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Evaluation of Ultrasound Applicability Skills of Paramedics Working in Prehospital Service

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ABSTRACT

Objective: The active use of ultrasound has become widespread in the pre-hospital setting for the last two decades. Because of its convenience, portability, and lack of radiation, ultrasound is extremely useful in the diagnosis of life-threatening conditions in trauma patients in the prehospital setting. For trauma patients, an ultrasound protocol, called Prehospital Focused Abdominal Sonography for Trauma, has been developed. The effective use of this protocol by paramedics has become the center of various studies in the literature. The purpose of this study is to determine whether paramedics can use an ultrasound device to successfully acquire the images of the Prehospital Focused Abdominal Sonography for Trauma protocol on a live model.

Material and Methods: The initial application of theoretical and practical training on the Prehospital Focused Abdominal Sonography for Trauma protocol for paramedics was followed by a practical examination performed on live models. Thirty-eight paramedics working in land ambulances of 112 Emergency Health Services in Sivas were given 16 hours of theoretical and practical training on the P-FAST protocol. In practical training, images of the P-FAST protocol were acquired by a portable ultrasonic device with convex and linear probes on healthy live models. At the end of the training, the paramedics were given a practical exam on the live model with a portable ultrasound device.

Results: All participants (38) were able to acquire all five images, but some were not at the desired angles or at the appropriate gain and depth. The number of paramedics who achieved complete success in the study was 26 (68.4%).

Conclusion: Following the two-day training, 68.4 % of the participants correctly acquired and assessed the images.

Keywords: Pre-hospital, trauma, ultrasound

ÖZ

Hastane Öncesi Alanda Çalışan Paramediklerin Ultrasonografi Uygulayabilme Becerilerinin Değerlendirilmesi

Giriş: Ultrasonun aktif kullanımı son yirmi yıldır hastane öncesi alanda yaygınlaşmıştır. Ultrason, hastane öncesi alanda kullanım kolaylığı, taşınabilirliği ve radyasyon içermemesi nedeniyle travma hastalarının hayatı tehdit eden durumlarının tanısında oldukça pratiktir. Travma hastaları için Hastane Öncesi Travma Odaklı Batın Sonografisi adı verilen bir ultrason protokolü geliştirilmiştir. Bu protokolün paramedikler tarafından etkin kullanımı literatürde çeşitli çalışmaların merkezi haline gelmiştir. Bu çalışma, paramediklerin ultrason cihazını kullanıp kullanamayacaklarını ve Hastane Öncesi Travma için Batın Sonografisi protokolünün görüntülerini canlı bir model üzerinde başarılı bir şekilde elde edip edemediklerini araştırmayı amaçlamaktadır.

Gereç ve Yöntemler: Paramedikleri hedef alan Hastane Öncesi Travma Odaklı Batın Sonografisi protokolüne ilişkin teorik ve pratik eğitimini, canlı modeller üzerinde uygulamalı bir inceleme izleyecektir. Sivas'ta 112 Acil Sağlık Hizmetleri'nde kara ambulanslarında görev yapan 38 paramediğe Hastane Öncesi Travma Odaklı Batın Sonografisi protokolü için 16 saat teorik ve uygulamalı eğitim verildi. Pratik eğitimde, Hastane Öncesi Travma Odaklı Batın Sonografisi protokolünün görüntüleri, sağlıklı canlı modeller üzerinde konveks ve lineer problara sahip taşınabilir ultrasonik cihaz ile elde edildi. Eğitim sonunda sağlık görevlilerine taşınabilir ultrason cihazı ile canlı model üzerinde uygulamalı bir sınav yapıldı.

Bulgular: Tüm katılımcılar (38) beş görüntünün tümünü elde edebildi, ancak bazıları istenen açılarda veya uygun kazanç ve derinlikte değildi. Çalışmada tam başarı elde eden sağlık görevlisi sayısı 26 (%68.4) idi.

Sonuç: İki günlük eğitimin ardından, katılımcıların %68.4'ü görüntüleri doğru bir şekilde elde etti ve değerlendirdi.

