

ORIGINAL ARTICLE

# Validity of using still images for written competency assessments for point-of-care ultrasound among nonradiologists-pilot study

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## ABSTRACT

**Background and Objective:** Point-of-care ultrasound (POCUS) has become an integral part of the curricula of various specialty residency programs. POCUS education requires learners to be proficient in image acquisition, image interpretation, and integration into clinical practice. The assessment of POCUS skills and competency is variable. This study aimed to assess the validity and reliability of using still ultrasound images as examination test items without providing clinical vignettes or anatomical locations.

**Methods:** This is a proof-of-concept survey pilot study, residents from the Middle East who had completed their training in emergency medicine were surveyed during their competency assessment examination. They were provided with a single ultrasound image of an abdominal aortic aneurysm in both print and PowerPoint slide format. The task was to identify the diagnosis based on this image, which was taken from a reference emergency medicine textbook.

**Results:** The study showed that only 50% of the residents correctly identified the diagnoses based on the still images. Many of the incorrect answers included diagnoses that were not related to the anatomical structure that was scanned, indicating that the residents were not able to identify the anatomical locations, which highlighted the challenges of interpreting a single still image without clinical context and emphasized the need for valid and reliable test items in POCUS education and assessment.

**Conclusion:** National and international emergency medicine societies should establish standards for writing POCUS examination test items to ensure their validity and reliability.

**Keywords:** Point-of-care ultrasound (POCUS), examination test item validity, examination test item reliability, objective structured clinical examination (OSCE), examination test item.

## Introduction

In point-of-care ultrasound (POCUS) education, there are four important stages that learners should undergo to become proficient in the application of POCUS. The first stage is induction, in which learners attend a recognized lecture, use online learning or modular training, or use a combination of these three to learn about a specific ultrasound application.

During induction, learners review the background knowledge and relevant anatomy and learn the scanning technique, the methods of image interpretation, and the limitations and pitfalls of the application. The second stage is gaining experience, in which the focus is on skill acquisition in ultrasound application.

The emphasis is on three elements including the techniques of acquiring ultrasound images, the skill of interpreting the ultrasound image, and the clinical integration of the findings into clinical decision-making

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and management of the patient. This stage is achieved by attending a workshop or hands-on skill session, followed by practicing the skill under the supervision of faculty. The number of scans required to be proficient depends on the ultrasound application.

For example, studies have estimated that learners need to acquire a minimum of 25 focused assessments with sonography in trauma scans to achieve proficiency. The third stage is about achieving competence, in which learners should demonstrate proficiency in all the skills gained, including image acquisition, interpretation, and integration into clinical practice.

Competence in the knowledge and skills gained is assessed with a combination of methods, including a written examination, an objective structured clinical examination (OSCE), and workplace assessments. The fourth stage is maintenance, which aims to ensure that a learner who has become competent is maintaining their skills; this is usually assessed via peer review or auditing [1].

Interpreting an ultrasound image is easier if the learner acquires the image themselves and understands the clinical context of the case. However, interpretation of images acquired by someone else is an important skill and requires an understanding of the sonographic anatomy as well as the background clinical information [2].

Interpretation of imaging findings is a common test item in OSCEs, but clinical information and hints about where an ultrasound transducer is placed on the body in an ultrasound image might not be provided, which might render the test item invalid [3].

Emergency physicians began to incorporate POCUS in their clinical practice in the early 1990s and the first ultrasound curriculum of the American College of Emergency Physicians was published in 1994 [4]. All emergency medicine ultrasound guidelines focus on the scope of practice, training requirements, quality assurance, and reimbursement; however, these guidelines do not discuss ultrasound characteristics in written and OSCE test items [5,6].

Emergency physicians are neither sonographers nor radiologists; their training requirements are competency based. Thus, they are challenged with the interpretation of an ultrasound image without being provided clinical information. The lack of use of appropriate imaging markers or labels to point out the anatomy in an image is likely confusing and can lead to an incorrect interpretation, thus rendering the test item invalid, rather than reflecting the learner's lack of competence [2,3]. This study assessed the validity and reliability of an examination test item involving the interpretation of a still ultrasound image without providing a clinical vignette or the anatomical location of the ultrasound probe.

## Subjects and Methods

A total of 72 emergency medicine residents were surveyed in the Middle East who had completed their 4-year emergency medicine residency training and were board-eligible. A single ultrasound image of an abdominal aortic aneurysm was provided in print format and projected the

same image on a PowerPoint slide. The residents were required to identify the diagnosis. An ultrasound image of an abdominal aortic aneurysm was acquired from a reference emergency medicine textbook to ensure that a high-quality image was used that the residents had access to during their training years [7]. The approval of an ethics committee was not sought, given that this was a proof-of-concept pilot study.

## Results

A total of 72 emergency medicine residents participated in the survey. Of them, 36 (50%) identified the diagnosis correctly and 36 (50%) were incorrect. Of the 36 who provided an incorrect diagnosis, 75% (27) gave a diagnosis for an anatomic part that was distant from the anatomy presented in the ultrasound image. Among the 36 residents who incorrectly interpreted the image, the following were the most common diagnoses including ectopic pregnancy (25%), intussusception (25%), and aortic dissection (19%) (Table 1).

