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Simulation-based clinical learning for final year medical students about Focused Assessment Sonography for Trauma

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Abstract

Background/Aim: Point-of-care ultrasound is a focused exam. It is a method that can be easily repeated by clinicians, especially as it aims for answering specific questions. The current study aimed to evaluate how successfully the students could learn Focused Assessment with Sonography for Trauma (FAST) and the permanence of the education after the simulation-based training.

Methods: This study was conducted with final year medical students in Acibadem Mehmet Ali Aydinlar University Hospital Emergency Department and Acibadem University Center of Advanced Simulation and Education. The FAST course was taught by emergency physician specialists. After 2 h of theoretical training, a 3-h hands-on small group practical session was held face-to-face in which the students performed FAST scans with a CAE Vimedix high-fidelity simulator. After ultrasound training, the participants were separated into three groups of 20 each. One group was considered a control group in which they did not perform FAST on any real patient during the emergency medicine rotation (Group A). Group B performed FAST on 20 real patients, and Group C performed the technique on 40 real patients in the emergency department. A re-evaluation exam was done six months later.

Results: This study included 60 participants. At the end of the first evaluation, the mean scores of Groups A (Control Group), B, and C were 6.05 (1.72), 6.05 (1.27), and 5.55 (13.2), respectively. The second evaluation results were 2.51 (0.51) with $P < 0.001$) and 8.84 (0.73) with a $P < 0.001$, and 9.71 (0.27) with $P < 0.001$, respectively.

Conclusion: The long-term memory retention of the training presented in the simulation alone may be controversial. In our study, the take-home point is that for 2 h of theoretical lectures and 3 h of simulation training to be permanently retained, practicing the technique with at least 20 patients is needed.

Keywords: Simulation, FAST, Education, Bedside ultrasound, Emergency medicine

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All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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No conflict of interest was declared by the authors.

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Introduction

Healthcare providers still use the same old instruments for physical examination. An ophthalmoscope, otoscope, and stethoscope are components of the traditional physician's black bag. Educators and students are increasingly using visual systems, simulation, tridimensional (3D) images, and schematic patterns which are all based on computer processing. Ultrasound is becoming increasingly popular in medicine for a variety of reasons: (1) it does not emit potentially harmful ionizing radiation, (2) it is inexpensive and portable, (3) tests can be easily repeated, and (4) it provides speedy answers to clinically significant problems [1]. A bedside ultrasound is a focused exam that can be performed at a patient's bedside by the clinician caring for the patient to answer specific questions. This method is now standard practice for screening of abdominal aortic aneurysms, vascular access, critical care, rheumatology, and emergency cardiac function testing [2].

Focused Abdominal Sonography for Trauma (FAST) scanning has been adopted by emergency physicians to evaluate the presence of free fluid in the abdomen, pelvis, or pericardium with the aim of guiding further assessment using computed tomography or to speed surgical investigation. The evaluation for the detection of free intraperitoneal fluid has been shown to be both sensitive and specific [3]. Physicians practicing emergency medical services have been using FAST in many facilities worldwide for those reasons. FAST produced an increase in diagnostic accuracy, a drop in trauma mortality, a shorter time to surgery, and a reduction in hospital stay and expenditures. To obtain the necessary proficiency, the traditional training model requires significant practice on patients. Training novices in FAST during the acute resuscitation phase of a critically sick patient with trauma may not be acceptable or possible. Medical picture simulation is a growing topic of study that allows researchers to artificially replicate clinical scenarios with crucial and/or aberrant events in a safe environment [4]. According to consensus guidelines, such simulators should be validated before clinical teaching [5].

The study's major aim was to assess medical students' capacities to incorporate themselves into the practical teaching of fundamental components of clinical ultrasonography using simulation in addition to assessing their effectiveness and whether memory of these techniques was retained six months later.