Anahtar Kelimeler: Hastane öncesi, travma, ultrasonografi

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INTRODUCTION

Ultrasonographic imaging is widely used in emergency departments, especially in the diagnosis and follow-up of trauma patients (1). With the development of ultrasound devices in parallel with ever-developing technology, ultrasound has been commonly used in the pre-hospital setting for the last 20 years in the US and some European countries (2). There are many studies in the literature that have demonstrated the feasibility and usefulness of ultrasonography in the pre-hospital setting (2,3). Ultrasound, as an imaging method, aids in the detection and management of life-threatening conditions in pre-hospital trauma patients who require quick decision-making thanks to its ease of use, lack of radiation, and portability (4). There are studies in the literature showing that paramedics, and emergency medical service (EMS) providers, can successfully use ultrasound in the pre-hospital setting (4-7). After blunt and penetrating traumas, the pre-hospital focused abdominal sonography for trauma (P-FAST) protocol can detect life-threatening pathologies such as hemopericardium, hemoperitoneum, hemothorax, and/or pneumothorax early and help transfer patients to the appropriate treatment center. Furthermore, the addition of ultrasound imaging to disaster circulation in events such as natural disasters or mass accidents improves triage accuracy (8). This saves time for critical situations in the pre-hospital setting and results in better patient survival (3).

MATERIALS and METHODS

In this prospective, educational, single-centered study, the ability of paramedics working in land ambulances in 112 emergency health services in Sivas province with no previous ultrasound experience to perform P-FAST was investigated after the module training consisting of eight hours of theoretical and eight hours of practical lessons.

The inclusion criteria for the study are as follows:

1. Working in the pre-hospital setting (112 Emergency Health Services) and being a volunteer.
2. Having at least 1 year of professional experience.
3. Completion of the training modules of the Ministry of Health (basic life support, advanced cardiac life support, pediatric advanced life support, and trauma life support).
4. Having no formal previous ultrasound experience and knowledge (no prior ultrasonography experience, no formal education, no informal training).

A total of 38 paramedics were included in the study. Volunteering participants were given eight hours of ultrasound training per day, four hours of theory, and four hours of practice, in total, 16 hours in two days. The training was given by two emergency medicine specialists and one radiology specialist, who are ultrasound instructors. Module training was carried out in line with the learning objectives presented in Table 1. In theoretical training, the basic anatomy of the abdomen, heart, and lungs, ultrasonography physics and working principles of an ultrasound device, probe selection, and probe placement, basic image acquisition techniques, basic image interpretation, and P-FAST protocol (Figure 1), which is specifically used in the ultrasonographic evaluation of trauma patients, were explained. Along with the normal FAST images, pathological (pericardial effusion, hemopericardium, hemoperitoneum, and pneumothorax) images were also shown in video presentations. Theoretical lectures were given collectively to all participants in a classroom environment.

In practical training (hands-on training), it was demonstrated how to acquire images of the P-FAST protocol by Philips Lumify^{TM} portable ultrasonic device with convex and linear probes on healthy live models. Before the practical session, the ultrasound device, its technical features, and frequently used functions (gain, depth, freeze, calculation, doppler, etc.) were shown. Probe orientation and methods of acquiring quality images were explained. After the images of the P-FAST protocol (Hepatorenal, Subxiphoid, Splenorenal, Suprapubic, and Lungs) were acquired by the trainers with optimum quality, each trainee practiced the acquisition of these images (Figure 2). In practical training, paramedics were divided into eight groups of five and four (six groups of five, two groups of four). The instructor/student ratio was 1/5 and 1/4.

Assessment and Evaluation

At the end of the module training, the participants were given a test in accordance with the psychomotor learning objectives under the supervision of an instructor. For this test, a live model and a portable USG device were used. The participants were asked to choose the right probe, position it in the right place, acquire the optimum image, use the appropriate gain and depth settings, scan in both planes in the acquired images, and define the existing anatomical organs and neighboring structures in the images they obtained. Each image was scored separately in three categories:

1. The image was not acquired.
2. The image was acquired but not sufficient.
3. The image was acquired appropriately and the neighboring anatomy was described.

Table 1. Learning objectives of module training

Cognitive domain	Affective domain	Psychomotor (skill) domain
Working principles of ultrasound device Features of probes	Raising awareness about field (disaster) triage with portable ultrasound device	Ability to select the appropriate probe Developing probe orientation
Basic probe areas, positions and movements	Raising awareness about the transfer of patients to the appropriate hospital with a portable ultrasound device	Ability to make basic ultrasound settings (appropriate gain and depth settings)
Basic anatomy 1. Abdomen 2. Heart 3. Lungs	Raising awareness on the possibility of early treatment with a portable ultrasound device	Being able to acquire an ideal image on the live model with the appropriate probe location and angle
Images of normal anatomical structures on ultrasound image. P-FAST protocol 1. Hepatorenal area normal image 2. Normal pericardial image of subxiphoid area 3. Normal image of the splenorenal area 4. Normal image of the suprapubic area 5. Thorax normal pleural sliding motion		Being able to tell normal anatomical structures in the acquired image
Images of pathological conditions in the ultrasound image. P-FAST protocol, (pericardial effusion, hemopericardium, hemoperitoneum and pneumothorax) 1. Pathological fluid image in the hepatorenal area 2. Pericardial pathological fluid image in subxiphoid screening 3. Pathological fluid image in the splenorenal area 4. Pathological fluid image in the suprapubic area 5. Pneumothorax image in the thorax		

Participants who were able to acquire the correct and appropriate image in all areas and interpret the neighboring structures were deemed successful (assessment and evaluation category 3).

