile block cases were excluded because of sparse outcome counts and resultant model instability, leaving 1725 cases in the final analytic sample (Figure 1). Of these, 82 (4.8%) were reported as technically difficult. Technical difficulty differed across BMI categories and was more common among patients with BMI $\geq$ 30, who accounted for 40.2% of difficult blocks compared with 27.1% of nondifficult blocks ($p = 0.023$; Figure 2B). Block group also differed by difficulty status ($p < 0.001$),

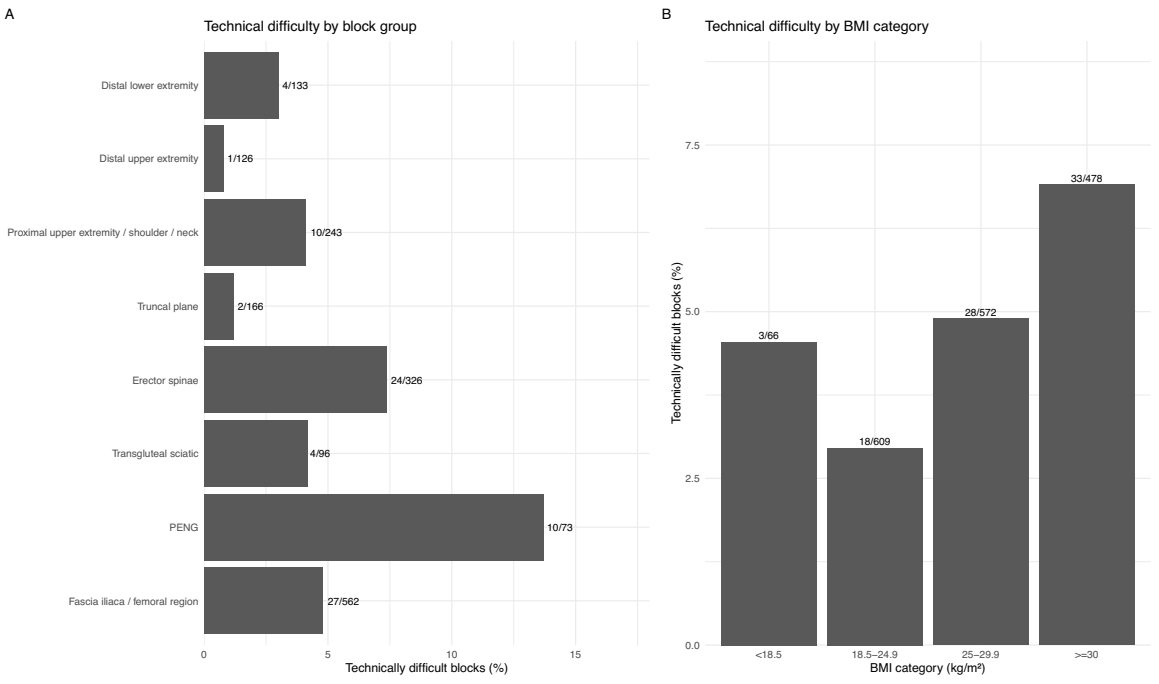


Figure 2. Technical difficulty by block group and body mass index (BMI) category. (A) Proportion of ultrasound-guided nerve blocks reported as technically difficult within each block group. (B) Proportion reported as technically difficult within each BMI category. Labels indicate the number of technically difficult blocks divided by the total number of blocks in each category.

with higher unadjusted rates observed for pericapsular nerve group (PENG) and erector spinae blocks and lower rates for truncal plane and distal upper-extremity blocks (Figure 2A). Age, gender, provider type, and provider experience were not significantly associated with difficulty (Table 2).

After AIC-based variable selection, provider role, provider experience, and patient gender were not retained in the final model, which included block group and BMI category. In mixed-effects logistic regression with institution included as a random intercept, BMI $\geq$ 30 was independently associated with greater odds of technical difficulty compared with BMI 18.5–24.9 (OR 2.94, 95% CI 1.58–5.47; $p < 0.001$). Compared with fascia iliaca/femoral region blocks, truncal plane blocks (OR 0.20, 95% CI 0.05–0.87; $p = 0.032$), distal upper-extremity blocks (OR 0.12, 95% CI 0.02–0.94; $p = 0.043$), and distal lower-extremity blocks (OR 0.32, 95% CI 0.10–0.99; $p = 0.047$) were associated with lower odds of technical difficulty. PENG, transgluteal sciatic, erector spinae, and proximal upper extremity/shoulder/neck blocks were not significantly associated with difficulty (Table 3). The model demonstrated good discrimination (AUROC 0.79; Supplementary Figure 1). The intraclass correlation coefficient (ICC) was 0.27, indicating substantial between-site clustering. Eight site-level groups were represented in the complete-case analysis, with site-specific block volume and technical difficulty shown in Supplementary Figure 2.

