Original Article

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Assessment Of Knowledge Level Of Emergency Medicine Residents Regarding The Use Of Ultrasonography

Bilal Araç[1] Şeyma Nur Çalışır[2] Bahadır Taşlıdere[3] Başar Cander[3]

1 Department of Emergency Medicine, Başakşehir State Hospital, Istanbul Turkiye
2 Department of Emergency Medicine, Basaksehir Cam and Sakura City Hospital, Istanbul, Türkiye.
3 Department of Emergency Medicine, Bezmialem Vakıf University, Istanbul Turkiye

Abstract

Background: Ultrasonography, a radiological method that has been used in the medical field for diagnostic and therapeutic purposes for a long time, employs sound frequencies. This study aims to examine the use of ultrasonography among emergency medicine residents, investigate the frequency of its usage over the years, and provide recommendations.

Material and Method: In our study, emergency medicine residents currently training at EAH-City hospitals and university hospitals were included. Those who passed the specialty exam were excluded from the study. A comprehensive survey was developed, recording questions regarding the residents' gender, training center, year of residency, availability of ultrasound (USG) equipment in the emergency department, adequacy of the equipment for current diagnoses, USG training, changes in frequency of use after training, frequency of USG use overall, frequency of USG use in resuscitation, for FAST examination, for detecting wall motion abnormalities in myocardial infarction, for measuring optic nerve sheath diameter, for diagnosing deep vein thrombosis (DVT), for the BLUE Protocol, and for diagnosing testicular torsion.

Results: In the study, a total of 190 emergency medicine residents participated, comprising 116 males and 74 females. Among them, 112 were undergoing training at university hospitals, while 78 were at EAH-City hospitals. The distribution of participants based on years of residency showed 47 in the 0-12 month range, 45 in the 12-24 month range, 40 in the 24-36 month range, 31 in the 36-48 month range, and 27 with more than 48 months of current residency. Regarding ultrasound (USG) equipment, 94.7% of participants reported that their training emergency department had at least one USG device. However, 39% of participants felt that these devices were not sufficient for making diagnoses. Two-thirds (67.7%) of participants indicated they had received USG training, and a significant majority (62.9%) reported an increase in the frequency of USG use after receiving training.

Conclusion: In our study, we found that emergency medicine residents training at university hospitals used USG devices more frequently across various types of USG compared to those training at EAH-city hospitals. Additionally, we believe that replacing all devices at the centers with state-of-the-art technology that aids in diagnosis will increase the frequency of use and, over time, reduce examination costs and diagnosis times.

Key words: Ultrasonography, FAST, BLUE Protocol, Emergency Medicine

Introduction

Ultrasonography (US) is a non-invasive, real-time imaging modality that has become an indispensable diagnostic and procedural tool in modern emergency medicine. A fundamental understanding of ultrasound physics is essential for clinicians to obtain and accurately interpret high-quality images. Ultrasound systems generate high-frequency sound waves, typically ranging from 2 to 15 MHz, through piezoelectric crystals embedded within the transducer. These sound waves propagate through tissues and interact with anatomical structures according to differences in their acoustic impedance (1). During propagation, ultrasound waves undergo attenuation, reflection, refraction, scattering, and absorption, all of which contribute to image formation and influence image quality. The degree of sound wave reflection varies according to tissue composition. Highly dense structures such as bone strongly reflect ultrasound waves and appear hyperechoic (bright white), whereas fluid-filled structures transmit sound with min-

Corresponding author: Bilal Araç
e-mail: drbilalaracc@gmail.com
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ORCID:
Bilal Araç: orcid.org/ 0000-0002-2595-931X
Şeyma Nur Çalışır: orcid.org/ 0000-0001-5512-7445
Bahadır Taşlıdere: orcid.org/ 0000-0002-5920-8127
Basar Cander: orcid.org/ 0000-0002-3308-5843

