

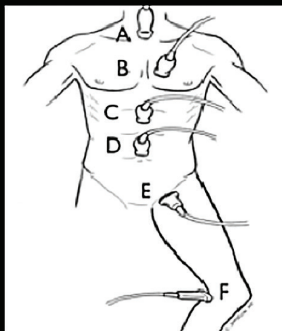
PART 3

The third and last part of the RUSH exam is to examine “the pipes,” and is performed through evaluation of both the major arterial and venous systems.

- The thoracic aorta can be examined for dissection and aneurysm using the parasternal and suprasternal notch views.
- The abdominal aorta can be evaluated for abdominal aortic aneurysm. The abdominal aorta may also be examined for the presence of an intimal flap, suggesting a dissection extending inferiorly from the thoracic aorta.
- In the patient in whom a pulmonary embolus is suspected and the cardiac ultrasound demonstrates right ventricular dilation, the leg veins can be examined for DVT.
- The limited DVT exam, specifically looking at compression of the femoral and popliteal veins, can be performed rapidly with relatively high sensitivity.

Rapid Ultrasound in SHock (RUSH) Step 3: Evaluation of the Pipes

- Probe Position A: Suprasternal Aorta
- Probe Position B: Parasternal Aorta
- Probe Position C: Epigastric Aorta
- Probe Position D: Supraumbilical Aorta
- Probe Position E: Femoral DVT
- Probe Position F: Popliteal DVT



Utilization of the RUSH exam can assist the clinician in determining the etiology for shock and potentially lead to improved therapy.

Rapid Ultrasound in SHock (RUSH) protocol: Ultrasound findings seen with classic shock states				
RUSH Evaluation	Hypovolemic Shock	Cardiogenic Shock	Obstructive Shock	Distributive Shock
Pump	Hypercontractile heart Small chamber size	Hypocontractile heart Dilated heart	Hypercontractile heart Pericardial effusion Cardiac tamponade RV Strain Cardiac thrombus	Hypercontractile heart (early sepsis) Hypocontractile heart (late sepsis)
Tank	Small, collapsible IVC Small, collapsing IJ veins Peritoneal fluid (fluid loss) Pleural fluid (fluid loss)	Distended IVC Distended IJ veins Lung rockets (pulmonary edema) Pleural fluid (effusions) Peritoneal fluid (ascites)	Distended IVC Distended IJ veins Absent lung sliding (pneumothorax)	Small, collapsible IVC (early sepsis) Peritoneal fluid (peritonitis) Pleural fluid (empyema)
Pipes	Abdominal aneurysm Aortic dissection	Normal	DVT	Normal

Abbreviations: DVT, deep venous thrombosis; IVC, inferior vena cava; RV, right ventricle; IJ, internal jugular veins

This document provides a general overview of the RUSH Protocol and is not intended to replace formal training through CME courses or other programs and in no ways constitutes professional medical advice or a complete course of training. You should not perform ultrasound exams solely in reliance upon the information presented in this document.

In addition to this document, four videos are available that describe the RUSH exam. Go to youtube.com/sonosite, click on Playlists (you may need to scroll down) then click on RUSH Exam to see the playlist.

References:

Perera P, Mailhot T, Riley D, Mandavia D. The RUSH Exam: Rapid Ultrasound in SHock in the Evaluation of the Critically Ill. *Emergency Medicine Clinics of North America*. 2010; Volume 28: 29-56.

Perera P, Mailhot T, Riley D, Mandavia D. The RUSH Exam: Rapid Ultrasound in SHock in the Evaluation of the Critically Ill, Update 2012. *Ultrasound Clinics of North America*. 2012; Volume 7: 255-278.

Seif D, Perera P, Mailhot T, Riley D, Mandavia D. Bedside Ultrasound in Resuscitation and the Rapid Ultrasound in Shock Protocol. *Critical Care Research and Practice*. 2012; Article 503254. Available at: <http://www.hindawi.com/journals/ccrp/2012/503254/>

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THE RUSH EXAM

RAPID ULTRASOUND IN SHOCK IN THE CRITICALLY ILL PATIENT

The ultrasound protocol termed the RUSH exam (Rapid Ultrasound in Shock) is a 3-part comprehensive examination specifically designed to determine the cause of shock in the critically ill patient. Information gained from this exam can then guide management of these patients.

The RUSH exam consists of the evaluation of three main parts: The “PUMP,” the “TANK,” and the “PIPES.”

