

# Application of rapid ultrasound in shock protocol in the ICU for management of shock

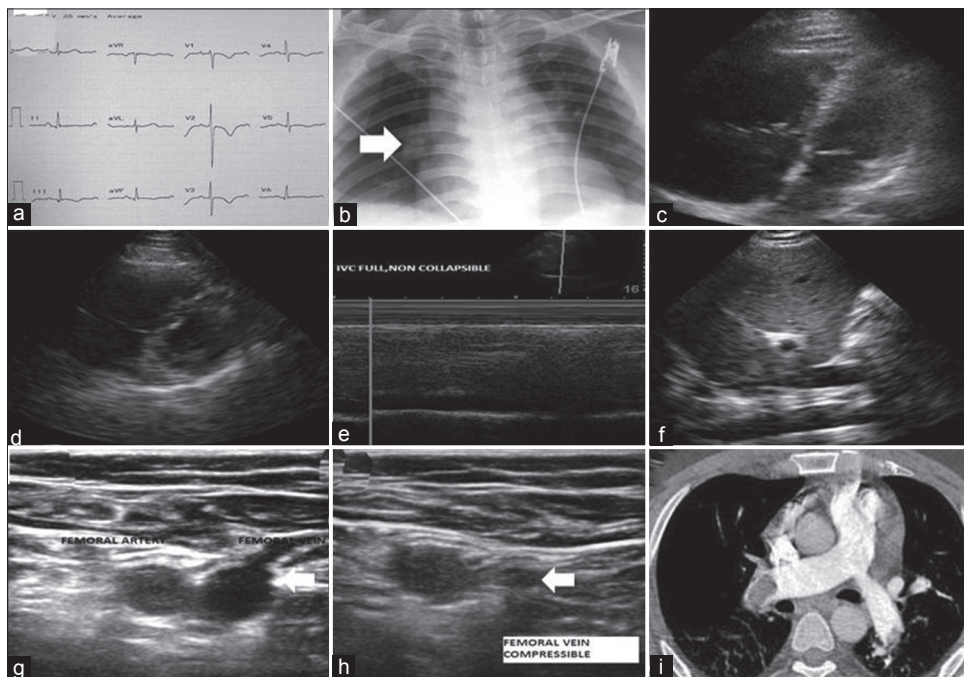
Sir,

One of the most challenging tasks in the Intensive Care Unit (ICU) is to rapidly determine the cause of shock in a critically ill patient and decide the most appropriate treatment in a short time. We describe a case of 34-year-old male with shock and impending respiratory failure presenting to ICU and its management based on information provided by rapid ultrasound in shock (RUSH) protocol.

A 34-year-old male patient presented to the ICU with the complaints of recent onset severe dyspnea and dry cough. There was no history of chest pain, fever, and chest trauma. His physical examination revealed tachycardia (pulse rate: 112/min), tachypnea (respiratory rate: 48/min) and hypotension (blood pressure: 80/50 mmHg). Electrocardiogram showed sinus tachycardia, right axis deviation with S1Q3T3 pattern. Patient was intubated and mechanically ventilated in view of impending respiratory failure and shock. Along with initial resuscitation for the

shock, she underwent ultrasound according to RUSH Protocol to evaluate the cause of shock. Pump: Grossly enlarged right atrium and right ventricle with D shaped left ventricle. McConnell’s sign was present. Pulmonary artery was dilated with pulmonary artery systolic pressure 80 mm of Hg. Left ventricular contractility was adequate. There was no evidence of pericardial effusion or valvular dysfunction. Tank: Inferior vena cava was full and noncollapsing with respiration. Pipes: Deep venous thrombosis screening was done (femoral vein in the femoral canal, popliteal vein in popliteal fossa) which was normal. Screening of the aorta was also normal [Figure 1]. With this information, diagnosis of pulmonary thromboembolism (PTE) causing obstructive shock was considered. Computerized tomography based pulmonary angiography (CTPA) could not be as the patient was on the ventilator and hemodynamically unstable. We thrombolysed the patient with recombinant tissue-type plasminogen activator 100 mg intravenous infused over 90 min. SpO<sub>2</sub> with subsequent improvement in hemodynamic parameters. Patient was gradually weaned off the ventilator by 5<sup>th</sup> day. Subsequently, CTPA showed embolism in the main and segmental branches of both pulmonary arteries.

Rapid ultrasound in shock protocol is recently proposed systemic algorithm for evaluation of shock.<sup>[1]</sup> This protocol involves a three-step bedside sonographic assessment simplified as step 1:



**Figure 1:** (a) ECG showing S1Q3T3 pattern (b) Chest x-ray showing Palla’s sign (prominent right descending pulmonary artery) (c) Dilated right atria and ventricle (d) “D” shaped left ventricle (e and f) Non collapsible IVC seen on m mode (g) Femoral artery and femoral vein (h) Compressible femoral vein (i) CTPA showing bilateral pulmonary artery thromboembolism

**Table 1: Rapid ultrasound in shock protocol: Ultrasonographic findings seen with classic shock states\*\***

Rush evaluation	Hypovolemic shock	Cardiogenic shock	Obstructive shock	Distributive shock
Pump	Hyper contractile heart Small chamber size	Hypo contractile heart Dilated heart	Hyper contractile heart Pericardial effusion Cardiac tamponade RV strain Cardiac thrombus	Hyper contractile heart (early sepsis) Hypo contractile heart (late sepsis)
Tank	Flat IVC Flat jugular veins Peritoneal fluid (fluid loss) Pleural fluid (fluid loss)	Distended IVC Distended jugular veins Lung rockets (pulmonary edema) Pleural fluid Peritoneal fluid (ascites)	Distended IVC Distended jugular veins Absent lung sliding (pneumothorax)	Normal or small IVC (early sepsis) Peritoneal fluid (sepsis source) Pleural fluid (sepsis source)
Pipes	Abdominal aneurysm Aortic dissection	Normal	DVT	Normal

DVT: Deep venous thrombosis; IVC: Inferior vena cava; RV: Right ventricle; RUSH: Rapid ultrasound in shock. \*\*Perera P, et al. The RUSH exam: Rapid ultrasound in shock in the evaluation of the critically ill patients. *Emerg Med Clin North Am* 2010;28:29-56

Evaluation of pump, step 2: Evaluation of tank, step 3: Evaluation of pipes [Table 1]. By focusing on both the anatomy and the physiology, points of care ultrasound by intensivists may help in differentiating between various etiologies of hypotension in the unstable patient. Characteristic ultrasonography finding facilitates the early diagnosis as well as provides prognostic information in PTE.<sup>[2,3]</sup> These findings needs to be interpreted in the context of the clinical picture as similar finding can be seen in chronic obstructive pulmonary disease, obstructive sleep apnea, pulmonary hypertension and right sided myocardial infarction. The relatively poor sensitivity of ultrasound findings necessitates other investigations to rule out the diagnosis of PTE in critically ill patients.

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