Emergency point-of-care ultrasound applications

Basic applications for the clinician performing bedside ultrasound.

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Clinicians who regularly manage critically ill and injured patients often lack the immediate clinical information that is essential to make correct clinical decisions. Emergency point-of-care ultrasound (EPCUS), performed by bedside clinicians, may provide some of this information, which will help in making the correct clinical decisions and improve overall patient outcomes.

Important points to remember:
- EPCUS is only an adjunct to your physical examination.
- EPCUS is not a formal radiological investigation.
- EPCUS should enhance your clinical examination, not replace it.
- EPCUS should be used to answer highly specific clinical questions, usually binary (example: is there a pneumothorax present? yes/no).

The following quote is pertinent for those who feel that EPCUS may be too complex an examination:

“That it will never come into general practice, I am extremely doubtful because its beneficial application requires much time and gives a great deal of trouble both to the patient and the practitioner” – J Forbes 1823, Preface to Laennec’s treatise on the stethoscope.

EPCUS has many advantages (Table 1). However, its correct use and the interpretation of results are operator dependent. To make the best use of this technique there is a rigorous training curriculum available, as well as thorough credentialing and proper accreditation procedures. (Refer to the current EPCUS credentials and accreditation in the More About section of this issue.)

There are multiple uses for EPCUS by bedside physicians across all specialties and in general practice (Table 2). Choosing the correct module will depend on your scope of practice and patient composition.

Utilising peer EPCUS curricula from abroad, the College of Emergency Medicine of South Africa (CEMSA) formalised a local curriculum of core modules, each chosen for the technical ease of use and the impact on the patient. The current CEMSA core modules are discussed in more detail below.

**EFAST**
Ultrasound in trauma patients (used by non-radiologists) was first introduced in the 1980s and subsequently led to the
Ultrasound

development of the focused assessment with sonography in trauma (FAST). The FAST examination was not designed to identify all sonographic detectable pathology, but rather as a bedside screening tool to detect free intrathoracic or intraperitoneal fluid. The additional evaluation for pneumothoraces led to the development of the extended FAST (EFAST) and can be used in abdominal (blunt) and chest (blunt and penetrating) trauma. The operator obtains six views to systematically evaluate the unstable trauma patient (Fig. 1).

Ultrasound uses no contrast media and is rapid, repeatable, portable, non-invasive, and accurate, which make it the preferred diagnostic modality in shocked patients, rather than diagnostic peritoneal lavage (DPL) and abdominal computed tomography (CT). On the other hand, CT offers more detailed and specific anatomical information and has the advantage of identifying alternative diagnoses. Important traumatic conditions causing minimal intra-abdominal bleeding (e.g. diaphragmatic rupture) may also be overlooked. Lastly, EFAST’s utility in penetrating abdominal trauma and in the paediatric population is still unclear.

EFAST is not without limitations. It remains operator dependent, and certain conditions (e.g. bowel gas, obesity and subcutaneous emphysema) may result in sub-optimal examinations. In the acute setting, it is also nearly impossible to distinguish between different types of fluid such as urine, ascites and blood.

The use of EFAST as a bedside screening tool had shortened time to definitive surgical treatment and subsequently shortened hospital stays and lowered hospital costs. In addition, fewer CT scans were ordered and patients had fewer complications.

Although EFAST has not improved mortality in blunt trauma, it has an important role in decision making in the unstable trauma patient (Fig. 2).

### Abdominal aorta aneurysm

Syncope, hypovolaemic shock and/or anaemia associated with abdominal or back pain are all possible presentations of abdominal aortic aneurysm (AAA). A thorough clinical examination is not sufficient to exclude the diagnosis. Although CT and MRI remain the
gold standard for AAA assessment, patients often present in a shocked clinical state and moving them out of the emergency centre for further diagnostic imaging is not ideal. EPCUS is the best diagnostic tool in this situation due to its high diagnostic accuracy, reproducibility and lack of contrast material administration. The positive finding of an AAA by ultrasound expedites the diagnosis and ensures the patient receives timely life-saving surgery.

The abdominal aorta is visualised from the diaphragmatic hiatus to the aortic bifurcation. Patients in whom AAA is identified are also assessed for the presence of free intraperitoneal fluid. The absence of free intraperitoneal fluid does not rule out acute AAA rupture, however. Most acute AAAs presenting to the EC do not have free peritoneal fluid as the aorta is a retroperitoneal structure. The presence of retroperitoneal haemorrhage cannot be reliably identified by EPCUS. It is most commonly used to evaluate for infrarenal AAAs, but the presence of suprarenal AAAs can also be detected.

EPCUS is not intended to identify all abnormalities or diseases of the aorta and its results should be interpreted in the context of the entire clinical picture. This focused assessment for AAA may be technically limited by abdominal tenderness, bowel gas and obesity.

Deep-vein thrombosis
The use of bedside ultrasound to determine the presence of a deep-vein thrombosis (DVT) is common practice in many emergency care settings with access to bedside ultrasound.

