ISSN: 3005-8449
IRABCS https://irabcs.com INNOVATIVE RESEARCH IN APPLIED, BIOLOGICAL AND CHEMICAL SCIENCES

Research Article

IRABCS, vol. 2, issue 2, pp. 167-173, 2024
Received: July 1, 2024
Revised: October 2, 2024
Accepted: October 3, 2024
https://doi.org/10.62497/IRABCS.2024.57

Implementation of the Focused Assessment with Sonography for Trauma (FAST) Scan as a Diagnostic Adjunct in the Training for Medicine, Surgery and Anesthesia Residents

Dr. Aiman Balouch [1*], Dr. Tanzeel Omer [2,3], Dr. Usama Ali [4*] and Dr. Ambreen Farooq [5,6,7]

1. *MBBS, Khyber Medical University- Institute of Medical Science Kohat , KPK , Pakistan*
2. *MBBS, Rawalpindi Medical University, Punjab, Pakistan*
3. *FCPS Diagnostic Radiology, Armed Forces institute of Radiological Imaging (AFIRI), EDiR, Rawalpindi, Pakistan*
4. *Final Year MBBS, Pak International Medical College, Peshawar, Pakistan*
5. *MBBS, Foundation University Medical College (FUMC), Islamabad, Pakistan*
6. *FCPS Diagnostic Radiology, Pakistan Institute of Medical Sciences Islamabad (PIMS), Pakistan*
7. *FRCR 1, Royal College of Radiologists, London, Unided Kingdom*
8. *E-mail any correspondence to: aimanbaloch279@gmail.com; Ua54120@gmail.com*

How to cite: Aiman Balouch, Tanzeel Omer, Usama Ali, Ambreen Farooq. Implementation of the Focused Assessment with Sonography for Trauma (FAST) Scan as a Diagnostic Adjunct in the Training for Medicine, Surgery and Anesthesia Residents. IRABCS. 2024. vol. 2, issue 2, pp. 167-173. DOI: https://doi.org/10.62497/IRABCS.2024.57

Abstract

Introduction: Hemorrhages, often caused by blunt trauma, are a leading cause of death in individuals under 45. The FAST (Focused Assessment with Sonography for Trauma) scan is a noninvasive, ultrasound-based method that improves diagnostic accuracy for distinguishing intraperitoneal free fluid (IPFF) from other causes of acute abdominal pain. This study aimed to assess the current attitudes of postgraduate trainees toward FAST scanning and to provide targeted training for trainees in anesthesia, medicine, and surgery to enhance their emergency response skills.

Methodology: The study, conducted at Bahria International Hospital, Rawalpindi, from May 1 to May 30, 2023, included 14 postgraduate trainees—6 from medicine, 6 from anesthesia, and 2 from general surgery—who had no prior training in FAST scanning. Those with previous training were excluded. In the first phase, participants completed a 12-question survey assessing their baseline knowledge. They then underwent practical training supervised by radiologists. A post-training survey with nine questions measured their confidence levels using an eleven-point Likert scale.

Results: Before training, participants showed limited knowledge and confidence in FAST scanning, with significant gaps in probe usage and image optimization. The majority of participants correctly identified the number of quadrants to be scanned, and most were unfamiliar with the appropriate probe. After training, confidence significantly improved, especially in probe selection, orientation, and image adjustment. However, visualizing the left upper quadrant remained a challenge. The results were statistically significant, with participants' confidence in performing emergency scans increasing to high or moderate levels.

Conclusion: This study shows that structured FAST scan training markedly raises trainee confidence and abilities in using emergency ultrasound. Formal training programs that are routine have to be part of medical residency to reinforce the skills important for diagnosis in trauma care.

