>>EMERGENCY ULTRASOUND

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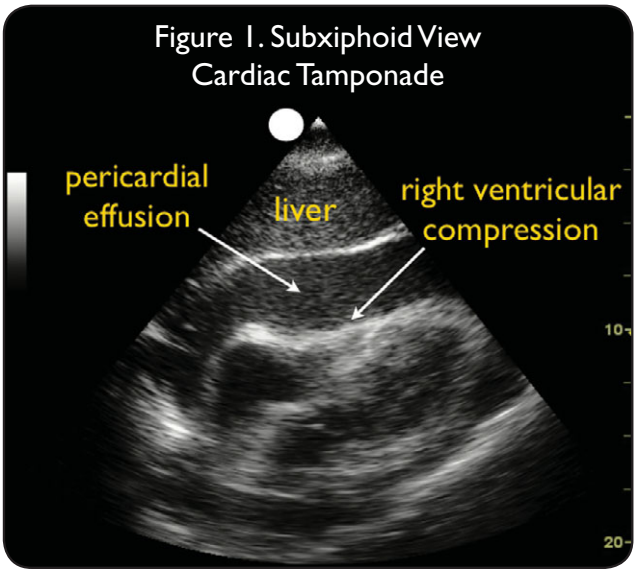
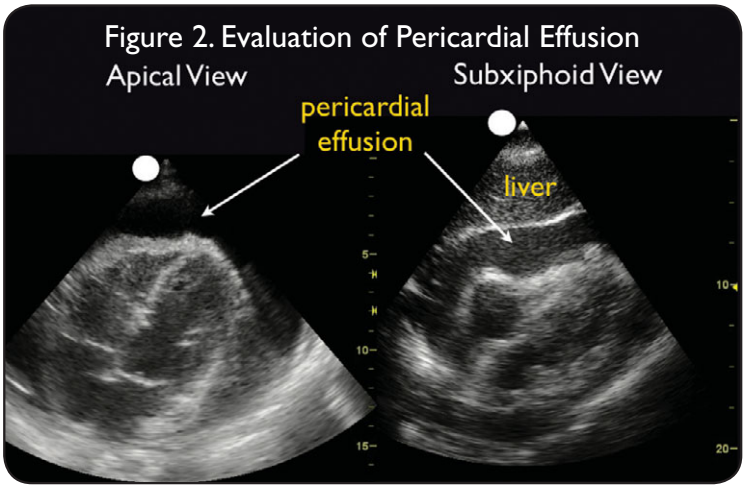
Rapid Ultrasound in SHock: The RUSH Protocol

This month, we present three cases showing the valuable role of the RUSH protocol in rapidly assessing ED patients with dyspnea and chest pain.



CASE 1

A 64-year-old woman presents to the ED with shortness of breath and chest pain. She reports a distant history of breast cancer but states that the disease has been "stable"; her most recent chemotherapy treatment was 3 years ago. She appears acutely ill, with a blood pressure of 74/58 mm Hg; heart rate, 120 beats/min; respiratory rate, 30 breaths/min; and temperature, 36.7°C. Her lungs have rales and it is difficult to hear heart tones, although the ED environment is very noisy. Using bedside ultrasound, you obtain the subxiphoid cardiac view, noting a very large pericardial effusion that circumferentially wraps around the heart (Figure 1). Further inspection for signs of cardiac tamponade reveals diastolic collapse of the right ventricle, a pathognomonic finding for the presence of tamponade.



