Cardiac Cases

Case 1:

A 29 year old male is admitted to the surgical ICU after a motor vehicle collision. His injuries include a fractured sternum, lacerated liver and right comminuted ankle fracture. The patient spent 6 hours in the emergency department due to a bed shortage, and has just arrived to the ICU hypotensive. Based on the following image, how would you manage this patient?

Answer: The image shown is a short axis view of the left ventricle. Given the patient's injury pattern, a high level of suspicion must be maintained for cardiac contusion secondary to the seatbelt, airbag deployment or steering wheel impact. Patients who are involved in car accidents can also have deceleration injuries that can result in tearing of the descending thoracic aorta just distal to the subclavian takeoff. Although this patient deserves a multitude of tests (ie chest x-ray, CT with contrast, FAST exam), this point of care ultrasound image can help you arrive at at least three conclusions: 1)The patient is not tachycardic, likely indicating that he is not compensating for massive blood loss. 2) He is adequately volume resuscitated as indicated by a full (but not distended) left ventricle at the mid-papillary level. 3) The patient is likely not suffering from a cardiac contusion, as the left ventricle contracts and thickens in all the way around. This also tells you that the patient has good blood flow to all three distributions of the coronary arteries (RCA LCX, LAD). This is important because trauma patients with decelerating injuries to the aorta may begin to dissect proximally, effecting blood flow to the coronary arteries. Given the normal image in this question, other causes of hypotension should be ruled out.

Case 2:

A 75 year old female with a history of alcohol abuse is admitted from a nursing home with severe epigastric pain radiating the the back. She states that she has not been able to eat or drink for the past 5 days. On review of systems, she additionally complains of nausea, vomiting and bloating. Her serum lipase is 653. Upon admission to the ICU, her heart rate is 130 and her blood pressure is 84/51. Her temperature is 39.1 degrees Celsius but is cool and clammy to the touch. What management decision would you make based upon the following ultrasound image?

Answer: This patient most likely has necrotizing pacreatitis and is septic. The image demonstrates a hyperdynamic, volume-deplete left ventricle. This patient requires immediate vascular access and fluid resuscitation, in addition to blood cultures, antibiotics, scheduled laboratory studies and possibly vasopressors. While the complete pathophysiology of sepsis is outside the scope of this question, it is important to understand that these patients develop leaky capillaries and tend to third-space much of their intravascular volume. As a result, they are hypotensive and require large volumes of crystalloid in order to restore hemodynamic stability and organ perfusion. Studies that should be ordered routinely on these patients include ABG's, CBC's, BMP's and lactates, as a marker of peripheral perfusion.

Case 3:

An 81 year old male with a history of end-stage renal disease is admitted to the ICU from the emergency department, hypotensive. The patient states that he doesn't like going to dialysis because it makes him extremely cold. During your physical exam, you hear a grating, scratching heart sound. In an effort to ascertain the cause of the patient's hypotension, you perform a bedside ultrasound. What is the cause of this patient's hypotension and how is it best managed?

Answer: The image shows a pericardial effusion. While the causes of effusions are many, it is likely that this patient developed a uremic pericardial effusion secondary to routinely missing dialysis. Uremic pericardial effusions are usually insidious and do not cause a great degree of hypotension. This is because the pericardium has time to stretch and accommodate the fluid, meaning that hemodynamically significant cardiac chamber collapse does not occur. This implies that the single most important factor in the development of cardiac tamponade is time to accumulation. The pericardial space can accomodate approximately one liter of fluid without any signs of hemodynamic instability if it occurs over a long period of time. Uremic effusions can present with friction rubs, as was heard here. This can sound like a grating, scratching or rasping when auscultating the heart. The goals for patients in tamponade is to keep the heart full (maintain adequate preload), fast (these patients are dependent on heart rate for cardiac output secondary to inadequate filling volumes) and tight (maintain appropriate afterload). If the patient cannot be stabilized medically, they require either a pericardiocentesis, which may be performed emergently at the bedside with ultrasound guidance, or a pericardial window in the operating room by a cardiothoracic surgeon. If the patient requires sedation or induction of general anesthesia, ketamine is a good choice, in the absence of any contraindications. Ketamine has sympathomimetic properties, which tend to maintain heart rate and blood pressure, as well as spontaneous respirations. Bare in mind that any anesthetic given in induction doses has the potential to cause profound hypotension. Extreme caution should be exercised when anesthetizing any patient in tamponade. Any abrupt decrease in afterload can lead to irrecoverable cardiovascular collapse. For normotensive patients with insidious uremic pericardial effusions, the treatment is to resume scheduled hemodialysis as soon as possible.