Materials and methods

This study was designed prospectively at Acibadem Mehmet Ali Aydinlar (MAA) University Hospital Emergency Department and Acibadem MAA University Center of Advanced Simulation and Education (CASE). Approval for the study was obtained from the Acibadem University and Acibadem Healthcare Institutions Medical Research Ethics Committee (ATADEK; Approval number: 2015-6/12 and Approval date: 05/05/2015). When the post-hoc power analysis with 57 participants was performed using the G*power software 3.1.9.7 version, it was found that the power = 0.75, the effect size (odds ratio [OR]) = 0.4, and alpha error = 0.05. Sixty participants were included in the study, and written informed consent was obtained from 60 medical students at Acibadem University. The inclusion criteria for the study included several parameters: (1) final year medical student (FYMS), (2) never having taken any seminars/courses/training modules on ultrasonography, and (3) also fulfilling the same criteria after six months for the second evaluation in terms of no other training other than the one on their emergency medicine (EM) rotation. Potential participants were informed that they would be excluded if they underwent any educational experience concerning ultrasonography. Informed consent was obtained. Potential participants who did not meet these criteria were excluded from the study.

A pilot course was designed to teach FAST scanning to final year medical students in the Simulation laboratory at the start of the EM rotation. All participants had no prior experience with FAST. The course consisted of seminars on introductory ultrasound physics and the principles of FAST scanning in addition to the role of ultrasound in surgical decision-making. The course was taught over a period of 2 h by EM specialists qualified for ultrasound and simulation training. Teaching methods included a formal seminar, practical demonstrations, and problem-solving exercises using a constructivist, learner-centered approach. These activities were followed by a 3-h hands-on small group practical sessions face-to-face for which students performed FAST scans with CAE Vimedix high-fidelity simulator. The students calibrate the probe according to its position on the mannequin on the monitor, and as he/she moves the probe, the ultrasound image obtained from a real patient on the monitor moves correlated with the hand movements of the student. In this way, the students tried to catch the site to be visualized by moving the probe to the desired direction and free fluid.

A complete FAST scan was defined as an assessment of the splenorenal recess, hepatorenal recess (Morrison's pouch), 4-chamber view of the heart and pericardium, in addition to a transverse and longitudinal view of the bladder and pelvis. At first, normal findings were taught followed by the method for searching for free fluid in these areas was taught. At the end of the training, the course concluded with a one-on-one FAST performed on 10 cases by each student. The program included 10 FAST cases consisting of a wide range of issues ranging from those with no free fluid to those with a large amount of fluid. When the participant performed FAST on different cases, two emergency physicians evaluated them. Both emergency physicians were blinded to each other's evaluation. The evaluation rubric was influenced by a study by Shaukat et al. [6] (Table 1). Based on the rubric, participants who scored 5 or higher were classified as adequate, and those who scored 4 or lower were classified as inadequate. In each question, the average of two raters was taken. Each of the essential assessment views involved in the FAST examination, and their interpretation is described in Table 1. For each case, five evaluation items were found, and for each evaluation item, points (such as 0, 1, and 2) were assigned.

The participants were separated into three groups after FAST training in the CASE and after that the first evaluation was done. After the first assessment, participants began their emergency rotation of seven weeks in emergency service. Participants in Group A (Control Group) never performed FAST on any patients in their EM rotation, Group B performed FAST on 20 patients during their EM rotation, and Group C performed FAST on at least 40 patients. During the EM rotation, the students used ACUSON X150 Ultrasound System to perform FAST on real patients. Six months after the first evaluation, participants were invited to the simulation unit. The same exam (10 cases) was used each time. The flow chart is provided in Figure 1. Two independent emergency physicians re-evaluated them. After the second evaluation, 40 students who were in Groups B and C were asked to give points to with respect to comparing FAST on a simulator versus the real patient for all the regions separately: (1) suprarenal recess, (2) subxiphoid approach, (3) hepatorenal recess, and (4) pelvic approach. They assigned points based on a 5-point Likert scale to the ultrasound experience on the simulated patient versus the real patient under four topics.

