

Abdomen Module:

Case 1:

A 16 year old male presents to the emergency department with right lower quadrant pain, fever and a white blood cell count of 23,000. He states the the pain was a 9/10 this morning but seemed to have resolved somewhat over the course of the day. He decided to come to the the hospital when he began having diffuse abdominal pain late this afternoon. His blood pressure is now 85/50 and his heart rate is 140. He is mildly short of breath and states that he feels like his heart is pounding in his chest. You have decided to place a central venous line and obtain the following image of the neck. What intervention should be performed based on the following ultrasound image?

Answer: Based on the patient's presentation, he has a perforated appendicitis with resultant peritonitis. Given his vital signs, he is likely in the process of becoming septic. The ultrasound image of the left side of the neck demonstrates flow in the carotid artery and internal jugular vein. The operator has angled the probe caudad in order to perform a color doppler study. The doppler effect states that the frequency of a wave will increase as the wave is coming toward a measuring device (ie the ultrasound probe) and decrease as they go away from it. By convention, the color red is used to define flow toward the probe and blue is used to define flow away from the probe. We know that blood in the carotid should be traveling cephalad and blood in the internal jugular should be traveling caudad. The image clearly demonstrates this, indicating a patent IJ vein at the examined level. To be sure, however, a compression test should be performed. Applying just enough pressure to begin to compress the carotid artery should be enough pressure to completely compress the internal jugular vein. If more pressure is needed, it is possible that the vein is occluded. In addition, the vein should be scanned up and down to ensure patency. This patient appears to have a wide-open IJ. A central line should be placed and the patient should be volume resuscitated.

Case 2:

The same patient from above receives a 30mL/kg fluid bolus. His blood pressure is now 90/65. He is becoming increasingly tachypnic and somewhat obtunded. An arterial blood gas demonstrates a pH of 7.3, a PaCO₂ of 30 and a PaO₂ of 85 on a nonrebreather. His SaO₂ is 92%. Based on the following ultrasound image, what intervention should be performed?

Answer: The image demonstrates a phenomenon known as IVC collapse. IVC collapse, in addition to TTE, is an important component of volume evaluation in a patient who is in shock. Collapse indicates that the patient is still volume responsive. In a spontaneously breathing patient, IVC collapse of greater than 30% indicates that the hypotensive patient may still benefit from additional fluid. In an intubated patient, an increase of greater than 13% is significant. Note that in the intubated patient, positive pressure ventilation decreases venous return and expands the IVC. If the expanse is greater than 13% of the measured diameter in exhalation, the patient may benefit from more volume resuscitation. Normal IVC diameter is about 1.5 to 2cm.

Case 3:

A 21 year old female riding a scooter was involved in a motor vehicle accident. She was found approximately 45 feet from her scooter. In the trauma bay, a left chest tube is placed after a physical exam failed to reveal breath sounds. The chest tube immediately drains a liter of blood. The following ultrasound image is obtained during the FAST exam. What is the next step in management of this unstable patient?

Answer: A FAST exam is a focused assessment with sonography for trauma. It is used to rule out fluid (ie blood) in four specific areas after a trauma. The exam evaluates four specific areas for fluid: the pericardial space, the splenorenal space, the hepatorenal space and the rectovesicular space. While it is difficult to determine whether this image is of the splenorenal or hepatorenal space, there is free fluid present, as evidenced by the hypoechoic (black) area. Given the mechanism of the patient's injury, this most likely represents new blood. Since the patient is unstable, she should go directly to the operating room for an exploratory laparotomy and source control for the bleeding.

Case 4:

A 43 year old obese female presents to the emergency department with right upper quadrant pain and vomiting since eating fast food about two hours ago. What structure is seen in the following ultrasound image and what is the next step in management?

Answer: The image is of the right upper quadrant and the gallbladder. Given the patient's history, she is likely suffering from acute cholecystitis. When assessing the gallbladder, it is important to answer several questions: 1) Are gallstones present? These can be seen as hyperechoic structures that cast a shadow below them. A shadow is a type of artifact seen when ultrasound waves cannot penetrate an object. As a result, there is signal dropout distal to that object. Rib shadows are another example of this phenomenon. 2) Is there gallbladder thickening? The gallbladder wall should be measured. Anything greater than 3mm is considered abnormal. 3) Does the patient have a sonographic Murphy's sign? A sonographic Murphy's sign is positive right upper quadrant pain upon compression of the gallbladder with the ultrasound under visualization. 4) Is the common bile duct visualized? If so, it should be less than 7mm across. Anything greater than this is abnormal and indicates a dilated duct. The presence of an obstructive stone distal to the CBD may be the cause of this. 5) Is there fluid around the gall bladder? Pericolocystic fluid can indicate a localized inflammatory process and adds support to the diagnosis of acute cholecystitis. In this case, the patient should be made NPO and surgery consult called for possible cholecystectomy.