You call for a stat cardiology consult; the fellow confirms your diagnosis. The pericardial effusion is further investigated using ultrasound and the findings shown in Figure 2 demonstrate that the subxiphoid approach for pericardiocentesis in this patient is limited by a large amount of intervening liver. The apical approach is determined to be the safest route to the fluid, and pericardiocentesis is performed via this approach. This case illustrates the utility of bedside echocardiography in looking for cardiac tamponade. Because the right side of the heart is a lower pressure circuit as compared with the left side, it is often easiest to identify tamponade by looking for diastolic collapse of the right atrium and/or right ventricle. This patient had extremely advanced tamponade with

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"Emergency Ultrasound" presents clinical cases involving the diagnostic use of bedside ultrasound in the emergency department. Cases can be explored in more detail on the Web in the SoundBytes section of CMEDownload.com, which can be accessed directly at www.sound-bytes.tv. Instructional videos detailing the components of the RUSH exam are available for download.

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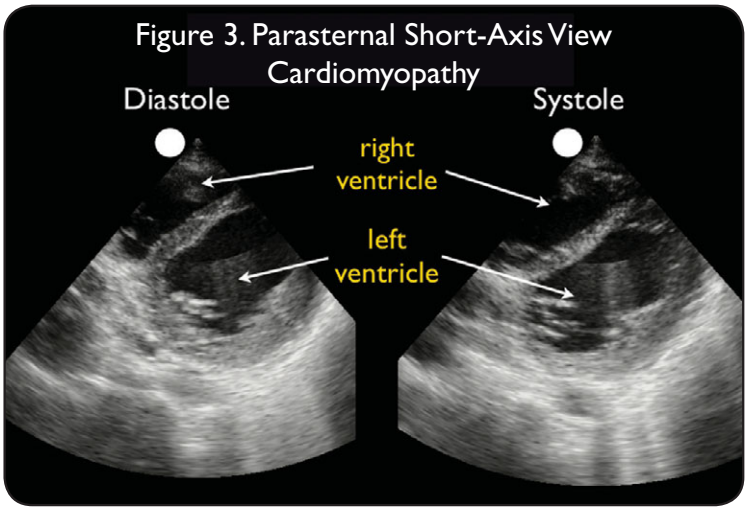

complete collapse of the right ventricle through both diastole and systole. After pericardiocentesis and removal of 600 cc of serosanguinous fluid, her vital signs normalized. She felt much better and sat up and asked for lunch.

CASE 2

A 45-year-old man presents reporting acute shortness of breath. He states that he had asthma as a child but the disease has improved in his adulthood. He appears critically ill, with a respiratory rate of 36 breaths/min and a blood pressure of 88/60 mm Hg. Diffuse wheezing can be heard in his lungs. An ED resident has evaluated the patient and requested albuterol for presumed asthma. To further investigate, you use bedside ultrasound to obtain the parasternal long- and short-axis (Figure 3) views. Note the small relative percentage of contraction of the left ventricular endocardial walls, which clinches the diagnosis of acute heart failure. Knowledge of the overall contractility of the left ventricle is very helpful in zeroing in on the correct diagnosis as well as in optimal delivery of therapy. This patient had acute systolic heart failure, a diagnosis which can be rapidly made using RUSH by looking for a poorly contracting left ventricle.

Last month, we presented a patient in heart failure with a left ventricle that was hypercontracting. This was due to the ventricle's attempt to compensate for the valvular regurgitation resulting from acute bacterial endocarditis. However, heart failure with a normal left ventricular contractility, known as *diastolic dysfunction*, is increasingly being diagnosed, as more patients are living with hypertension. In such cases, the left ventricle cannot relax sufficiently to allow for adequate inflow of blood. This diagnosis can be a bit complex and requires advanced cardiology training, but the next stage of the RUSH exam—the evaluation of the "tank"—assists in diagnosing this condition. In diastolic heart failure, the inferior vena cava and jugular veins are distended and have little respiratory variation in size (normally there should be inspiratory collapse of the inferior vena cava and jugular veins, which will be discussed in the segment on the "tank").