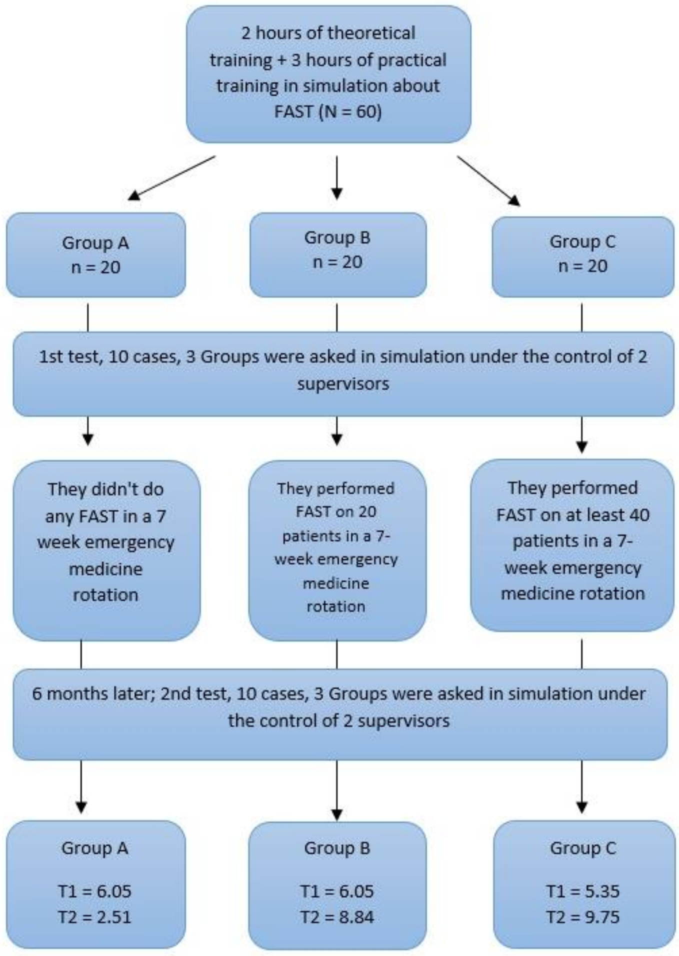
Students were blinded to both the correct answers and their previous scores. However, asking the same questions in the first and second evaluation could develop a bias in terms of the participants' ability to remember the cases. However, this method underwent standardization. Between the two evaluation processes, the participants were not followed closely on whether they were trained again (or not) about FAST. Therefore, prior to the second evaluation, consent was obtained from all the participants indicating that they had not received any other ultrasound training.

Table 1: Assessment and scoring Checklist for Performance of Focused Assessment with Sonography for Trauma (FAST) Examination

	0 Point (Fail)	1 Point (Sufficient)	2 Point (Sufficient)
1- Overall FAST rating, contrast, brightness, focus adjustment. placement of the transducer in the appropriate anatomical location, transducer angles	Transducer misplacement, inappropriate anatomical image, missing 1 or more of the 4 areas to be viewed. inability to detect pathology or detect pathology in a healthy place.	Detecting pathology but needs guidance to obtain better images.	Detailed view of the region and obtaining a quality image. being able to clearly indicate whether there is free fluid or not.
2- Hepatorenal recess or Morison's pouch (RUQ)	Transducer misplacement, inability to detect pathology or detect pathology in a healthy place.	Detecting pathology, but needs guidance to obtain better images.	Detailed view of the region and obtaining a quality image. Being able to clearly indicate whether there is free fluid or not.
3- Splenorenal or perisplenic view (LUQ)	Transducer misplacement, cannot detect pathology or detect pathology in a healthy place.	Detecting pathology but needs guidance to obtain better images.	Detailed view of the region and obtaining a quality image. Being able to clearly indicate whether there is free fluid or not.
4- Pelvic view	Transducer misplacement, inability to detect pathology or detect pathology in a healthy place.	Detecting pathology but needs guidance to obtain better images.	Detailed view of the region and obtaining a quality image. Being able to clearly indicate whether there is free fluid or not.
5- Pericardial or subxiphoid view	Transducer misplacement, inability to detect pathology or detect pathology in a healthy place.	Detecting pathology but needs guidance to obtain better images.	Detailed view of the region and obtaining a quality image. Being able to clearly indicate whether there is free fluid or not.