For this study, approval (number 2020-01/08) was obtained from the Ethics Committee of Sivas Cumhuriyet University.

RESULTS

Each participant was asked to acquire the correct images of the five regions described in the P-FAST protocol. All participants (38) were able to acquire all five images, but some were not at the desired angle or the appropriate gain and depth. Participants who acquired and interpreted the optimum images in all five body areas correctly by scanning at appropriate angles received full points and were deemed to have achieved complete success (measurement and evaluation category 3). The number of paramedics who achieved complete success in the study was 26 (68.4%). The rates of successful acquisition of the Hepatorenal, Splenorenal, and Suprapubic images by the participants were the same (89.5%). The subxiphoid image was the one acquired with the lowest success rate (71.1%) (Table 2).

DISCUSSION

This study revealed that after a two-day module training program of eight hours of theoretical and eight hours of practical training, paramedics could use the ultrasound device and successfully acquire images of the P-FAST protocol on a live model, despite their lack of ultrasound experience in their educational and professional backgrounds.

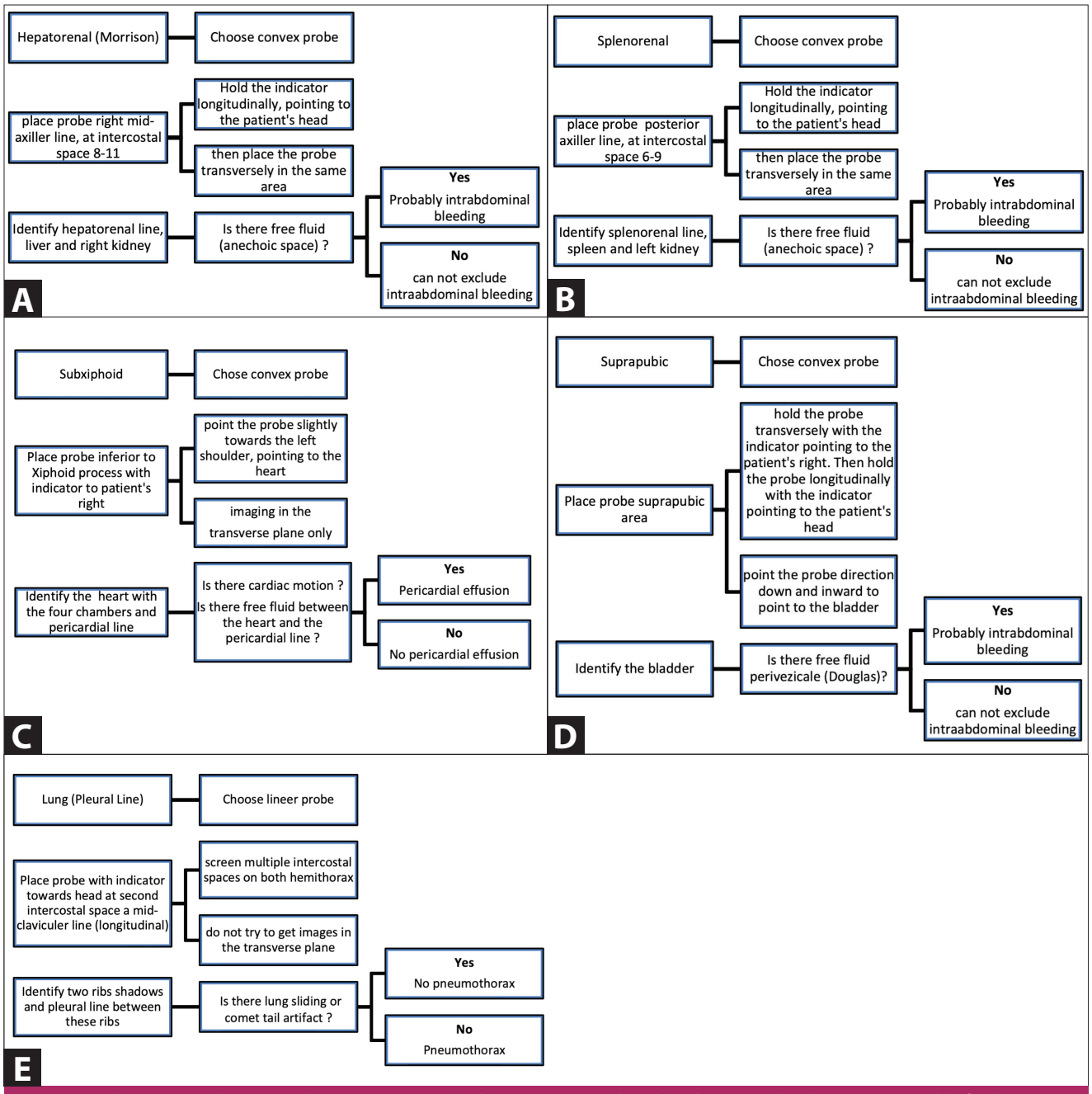

Figure 1. Body regions and anatomical structures imaged in the P-FAST protocol. Probe selection and probe position suitable for the imaging areas.

There are several studies on the use of ultrasound equipment by non-physician healthcare professionals. Many academic investigations on the use of pre-hospital ultrasonography have found that ambulance workers may readily and successfully utilize this equipment following a brief training period. A study of 50 team leaders at the Siena Ambulance Service in Italy found that even a brief training of eight hours of academic and practical training yielded positive outcomes (82%) (9). In a study conducted in the United States, it was determined that 20 paramedics working in integrated emergency departments who had not previously received any ultrasound training were able to recognize pneumothorax, pericardial effusion, and cardiac arrest after completing the pre-hospital assessment with ultrasound for emergencies (PAUSE) protocol training (two hours). Furthermore, it has been reported that the PAUSE procedure may be effective in

