Intensive Care Med (2014) 40:1763–1765
DOI 10.1007/s00134-014-3465-7

EDITORIAL

**Anthony McLean**
**Massimo Lamperti**
**Jan Poelaert**

# Echography is mandatory for the initial management of critically ill patients: Yes

Received: 21 July 2014
Accepted: 22 August 2014
Published online: 7 October 2014


For contrasting viewpoints, please see doi:
10.1007/s00134-014-3460-z and doi:10.1007/s00134-014-3469-3

A. McLean
Department of Intensive Care Medicine, Sydney Medical School–Nepean, Sydney, Australia
e-mail: anthony.mclean@sydney.edu.au

M. Lamperti (✉)
Anesthesiology Institute, Cleveland Clinic Abu Dhabi, Al Maryah Island, Abu Dhabi, United Arab Emirates
e-mail: docmassimomd@gmail.com
Tel.: +971 2 659 0200

J. Poelaert
Dienst Anesthesiologie en Perioperatieve Geneeskunde, UZ Brussel, Brussels, Belgium
e-mail: jan.poelaert@uzbrussel.be

"The perfect nightmare": Late on a Friday afternoon a 76-year-old man presents to the emergency department after a syncopal episode where he crashed his car into a stone wall. On arrival he was complaining of acute dyspnoea and is found to be tachypnoeic, cyanotic and hypotensive with cool extremities. Both the clavicle and femur on the right side appear to be fractured. He has a past history of COPD, ischaemic heart disease and prostate cancer. His blood pressure is 65/30 mmHg, heart rate 120 beats per min and regular, SpO2 84 %, respiratory rate of 20 per min with rales, marked peripheral cyanosis and a rectal temperature of 38.50 °C.

Obviously immediate resuscitation is required, but with an uncertain diagnosis it is not apparent whether administration of intravenous fluid given for his hypotension may increase preload but also cause deterioration if the chest rales represent pulmonary oedema. The introduction of ultrasound imaging (US) into advanced life and trauma support for critically ill patients allows for a rapid and holistic approach to such patients. To effectively treat our patient there is an urgent need to identify the cause of hypotension and hypoxaemia to restore intravascular volume and increase oxygenation. US examination can be complementary to CT scanning, traditionally of inestimable value in such a patient. An US examination can be commenced without any time delay as depicted in Fig. 1 and may even negate the need for a subsequent CT scan. It can be performed prior to obtaining the patient's blood laboratory results, mitigating the concern about the possible presence of a coagulopathy and subsequent US-guided central line insertion. Further sonographic examination should be considered to rule out potential bleeding or source of sepsis in the abdomen (spleen, liver, gallbladder, kidneys) [1].

The role of static measurements of preload have been superseded by dynamic evaluations, and US offers rapid and reliable methods of assessment, pre-empting central line insertions, including imaging of either the inferior or superior vena cava respiratory variation [2], measuring aortic velocity time integral, pulse pressure variation or cardiac output in response to passive leg raising or volume challenge to name a few [3, 4]. Insertion of central lines and arterial lines is required in such a patient, and in the presence of shock a US-guided approach saves time and complications. A peripherally inserted central venous catheter could be inserted in a deep peripheral vein of the arm by ultrasound guidance, thereby reducing the risks of major complications such as pneumothorax and arterial puncture [5]. Choosing an appropriate size of the catheter according to the size of the vein can reduce the risk of haematoma and thrombosis. It has been demonstrated that these catheters are associated with fewer risks of central line associated bloodstream infections [6].

US imaging techniques to obtain rapid diagnoses in lung and heart emergencies have been developed,