## Discussion

The validity of an examination item is defined as the degree to which the item measures what it was intended to measure [8]. When writing an examination item, certain principles must be observed for the item to be valid; for example, the item must assess the learning objective, test a single concept to detect knowledge or skill deficiencies, and avoid connecting multiple objectives together, especially when depending on the information that was not provided [9].

Examination reliability is defined as the extent to which an examination item measures that objective without error [10]. Both validity and reliability are highly related; validity is the accuracy when measuring the objective, while reliability is the precision when measuring the objective without error [10].

Using a still ultrasound image as a test item without providing clinical information or pointing out the transducer's location on the patient's body could be technically misleading and unrealistic because, in reality, a physician would have gathered history, performed clinical examinations, and performed POCUS, so there

**Table 1.** Breakdown of the incorrect answers.

Incorrect diagnosis	Number of subjects	Percentage (n = 36)
Ectopic pregnancy	9	25%
Intussusception	9	25%
Aortic dissection	7	19%
Aortic thrombus	2	6%
Pulmonary embolism	2	6%
Retinal hemorrhage	2	6%
Aortic stenosis	1	3%
Hypertrophic cardiomyopathy	1	3%
Intrauterine pregnancy	1	3%
Retinal detachment	1	3%
Vitreous hemorrhage	1	3%

is no way for them to mistake a rounded structure in the abdomen for a retinal detachment or a pulmonary embolism.

Obtaining a proper ultrasound image is operator dependent; hence, when attempting to reach a diagnosis based on one still image without knowing the site of the transducer, the orientation can be challenging and might lead to diagnostic errors [11]. The results of the current study supported this notion, as 50% of the participating residents were incorrect in their diagnosis of the still ultrasound image that was provided and 75% of these incorrect diagnoses were of a different part of the anatomy than that presented in the ultrasound image. This indicated that participants were not able to identify the anatomical location that was scanned based on the image presented.

According to the Society and College of Radiographers and the British Medical Ultrasound Society, there are nine essential steps for producing an ultrasound report including the understanding of the clinical information, technical knowledge for evaluating whether the image at hand is adequate or not, observation, analysis of the observed findings, medical interpretation, advice, communication with the referrer, taking appropriate action, and communication with the patient. Reporting on an image or identifying a diagnosis, as the residents in this study were asked, is part of reporting a clinical ultrasound finding; hence, at the bare minimum, images must be presented in the clinical context to arrive at the correct diagnosis.

An emergency department's goal when using POCUS is to answer a specific question with "Yes," "No," or "Indeterminate," such as in this case, is there an abdominal aortic aneurysm or not? The basic and advanced applications that emergency medicine physicians were eligible to perform once they had acquired the required competency as defined by the Canadian Association of Emergency Physicians (Table 2).

Twelve advanced applications were also defined including the evaluation of left ventricular function; assessment of volume status; assessment of the etiology of undifferentiated hypotension; shortness of breath or chest pain; assessment of gallbladder disease; hydronephrosis and bladder volume; assessment of the compressibility of deep veins to rule out deep vein thrombosis; assessment of pneumothorax or pleural effusion; assessment of elevated intraocular pressure; assessment of testicular pain; assessment of joint effusion and tendon rupture in sports injury; and finally, facilitating peripheral vascular access [12,13].

**Table 2.** ED POCUS six basic applications.

1	Assessing the presence of cardiac activity in cardiac arrest;
2	Assessing pericardial effusion;
3	Assessing thoraco-abdominal trauma;
4	Confirming intra-uterine pregnancy;
5	Ruling out abdominal aortic aneurysms;
6	Ultrasound-guided central vascular access.

It was noted that some residents gave diagnoses of intussusception and aortic thrombus, which are not POCUS applications that emergency physicians are expected to look for when performing POCUS, which might reflect a lack of understanding of their POCUS training objectives.

The Royal College of Physicians and Surgeons of Canada started assessments of POCUS in their board examinations in 2010; according to their standards, the test image and laboratory interpretation in the applied examinations, and these are always structured around a clinical vignette [14].

A recent study in Canada showed variability in POCUS education in residency training programs, as well as a quality assurance process in which structured training in POCUS was the standard of care for over 10 years [15]. Therefore, enthusiasm for applying POCUS and incorporating it into clinical practice should be gauged with a clearly defined curriculum that has clear training objectives and an assessment method that is valid and reliable. Hence, it is highly recommended that POCUS training objectives can be specified in training manuals with a clear description of basic and advanced applications, as well as the time frames expected for competency acquisition. It is also recommended that POCUS examination test items assess specific objectives, whether they might be image adequacy, image interpretation, or image acquisition.

In addition, to test items to be valid, it is recommended that images must be provided with clinical vignettes. For the example provided in this study, the question should have been the following to ensure the test item was valid. A 50-year-old with a past medical history of hypertension has presented with flank pain having performed a bedside POCUS examination of the abdomen, what is the diagnosis?

## Conclusion

Examination test items must be valid and reliable for measuring the objectives that they are intended to measure without error. Providing a still ultrasound image as a test item without a clinical vignette would render the test item invalid and unreliable. It is highly recommended that national and international emergency medicine societies specify writing standards for POCUS examination test items.

## Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

## Funding

None.

## Consent to participate

Not applicable. This survey was part of a competency assessment; hence, participants had to complete all assessment test items including the pilot study test item.

## Ethical approval

Not obtained given this was a proof-of-concept pilot study.

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