In sensitivity analysis using Firth penalized logistic regression, BMI $\geq$ 30 remained independently associated with technical difficulty (OR 2.67, 95% CI 1.49–4.90; $p < 0.001$). Truncal plane and distal upper-extremity blocks were associated with lower odds of difficulty, while PENG was associated with higher odds of difficulty. These findings were broadly consistent with the primary analysis, although the association between PENG and difficulty was not observed in the mixed-effects model.

Discussion

In this multicenter registry study, technical difficulty during ED ultrasound-guided nerve blocks occurred in 4.8% of procedures. BMI $\geq$ 30 kg/m² was the most consistent predictor across models. In the primary mixed-effects model accounting for clustering by institution, truncal plane and distal extremity blocks had lower odds of reported difficulty than fascia iliaca/femoral region blocks, whereas other block-group associations were not statistically significant. Provider role and prior block experience were not consistently associated with technical difficulty.

These findings suggest that both patient habitus and institutional context contribute to perceived UGNB complexity. Greater tissue depth and reduced sonographic

Table 2. Characteristics of the Analytic Sample by Technical Difficulty Status.

Characteristic	Overall (N = 1725)	Not Difficult (N = 1643)	Difficult (N = 82)	*p*-value*
Age, y	61 (41, 75)	62 (41, 75)	60 (42, 74)	0.601
Gender				0.91
Female	798 (46.3%)	761 (46.3%)	37 (45.1%)	
Male	927 (53.7%)	882 (53.7%)	45 (54.9%)	
BMI category				0.023
<18.5	66 (3.8%)	63 (3.8%)	3 (3.7%)	
18.5–24.9	609 (35.3%)	591 (36.0%)	18 (22.0%)	
25–29.9	572 (33.2%)	544 (33.1%)	28 (34.1%)	
≥30	478 (27.7%)	445 (27.1%)	33 (40.2%)	
Provider type				0.114
Ultrasound-trained attending	171 (9.9%)	164 (10.0%)	7 (8.5%)	
APP	54 (3.1%)	53 (3.2%)	1 (1.2%)	
Nonultrasound-trained attending	188 (10.9%)	185 (11.3%)	3 (3.7%)	
Resident	1,240 (71.9%)	1,174 (71.5%)	66 (80.5%)	
Fellow	72 (4.2%)	67 (4.1%)	5 (6.1%)	
Provider experience (no. of prior blocks)				0.559
<10	638 (37.0%)	605 (36.8%)	33 (40.2%)	
≥11	1,087 (63.0%)	1,038 (63.2%)	49 (59.8%)	
Block group				<0.001
Fascia iliaca/femoral region	562 (32.6%)	535 (32.6%)	27 (32.9%)	
PENG	73 (4.2%)	63 (3.8%)	10 (12.2%)	
Transgluteal sciatic	96 (5.6%)	92 (5.6%)	4 (4.9%)	
Erector spinae	326 (18.9%)	302 (18.4%)	24 (29.3%)	
Truncal plane	166 (9.6%)	164 (10.0%)	2 (2.4%)	
Proximal upper extremity/shoulder/neck	243 (14.1%)	233 (14.2%)	10 (12.2%)	
Distal upper extremity	126 (7.3%)	125 (7.6%)	1 (1.2%)	
Distal lower extremity	133 (7.7%)	129 (7.9%)	4 (4.9%)	

Values are median (IQR) or n (%). BMI = body mass index; APP = advanced practice provider; PENG = pericapsular nerve group.

* Continuous variables were compared using the Wilcoxon rank-sum test. Categorical variables were compared using chi-square or Fisher exact tests, as appropriate.

visibility in patients with obesity may make target identification and needle visualization more challenging, and these deeper blocks often require a curvilinear probe, which can make in-plane guidance more difficult. Although some block groups had higher unadjusted rates of difficulty (Table 2; Figure 2A), these associations were attenuated after accounting for clustering by institution, suggesting that site-level factors also shape perceived difficulty.

These findings may have implications for procedural planning and training. In patients with obesity, clinicians may benefit from anticipating greater technical complexity, including the need for deeper imaging windows, more deliberate needle visualization, and additional time or attempts for learners. This association should not discourage UGNB use but rather support better preparation and targeted training.

Table 3. Mixed-effects Logistic Regression for Factors Associated With Technical Difficulty, With Institution Included as a Random Intercept.

Variable	OR	95% CI	*p*-value
Block group			
Fascia iliaca/femoral region		—	—
	Reference*		
PENG	1.92	0.83–4.45	0.130
Transgluteal sciatic	0.92	0.29–2.89	0.889
Erector spinae	1.2	0.64–2.23	0.571
Truncal plane	0.2	0.05–0.87	**0.032**
Proximal upper extremity/shoulder/neck	0.59	0.27–1.31	0.198
Distal upper extremity	0.12	0.02–0.94	**0.043**
Distal lower extremity	0.32	0.10–0.99	**0.047**
BMI group			
18.5–24.9		—	—
	Reference*		
<18.5	1.25	0.33–4.76	0.743
25–29.9	1.49	0.79–2.80	0.219
≥30	2.94	1.58–5.47	**<0.001**

PENG = pericapsular nerve group; BMI = body mass index.
Bolded values in the table statistically significant.
* Reference categories were fascia iliaca/femoral block group and BMI 18.5–24.9.