Keywords: Focused Assessment with Sonography in Trauma (FAST), training, clinical audit

Introduction

Death from traumatic injury is the primary cause of death for people under 45 years old [1]. Eighty percent of traumatic injuries are blunt, and hypovolemic shock accounts for the majority of fatalities [2]. The ideal test for traumatic damage assessment should be quick, precise, and noninvasive. When a trauma patient presents to the emergency department, a point-of-care ultrasound (POCUS) examination, known as a Focused Assessment with Sonography for Trauma (FAST) scan, is conducted. To facilitate quick decision-making, it is usually carried out by a qualified clinician. One may consider it an "extension" of the primary trauma. Some

studies suggest there is no appreciable difference between radiologists and non-radiologists regarding diagnostic accuracy [3].

For the detection of intraperitoneal free fluid, FAST scanning has shown a claimed sensitivity of around 90% (range 75-100%) and specificity of almost 95% (range 88-100%) [4]. The primary goal of the investigation is to ascertain intraperitoneal free fluid, frequently thought to be hemoperitoneum, in trauma patients. These findings allow prompt triage and quick transport to an operating room, CT scan, or other suitable location. Solid organ damage is uncommon and may require further investigation when it happens. In several recent studies, thoracic ultrasonography performed better at identifying pneumothorax following physical damage than supine chest x-rays, with sensitivity and specificity of 86-98% and 97-100%, respectively [5]. When diagnosing intra-abdominal injuries, CT scans remain the gold standard since they may detect minimal intraperitoneal fluid (100 cc). Nevertheless, the assessment of hemodynamically unstable patients is complicated by transportation issues and delays outside of the emergency room. This study aimed to assess the current attitudes of postgraduate trainees toward FAST scanning and to provide targeted training for trainees in anesthesia, medicine, and surgery to enhance their emergency response skills.

Materials and methods

This clinical audit was conducted at Bahria International Hospital from May 1 to May 30, 2023, with the aim of enhancing participants' skills in rapid scanning techniques through a structured training model. Fourteen trainees participated, including six from general medicine, two from general surgery, and six from anesthesia. None of the trainees had prior experience with FAST (Focused Assessment with Sonography for Trauma) scans. Prior to the study, ethical approval was obtained, and informed consent was secured from all participants.

The training program began with a pre-seminar questionnaire, designed to assess the trainees' baseline knowledge. The questionnaire, created and validated by a radiologist, included a combination of open-ended and closed-ended questions, along with an eleven-point Likert scale. This scale was used to enhance the sensitivity of the responses, as it provides more nuanced feedback compared to traditional scales. The initial results indicated insufficient knowledge of appropriate imaging techniques, depth settings, and necessary adjustments.

To address these gaps, information materials were distributed to encourage self-directed learning. This was followed by a comprehensive one-day live presentation for all participants. Over the next three days, three different radiologists led hands-on collaborative sessions, organized in groups of five to ensure personalized attention and ample time for practice. During these sessions, trainees practiced performing FAST scans on each other, with the radiologists providing demonstrations and guidance on how to adjust gain and depth settings, as well as how to locate and analyze specific quadrants in the imaging field.

Each trainee had between two and five minutes of individual practice while the demonstrations were ongoing. After the seminar, a performance evaluation was conducted to gather feedback on participants' experiences and challenges during the training. The results showed that while the trainees became proficient in adjusting gain and depth settings, they encountered difficulty visualizing specific anatomical regions on the scans. To address this, the program emphasized the importance of additional practice, particularly through emergency case simulations, to better prepare trainees for real-world scenarios.

During the training exercise, each trainee performed two FAST scans, alternating roles as the subject. The first scan was guided, and the second was completed independently. Trainees successfully identified all five key regions: the Morrison pouch in the right upper quadrant, the pericardium, splenorenal, and perisplenic spaces, the para-colic gutter in the left upper quadrant, the suprapubic area for free fluid collection, and the anterior thoracic section for pneumothorax. The average time for the first scan was five minutes, while the second scan took an average of six minutes.