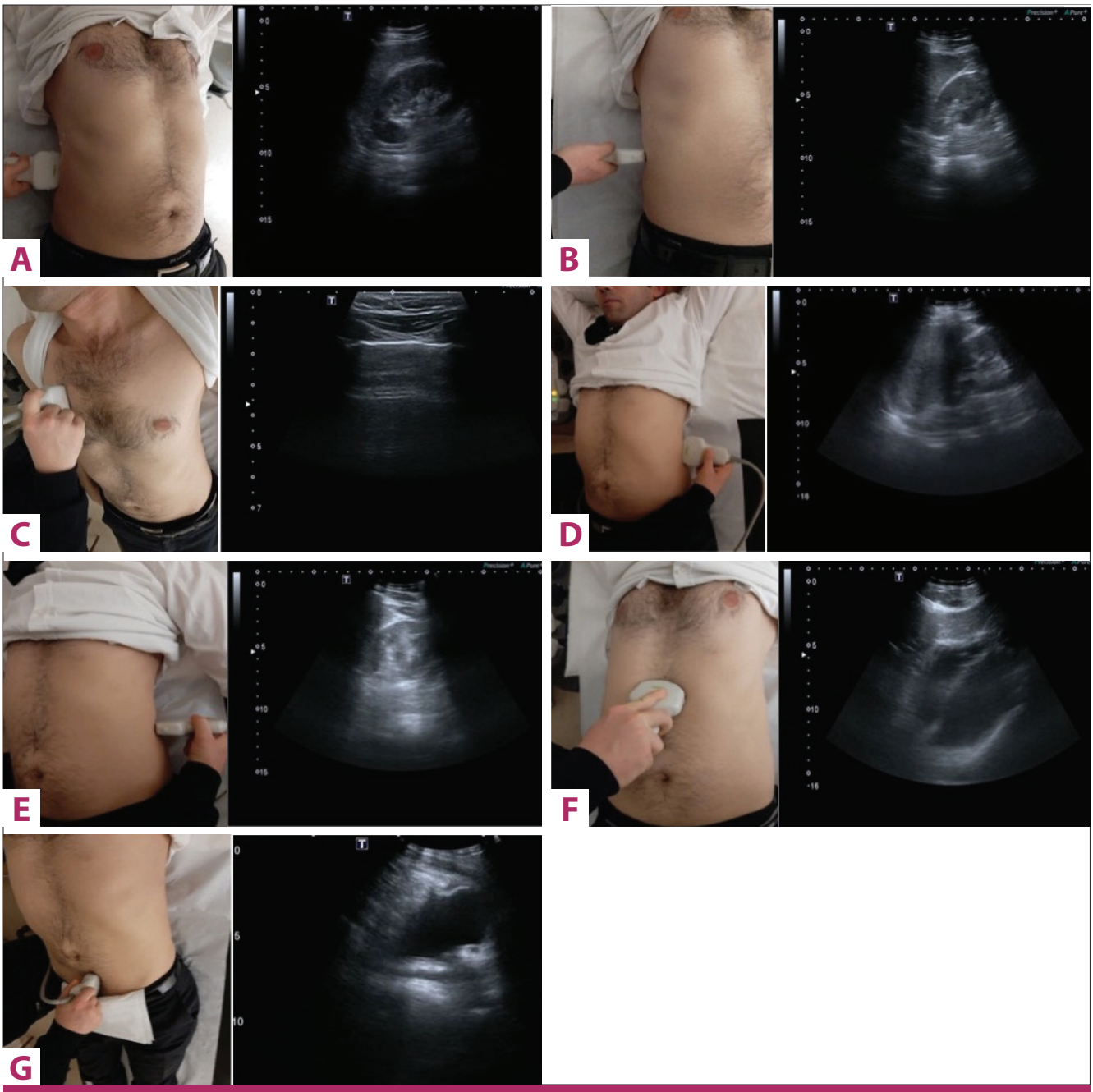

Figure 2. Photographs and ultrasound images of the body regions imaged for P-FAST on the live model.

identifying some life-threatening conditions in the pre-hospital setting (10).

In a multicenter study conducted in the United States, 93 advanced life support (ALS) providers received six hours of training on the FAST examination and evaluation of the abdominal aorta via an ultrasound training curriculum, which included theoretical lectures, hands-on scanning experience, and observed structured clinical encounter (OSCE) scenarios. It has been shown that providers' image recognition abilities increased considerably following the training procedure (11).

The focused assessment with sonography for trauma (FAST) technique has been demonstrated to be a useful method for detecting hemoperitoneum in the emergency room (5). Pre-hospital imaging techniques aid in the evaluation and management of time-sensitive emergencies. Ultrasound is the primary modality used by EMS professionals in

Table 2. Successful acquisition rates of P-FAST images

P-FAST Images	Number of People Succesfully Acquired The Images n= 38	Percentage (%)
Hepatorenal	34	89.5
Splenorenal	34	89.5
Suprapubic	34	89.5
Subxiphoid	27	71.1
Lung	32	84.2
Fast Full	26	68.4

the field. The use of emergency ultrasonography has been linked to improved results (3).

In a study by Ünlüer et al. in Türkiye, it was shown that paramedics working in the hospital emergency departments can perform FAST with high diagnostic accuracy (sensitivity 84.62%, specificity 97.37%) in the first examination of trauma patients upon admission to the emergency service. In a study of the accuracy of pre-hospital focused assessment with sonography for trauma (P-FAST) performed by paramedics on trauma patients admitted to the ED, it was discovered that paramedics working in hospital EDs perform FAST with high accuracy (12).

CONCLUSION