Case 5:

A 63 year old female is admitted to the ICU with multiple bilateral rib fractures after having fallen off the roof of her motor home. She has a history of atrial fibrillation and she says she takes Eliquis (apixiban) at home. In addition to her rib pain, she states that she has right-sided flank pain. You cannot find any documentation of a FAST exam, so you obtain the following image. What is the next step in management?

Answer: The image obtained, as part of the FAST exam, evaluates the

hepatorenal space for evidence of free fluid. From the image, fluid is seen surrounding the kidney. Given the trauma, this is likely blood. The trauma team should be notified immediately, as they need to make a decision whether to take the patient to the operating room. The patient should be transfused based on hemodynamic parameters and laboratory studies. As will all trauma patients, especially those taking anticoagulation at home, a high level of suspicion should be maintained for hemorrhage if the patient decompensates in any way.

Case 6:

A 32 year old intoxicated female is brought to the ED after having crashed her car into a tree. The EMT's report a prolonged extrication, but that she was found wearing her seat belt. They also state that there was intrusion of the entire driver's console into the driver's seating area, with the steering wheel found against her chest. The following ultrasound image is obtained. What is the next step in management?

Answer: The image demonstrates free fluid surrounding the spleen, indicating a likely splenic laceration. The AAST grading system for splenic lacerations is based on CT scan findings:

Organ Injury Scaling Spleen

| Grade | Injury Description |
|-------|---|
| I | Haematoma Subcapsular, <10% surface area |
| | Laceration Capsular tear, <1cm parenchymal depth |
| II | Haematoma Subcapsular, 10-50% surface area Intraparenchymal, <5cm diameter |
| | Laceration 1-3cm parenchymal depth not involving a parenchymal vessel |
| III | Haematoma Subcapsular, >50% surface area or expanding. Ruptured subcapsular or parenchymal haematoma. Intraparenchymal haematoma >5cm |
| | Laceration >3cm parenchymal depth or involving trabecular vessels |
| IV | Laceration Laceration of segmental or hilar vessels producing major devascularization (>25% of spleen) |
| V | Laceration Completely shattered spleen |
| | Vascular Hilar vascular injury which devascularized spleen |

Advance one grade for multiple injuries to same organ up to Grade III.

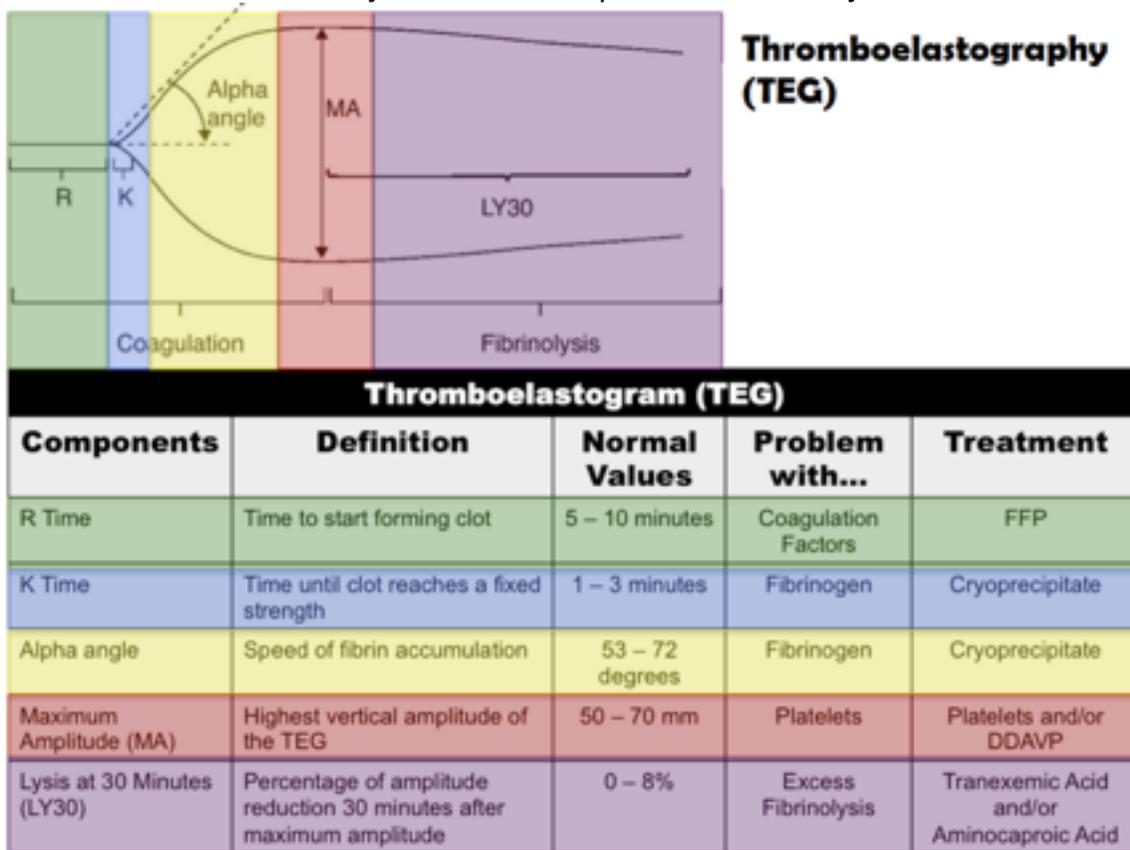
(Source: Trauma.org and aast.org, reprinted with permission from Moore et al.)