Following the practical training, trainees completed a second questionnaire using the eleven-point Likert scale to assess their confidence in performing FAST scans (Table 1). Confidence levels were rated from zero (low confidence) to ten (high confidence), with scores between zero and four representing low confidence, scores between five and seven representing moderate confidence, and scores between eight and ten indicating high confidence. The results of this evaluation suggest that the structured methodology effectively enhanced the trainees' skills and confidence in performing FAST scans, preparing them for clinical practice.

Table 1: Pre-seminar and Post seminar questionnaire

Pre-seminar questionnaire	Post seminar questionnaire
1-How familiar are you with the FAST scan skill in general?	1- Are you at ease choosing the appropriate probe for a quick scan?
2-What are the advantages of conducting a FAST scan?	2-Are you able to accurately detect the probe's orientation?
3-What are the absolute indications for a FAST scan?	3-Are you comfortable modifying gain and depth to achieve the best possible image quality?
4-What are the absolute contraindications for a FAST	4-How confident are you in visualizing the right upper

scan?	quadrant?
5-What is the correct patient position for a FAST scan?	5-How confident are you in visualizing the pericardium?
6-Are you Familiar with the probe utilized for a FAST scan?	6-How confident are you in visualizing the left upper quadrant?
7-Are you at ease using the right probe for a FAST scan?	7-How confident are you in visualizing the supra-pubic view?
8-To improve the quality of the picture, are you at ease modifying the gain and depth?	8-How do you feel about visualizing the anterior thoracic area?
9-What can you observe on a FAST scan?	9-How comfortable would you feel doing a FAST scan on a patient who has suffered trauma?
10-How comfortable are you doing a FAST scan on a patient who has had trauma?	10-To what extent would you feel comfortable utilizing the data of your FAST scan to make clinical decisions?

The significance of the changes in confidence levels before and after training was assessed using a simple t-test. Utilizing SPSS software version 27, the data were examined, with a significance threshold of $p < 0.05$.

Informed consent

Informed consent has been obtained from all individuals included in this study.

Ethical approval

The research related to human use has been complied with all relevant national regulations, institutional policies and in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

Results

Regarding sex, 35% (n=5) of participants were men, and 65% (n=9) were women. On average, participants were 27.71 years old. All participants were postgraduate trainees (PGT), with 35.7% (n=5) in PGT Anesthesia, 57.1% (n=8) in PGT Internal Medicine, and 7.1% (n=1) in General Surgery.

Before the training, most participants exhibited low confidence in performing a FAST scan. Specifically, 12 out of 14 participants expressed uncertainty regarding selecting the appropriate probe, and 9 lacked confidence in determining the correct probe orientation. Furthermore, 8 participants were uncomfortable adjusting the gain and depth for optimal image quality, and 11 reported low confidence in performing a FAST scan on trauma patients.

Post-training assessments demonstrated significant improvements: 93% of participants reported high confidence in both selecting the correct probe and determining its orientation. This is a substantial improvement from the pre-training phase, where only 14% expressed such confidence. Confidence in adjusting image quality also improved, with 79% of participants expressing high confidence in this area. Additionally, confidence in performing a FAST scan on trauma patients increased, with 57% of participants achieving high confidence and 43% reporting moderate confidence. These results indicate that the targeted training effectively enhanced participants' skills and confidence in conducting FAST scans (see Table 2).

Table 2: Pre- and Post-Seminar Confidence Level in FAST Scan Skill.

Questions	Pre-seminar response			Post-seminar response		
	Confidence interval (n)			Confidence interval (n)		
	Low	Moderate	High	Low	Moderate	High
How confident are you in choosing the correct probe for a FAST scan?	12	2	0	0	1	13
Do you feel you can choose the correct orientation of the probe?	9	4	1	1	0	13
Do you feel comfortable adjusting the gain and depth to maximize the picture Quality?	8	4	2	0	3	11
How confident would you feel performing a FAST scan on a trauma patient?	11	2	1	0	6	8