Case 4:

A 19 year old male who sustained bilateral femoral shaft fractures has just returned from the operating room after bilateral external fixations. The intraoperative period was uneventful according to the anesthesiologist, but the patient had to be maintained on a phenylephrine infusion that was weaned off on the way up from the operating room. He received two liters of Ringer's lactate and one unit of packed red cells. Upon arrival to the the ICU, the patient's blood pressure is 86/30. Based on the image below, how would you manage this patient?

Answer: The ultrasound image is a short axis mid-papillary view of the left ventricle.

It appears volume-deplete and hyperdynamic, indicating that this patient requires more intravascular volume. Depending on post-operative labs, the patient may benefit from either a blood transfusion or crystalloid. While hypovolemic shock is most likely the cause of the patient's hypotension, it is important to keep in mind that, due to this patient's mechanism of injury, fat emboli syndrome should be included in the differential for hypotension after long bone fractures. This may appear as right heart strain (a dilated right ventricle) secondary to increased pulmonary vascular resistance due to an inflammatory reaction within the lungs. Patients with femoral shaft fractures can sequester a significant amount of blood in the thigh. This may cause compartment syndrome, warranting fasciotomies if neurovascular compromise is suspected.

Case 5:

A 35 year old female is admitted with a ruptured ACA aneurysm. She taken to the operating room for coiling. She comes to the ICU intubated and hypotensive. The following ultrasound image is obtained. What is the next step in management of this patient?

Answer: This image demonstrates apical ballooning of the left ventricle, also known as Takotsubo cardiomyopathy. This is stress induced cardiomyopathy primarily effecting the apex of the heart, as this is the where there exists the highest concentration of catecholamine receptors. This causes an apical stunning and a ballooning of heart during systole. Catecholamine release during intracerebral hemorrhage is common, and can cause EKG changes such as ST elevations or depressions. Care is supportive and the cardiomyopathy will resolve as the primary process is corrected. The patient may require vasopressors and/or inotropic support during this time. A repeat echocardiogram will generally demonstrate resolution of Takotsubo's within 4-8 weeks, with a 95% recovery rate.

Case 6:

A 73 year old female with a history of atrial fibrillation is admitted to the ICU with stroke-like symptoms. She admits to a feeling an irregular heartbeat for the past two months. An EKG demonstrates an irregular heart rhythm with a rate from 105 to 130 beats per minute. A bedside echocardiogram is performed. A medical student asks you about cardioversion. How do you respond?

Answer: The echocardiogram demonstrates a large clot in the left atrium. Given the time course (greater than 48 hours) and the large clot, she is not a candidate for cardioversion, chemical or electrical. She requires therapeutic anticoagulation and rate control.

Case 7:

A 36 year old male is admitted to the ICU status post splenectomy for a Grade 4 splenic laceration due to a jet ski accident. The anesthesiologist reports that the patient was hypotensive throughout the case, requiring a phenylephrine infusion despite 4 liters of crystalloid and one liter of albumin. A TTE is performed. What is the next step in management?

Answer: This patient is profoundly hypovolemic given the size of the left ventricle in this short access view. It is clear that there is very little volume present. The "kissing ventricle" is a phenomenon observed when profound hypovolemia leads to the approximation of opposite sides of the ventricle. The patient has likely third-spaced much of the crystalloid given (approximately 2/3 ends up in the interstitial space) and requires multiple units of blood at this time.