For each question, students can get a minimum of 0 and a maximum of 10 points. Successful for Focused Assessment with Sonography for Trauma (FAST) 5 points and above

Figure 1: Flowchart of the study



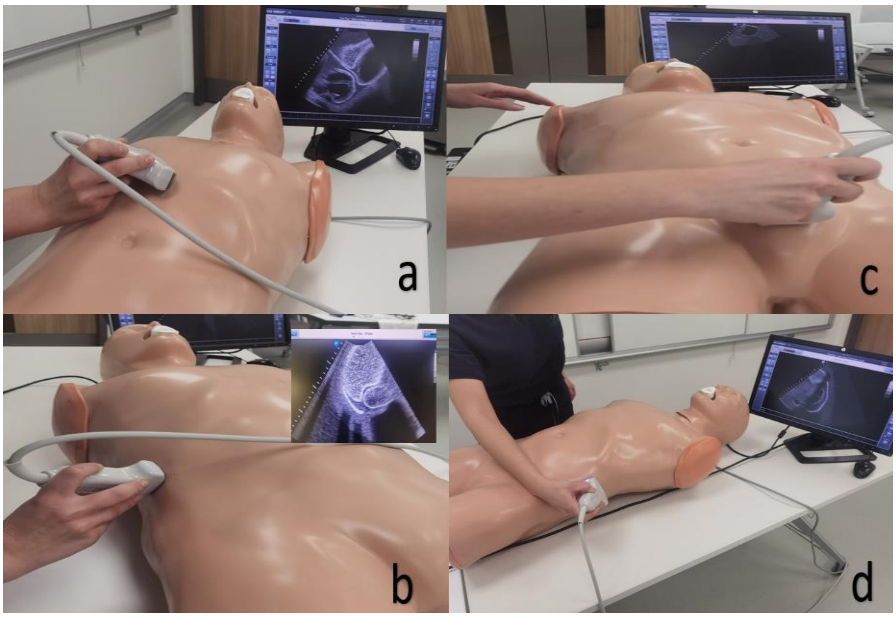
T1: 1st exam average score, T2: 2nd exam average score
FAST: Focused assessment with sonography in trauma

The workshop was conducted using the CAE Vimedix high-fidelity simulator. An integrated ultrasound simulator consists of a human mannequin, a probe, and a computer. The probe is directly attached to a monitor, which displays an ultrasound image based on the position and movements of the probe. The position of the probe in this simulator is defined by electromagnetic tracking technologies. A 3D sensor, capable of capturing virtual location data in real time, is frequently included in the probe. This simulator is mostly used to teach both EM students and residents the fundamental skills of doing a FAST assessment (Figure 2).

Statistical analysis

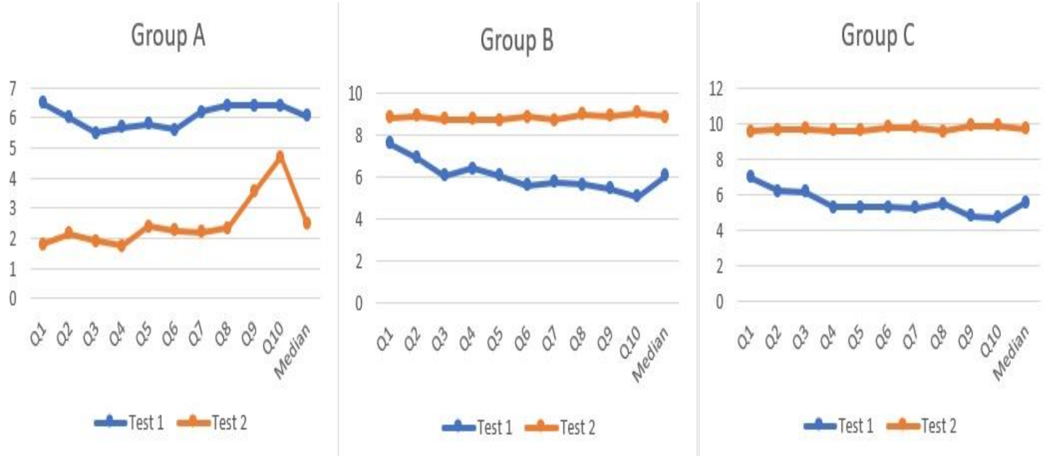
The data were collected based on descriptive statistics, such as frequency, percentage, and mean (standard deviation). The result of evaluations obtained by the attendees for the images obtained and diagnosing were compared between Group sA, B and C. Construct validity was assessed using Kruskal–Wallis test and Mann–Whitney U test as appropriate. A *P*-value of < 0.05 was accepted as statistically significant. In the comparison of categorical variables between the groups, Fisher's Exact and chi-squared tests were used. The statistical analysis was performed using IBM SPSS Statistics 22.0 (IBM, Armonk, NY, USA).