imal reflection and appear anechoic (black). Soft tissues demonstrate intermediate echogenicity and are visualized in varying shades of gray. Appropriate transducer selection is critical for optimal imaging (2,3). High-frequency probes provide superior spatial resolution but have limited tissue penetration, making them suitable for superficial structures. Conversely, low-frequency probes allow deeper tissue penetration at the expense of image resolution and are preferred for abdominal and cardiac examinations. Probe selection should therefore be tailored to the target organ, imaging depth, and patient characteristics. To eliminate the air interface between the transducer and the skin, a water-based coupling gel is routinely applied, allowing efficient transmission of ultrasound waves into the body (3,4). Ultrasound imaging includes four principal modes: A-mode, B-mode, M-mode, and Doppler imaging. B-mode is the standard two-dimensional grayscale modality used in routine clinical practice. M-mode is primarily used in echocardiography to assess moving cardiac structures with high temporal resolution (4,5). Doppler ultrasonography evaluates the velocity and direction of blood flow by utilizing the Doppler effect, while color Doppler superimposes blood-flow information onto the grayscale image, conventionally displaying flow toward the transducer in red and flow away from the transducer in blue. These imaging principles enable rapid bedside assessment of a wide range of emergency conditions and form the foundation of point-of-care ultrasonography. Ultrasonography has become an indispensable component of emergency medicine because of its rapid, non-invasive, repeatable, and radiation-free nature. As the scope of point-of-care ultrasonography (POCUS) continues to expand, competency in ultrasound has become a core skill expected of emergency medicine residents. Understanding the fundamental principles of ultrasound, selecting the appropriate transducer, and recognizing the capabilities of different imaging modes are essential prerequisites for its effective bedside application. However, the availability of ultrasound equipment alone is insufficient to ensure its optimal clinical use; adequate training and regular practice are equally important. In light of these considerations, the present study was designed to evaluate the current use of ultrasonography among emergency medicine residents in Türkiye, determine the frequency of its use across different clinical applications and stages of residency training, and identify areas where ultrasound education and implementation may be improved.

Materials and Methods

This study included emergency medicine residents who were in training between May 1, 2024, and May 31, 2024, and who agreed to participate in the study. Ethical approval was obtained from the Bezmialem Vakıf University Ethics Committee (Approval No. 2024/80, dated April 1, 2024). The study was conducted in accordance with the principles of the Declaration of Helsinki. This was a prospective, cross-sectional questionnaire-based study. All questionnaires were completed through face-to-face interviews. All participants were emergency medicine residents. Written informed consent was obtained from all participants prior to enrollment, and those who declined to participate were excluded from the study. The questionnaire consisted of a total of 15 items. In addition to demographic characteristics such as sex and the institution where residency training was being completed, the questionnaire included items regarding duration of emergency medicine residency training, availability of an ultrasound device at the training institution, adequacy of the ultrasound equipment for diagnostic purposes, previous ultrasound training, changes in ultrasound utilization following training, frequency of ultrasound use in daily practice, frequency of ultrasound use during resuscitation, frequency of performing the Focused Assessment with Sonography for Trauma (FAST) examination, frequency of echocardiography use, use of optic nerve sheath diameter measurement, use of ultrasound for the diagnosis of deep vein thrombosis (DVT), use of the BLUE protocol, and use of ultrasound in the evaluation of testicular torsion. The questionnaire was developed by the Department of Emergency Medicine based on the current literature and consisted of items rated on a 5-point Likert scale. Considering the study population as all emergency medicine residents in the department, the minimum required sample size was calculated using the Raosoft Sample Size Calculator. The minimum sample size was determined to be 22 participants (margin of error: 5%, confidence level: 95%, population size: 23, $\alpha = 0.05$, power $[1-\beta] = 0.90$).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 26.0. The normality of continuous variables was assessed using histogram plots and the Kolmogorov–Smirnov test. Descriptive statistics were presented as mean, standard deviation, median, and minimum–maximum values, as appropriate. Categorical variables in 2×2 contingency tables were compared using the Pearson chi-square test. Continuous variables that did not follow a normal distribution were compared between groups using the Mann–Whitney U test. A p-value < 0.05 was considered statistically significant.