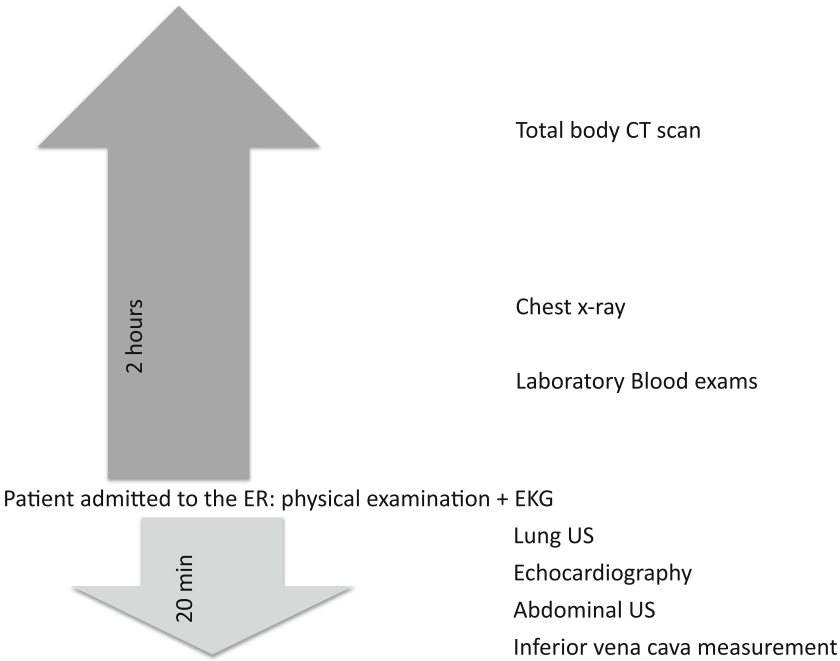


**Fig. 1** Time course of a traditional clinical management and ultrasound-guided management of a critically ill patient

allowing for immediate treatment in case of acute respiratory [7], cardiac [8] and circulatory failures [9]. Undifferentiated hypotension in the emergency department should be guided by cardiac ultrasound after a standard 12-lead EKG has been obtained [10]. Mandatory assessment includes cardiac, lung, abdominal and inferior caval vein ultrasound. Underlying potential diagnoses include right heart dysfunction, pulmonary embolus, and sepsis with or without cardiac involvement, acute coronary syndrome, chronic ischaemic heart disease, and a malignant pericardial effusion, in addition to the blood loss associated with orthopaedic injuries. Whilst invasive techniques, such as a pulmonary artery catheter or PiCCO, may provide general parameters such as cardiac output or extravascular lung water, echocardiography provides not only these answers but much more information including differentiation between right and left heart failure, left ventricular systolic/diastolic dysfunction, pulmonary artery pressures, left ventricular outflow obstruction, valvular dysfunction, the presence of segmental wall defects and a guide to intravascular volume status. The majority of this information can be obtained with basic competency in critical care echocardiography as outlined in international guidelines and now mandated by a number of different countries' training schemes [11]. An ever-increasing number of clinicians are now achieving advanced competency, negating the need for applying more invasive methods [12]. Advanced competency includes the addition of TEE to TTE examination, allowing assessment of possible thoracic aorta pathology—though in a well-sedated patient. Following even a basic echocardiographic examination, the clinician should now have an understanding of the likely multiple causes of this man's haemodynamic instability. Armed with this information, appropriate management in the use of fluid administration, need for inotropes/vasopressors, and the need for urgent coronary intervention can be initiated.

Lung US could distinguish between pneumonia and pulmonary oedema by the presence of a B-lines profile or a PLAPS profile [13]. A recent comparative study [14] showed a clear advantage of lung US compared to chest X-ray, in terms of sensitivity, specificity and diagnostic accuracy for consolidation, pneumothorax, interstitial syndrome and pleural effusion, including results reaching diagnostic accuracy of a chest CT scan [15]. The latter technique has the huge disadvantage that a potentially unstable patient needs transportation for diagnostic purposes. At this point, a fluid load challenge could assist in differentiating between hypovolaemic or distributive shock. If patients have an A-lines profile they could benefit from fluid administration until B-lines appear. In our patient, even a small fluid load challenge could cause a massive B-lines profile without improvement of circulatory failure. This raises the suspicion of underlying sepsis and to assess whether the patient is a fluid responder, the clinician could just bring the patient into a Trendelenburg position and then visualize if the lung pattern changes from an A to a B profile.