Figure 2: Student's FAST practice on simulator



a: Pericardial or subxiphoid view, b: Hepatorenal recess or Morison's pouch, c: Pelvic view, d: Splenorenal or perisplenic view

Figure 3: The differences between groups after the first and second evaluations



Q: Question; Median: Proficiency rate in the test, T1: First Evaluation; T2: Second Evaluation

Table 2: First evaluation and second evaluation in groups and distribution of points in each question and in society

	Group A			Group B			Group C		
	T1 Mean (SD)	T2 Mean (SD)	*P*-value	T1 Mean (SD)	T2 Mean (SD)	*P*-value	T1 Mean (SD)	T2 Mean (SD)	*P*-value
Q-1	6.5 (1.82)	1.85 (1.14)	< 0.001	7.6 (2.16)	8.8 (1.2)	0.055	6.95 (2.33)	9.55 (0.69)	< 0.001
Q-2	6.0 (1.86)	2.15 (1.27)	< 0.001	6.9 (1.86)	8.9 (0.85)	< 0.001	6.2 (2.33)	9.65 (0.67)	< 0.001
Q-3	5.5 (1.88)	1.9 (1.12)	< 0.001	6.05 (1.93)	8.75 (1.16)	< 0.001	6.15 (1.95)	9.7 (0.57)	< 0.001
Q-4	5.7 (1.98)	1.75 (1.21)	< 0.001	6.4 (1.76)	8.75 (1.37)	< 0.001	5.3 (1.59)	9.6 (0.5)	< 0.001
Q-5	5.8 (1.94)	2.4 (1.57)	< 0.001	6.05 (1.96)	8.7 (1.34)	< 0.001	5.3 (1.63)	9.8 (0.41)	< 0.001
Q-6	5.6 (1.96)	2.25 (1.07)	< 0.001	5.6 (1.73)	8.85 (1.27)	< 0.001	5.3 (1.53)	9.75 (0.55)	< 0.001
Q-7	6.2 (2.12)	2.2 (1.06)	< 0.001	5.75 (1.59)	8.7 (1.03)	< 0.001	5.25 (1.07)	9.8 (0.41)	< 0.001
Q-8	6.4 (2.37)	2.35 (1.04)	< 0.001	5.65 (1.6)	8.95 (0.76)	< 0.001	5.5 (1.36)	9.55 (0.76)	< 0.001
Q-9	6.4 (2.23)	3.55 (1.05)	< 0.001	5.45 (1.67)	8.9 (0.91)	< 0.001	4.8 (1.4)	9.85 (0.49)	< 0.001
Q-10	6.4 (2.16)	4.7 (1.38)	0.023	5.05 (1.79)	9.05 (0.89)	< 0.001	4.7 (1.56)	9.85 (0.37)	< 0.001
Result of evaluation	6.05 (1.72)	2.51 (0.51)	< 0.001	6.05 (1.27)	8.84 (0.73)	< 0.001	5.55 (1.32)	9.71 (0.27)	< 0.001

Wilcoxon Signed Ranks analysis, Q: Question; T1: First Evaluation; T2: Second Evaluation; SD: Standard Deviation