Case 8:

You are the busy provider in the intensive care unit when a nurse comes to you and tells you that their patient has new onset EKG changes. After assessing the patient to evaluate for any hemodynamic instability, you order an EKG and a troponin to evaluate. The EKG shows the following:

What does the EKG show? Atrial Fibrillation- rate controlled

What is your next step? Anticoagulation and beta blocker

You now have a troponin which has resulted: 0.05

What does this mean? The troponin is slightly elevated; however, in the setting of the above EKG tracing, an MI is not likely.

The patient is well rate controlled x 24 hours, however at 36 hours, the patient's heart rate jumps to the 170's in the above rhythm and they become acutely hemodynamically unstable with blood pressures of 50/30 bpm. You give the patient a dose of diltiazem which lowers the heart rate briefly while you obtain the ultrasound to perform a bedside TTE.

The bedside TTE reveals the following ultrasound: TTE 11- ventricular clot

What would your next step be? Ensure the patient is fully anticoagulated and contact the cardiology service to evaluate the large left ventricular clot that is present. (UpToDate Lip, et. al. Left ventricular thrombus after acute myocardial infarction, 2014).

Would you perform cardioversion in this patient due to hemodynamic instability? No, you would give rate lowering medications such as esmolol or metoprolol and tell cardiology to emergently come to the bedside.

Case 9:

You are the provider in the surgical intensive care unit. A 57 year old male patient status post left ankle disarticulation presents to your unit. He has a central line with a central venous pressure of 14 and is making 35 ml/hr of urine. His lab values are mostly all within normal limits and you are pleased with how he is doing. 3 hours after his admission, the nurse comes to you and reports that the patients urine output has decreased to 15 ml/hr.

What do you do? What questions do you need to ask? Ask if the foley catheter is functioning properly. Ensure that the tubing is not kinked and that it is positioned appropriately.

The low urine output of the patient does not really fit the lab values or vital signs that you are presented. After ensuring that the patients foley is correctly positioned and functioning, you decide to do a bedside transthoracic echocardiogram to evaluate the patient for volume status and contractility.

The first image you obtain with the ultrasound is as follows: Lung 6-A-Lines

What is depicted in this image: The apex of the right lung with A lines

Is this normal or abnormal? If the image is normal, how do you know? If abnormal, why is it abnormal? This image is normal. The image depicts A-Lines which are horizontal lines found in normal lung tissue.

You continue to ultrasound him, and find his ultrasound to have the following image: TTE 27- Long-Axis-Hypovolemia

What view is this? This is a parasternal long axis view

How would you interpret this? This image reveals adequate contractility which can be determined by the concentric squeeze of the heart, but this image does reveal a hyperdynamic left ventricle and volume depletion.

You then rotate views to obtain the following image: TTE 28-LV-Shortaxis-Hyperdynamic

What view is this? This is a left ventricular short axis view

Is this images interpretation the same as the prior image? Yes, this image reveals a hyperdynamic left ventricle and volume depletion.

What would you do next? The provider should administer a fluid bolus, despite the CVP and lab values. Often these values do not coincide directly with the images obtained on TTE, however, the adequately trained provider can better assess volume and contractility with TTE than with traditional volume measurements. (Sasai, T., et.al., Reliability of central venous pressure to assess left ventricular preload for fluid resuscitation in patients with septic shock. Journal of Intensive Care 2014).

Case 10:

You are the provider in an emergency department in a rural hospital. A patient presents to your emergency room complaining of chest pain. You immediately order an EKG, troponin, and cardiac echocardiogram. Unfortunately, it is a Sunday morning and there is no technician present to complete a formal echocardiogram, therefore, you decide to perform a bedside transthoracic echocardiogram to evaluate your patient. His vital signs are stable with BP 110/70, heart rate 92, oxygen saturation 96%, and respiratory rate 14 breaths per minute. Upon performing the transthoracic echocardiogram you find the following image: TTE29-pericardial-effusion-parasternal-long-axis.

What view of the heart does this ultrasound depict? Parasternal Long Axis

How and where do you position the probe to obtain this view? The parasternal window is typically found to the left of the sternum around the 3rd through 5th intercostal space. It is possible that this window could be found lower in some patients, especially those with lung diseases, such as COPD. The indicator of the ultrasound probe should be pointed toward the patients right shoulder to obtain this image.