Table 3 shows that the post-training questionnaire on what participants felt confident in showed that participants were less confident in visualizing the target areas of the body during the scan when using the FAST. 13 out of the 14 participants reported high confidence with visualizing the right upper quadrant, and 8 reported moderate confidence with visualizing the left upper quadrant while 6 reported high confidence. When generalizing the experience of using the ultrasound, high confidence was established in the application of ultrasound in pericardium and supra-pubic regions, where twelve participants were highly confident. However, the anterior thoracic region was hard to describe; only 10 participants had high confidence in the anterior thoracic site identification, while 3 had moderate confidence and 1 had low confidence. For clinical decision-making with regard to FAST scan results, 7 participants said they were highly confident, while 7 participants expressed moderate confidence level.

Table 3: Confidence Level of Participants in visualizing Anatomical Areas

Questions	Confidence Intervals (n)		
	Low	Moderate	High
How do you feel visualizing the right upper quadrant?	0	3	11
How do you feel visualizing the left upper quadrant?	0	8	6
How do you feel visualizing the pericardium?	0	2	12
How do you feel visualizing the supra-pubic view?	0	2	12
How do you feel visualizing the anterior thoracic?	1	3	10
How confident would you feel making clinical decisions based on the results of your FAST scan?	0	7	7

Statistical evaluation using paired t-assessments discovered a considerable development in members' understanding and self-belief tiers following the schooling. The p-values for all assessed areas had been much less than 0.05, indicating statistically sizable changes. This included a marked development within the typical information of the FAST scan (p=0.000), extended confidence in deciding on the perfect probe (p=0.000) and determining its orientation (p=0.000), in addition to more proficiency in adjusting benefit and depth to optimize picture high-quality (p=0.000). Furthermore, individuals validated a considerable confidence boost in performing FAST scans on trauma sufferers (p=0.000) and in visualizing critical regions, such as the proper higher quadrant (p=0.000; see Table 4).

Table 4: Confidence and Competency in Performing FAST Scan

Questions	Mean	df	P-value	Mean Difference	95% Confidence Interval	
					Lower	Upper
How well do you know FAST scan in general?	7.848	13	.000	1.214	.88	1.5
How confident you are choosing the correct probe for a FAST scan?	11.776	13	.000	1.143	.93	1.3
Do you feel you can choose the correct orientation of the probe?	8.272	13	.000	1.429	1.06	1.8
Do you feel comfortable adjusting the gain and depth to maximise the picture quality?	7.778	13	.000	1.571	1.13	2.0
How confident would you feel performing a FAST scan on a trauma patient?	7.870	13	.000	1.286	.93	1.6
Do you feel comfortable choosing the correct probe for a FAST scan?	41.000	13	.000	2.929	2.77	3.0
Do you feel you can choose correct orientation of the probe?	20.000	13	.000	2.857	2.55	3.1
How do you feel visualizing the right upper quadrant?	24.478	13	.000	2.786	2.54	3.0

The t-tests established a statistically considerable development in individuals' self assurance and capabilities across all evaluated areas following the schooling. Confidence in adjusting advantage and depth to optimize image greatly confirmed a huge increase (p=0.000). Notable improvements have been additionally found inside the ability to visualize critical regions, including the anterior thoracic place (p=0.000). Furthermore, members' confidence in appearing FAST scans on trauma sufferers (p=0.000) and making medical choices primarily based on their findings (p=0.000) showed big enhancement (see Table 5).

Table 5: Statistical Summary of Trainee Confidence and Comfort in FAST Scan Techniques; Confidence in Visualizing Key Areas and Performing FAST Scans