Results

A total of 190 emergency medicine residents participated in the study, including 116 (61.1%) males and 74 (38.9%) females. Of the participants, 112 (58.9%) were training

Table 1. Mean scores of participants' responses

Participant Responses	Mean ± SE
Residency year	1.71 ± 0.13*
Monthly frequency of ultrasound use	1.873 ± 0.09**
Frequency of ultrasound use during resuscitation	1.470 ± 0.09**
Frequency of FAST examination	1.680 ± 0.09**
Frequency of ultrasound use for detection of regional wall motion abnormalities in myocardial infarction	1.569 ± 0.10*
Frequency of ultrasound use for the BLUE protocol	0.718 ± 0.07*
Frequency of ultrasound use for deep vein thrombosis (DVT) diagnosis	1.275 ± 0.09*
Frequency of ultrasound use for optic nerve sheath diameter (ONSD) measurement	0.234 ± 0.02*
Frequency of ultrasound use for the diagnosis of testicular torsion	0.423 ± 0.04*

*Data are presented as mean ± standard error (SE). Residency year was categorized according to training duration. Ultrasound use frequency was scored based on the reported monthly frequency of use using a four-point ordinal scale (0 = never, 1 = 1–5 times/month, 2 = 6–10 times/month, 3 = >10 times/month).

at university hospitals, while 78 (41.1%) were training at training and research/city hospitals. Regarding residency duration, 47 (24.7%) participants were in their first 12 months of training, 45 (23.7%) in months 12–24, 40 (21.1%) in months 24–36, 31 (16.3%) in months 36–48, and 27 (14.2%) had been in training for more than 48 months. Among the respondents, 94.7% reported that an ultrasound (US) device was available in their institution, whereas 39.0% stated that the available device was not adequate for emergency department diagnosis and treatment. Of the 189 participants who answered the question regarding previous ultrasound training, 128 (67.7%) reported having received ultrasound training. Among the 178 participants who responded to the question regarding changes in ultrasound use after training, 112 (62.9%) reported an increase in the frequency of ultrasound use. Regarding monthly ultrasound use, 189 participants responded: 24 (12.7%) reported never using ultrasound, 58 (30.7%) reported using it 1–5 times, 25 (13.2%) reported 6–10 times, and 82 (43.4%) reported using ultrasound more than 10 times per month. For ultrasound use during resuscitation, 189 participants responded: 49 (25.9%) reported never using ultrasound, 57 (30.2%) reported using it 1–5 times, 28 (14.8%) reported 6–10 times, and 55 (29.1%) reported more than 10 uses. Regarding FAST examinations, 189 participants responded: 34 (18.1%) reported never performing FAST, 64 (34.0%) reported performing it 1–5 times, 18 (9.6%) reported 6–10 times, and 72 (38.3%) reported more than 10 times. For the assessment of regional wall motion abnormalities in suspected myocardial infarction, 188 participants responded: 45 (23.9%) reported never using ultrasound, 52 (27.7%) reported using it 1–5 times, 30 (16.0%) reported 6–10 times, and 61 (32.4%) reported more than 10 uses. Regarding optic nerve sheath diameter measurement, 188 participants responded: 154 (81.9%) reported never using ultrasound, 27 (14.4%) reported using it 1–5 times, 4 (2.1%) reported 6–10 times, and 3 (1.6%) reported more than 10 uses. For the diagnosis of deep vein thrombosis (DVT), 189 participants responded: 62 (32.8%) reported never using ultrasound, 61 (32.3%) reported using it 1–5 times, 18 (9.5%) reported 6–10 times, and 48 (25.4%) reported more than 10 uses. Regarding use of the BLUE protocol, 188 participants responded: 107 (56.9%) reported never using ultrasound, 47 (25.0%) reported using it 1–5 times, 14 (7.4%) reported 6–10 times, and 20 (10.6%) reported more than 10 uses. For the diagnosis of testicular torsion, 189 participants responded: 135 (71.4%) reported never using ultrasound, 37 (19.6%) reported using it 1–5 times, 8 (4.2%) reported 6–10 times, and 9 (4.8%) reported more than 10 uses (Table 1). Diagnostic ultrasound use was significantly more frequent among residents training at university hospitals than among those at training and research/city hospitals ($p = 0.004$). Ultrasound use during resuscitation was also significantly higher in university hospitals ($p = 0.022$). Similarly, ultrasound use for FAST examinations ($p = 0.032$), assessment of regional wall motion abnormalities in myocardial infarction ($p = 0.003$), diagnosis of DVT ($p = 0.003$), and implementation of the BLUE protocol ($p = 0.003$) was significantly more frequent among residents at university hospitals. No statistically significant differences were observed between the two hospital types regarding ultrasound use for the diagnosis of testicular torsion ($p = 0.072$) or optic nerve sheath diameter measurement ($p = 0.644$). Chi-square analysis showed no statistically significant differences between university hospitals and training and research/city hospitals regarding the availability of ultrasound devices in the emergency department, previous ultrasound training, or the adequacy of the available ultrasound equipment (Table 2).