PART 1

Part 1 is the evaluation of “the pump,” employing bedside echocardiography to visualize the heart using the 4 primary cardiac views to examine for 3 main findings.

The first step is to examine the area around the heart for a pericardial effusion:

- If a significant pericardial effusion is seen, the clinician can look more specifically for signs of cardiac tamponade (diastolic collapse of the right ventricle +/- right atrium).

The second step is to evaluate the left ventricle for contractility:

- Poor left ventricular contractility, as manifested by a small percentage change of the chamber’s endocardial walls from diastole to systole, suggests a cardiogenic etiology of shock.
- A hyperdynamic heart, demonstrating exaggerated motions of the left ventricle with the chamber’s endocardial walls almost touching during systole, represents a hypovolemic state often associated with septic shock.

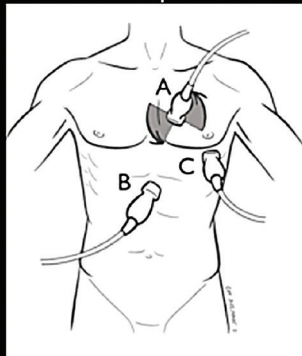
The third step is to look for right ventricular strain:

- A right ventricle, measuring the same size or larger than the adjacent left ventricle, is consistent with right ventricular strain. In the correct clinical scenario, this may be indicative of an acute pulmonary embolus as the etiology for shock.

Rapid Ultrasound in SHock (RUSH)

Step 1: Evaluation of the Pump

- Probe Position A: Parasternal Views Long / Short Axis
- Probe Position B: Subxiphoid View
- Probe Position C: Apical View



PART 2

Part 2 of the RUSH exam is the evaluation of “the tank.” This evaluation determines the status of the patient’s vascular volume and the integrity of the core vascular circuit and consists of 3 steps.

The first step is to assess “fullness of the tank” by looking at both the absolute size and the relative respiratory change in the diameter of the inferior vena cava (IVC).

- In states of low central venous pressure (CVP), correlating to a measurement < 10 cm water, the IVC should generally measure less than 2 cm in diameter and collapse greater than 50% with deep inspiration, or a sniff maneuver.
- Conversely, a larger IVC with a diameter greater than 2 cm and less than 50% collapse with inspiration or sniff generally correlates with an elevated CVP measurement > 10 cm water.
- Evaluation of the internal jugular (IJ) veins with a high frequency probe can corroborate the core vascular volume in patients in whom the IVC is difficult to visualize.
- For this exam, the patient’s head of the bed is positioned at a 30 degree incline. The IJ veins are followed from low in the neck superiorly to the angle of the jaw.
- Distended veins that extend high within the neck and demonstrate little respiratory variation are indicative of high CVP.
- Conversely, small IJ veins that collapse with inspiration to a position low in the neck correlate with low CVP.

The second step in tank assessment is to look for “leakiness of the tank.”

- This is done through the E-FAST exam (extended focused assessment with sonography in trauma) to analyze for free fluid in the abdominal/pelvic and thoracic compartments.
- A positive E-FAST exam with ascites or pleural effusion may point to failure of the heart, kidneys, or liver as contributing pathology.

- In the febrile patient, these findings may suggest an infection, such as peritonitis or empyema, leading to sepsis as the etiology for shock.
- While the RUSH exam is not specifically formulated for assessment of the patient following trauma, a positive E-FAST exam may suggest a traumatic etiology (hemoperitoneum, hemothorax) in the patient with occult trauma or a delayed presentation of trauma.
- Examination of the lung to look for pulmonary edema, as manifested by multiple ultrasound B-lines on both sides of the chest, can also support the diagnosis of high CVP and “a leaky tank” secondary to volume overload.

The third and final step in the evaluation of the tank is to examine for “tank compromise.”

- A pneumothorax under tension can compromise the vena cavae and cause hemodynamic instability.
- Ultrasound exam of the pleura, looking for the absence of lung sliding and the vertical comet tails found in normal lung, is diagnostic of pneumothorax.

Rapid Ultrasound in SHock (RUSH)

Step 2: Evaluation of the Tank

- Probe Position A: IVC Views
- Probe Position B: FAST / RUQ add pleural view
- Probe Position C: FAST / LUQ add pleural view
- Probe Position D: FAST / Pelvis
- Probe Position E: Lung Views