Question	t	df	P-value	Mean Difference	95% CI
Do you feel comfortable adjusting the gain and depth to maximize picture quality?	24.478	13	0	2.786	Lower: 2.54, Upper: 3.0
How do you feel visualizing the pericardium?	29.439	13	0	2.857	Lower: 2.65, Upper: 3.0
How do you feel visualizing the left upper	17.694	13	0	2.429	Lower: 2.13, Upper: 2.7

quadrant?					
How do you feel visualizing the supra-pubic view?	29.439	13	0	2.857	Lower: 2.65, Upper: 3.0
How do you feel visualizing the anterior thoracic?	15.614	13	0	2.643	Lower: 2.28, Upper: 3.0
How confident would you feel doing a FAST scan on trauma patients?	18.735	13	0	2.571	Lower: 2.27, Upper: 2.8
How confident would you feel making clinical decisions based on the results of your FAST scan?	18.028	13	0	2.5	Lower: 2.20, Upper: 2.8

Discussion

The findings of this study show the effects of structured training sessions on the postgraduate trainees' and their performance on the FAST scan. As expected, trainees lacked knowledge on various aspects of FAST scan, such as probe selection, image quality, and quadrant visualization before training. After their post-training assessments, it was found that there were significant gains in all aspects of their performance, especially in the efficient handling of probes and competency of images. The increase in confidence level from low to moderate to high validates on-site, specific training in applying the knowledge acquired in using emergency ultrasound techniques in practice.

Teaching in groups is one of the most effective strategies used in the teaching fraternity, especially regarding skill-related areas of learning [6]. Such sessions afford an organized and relevant setting where learners can confront the instructor, clear all their doubts, and get precise feedback [7]. Conversely, a study by Kyoung found that small group training sessions, as used in this study, improved the ultrasound skills of surgical residents, which is emphasized by the results obtained in this study. This personalized approach likely contributed to the sharp increase in trainee confidence observed in this study. Another study demonstrated that a structured ultrasound training program significantly improved surgical residents' proficiency and confidence level. Post-course assessments showed notable gains in ultrasound skills across all postgraduate students. These findings highlighted the importance of standardized ultrasound training to enhance competency in managing critically ill patients [8]. David and his colleagues found that a simulator-based curriculum significantly improved medical students' cardiac ultrasound (FOCUS) skills, with reduced angle errors post-training. The individual-paced learning approach proved effective with facilitator oversight, highlighting the value of simulator-based education [9].

FAST scanning has become a cornerstone in trauma care, serving as a rapid and non-invasive tool for detecting life-threatening injuries (10-12), such as hemoperitoneum, pneumothorax, and pericardial effusion. Fast is most valuable during the circulation phase, where the clinician's immediate priority is to identify any ongoing bleeding or cardiac tamponade (13). The ability to detect free fluid in pericardial space, pleural cavities, and peritoneal cavities enables clinicians to make time-sensitive decisions, such as determining the need for surgical interventions or further imaging. The ability to detect free fluid in the pericardial space, pleural cavities, and peritoneal cavity enables clinicians to make time-sensitive decisions [14, 15], such as determining the need for surgical intervention or further imaging.

Given its utility in trauma management, the importance of FAST scanning cannot be overstated; it provides a bedside evaluation that can be performed within minutes of the patient's arrival, giving the clinicians vital information without the delays associated with transporting the patients to radiology. This is particularly crucial in unstable patients where immediate decisions are needed. Several studies have shown that detecting trauma-related pathologies [16-19] further cements its role as an essential tool in emergency care.

The training classes designed for this look, with its focus handy on practice, mirrors the real-world programs of FAST in emergency settings; by incorporating direct exercise beneath the supervision of radiologists, trainees had been able to gain sensible revel in a managed putting, which possibly contributed to their marked growth in self-belief and competence. This method of training is essential in getting ready trainees for instant-paced, high-pressure surroundings of emergency medication, in which the potential to perform FAST scan accurately and effectively can, without delay, impact patient consequences.