During cardiac arrest resuscitation peripheral pulses can be difficult to confirm using palpation or auscultation.

The patient presenting with a swollen lower limb usually undergoes clinical pre-test probability assessments to determine the risk of clot development, which will determine the relevant screening or diagnostic test. It is important to confirm the diagnosis because of the 10 - 50% rate of propagation from DVT to pulmonary embolism. Numerous formal diagnostic tests are available to identify DVT. Some of these include formal whole-leg ultrasonography that can be time consuming, expensive and can result in diagnostic delays. A large randomised controlled study in 2008 demonstrated that the use of 2-point compression ultrasound, performed by clinicians, versus formal whole-leg ultrasound in D-dimer positive patients resulted in similar results in the detection of DVT.

The two areas compressed included the common femoral vein and the popliteal vein zones. A venous thrombosis is excluded when there is complete compression of the vein (Fig. 3). Any lack of complete obliteration of the venous lumen suggests the possibility of a clot and the patient should be managed with appropriate anticoagulant therapy.

Pitfalls of this technique include confusing an artery or a lymph node with a vein. A negative scan for a lower limb DVT does not rule out the diagnosis of a pulmonary embolism.

Central venous access
There are many indications for the placement of central lines. Placing central lines has a high complication rate, especially in the hands of clinicians who do not perform the procedure regularly.

There are two well-known techniques that use ultrasound to assist in placing central lines:

- Identify and mark out the central vein prior to performing the procedure by using bedside ultrasound imaging. The central line catheter is then placed blindly.
- Ultrasound imaging is used during the procedure in real-time ultrasound-guided central line placement (Fig. 4). The physician may visualise the needle using the short-axis, long-axis or the combined approach. The combined technique has the lowest proven complication rate.

The three most common sites for ultrasound-guided central access are the internal jugular, femoral and brachial veins, due to their close proximity to the surface and reduced influence of acoustic artefacts from surrounding anatomical structures. The shortened distance from the surface allows use of a high-frequency ultrasound probe, which assures better image quality. This improves the view of the proceeding needle until correct placement can be confirmed by
Ultrasound

withdrawing venous blood and by a real-
time view of the needle tip's location
within the central vein. When using these
recommended sites, there are no vital
structures between the surface and the
vein that can be accidentally punctured,
which reduces the risk of iatrogenic injury.
Placement of catheters in the subclavian
vein is less popular because of the acoustic
shadow cast by the overlying clavicle.

Ultrasound has the added advantage of
confirming the catheter position within
the central vein, and excluding possible
pneumothorax. Unfortunately this does not
eliminate the need for the standard post-
procedure chest X-ray since the operator will
still need to confirm the correct position of the
catheter tip in relation to the right ventricle.

There are many local training courses available
on ultrasound-guided central line placements.
However, current evidence shows that the
clinician’s skill will linearly improve with the
number of procedures performed and years of
experience utilising bedside ultrasound.

Focused echocardiography
evaluation in resuscitation
(FeER)

During cardiac arrest resuscitation
peripheral pulses can be difficult to
confirm using palpation or auscultation.
The 2010 American Heart Association
Advanced Life Support guidelines
suggested that future research should
focus on the role of ultrasound as a
targeted intervention during cardiac arrest
resuscitation. There are various clinical
algorithms in which ultrasound is used
during cardiac arrest to confirm asystole or
pulseless electrical activity (PEA). Studies
have shown that patients presenting to
emergency centres with complete cardiac
arrest have very little chance of survival.
Emergency echocardiography is very
useful to distinguish between asystole
and PEA given the widely disparate
clinical outcomes. The clinician can now
utilise ultrasound to further diagnose
possible causes of cardiac arrest, which
include cardiac tamponade, tension
pneumothorax, hypovolaemia and
pulmonary embolism.

Conclusion

The optimal use of EPCUS in clinical
practice is still in its infancy. New EPCUS
applications are added regularly to a rapidly
growing list. Maintaining standards by
assuring proper competency is the key,
as EPCUS will become a core skill in the
repertoire of the modern physician.

Further reading available at www.cmej.org.za

In a nutshell

• EPCUS provides more and faster clinical information.
• All doctors can use EPCUS to enhance their clinical examination of patients.
• The key is proper training, credentialing and accreditation of EPCUS.
• There are many modules available to suit the different scopes of practice.
• Patients who are haemodynamically unstable with blunt abdominal trauma and a positive EFAST scan should receive immediate surgical
laparotomy.
• A physician using a focused EPCUS DVT ultrasound examination can save substantial time by eliminating preceding screening tests.
• Real-time ultrasound-guided CVP insertion reduces patient complication rates.
• AAA screening of patients older than 50 years with suspicious symptoms is accurate, quick and effective.
• EPCUS can be used in cardiac arrest to determine the cause and to distinguish between asystole and PEA.
Further reading


Blaivas M, Fox JC. Outcome in cardiac arrest patients found to have cardiac standstill on the bedside emergency department echocardiogram. Acad Emerg Med 2001;8:616-621.