Discussion

Point-of-care ultrasonography (POCUS) has become an essential component of emergency medicine practice and is accepted as a core competency in emergency medicine

Table 2. Comparison of ultrasound utilization between residents training at university hospitals and those training at training and research/city hospitals

Ultrasound Application	P value
Overall ultrasound utilization	**0.004**
Ultrasound use during resuscitation	**0.022**
Ultrasound use for FAST examination	**0.032**
Ultrasound use for detection of regional wall motion abnormalities in myocardial infarction	**0.003**
Ultrasound use for optic nerve sheath diameter (ONSD) measurement	0.644
Ultrasound use for deep vein thrombosis (DVT) diagnosis	**0.003**
Ultrasound use for the diagnosis of testicular torsion	0.072
Ultrasound use for the BLUE protocol	**0.003**

residency training by organizations responsible for emergency medicine education in the United States and Canada (6,7). Although structured ultrasound curricula have been implemented in North America since the early 1990s, a standardized national curriculum has not yet been fully established in Türkiye (8). Therefore, evaluating the current level of ultrasound utilization among emergency medicine residents is important for identifying educational needs. In the present study, 94.7% of participants reported that an ultrasound device was available in their emergency department. This finding is consistent with the survey conducted by Selman et al.**,** who reported an ultrasound availability rate of 96% among emergency medicine residency training centers in Türkiye (9). Similarly, the Turkish Ministry of Health regulation published in 2022 recommends that ultrasonography units should be located within or adjacent to emergency departments (10). Despite this widespread availability, 39% of participants considered the existing ultrasound equipment insufficient for emergency department diagnosis and treatment. These findings indicate that equipment availability alone does not necessarily ensure adequate clinical utilization and that device quality and accessibility remain important issues. Although ultrasound devices were available in nearly all participating institutions, only 43.4% of residents reported using ultrasound more than ten times per month, while 12.7% reported never using ultrasound. Kokulu et al**.** similarly demonstrated that only approximately 75% of physicians working in emergency departments routinely used ultrasonography despite having access to an ultrasound device (11). Together, these findings suggest that barriers other than equipment availability continue to influence routine POCUS utilization. More than two-thirds of participants had received formal ultrasound training, and 62.9% reported increased ultrasound use after training. This finding supports the importance of structured educational programs in improving resident confidence and encouraging routine integration of ultrasound into clinical practice. Standardized ultrasound education during residency may therefore increase both competency and frequency of use. One of the major findings of the present study was the significant difference between university hospitals and training and research/city hospitals. Residents training at university hospitals reported significantly higher utilization of ultrasound for diagnostic examinations, FAST, focused cardiac ultrasound, DVT evaluation, the BLUE protocol, and resuscitation. These differences are likely related to the stronger academic environment, greater faculty supervision, and increased opportunities for structured ultrasound education available in university hospitals. Approximately one-quarter of participants reported never using ultrasound during cardiopulmonary resuscitation. Current international resuscitation guidelines emphasize that bedside ultrasound may help identify reversible causes of cardiac arrest and confirm cardiac standstill but should never prolong interruptions in chest compressions (12,13). Therefore, ultrasound training should focus not only on image acquisition but also on appropriate integration into resuscitation algorithms. FAST examination was one of the most frequently performed ultrasound applications in the present study. Nevertheless, 18.1% of residents reported never performing FAST. Özdemir et al. reported a comparable utilization rate for trauma-focused ultrasonography among emergency physicians (14). FAST has been incorporated into the Advanced Trauma Life Support (ATLS) algorithm because of its high specificity and rapid bedside applicability (15). Previous studies have demonstrated sensitivity ranging from 85% to 96% and specificity exceeding 98%, with sensitivity approaching 100% in hypotensive trauma patients (16). These findings support the importance of maintaining adequate FAST competency throughout residency training. Focused cardiac ultrasound for detecting regional wall motion abnormalities in suspected acute myocardial infarction was regularly used by only one-third of participants. Although echocardiography does not replace electrocardiography or cardiac biomarkers, regional wall motion abnormalities remain an important indicator of myocardial ischemia (17,18). Grenne et al. demonstrated that focused cardiac ultrasound could facilitate the early identification of acute coronary occlusion in patients with non-ST-segment elevation myocardial infarction and help identify patients requiring urgent revascularization (19). Increasing resident competency in focused cardiac ultrasound may therefore improve bedside assessment of patients presenting with chest pain. Optic nerve sheath diameter measurement was the least frequently used ultrasound application, with more than 80% of residents reporting that they had never performed the examination. Can et al. demonstrated