Continued training and talent development are vital to maintaining talent in FAST scanning. The outcomes of this take a look at underscore the need for ongoing training, inclusive of periodic refresher routes and clinical audits to ensure that trainees maintain the abilities they have acquired. Moreover, incorporating FAST scanning into a simulator primarily based on trauma eventualities to practice under conditions that mimic real-life emergencies reinforces both their technical competencies and selection-making capabilities [20]. E-learning modules incorporating interactive case studies and quizzes can complement hands-on practice reinforcing key concepts and decision-making pathways. Peer-led training, where advanced trainees mentor junior colleagues, is another method that can promote continuous learning while fostering a collaborative learning environment. Ultimately, a multifaceted approach that combines hands-on- practice, simulation, and peer teaching can provide a comprehensive framework for skill development in FAST scanning.

Limitation and recommendations

The limited generalizability of our results can be attributed to the small sample size (n=14) and the exclusion of trainees with prior experience with FAST scans. Additionally, the brief duration of the training program

may not accurately reflect the long-term retention of skills, suggesting the need for further research. Future studies should explore the long-term retention of FAST scan techniques and the potential of simulation-based training to address challenges, such as difficulties in visualizing the left upper quadrant. Expanding the sample size and incorporating multi-center participation could enhance the external validity of the findings. The feedback gathered from this study offers valuable insights for improving skills and fostering continuous development. To further enhance FAST scan proficiency, we recommend: implementing the Observe-Describe-Interpret method, practicing FAST scans on non-trauma patients, conducting a follow-up scan after 10 minutes if no free fluid is detected to avoid confusing free fluid with blood, and avoiding labeling a scan as negative if no free fluid is observed.

Conclusion

This study shows that FAST scan training should be a regular part of medical residency programs since it significantly improves trainee confidence and skills. It would not only helps residents excelling their careers but be of great help in immediate help in urgent care needed for patients. Formalized training methods should be devised to guarantee that all trainees, regardless of specialty, are competent in using this vital diagnostic tool.

Conflict of interest

The authors state no conflict of interest.

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Aiman Balouch
Acquisition, analysis, or interpretation of data: Usama Ali
Drafting of the manuscript: Aiman Balouch, Usama Ali, Tanzel Umer, Ambreen Farooq
Critical review of the manuscript for important intellectual content: Aiman Balouch, Usama Ali

References

1. Melniker LA, Leibner E, McKenney MG, Lopez P, Briggs WM, Mancuso CA. Randomized controlled clinical trial of point-of-care, limited ultrasonography for trauma in the emergency department: the first sonography outcomes assessment program trial. Annals of emergency medicine. 2006;48(3):227-35. https://doi.org/10.1016/j.annemergmed.2006.01.008

2. Teixeira PG, Inaba K, Hadjizacharia P, Brown C, Salim A, Rhee P, et al. Preventable or potentially preventable mortality at a mature trauma center. Journal of Trauma and Acute Care Surgery. 2007;63(6):1338-47. https://doi.org/10.1097/TA.0b013e31815078ae

3. Bhoi S, Sinha TP, Ramchandani R, Kurrey L, Galwankar S. To determine the accuracy of focused assessment with sonography for trauma done by nonradiologists and its comparative analysis with radiologists in emergency department of a level 1 trauma center of India. Journal of Emergencies, Trauma, and Shock. 2013;6(1):42-6. https://doi.org/10.4103/0974-2700.106324

4. Brenchley J, Walker A, Sloan JP, Hassan TB, Venables H. Evaluation of focused assessment with sonography in trauma (FAST) by UK emergency physicians. Emergency Medicine Journal. 2006;23(6):446-8. https://doi.org/10.1136/emj.2005.026864

5. Wilkerson RG, Stone MB. Sensitivity of bedside ultrasound and supine anteroposterior chest radiographs for the identification of pneumothorax after blunt trauma. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine. 2010;17 1:11-7. https://doi.org/10.1111/j.1553-2712.2009.00628.x

6. Haugland MJ, Rosenberg I, Aasekjær K. Collaborative learning in small groups in an online course–a case study. BMC Medical Education. 2022;22(1):165. https://doi.org/10.1186/s12909-022-03232-x