The information about left ventricular contractility that is acquired through the RUSH protocol also allows for improved resuscitation of septic patients. Given that most EDs do not routinely place an invasive central venous pressure monitoring line (as is often recommended in the most recent sepsis protocols[1]), ultrasound can be of assistance in offering a noninvasive gauge of the adequacy of the resuscitation. Knowing that a patient has a poorly contracting heart, the physician can anticipate a lower total fluid challenge to fill the "tank" and push the central venous pressure above 12 cm, as suggested in the sepsis protocols. With a vigorously contracting ventricle, a larger amount of fluid can be safely given before pulmonary edema becomes a risk. The first two parts of the RUSH protocol, assessment of "pump" and "tank," can offer a noninvasive alternative method of monitoring sepsis resuscitation when more invasive means are not available.

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CASE 3

A 25-year-old woman who is 2 weeks postpartum presents with shortness of breath that has been increasing over the last day. She also reports some left-sided chest pain. On evaluation, the patient appears to be in acute distress, with a blood pressure of 70/48 mm Hg; heart rate, 120 beats/min; respiratory rate, 34 breaths/min; and temperature, 37.2°C. Her pulse oximetry reading is 82% on room air and improves to 90% on face mask oxygen. Obviously, you are very concerned and the two major processes you consider in your differential diagnosis are acute pulmonary embolism and pregnancy-associated cardiomyopathy. Using bedside ultrasound, you obtain the parasternal long-axis view of the heart as seen in Figure 4. Note the large size of the right ventricle in relation to the left ventricle. The left ventricle, while appearing to contract normally, is compressed by the enlarged right ventricle. Now you suspect the patient has experienced a massive saddle pulmonary embolus leading to acute right heart strain.

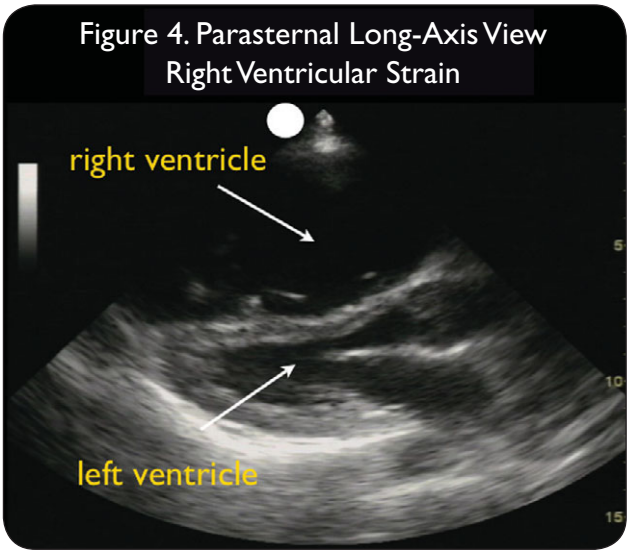

Figure 4. Parasternal Long-Axis View Right Ventricular Strain

You switch probes and move to step 3 of the RUSH protocol: evaluation of the "pipes." After confirming a large thrombus in the left femoral vein, you call for a stat critical care consult, and the attending concurs with your diagnosis. Due to the presence of hypotension and shock with a pulmonary embolus, the decision is made to treat with thrombolytics. The patient demonstrates improvement after this therapy, with a rise in blood pressure to 100/80 mm Hg and a decrease in heart rate to 96 beats/min. She is admitted to the critical care unit, where she makes a full recovery.

The cases discussed above illustrate the ability of the RUSH protocol to determine the etiology of a patient's shock state. Step 1, or evaluation of the "pump," should be rapidly initiated in the shock patient. Using the traditional echocardiography views (parasternal long- and short-axis, subxiphoid, and apical approaches), the emergency physician will obtain the information needed for accurate assessment of the "pump": detection of pericardial effusions and tamponade, evaluation of left ventricular contractility, and assessment for right heart strain.

REFERENCE

1. Rivers E, Nguyen B, Havstad S, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med.* 2001;345(19):1368-1377.

>> Look for more on the RUSH protocol in future issues.

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