Results

Sixty participants were included in the study. None of the FYMS had any knowledge concerning FAST. The average age of the participants was 26 (minimum 22–maximum 29). The study group consisted of 36 female and 24 male participants. The distributions of the average scores on the first and second evaluations are provided in Table 2. In the first evaluation, all three groups were found to be adequate when performing FAST. Table 3 shows in which cases the participants scored 5 or higher on the first and the second evaluations. In the first evaluation, differences in the adequacy of the groups in all cases were not found to be statistically significant ($P = 0.1$). In the second evaluation, the difference in the adequacy of the groups in all cases were found to be statistically significant ($P < 0.001$). The distribution of the first and the second evaluation results were shown in Figure 3. According to the similarity scores given by 40 students who performed ultrasound both with simulation and on real patients, the right upper quadrant view mean value was 4.5 (90%), left upper quadrant view mean value was 4.42 (88.5%), subxiphoid view mean value was 4.72 (94.5%), and pelvic view mean value was 4.3 (86%) with respect to similarity. FAST similarity mean value was 89.75%.

Table 3: Numbers of Student qualified for FAST at first evaluation and second evaluation

	Group A		Group B		Group C		*P*-value
	n	(%)	n	(%)	n	(%)	
T1							
Q-1	17	(85)	17	(85)	16	(80)	1.000
Q-2	15	(75)	18	(90)	15	(75)	0.440
Q-3	16	(80)	13	(65)	15	(75)	0.551
Q-4	15	(75)	17	(85)	15	(75)	0.789
Q-5	16	(80)	16	(80)	14	(70)	0.797
Q-6	15	(75)	14	(70)	13	(65)	0.788
Q-7	16	(80)	15	(75)	14	(70)	0.766
Q-8	16	(80)	14	(70)	15	(75)	0.766
Q-9	17	(85)	15	(75)	11	(55)	0.100
Q-10	17	(85)	13	(65)	11	(55)	0.116
Q_T	17	(85)	15	(75)	11	(55)	0.100
T2							
Q-1	0	(0)	20	(100)	20	(100)	< 0.001
Q-2	0	(0)	20	(100)	20	(100)	< 0.001
Q-3	0	(0)	20	(100)	20	(100)	< 0.001
Q-4	0	(0)	20	(100)	20	(100)	< 0.001
Q-5	2	(10)	20	(100)	20	(100)	< 0.001
Q-6	0	(0)	20	(100)	20	(100)	< 0.001
Q-7	0	(0)	20	(100)	20	(100)	< 0.001
Q-8	1	(5)	20	(100)	20	(100)	< 0.001
Q-9	3	(15)	20	(100)	20	(100)	< 0.001
Q-10	12	(60)	20	(100)	20	(100)	< 0.001
Q_T	0	(0)	20	(100)	20	(100)	< 0.001

Pearson Chi-Squared, Fisher's Exact test, Q: Question; QT: Proficiency rate in the test, T1: First Evaluation; T2: Second Evaluation

Discussion

In light of this study, it was found that participants have a critical increment in their capacity to interpret ultrasound images and coordinate them into clinical decision-making after a brief period of simulation education. The literature reflects general enthusiasm for ultrasound simulation-based medical education with reported instances of meaningful learning [7]. This finding demonstrates that ultrasound can be integrated as a curriculum topic in medical school training and provides students with focused diagnostic skills. [8]. Some universities worldwide have ultrasonography training in their curriculum, and the number of these universities is increasing [9].

Students have reported that after performing FAST on the simulated patient, performing FAST in the emergency department on real patients was not challenging for them. Simulation training before encountering a real patient appears to have provided some level of confidence to the student. Moreover, the students were acquainted with the display that they were going to view on the ultrasound screen and the points they were going to examine. This simulation training is favorable in terms of being both time- and cost-effective. Not having the capability of simulating pathological images is a dramatic shortcoming of using human models. The use of simulators eliminates the need for human models thereby also eliminating added costs for additional ultrasound machines for training purposes. Medical imaging simulation for detecting pathological processes in an unstable patient under stressful situations is an ongoing field of study field. In abnormal situations, it allows clinical scenarios to be artificially altered in a controlled environment without any risks to patient safety or confidentiality [10]. The total view of an ultrasonography image (including artefacts, anatomical region, detecting pathological conditions) and anatomical presentation in the simulation when compared with their real counterparts may be listed as the reason why students find understanding the principles of and performing FAST on a real patient to be undemanding.