In an attempt not to intubate this patient both a cervical and femoral block should be placed to provide pain relief ab initio, before orthopaedic stabilisation. Again, US provides insight into the anatomy and an opportunity to offer adequate analgesia with minimal doses of local anaesthetics [16, 17]. Moreover, a catheter can be inserted

at the femoral nerve level to administer continuous pain relief. At a later, more suitable time, formal femoral surgery can be undertaken.

In this debate on the need for whether ultrasound should be mandatory in the initial management of critically ill patients our opponents will argue that many clinicians can treat their patients well without applying it. However this is last century thinking because clinicians applying US in the emergency setting provide diagnoses more rapidly and accurately than can be obtained by other means. It allows safer working in those conditions where coagulopathy or therapy with antithrombotics or anticoagulants is present; it allows for earlier initiation of appropriate treatment. Any healthcare institution and medical school should consider echography as an integral part of a physician's curriculum as are anatomy and physiology. This technique has a low cost–benefit ratio when compared to other diagnostic tools such as invasive monitoring or CT scans and it will improve our patients' outcome in addition to reducing both direct and indirect financial costs due to complications and a delayed diagnosis.

**Conflicts of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest.

## References


1. Walcher F, Weinlich M, Conrad G et al (2006) Prehospital ultrasound imaging improves management of abdominal trauma. Br J Surg 93:238–242
2. Vieillard-Baron A, Chergui K, Rabiller A et al (2004) Superior vena caval collapsibility as a gauge of volume status in ventilated septic patients. Intensive Care Med 30:1734–1739
3. Cholley BP (2011) Measurement of stroke volume and cardiac output using echocardiography and Doppler. In: de Backer D, Cholley BP, Slama M, Vieillard-Baron A, Vignon P (eds) Hemodynamic monitoring using echocardiography in the critically iII. Springer, Berlin, pp 51–60
4. Lamia B, Ochagavia A, Monnet X et al (2007) Echocardiographic prediction of volume responsiveness in critically ill patients with spontaneously breathing activity. Intensive Care Med 33:1125–1132
5. Lamperti M, Bodenham A, Blaivas M et al (2012) International evidence-based recommendation on ultrasound-guided vascular access. Intensive Care Med 38:1105–1117
6. Chopra V, Ratz D, Kuhn L et al (2014) PICC-associated bloodstream infections: prevalence, patterns and predictors. Ann J Med 127:319–328
7. Lichtenstein D, Mezière G (2008) Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol. Chest 134:117–125
8. Lichtenstein D (2013) FALLS-protocol: lung ultrasound in hemodynamic assessment of shock. Heart Lung Vessel 5:142–147
9. McMurray J, Adamopoulos S, Anker S et al (2012) ESC guidelines for the diagnosis and treatment of acute and chronic heart failure 2012. Eur Heart J 33:1787–1847
10. Volpicelli G, Lamort A, Tullio M, Cardinale L, Giraudo M, Stefanone V, Boero E, Nazerian P, Pozzi R, Frascisco MF (2013) Point-of-care multi-organ ultrasonography for the evaluation of undifferentiated hypotension in the emergency department. Intensive Care Med 39:1290–1298
11. Expert Round Table on Ultrasound in ICU (2011) International expert statement on training standards for critical care ultrasonography. Intensive Care Med 134:2246–2249
12. Expert Round Table on Echocardiography in ICU (2014) International consensus statement on training standards for advanced critical care echocardiography. Intensive Care Med 40:654–666
13. Lichtenstein D (2014) Lung in the critically ill. Ann Intensive Care 4:1
14. Volpicelli G (2011) Sonographic diagnosis of pneumothorax. Intensive Care Med 37:224–232
15. Xirouchaki N, Magkanas E, Vaporidi K et al (2011) Lung ultrasound in critically ill patients: comparison with bedside chest radiography. Intensive Care Med 37:1488–1493
16. Beaudoin F, Haran J, Liebmann O (2013) A comparison of ultrasound-guided three-in-one femoral nerve block versus parenteral opioids alone for analgesia in emergency department patients with hip fractures: a randomized controlled trial. Acad Emerg Med 20:584–591
17. Lurf M, Leixnering M (2009) Ultrasound-guided ulnar nerve catheter placement in the forearm for postoperative pain relief and physiotherapy. Acta Anaesthesiol Scand 53:261–263