The next step in management is to complete the FAST exam and look for other free fluid. If the patient is stable, they should have a CTA to evaluate the aorta for a deceleration injury. If the patient is unstable, they should go immediately to the operating room for exploratory laparotomy and source control.

Case 7:

A 70 year old male is admitted to the ICU status post robotic prostatectomy. The case lasted approximately 7 hours in steep Trendelenburg position. The anesthesiologist states that, given the amount of facial edema, he did not feel comfortable extubating the patient in the operating room. The urology resident says that there was excessive amounts of bleeding when the prostatic venous plexus was violated, and that multiple blood products were given. At the bedside, you notice the patient is hypotensive with very low urine output. His Hb is 6.5. A TEG demonstrates an MA of 30, a LY30 of 20% and an R time of 75 seconds. You transfuse him accordingly after placing a central line. His CVP is 20 but he still is not making urine. You obtain the following image. What is the next step in management?

Answer: The image demonstrates a thrombus in the bladder, likely occluding the urinary catheter. The next step in management is to call the urology service so they can either irrigate the bladder or replace the catheter if necessary. This should never be done by an off-service provider, as the repair can be jeopardized. The other issue here is abnormal TEG, which indicates early thrombin burst and clot lysis (see the following table for values and ranges). It would appear as if the patient has a consumptive coagulopathy and is forming clots very quickly. This is the early stage of DIC, after which time it becomes very difficult for the patient to form any clot at all.



Case 8:

A 34 year old female presents to the trauma bay status post motor vehicle collision. Upon presentation, she is stable with HR 109, Blood Pressure 112/68, and oxygen saturation of 92% on 100% non-rebreather. She undergoes CT scan and is found to have small pulmonary contusions, fractures of the 9th and 10th rib on the right side, fractures of the 3rd and 5th rib on the left side, and a displaced right medial malleolus fracture. Subsequently she was transferred to the intermediate care unit to receive aggressive pulmonary toilet due to concerns of her low saturations on non-rebreather. An hour later, the nurse calls you to the patient's bedside because she acutely decompensates with tachycardia to the 130's, blood pressure to the 60's, and desaturations while still on 100% non-rebreather.