Our study showed that paramedics working in ambulances were able to acquire the ultrasound images of the P-FAST protocol on a live model with a 68.4% success rate (measurement and evaluation category 3) and could identify the neighboring anatomy after a two-day module of pre-hospital training.

Technological developments that transform ultrasound into user-friendly handheld devices and the decrease in device costs have increased the number of ultrasound applications in trauma management in out-of-hospital settings (13). The use of portable ultrasound in the pre-hospital setting is becoming widespread, with the use of physicians and non-physicians performing diagnostic and therapeutic procedures in various EMS systems in Europe and the United States (14-16).

In EMS systems with local trauma care and pre-hospital triage guidelines, the earliest possible detection of intra-abdominal free fluid, tamponade, or pneumothorax in patients having penetrating thoracic injury, pericardial effusion, or blunt trauma can greatly assist providers' transport method and enable appropriate center selection (17).

The results obtained in this study suggest that after providing the necessary technical infrastructure for the use of pre-hospital ultrasound in Türkiye, paramedics can perform pre-hospital ultrasound following pre-service and in-service training programs targeting EMS providers.

Limitations of the Study

Our study is not a diagnostic study as it was not conducted on real patients but rather on healthy individuals as live models. In the present study, the practices were performed using bedside USG devices. To more realistically reveal the impact of ultrasound use in the pre-hospital setting on patient care, an ultrasound device that can be used in the field and the ambulance is required.

Ethics Committee Approval: This study was approved by the Sivas Republic University Non-Invasive Clinical Research Ethics Committee (Decision Number: 2020-01/08, Date: 15.01.2020)

Author Contributions: Concept/Design: BG; Analysis/Interpretation: BG, EG; Data Acquisition: BG, EG, ŞÇ; Writing: BG; Critical Revision: EG, ŞÇ; Final Approval: BG.

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