EM physicians are expected to promptly detect any intra-abdominal hemorrhages, particularly in critical trauma patients, ask for appropriate consultations, and begin immediate resuscitation thus consequently decreasing the rate of mortality and morbidity in patients. The students in this study were all found to be adequate when performing FAST in the first evaluation. In the second evaluation, which occurred six months later, the adequacy ratio of Group A (control group), which did not perform FAST on any real patients, was insufficient, whereas Group B, which performed FAST on 20 real patients throughout their EM rotation, was same as the first evaluation, and Group C, which performed FAST on at least 40 patients, was found to be above 90%. These findings are consistent with previous studies previously concerning the adequacy of medical student training in ultrasonography [11–13]. Practice appears to be the best method for a given training to be retained in the long-term. The number of practice opportunities are directly proportional to the sustainability of the given training.

Ultrasound training provided to residents differs not only between countries, but even between universities in the same country. Residents are given ultrasound training according to their specialty [14]. Ultrasound is known for its many advantages; however, the most important drawback of ultrasound is that it is highly operator-dependent. The training level and the amount of practice with ultrasound equipment determines how easily an accurate diagnosis will be obtained [15]. Certain ultrasound trainings are included in the residency programs in most countries. Having obtained basic ultrasound skills in medical school would be a beneficent skillset for performing ultrasound to a higher standard [16]. As in every aspect of medicine, a need for continuing education in EM exists. It is necessary for the assistants in the clinic to practice the training they receive in sufficient numbers. It is important to keep up-to-date [17].

The use of ultrasound has dramatically increased in gastroenterology, general surgery, and EM as the use of ultrasound has been added to the algorithms on diagnosis, screening, and follow-up stages [1]. Addition of ultrasound to the medical school curriculum may assist the students with future residency program when residents need to evaluate patients with ultrasound or when there is ultrasound training [4, 18]. In a research study carried out with third year medical students, the efficacy of an hour long extended FAST training provided during general surgery rotation was assessed, and medical students were found to be successful in performing extended FAST in the evaluation done afterwards [19]. In the current study, the first evaluation adequacy rate also was high; however, in the second evaluation, which was done six months later, the group without practice opportunities were found to be inadequate when performing FAST.

FAST trainers utilize different models for training physicians to perform FAST on trauma patients. Models, including didactic imaginary presentation, video presentation of actual patients, animal models, simulator models, cadavers, normal healthy individuals, and/or peritoneal dialysis models have been utilized in training [19]. Having said that, simulation has been increasing in popularity in the recent years. One of the major determinants of the success of simulation training is the closeness of the images on anatomical features, pathologic conditions, and artifacts. Companies have been working on obtaining more realistic images with new ultrasound simulator models. The former ultrasound stimulators used for training were problematic because the images did not resemble the original ones [10]. In addition to the image on the screen, image changes with probe manipulation should be realistic, and the image needs to mimic a real patient. In this study, students reported a likeness ratio above 89.75%.

Limitations

The number of evaluated students could be higher. This study is a single-centered study with a single simulation model. Competency in FAST long after the 6-month period is not known. All students had similar backgrounds in terms of curriculum, and even though students with no previous ultrasound training were included, it does not eliminate the fact that some students may have been more prone to performing ultrasound individually. Although the simulation model cannot replace a real patient, evaluations were done using the simulation model (another limitation).

Conclusions

The role of medical simulation in ultrasound training has been expanding nowadays. It will be highly beneficial for students to learn ultrasound training in simulation during different rotations according to the proper topics before graduating from medical school. Medical simulation has gained importance for students or residents to be educated about ultrasound in simulation before performing ultrasound scans on real patients. FAST training, which is given only in simulation, does not provide long-term retention for students. After simulation training, the number of practice sessions on real patients is important so that students do not forget the training. In our study, the take-home point is that for two hours of theoretic lecture and three hours of simulation training to be permanent, practicing with at least 20 patients is needed.

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