7. Gay GH, Betts K. From Discussion Forums to eMeetings: Integrating High Touch Strategies to Increase Student Engagement, Academic Performance, and Retention in Large Online Courses. Online Learning. 2020;24(1):92-117. https://doi.org/10.24059/olj.v24i1.1984

8. Im KM, Kim EY. Focused Bedside Ultrasound Training Program for Surgical Residents in the Intensive Care Unit of Tertiary hospital. Indian Journal of Surgery. 2022;84(Suppl 1):246-58. https://doi.org/10.1007/s12262-022-03305-7

9. Elison DM, McConnaughey S, Freeman RV, Sheehan FH. Focused cardiac ultrasound training in medical students: Using an independent, simulator-based curriculum to objectively measure skill acquisition and learning curve. Echocardiography. 2020;37(4):491-6. https://doi.org/10.1111/echo.14641.

10. Patlas MN, Katz DS, Odedra D. Emergency and trauma imaging: General principles, modalities, challenges, and opportunities. Atlas of Emergency Imaging from Head-to-Toe. 2021:1-7. https://doi.org/10.1007/978-3-030-44092-3_1-2

11. Planquart F, Marcaggi E, Blondonnet R, Clovet O, Bobbia X, Boussat B, et al. Appropriateness of initial course of action in the management of blunt trauma based on a diagnostic workup including an extended ultrasonography scan. JAMA Network Open. 2022;5(12):e2245432-e. https://doi.org/10.1001/jamanetworkopen.2022.45432

12. Galvez C, Arenas-Jimenez J, Del Campo J, Maroto S, Sirera M, Lirio F. Diagnostic imaging pathways in the setting of acute chest wall trauma. Journal of

Visualized Surgery. 2020;6. https://doi.org/10.21037/jovs.2019.11.08

13. Dubina ED, Emigh B, Grigorian A, Inaba K. Critical decision points in the management of acute trauma: a practical review. International Anesthesiology Clinics. 2021;59(2):1-9. https://doi.org/10.1097/AIA.0000000000000317.

14. Haase D, Patel R. Ultrasound for Shock Evaluation, Resuscitation, and Critical Care Procedures. Emergency Department Critical Care. 2020:637-86. https://doi.org/10.1007/978-3-030-28794-8_37

15. Paul JA, Panzer OP. Point-of-care ultrasound in cardiac arrest. Anesthesiology. 2021;135(3):508-19. https://doi.org/10.1097/ALN.0000000000003811.

16. Arnold MJ, Jonas CE, Carter RE. Point-of-care ultrasonography. American family physician. 2020;101(5):275-85. https://doi.org/10.3122/jabfm.2021.04.200452

17. Omraninava1 M, Besheli AA, Mohammadi I. Evaluation of Focused Assessment with Sonography in Trauma (FAST) to Detect Non-penetrating Abdominal Trauma. https://doi.org/10.4103/jmu.jmu_12_23.

18. Gamberini L, Scquizzato T, Tartaglione M, Chiarini V, Mazzoli CA, Allegri D, et al. Diagnostic accuracy for hemoperitoneum, influence on prehospital times and time-to-definitive treatment of prehospital FAST: A systematic review and individual participant data meta-analysis. Injury. 2023;54(6):1421-31. https://doi.org/10.1016/j.injury.2023.03.024

19. Goodarzi H, Timarchi AN, Raeeszadeh M, Mahmoodi S, Javadzadeh HR, Heydari S. Evaluation of the accuracy of E-FAST ultrasound in blunt trauma patients referred to the Emergency Department. Romanian Journal of Military Medicine. 2021;124(3):384-7. https://doi.org/10.55453/rjmm.2021.124.3.17

20. Lateef F, Suppiah M, Chandra S, Yi TX, Darmawan W, Peckler B, et al. Simulation centers and simulation-based education during the time of COVID 19: A multi-center best practice position paper by the world academic council of emergency medicine. Journal of emergencies, trauma, and shock. 2021;14(1):3-13. https://doi.org/10.4103/JETS.JETS_185_20