

Emergency Department Assessment Evolution

a report by

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We are in the midst of a major phase of the evolution of patient assessment in emergency medicine. Ultrasound is changing the way we evaluate and approach patients in a manner that may be as significant as the clinical application of X-ray in the early 1900s. One of our third-year residents, on a recent shift in the emergency department (ED), presented the following physical exam on a man with chest and abdominal pain:

BP-164/105, HR-110, RR-22, T-99, HEENT-unl, neck-supple, chest-clear and equal with no pleural effusion, heart-RRR no murmur, ectopy, or pericardial fluid, abdomen-soft, BS+, moderate epigastric tenderness, gall bladder-unl, no free fluid, cysts on both kidneys, aorta-unl.

Low cost, lightweight, easy to transport, and improving quality are features of ultrasound machines that are becoming readily available. The emergency medicine literature has proven that there are a growing number of applications that emergency physicians can quickly and accurately utilize to facilitate patient evaluation and medical decision-making. The learning curve is steep, patient satisfaction is improved, and time spent in the emergency department is decreased. The Institute of Medicine has identified ultrasound as a significant means to decrease procedure related complications. As important as the physical examination is, it simply cannot compete with the images and perspectives afforded by ultrasound. The only downside to this evolution will be further erosion of physical exam skills that have already suffered from the technology of the past 20-plus years.

Over the past ten years, battles have been waged, and continue, but there has been fairly rapid growth and acceptance of traditional emergency medicine ultrasound. All residencies now teach ultrasound applications as part of their basic curriculum and their graduates are taking these skills into community emergency departments around the country. As our literature continues to document the advantages and the list of ultrasound applications continues to expand, costs will come down, quality will continue to improve, and the speed of this evolution will accelerate.

Although not specifically studied, extrapolation and some published data would predict that it will take from four to ten minutes to scan all of the key parts of the body (chest, heart, abdomen), far less than if the application was more focused.^{1,2} As emergency physicians become more comfortable with this modality the benefits will grow to include decreased use of confirmatory tests, decreasing costs, and radiation exposure.³ Consider the value added for the busy ED physician based upon a patient's 'chief complaint' (see Table 1). What follows is a discussion of some of the newer applications of ultrasound that fall outside of the traditional uses in the emergency department.

Deep Vein Thrombosis

Assessing for the possibility of deep vein thrombosis in the lower extremities is a problematic area for emergency physicians. DVT carries the risk of significant morbidity and mortality and it is often difficult to get formal vascular studies of the leg on an emergent basis, especially at night. One's clinical suspicion may be low enough to make one reluctant to order a formal study, yet concern lurks in the back of the mind. Literature has confirmed that compression ultrasound performed by emergency physicians is fast and reliable.¹

The procedure is not difficult and requires fewer than 25 exams to become comfortable with the study. Using a 5–10MHz transducer (generally higher is better for optimum resolution) with the patient lying supine, the probe is placed in a transverse plane to image the femoral vessels at the level of the groin. The vein is identified medial to the artery, and if a clot is not present, the vein is easily compressible, completely occluding the lumen. An abnormal test is defined by the inability to completely compress the vein, when the pressure needed to compress the vein is so great that the wall of the artery is deformed, and when the pressure to compress the vein is significantly greater than the opposite leg.⁴ The appearance of a clot in the vein is a sensitive but nonspecific finding. This exam should be continued distal to the inguinal ligament for several centimeters. Following this the patient should be rolled prone and the study is repeated in the popliteal fossa.



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Table 1: Patients' Chief Complaints and Possible Diagnoses

Abdominal pain	Gall bladder disease, AAA, ascites, bowel obstruction, hernia, renal disease, bladder distension
Unexplained hypotension/ tachycardial dyspnea	FASH (focused assessment with sonography in hypotension) Pericardial effusion, DVT, pleural effusion, AAA, ectopic, free fluid in the abdomen, pneumothorax, assess hydration status by evaluating IVC size and change in size
Chest pain	Pericarditis, pericardial effusion, poor ejection fraction, pleural effusion, pneumothorax
Skin infection	Abscess versus cellulitis versus necrotizing fasciitis
Laceration	Foreign body, tendon laceration
Swollen leg	DVT versus bakers cyst
Abdominal pain with vaginal bleeding	Ectopic versus threatened AB
Eye trauma – loss of vision	Ruptured globe, retinal detachment, lens dislocation, foreign body
Obese patient needs a spinal tap	Locate the midline with ULS
Line Placement	Femoral line during code, IVDU cannot get access, limit risk with the central line
Is there ascities	No more shifting dullness
Limit Procedure risk	Thoracentesis, suprapubic tap, paracentesis
Swollen painful knee	Patella tendon rupture, fluid in the bursa, fluid in the joint
Testicular pain, swelling	Torsion, mass, hydrocele, testicular hematoma
Trauma	FAST (focused assessment with sonography in trauma), FHT for fetal distress, fractures
Fracture reduction	ULS limits the need for films to confirm good reduction
Sore throat	Peritonsillar abscess
Headachefacial pain	Sinusitis
Facilitate procedures	Nerve blocks: brachial plexus, ulnar, femoral
Tendon tear and rupture	Patellar tendon, Achilles, and others

Color 'Doppler' can be useful to help identify the vessels but has not been shown to improve the sensitivity or specificity of the study.

Ocular Ultrasound

We recently saw a patient who presented with painful, monocular loss of vision, which began the night before. She had a cataract in the affected eye making the fundoscopic exam difficult. I suspected domestic violence, and decided to augment her examination with an ultrasound evaluation of the eye. The image demonstrated the finding of retinal hemorrhage. Ophthalmology was called and assumed care of the patient following consultation by the social worker.