An ICC of 0.27 indicates substantial between-site clustering, with approximately 27% of residual variation on the latent logistic scale attributable to differences between sites, which may reflect differences in local training practices, patient populations, procedural selection, or ED-specific workflows. Taken together, these findings build on the existing UGNB literature by identifying patient- and procedure-level factors associated with self-reported technical difficulty. Although the clinical implications of technical difficulty remain incompletely understood, recognizing factors associated with procedural complexity may help clinicians anticipate challenges and inform educational efforts. Understanding which patient and procedural factors are associated with technical difficulty may ultimately help clinicians anticipate challenges before they arise, prepare more deliberately, and refine how UGNB skills are taught and policies are standardized in the ED. Future work could examine how novice and experienced operators define technical difficulty and whether the factors contributing to perceived difficulty differ by experience level.

Limitations

Technical difficulty was self-reported, introducing the potential for reporting bias and inter-operator variability. Although captured via a standardized registry question, this outcome remains subjective and may not reflect all dimensions of procedural complexity. Objective measures such as procedure duration, number of attempts, and image quality were not available. Candidate predictors were also limited to variables captured in the NURVE Registry and entered by treating clinicians, which restricted the range of factors that could be evaluated in the model. Residual confounding cannot be ruled out despite multivariable adjustment, and complete-case analysis may have introduced selection bias. Participating sites likely represent EDs with above-average ultrasound experience, which may limit generalizability. Sensitivity analyses also showed that associations between block type and technical difficulty varied by model specification, with the PENG block reaching significance only under Firth penalized regression. Associations involving block type should therefore be interpreted with caution.

Conclusions

In this multicenter retrospective registry analysis, technical difficulty during emergency department ultrasound-guided nerve blocks was uncommon. Obesity was the most consistent predictor of technical difficulty across models, while block-group associations were more mod-

est and varied after accounting for site-level clustering. These findings suggest that patient body habitus and local practice patterns contribute importantly to perceived procedural complexity and may inform procedural preparation and educational prioritization in the ED.

Data Statement

Deidentified data that support the findings of this study are available from the corresponding author upon reasonable request and with permission of the NURVE Registry and participating institutions.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Andrew Goldsmith reports a relationship with UltraSight that includes: consulting or advisory, employment, and funding grants. Arun Nagdev reports a relationship with Butterfly Network Inc that includes: employment and funding grants. Nicole M. Duggan reports a relationship with UltraSight that includes: consulting or advisory. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jemermed.2026.09.022.

CRediT authorship contribution statement

Lachlan Driver: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Leland Perice:** Writing – review & editing, Data curation, Conceptualization. **Tasneem Zaihra Rizvi:** Formal analysis, Data curation, Conceptualization. **Nicole M. Duggan:** Data curation, Conceptualization. **Matthew Riscinti:** Writing – review & editing, Investigation, Data curation, Conceptualization. **David Martin:** Writing – review & editing, Data curation, Conceptualization. **Frederick Milgrim:** Writing – review & editing, Data curation, Conceptualization. **Andrea Dreyfuss:** Data curation, Conceptualization. **Christopher Fung:** Data curation, Conceptualization. **S. Zan Jafry:** Data curation, Conceptualization. **Michael Macias:** Writing – review & editing, Data curation, Conceptualization. **Joseph Brown:** Data curation, Conceptualization. **Arun Nagdev:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Andrew Goldsmith:** Writing – review & editing, Writing – original draft, Supervision, Data curation, Conceptualization.

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Article Summary

1. Why is this topic important?

Ultrasound-guided nerve blocks are increasingly used in emergency medicine as effective, opioid-sparing analgesic interventions. Better understanding of factors associated with procedural difficulty may improve procedural planning, education, and implementation across various emergency department settings.

2. What does this study attempt to show?

This study sought to characterize the frequency of technical difficulty during emergency department ultrasound-guided nerve blocks and explore patient-, provider-, and procedure-level factors associated with difficult block placement.

3. What are the key findings?

Technical difficulty during emergency department ultrasound-guided nerve blocks was uncommon, occurring in fewer than 5% of procedures. Obesity was the most consistent predictor of technical difficulty, while associations between specific block groups and procedural difficulty were more modest and varied after accounting for site-level clustering. Additionally, substantial between-site variability suggested that institutional practices and training patterns contribute importantly to perceived procedural complexity.

4. How is patient care impacted?

These findings may help clinicians better anticipate procedural challenges, particularly in patients with obesity, and encourage additional preparation when performing technically complex blocks. The results may also inform educational initiatives and standardization efforts aimed at improving procedural performance and facilitating broader implementation of ultrasound-guided nerve blocks in emergency departments.