that an optic nerve sheath diameter greater than 5 mm was significantly associated with intracranial pathology on computed tomography and elevated intracranial pressure (20). Similarly, Restrepo et al**.** concluded that optic nerve sheath ultrasonography may represent a valuable bedside method for detecting elevated intracranial pressure in emergency department and intensive care unit patients (21). Despite growing evidence, the present findings suggest that this application has not yet been widely incorporated into emergency medicine training. Only one-quarter of participants reported frequent ultrasound use for the diagnosis of deep vein thrombosis. Compression ultrasonography is widely accepted as a rapid and reliable bedside diagnostic method. Su et al. reported a sensitivity of 100%, specificity of 97%, positive predictive value of 96%, negative predictive value of 100%, and overall diagnostic accuracy of 98% for color Doppler ultrasonography in DVT diagnosis (22). Likewise, Hamper et al. reported sensitivity and specificity approaching 95–100% (23). Despite this strong evidence, DVT ultrasonography appears to remain underutilized in routine emergency practice. Similarly, ultrasound utilization for the BLUE protocol was relatively low, with more than half of residents reporting that they had never applied the protocol. Previous studies have consistently demonstrated that lung ultrasonography is a safe, non-invasive, bedside imaging modality that significantly contributes to the diagnosis and management of critically ill patients (24,25). Furthermore, lung ultrasonography plays an important role in the rapid evaluation of acute respiratory failure by facilitating the diagnosis of pneumothorax, pleural effusion, pulmonary edema, pneumonia, and pulmonary contusion (26). These findings suggest that greater emphasis should be placed on lung ultrasound education during emergency medicine residency. Finally, ultrasound use for the diagnosis of testicular torsion was uncommon, and no significant difference was observed between university hospitals and training and research/city hospitals. Because testicular torsion is a time-critical condition in which prompt diagnosis directly affects testicular salvage, further studies are needed to investigate barriers limiting bedside ultrasound use in this clinical setting. Overall, our findings indicate that although ultrasound equipment is widely available in emergency departments, utilization remains inconsistent across different clinical applications. The significantly higher utilization rates observed in university hospitals suggest that structured education and academic training play a greater role than equipment availability alone. Establishing a standardized national POCUS curriculum and increasing supervised hands-on training may improve competency and promote more consistent ultrasound use among emergency medicine residents in Türkiye.

Conclusion

This study demonstrated that structured ultrasound education is associated with increased utilization of point-of-care ultrasonography (POCUS) among emergency medicine residents in Türkiye. Although ultrasound devices are available in most training centers, variability in equipment quality and the absence of standardized training programs remain important barriers to the widespread and effective use of POCUS. These findings highlight the need to incorporate standardized ultrasound training into the national emergency medicine residency curriculum and to ensure that training centers are equipped with adequate ultrasound devices. Expanding structured POCUS education and improving access to appropriate equipment may increase the use of bedside ultrasonography in emergency departments, facilitate more rapid diagnosis and treatment, and potentially reduce the need for additional imaging modalities and associated healthcare costs. Further multicenter studies are warranted to evaluate the long-term impact of standardized ultrasound education on clinical practice and patient outcomes.

Ethics Committee Approval: Ethical approval was obtained from the Bezmialem Vakıf University Ethics Committee (Approval No. 2024/80, dated April 1, 2024).

Informed Consent: Informed consent was waived due to the retrospective design of the study.

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