Eye complaints are common in the ED, and vision-threatening pathology such as globe penetration, retained ocular foreign body, acute glaucoma, retrobulbar hematoma, lens dislocation, central retinal vein and artery

occlusion, retinal detachment, and vitreous hemorrhage, can be difficult to diagnose without sophisticated tools and training. Simply examining the eye can be complicated when the lids are swollen shut after trauma, or the patient has a cataract blocking the view of the posterior chamber. Traditionally, we have been taught to pry open lids that are swollen shut in order to view the eye, but this maneuver tends to be difficult, painful, and potentially dangerous in that it increases intraocular pressure and can extrude ocular contents in the presence of a globe rupture. Timely ophthalmologic consultation can be difficult, particularly at night, and may lead to delayed diagnosis and treatment.

One of the most exciting new uses of ultrasound we have implemented in our emergency department in the past year is the ocular exam.⁵ We have diagnosed cases of retinal detachment, vitreous hemorrhage, hyphema, and lens dislocation. As demonstrated in the case above, ultrasound can dramatically improve patient care by providing a rapid, accurate diagnosis, which leads to quicker treatment. Emergency indications for ocular ultrasound include a sudden change in vision, pain or trauma. In keeping with principles of emergency ultrasound, this exam is quick (less than or equal to three minutes) and simple (the eye is not difficult to find). The pathological findings are not subtle and are amenable to recognition by emergency physicians with basic ultrasound training. The eye is a fluid-filled structure and therefore a perfect acoustic window. This produces images with excellent detail. Since only one eye is usually involved, the other eye can act as a normal control.

The high frequency linear transducer is used to maximize resolution of detail. The close focal zone of this probe is perfect for a superficial structure like the eye. Most of these probes can modulate their frequency from 5–10MHz. The highest frequency should be used. With the patient sitting comfortably in an exam chair, or even on a backboard with a trauma patient, the gel-coated probe is placed on the closed lid of the eye. Since globe rupture may be in the differential, care must be taken to brace the hand holding the transducer on the patient's face and forehead to minimize the pressure to the eye. If globe rupture is suspected, a large quantity of gel should be applied to the closed lid so that the transducer does not actually have to make contact with the eyelid. Depth should be adjusted so that the image of the eye fills the screen, and gain should be adjusted to improve detail.

The anterior chamber will appear narrowed in a globe rupture or glaucoma. Hyphema will appear as echo-genic white areas in the anterior chamber. A dislocated lens is angled off center. Vitreous hemorrhage appears as echo-genic material in the posterior chamber. The material may be ill-defined or may appear to be an elevated flap of

detached retinal. Central retinal artery and vein occlusion can be diagnosed using color and spectral Doppler.

Use of ocular ultrasound has been studied in the emergency setting. In a primary article, Michael Blaivas et al. evaluated the use of ocular ultrasound in 61 ED patients with eye trauma or acute change in vision. They identified 26 pathologic findings including nine retinal detachments, three globe penetrations, two lens dislocations, and one retinal artery occlusion. Their findings agreed with a gold standard of orbital CT or complete evaluation by an ophthalmologist in 60 out of 61 patients. The one discordant case involved a small vitreous hemorrhage that was not seen on examination by the ophthalmologist. The ultrasound tape was shown to a board-certified ophthalmologist with considerable experience in ocular ultrasound, who agreed the hemorrhage was present and thought it could have been missed on initial evaluation.

ED ultrasound provides a quick, accurate, safe, non-invasive tool for evaluating potentially vision-threatening pathology at the bedside. Ultrasound is already within our scope of practice, and the ocular exam is easy to learn. Ultrasound has truly changed our approach to examining patients with eye complaints.

Unexplained Hypotension

In many cases the cause is obvious; a gastrointestinal (GI) bleed with hematemesis and hematochezia, trauma with intraabdominal hemorrhage, the pregnant woman with lower abdominal pain and massive vaginal bleeding. The assessment in these kinds of cases is straightforward and may or may not be readily facilitated by accepted ultrasound applications. In 2001 a series of three cases was published describing patients with no obvious cause for their hemodynamic instability.⁶ Within minutes of

their arrival pericardial effusion and tamponade was identified and treated in one patient, a leaking abdominal aortic aneurysm in another, and the third had free fluid in their abdomen adjacent to the spleen that ultimately led to a diagnosis of spontaneous rupture of the spleen. Bedside directed ultrasound is quickly becoming an invaluable tool in the early assessment of unstable patients. The cases above are great examples of this application and compellingly support this role for ultrasound. The utility of bedside ultrasound in patients with unexplained hypotension is becoming far more sophisticated and with ultrasound application that are not as traditional as in the above cases. Emergency department physicians are beginning to look at the heart, not just to examine for the presence of pericardial fluid but also to look at contractility. Studies have confirmed the ability of emergency physicians to accurately determine ejection fraction at least in ranges of 'good', 'intermediate', and 'poor'.⁷ The intent is to determine if cardiac function is a major contributor to the patient's poor perfusion.

We refer to the corollary the traditional 'FAST' exam in trauma patients and the 'Focused and Limited Assessment with Sonography in Hypotension' (FLASH) exam in the patient with undifferentiated hypotension. The exam includes evaluating overall cardiac function, looking for free fluid in the pericardial space, pleural space, or in the abdomen, interrogating the IVC for > 50% collapse with inspiration, evaluating the aorta for aneurysm and leakage and perhaps looking at the chest for an occult pneumothorax especially if hypotension occurs after intubation or a chest or neck procedure. As noted in the study below by Jones et al. incorporating a goal-directed ultrasound protocol into the routine evaluation of patients with symptomatic, non-traumatic, undifferentiated hypotension has the potential to lead to more timely and accurate diagnosis of critically ill patients.⁸ ■

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