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EDITORIAL

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Echography is mandatory for the initial management of critically ill patients: No

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The potentials of point-of-care ultrasound (US) and fair expectations of its utility in the ICU are sometimes reappraised by the general paucity of the literature on the topic, mainly due to the relative novelty of many applications of US. While many studies showed the practical utility and diagnostic accuracy of US, bedside application of US does not necessarily improve patient outcome. Moreover, the convenience of US based on saving costs and time and also in terms of improved efficiency has been hypothesized, but not so far fully demonstrated. This may have influenced the fact that US is still not considered the standard of care for many applications in the ICU.

Lung US suffers from many intrinsic limitations mainly due to the peculiar interaction between the ultrasound beam and the alveolar air [1]. Ultrasonography is sensitive to the variations of the balance between air and fluids in the lung, which is of practical usefulness in the diagnosis of many lung diseases and assessment of extravascular lung water, but cannot visualize deep pulmonary lesions because it is only limited to the observation of the organ surface [1]. Consolidations and interstitial pathologies of the lung that do not abut the pleural surface, cause false negative examinations [2]. Thus, in comparison with chest radiography, US is far inferior in the ability to provide panoramic views of the chest. The interpretation of the B-lines is extremely easy as a sign of loss of aeration, but lose specificity when differentiation between specific pulmonary diseases, like ARDS and pulmonary edema, is clinically in doubt. These cases mandate consideration of adjunctive and more complicated US signs, and multiorgan US approaches including echocardiography (Fig. 1c), [3, 4]. Even though the use of US as a guide of thoracentesis during the procedure has recently been considered standard of care, the safety advantages of US for thoracentesis might be tracked particularly for mechanically ventilated patients rather than for the whole ICU population [5, 6]. Lung US may also contribute to the hemodynamic assessment of critically ill patients by indicating the lung tolerance to a fluid load, but cannot assess the fluid responsiveness, which remains the most important hemodynamic parameter to predict the necessity of fluid replacement [7, 8]. To date, no one has been able to demonstrate the ability of lung US in differentiating between normally aerated lung and conditions of over-inflation, due, for instance, to an excess of positive pressure ventilation. Normal alveolar air content and alveolar distension cannot be distinguished at lung US because they create the same indistinguishable ultrasound pattern [1]. Some studies have shown that lung ultrasound has significant therapeutic impact and influences the decision-making process of ventilated patients in the ICU [9]. However, how this might affect patient outcome and real cost savings needs