What are a few differential diagnoses that can be made from the above based on the patient's presentation? **Pericardial effusion, tension pneumothorax, or any cause of hemorrhage and hemorrhagic shock are the most likely in a young trauma patient.**

What is the fastest way to evaluate for the cause of the patient's hemodynamic instability? **Bedside ultrasound should be utilized to evaluate the patient. The patient is not stable enough to go for a CT scan and x-ray is not the best modality.**

What is the best ultrasound to obtain to evaluate for the majority of the above conditions in the fastest manner? **The focused assessment with sonography for trauma is the best way to evaluate for pericardial effusion and intra-abdominal hemorrhage in an efficient, time effective manner. This modality can be used serially to evaluate for missed injuries and can be especially useful in patients who have acute hemodynamic changes after trauma.**

What are the four images that one obtains when performing a Focused Assessment with sonography in trauma? **The hepatorenal recess (Morison Pouch), the perisplenic view, the subxiphoid pericardial window, and the suprapubic window (Douglas Pouch).**

During your FAST exam, you obtain the following still image: [ABD9-Free-Fluid-in-the-Hepatorenal-Space](#)

How would you interpret this image? **This image shows free fluid in the hepatorenal space.**

What would be your next step after completing the FAST exam and discovering the above finding? **Free fluid in the abdomen in a hemodynamically unstable patient is a surgical emergency. If you are not a surgeon, you should immediately contact an on-call trauma or general surgeon.**

What can you do while you await the surgery service to come to the patient beside? **Based on this patient's positive FAST exam and hemodynamic instability, it is highly**

likely that the patient is going into hemorrhagic shock. Consider initiating a massive transfusion protocol. Labs should be sent and if available bedside point of care labs including coagulation markers should be ordered.

Case 9:

You are the provider in the emergency department and a patient presents complaining of severe abdominal pain and cramping. You begin to perform your health assessment and find the patient to have a grossly distended abdomen, however, the abdomen is soft and the patient does not have peritonitis. As you interview the patient, you discover that the patient has had normal bowel movements for the last week, however, they have had worsening difficulty urinating. You continue to ask the patient about their voiding habits and they tell you that the last time they were able to fully urinate was 3 days ago. Your first thought is to place a urethral catheter, but as a prudent provider you decide to perform a bedside ultrasound of the patient's bladder to evaluate for any cause of obstruction prior to placement of the foley catheter.

What would be your differential diagnosis at this point? **Some examples of differential diagnoses for this case could be renal failure with oliguria, bladder obstruction, ureteral obstruction, severe dehydration, etc.**

While you are waiting on the nurse to obtain the ultrasound from the storage room, you note the patient to be mildly hypertensive, frail in appearance, and diaphoretic. The nurse arrives with the ultrasound and you ultrasound the bladder.

Where should you place the ultrasound probe to adequately assess the bladder? **The ultrasound probe should be placed directly above the pubic symphysis. The probe should then be pointed inferiorly for the bladder to come into view. This image is difficult to obtain once a urethral catheter has been inserted due to the fact that the bladder will be decompressed.**

During your exam, you obtain the following two images: **ABD3-Bladder-Mass and ABD4-Bladder-Mass**

How would you interpret these images? **These images reflect a mass in the bladder. This mass could be a blood clot or it could be a tumor. It is important now to make a decision as to what the mass is based off of the ultrasound that you obtain.**

What would be your next step? **First of all, the patient's bladder is full and it appears that the mass could be obstructing the urethra. Consider contacting urology for an emergency evaluation and catheter placement. If urology is immediately unavailable, consider placing a urethral catheter but do not force the catheter as it could cause trauma and bleeding of the urethra.**

Case 10:

A patient presents to the intensive care unit status post motor vehicle crash. The patient was the unrestrained driver of a sports utility vehicle that rolled over. The patient's injuries on preliminary radiographs and CT scans include a right open femur fracture, a comminuted mandibular fracture, and a fracture of the 3rd lumbar vertebral body. While awaiting neurosurgical evaluation, he begins to complain of abdominal pain and his blood pressure decreases from 130/78 to 100/68. You elect to perform a bedside FAST exam to evaluate the patient.

The first image that you obtain is of the hepatorenal space. [Hepatorenal2](#)

How would you interpret this ultrasound? **This is an image of the hepatorenal space that reveals no free fluid.**

The second image that you obtain is of the splenorenal space. [Splenorenal2](#)

How would you interpret this ultrasound? **This is an image of the splenorenal space that reveals no free fluid.**

The third image that you obtain is of the subxiphoid pericardial window. [subcostal-normal](#)

How would you interpret this image? **This is a normal subxiphoid view of the heart that reveals no pericardial effusion.**

The last image that you obtain is the suprapubic view of the bladder? [Bladder2](#)

How would you interpret this image? **This is an image of Douglas Pouch, which reveals a full bladder with no free fluid in the pelvis.**

Overall, how would you interpret this FAST Exam and what steps would you take next? **This FAST exam would be considered negative. Next, you should evaluate for other causes of the patient's hypotension.**