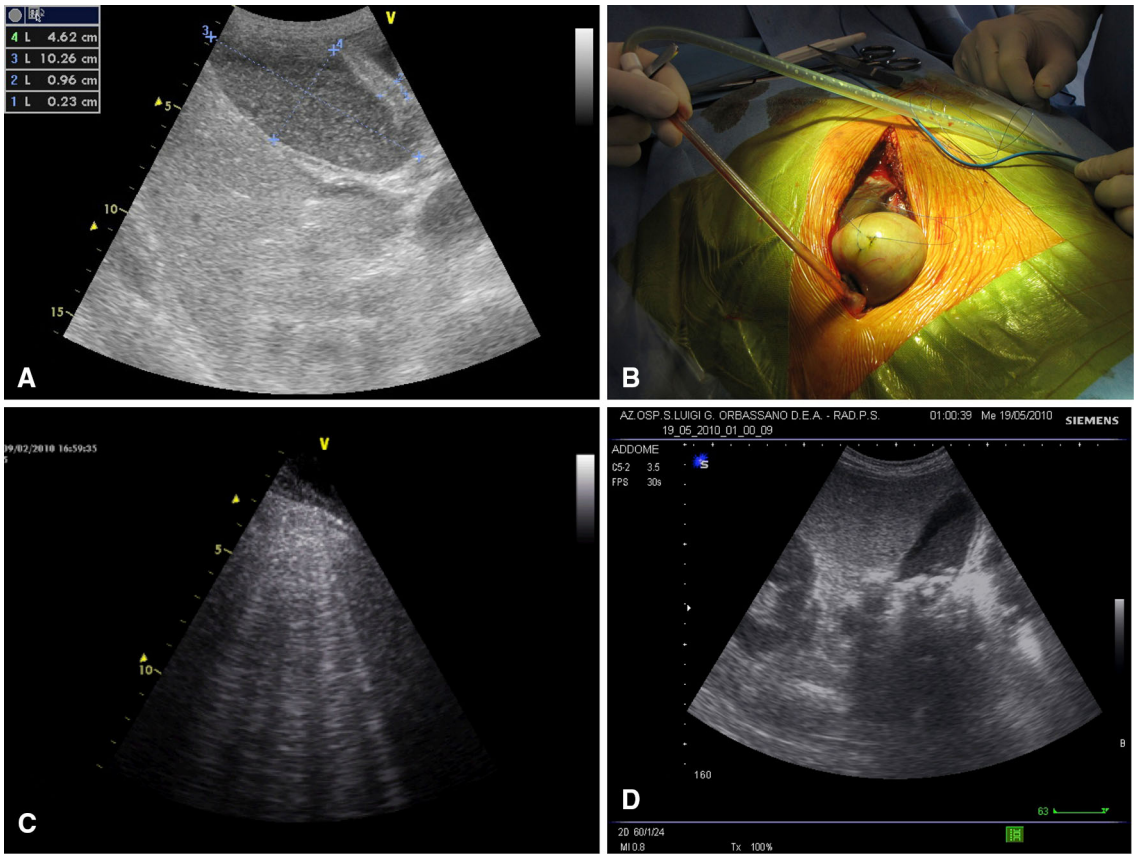

Fig. 1 **a** In a case of septic shock, the US abdominal examination shows thickened gallbladder wall (dist. 2 of 0.96 cm) with small cavitations within the wall (dist. 1 of 0.2 cm) and echoic material inside the lumen. The size of the gallbladder is 4.6 × 10.3 cm. **b** Intraoperative picture of the same patient shows enlarged but not inflamed gallbladder which was not a source of sepsis. **c** Parallel lung ultrasound shows multiple B-lines. The patient was not fluid overloaded but in septic shock with low preload. B-lines indicate loss of aeration, but based only on this artifact, pulmonary edema and ARDS are hardly distinguishable. Consideration of adjunctive lung ultrasound signs, like characteristics of the pleural line, distribution of B-lines and sub-pleural consolidations, may help. Moreover, a multiorgan ultrasound approach that should include cardiac evaluation, and integration with clinical and radiologic data, is often decisive. **d** Ultrasound abdominal examination in another critically ill patient with sepsis from acute cholecystitis. In this case, the combination of thickened walls with pericholecystic fluid and gallstones make the ultrasound diagnosis of acute cholecystitis more specific

to be definitively demonstrated. While many studies of lung US in the ICU have been performed on selected populations based on the suspicion of a pulmonary condition, there is still no evidence on the value of routine performance of lung and general ultrasound in critically ill patients.

In gastrointestinal perforation, US has the potential of visualizing free peritoneal air more reliably than plain radiography [10]. This may be a great advantage in critically ill patients, because US may be performed at bedside in emergency scenes, when patients cannot be moved to a radiographic examination area. However, abdominal US diagnosis is based on artifacts imaging and free peritoneal air may not always be easily differentiated from other high-echoic findings of different origin [11]. Thus, the main problem in analyzing any study on the US diagnosis of gastrointestinal perforation is the real accuracy of the interpretation of the US signs and findings, which is still too much based on a subjective impression of the examiner rather than on a systematic method. The duration of the procedure makes US for free peritoneal air unsuitable during extreme emergencies and as a primary survey application in traumatology. Moreover, it is known that intestinal perforation does not always imply free peritoneal air. While abdominal US may be useful in the identification of free air, it cannot be used to make a diagnosis of gastrointestinal perforation without any air leakage in the peritoneal space [12].

US is useful for the very early diagnostic process of critically ill patients with trauma, undifferentiated hypotension and shock. However, US may not identify the site of infection in septic shock, particularly when intestinal, retroperitoneal or musculoskeletal sources are in the

differential [4]. When there is a suspicion of cholecystitis in critically ill patients with sepsis, US may be of help. However, although US remains highly reliable in detecting the presence of cholelithiasis, other signs, like the thickened wall and intraluminal sludge, are considered less accurate in predicting cholecystitis as a source of infection. In particular, thickened wall, pericholecystic fluid and emphysematous gallbladder show as non-specific signs in the setting of critically ill trauma patients [13]. Thickened gallbladder remains a non-specific US finding, and US has insufficient sensitivity to apply it as a routine method to rule out cholecystitis in the ICU (Fig. 1a, b, d). Exclusion of obstructive uropathy is a routine in patients with renal insufficiency and in search of a source of sepsis. US may detect dilation of the urinary tract, but attention should be paid to renal cysts and hypotonic renal pelvis as challenging differential diagnosis. US is also limited in the diagnosis of retroperitoneal bleeding compared to newer multidetector CT. These limitations of US are even more evident in morbidly obese patients and in subcutaneous emphysema [14]. Moreover, US is a powerful tool to detect peritoneal effusion but is of limited usefulness in the differential diagnosis between blood, ascites or purulent collections. In septic shock, Doppler-based evaluation of the renal arteries for resistive index is a bedside method to assess renal injury. It is a promising method, but there is uncertainty about its applicability on the general ICU population. Evidence published so far has been limited to single-center studies, performed by few highly skilled operators, on selected populations [15]. Moreover, the influence of catecholamine treatment on the US determinants of the renal resistive index has not been tested.

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Conflicts of interest None of the authors has a conflict of interest to declare.

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