What is normal or abnormal about this ultrasound? This ultrasound depicts a parasternal long axis view that reveals a small pericardial effusion along with good contractility of the left ventricle. The patient appears adequately volume resuscitated which is most likely what is contributing to his normal vital signs.

You then decide to transition from the parasternal long axis view to the parasternal short axis view. How would you make this transition? To transition to the parasternal short axis view, you would rotate the ultrasound probe 90 degrees clockwise until the indicator on the probe is pointing toward the left shoulder. You would then gently tilt the ultrasound probe until the image came into view.

This is the image that you discover upon capturing the parasternal short axis view: TTE30-pericardial-effusion-parasternal-short-axis

How would you describe this image: This is a parasternal short axis view which depicts a moderate pericardial effusion with good contractility and mild hypovolemia.

Does the abnormality in these ultrasound clips need an emergent intervention? An effusion of this size could be monitored with serial ultrasound to monitor for growth of the pericardial effusion, however, this is most likely not the source of the patients chest pain. Considering the patients hemodynamic stability, pericardial tamponade can be ruled out

Case 11:

You are the provider in the intensive care unit and the nurse calls you to the bedside to evaluate a patient due to tachycardia and desaturation. You go to the patient's bedside and find the patient to be tachycardic, normotensive, with a saturation of 89% on 4 L nasal cannula. The patient is slightly edematous, making adequate urine output, and their last set of labs were normal. You decide to obtain a bedside echocardiogram to evaluate the patient.

You perform the echocardiogram and you obtain the following image: TTE15-RV-Dilation-with-D-sign

What view is this image? Parasternal short axis view

What is normal or abnormal about this image? This image reveals a dilated right ventricle with D sign, meaning the right ventricle is intruding on the left ventricle. The left ventricle has adequate contractility and the heart appears euvolemic.

What would be your differential diagnosis at this point, based on the findings of your TTE? Some causes of right heart dilation on TTE are pulmonary embolus, right heart failure, pulmonary hypertension, and volume overload.

Would you consider additional imaging? If so, what would you consider ordering in addition to your echocardiogram to further evaluate this patient? In this patient who is tachycardic and desaturating on oxygen with a left ventricle that appears euvolemic, one should consider a CT PE protocol to rule out pulmonary embolus. The use of ultrasound can assist the provider in the rapid bedside assessment of the patient, however, CTA would be the gold standard for diagnosis of pulmonary embolus. (http://www.iaecho.org/pdf/approach-to-a-dilatedrv-liae.pdf Parahar article A formal echocardiogram should be obtained to further evaluate with a cardiologist.

Case 12:

You are the physician in the surgical intensive care unit of a Level 1 academic trauma center. You are covering the intensive care unit and receive a phone call that a patient is being transferred to you from the floor who had ECG changes on the floor after undergoing a femoral-popliteal bypass for the treatment of claudication. The patient is hypotensive and has poor urine output. The floor physician ordered a full set of labs and cardiac enzymes to be sent. The patient arrives to the ICU with a blood pressure of 83/56, HR-68 (on a beta blocker), O2 sat 93 % on 50% venturi mask, and respiratory rate is 27. The patient arrives with a liter of normal saline hanging on a pressure bag. You decide to perform a bedside transthoracic echocardiogram to evaluate the patient.

The first image that you obtain during your ultrasound is the following: Lung37-B-Lines

What do you call the markings in this image? How would you interpret these findings? This image reveals B-lines. These lines are indicative of volume overload and pulmonary edema.

You continue to perform the transthoracic echocardiogram and obtain the following image: TTE2-Poor-Contractility

What is abnormal about this image? The image reveals an extremely dilated heart with very poor contractility.

What is the most likely diagnosis considering the above findings? This patient most likely has congestive heart failure with pulmonary edema and acute volume overload.

What would be your next step in the care of this patient? Considering the evidence of acute volume overload, this patient would benefit most likely from diuresis. IV diuretics should be utilized considering the patients poor respiratory status. If the patient remains hypotensive, an inotrope should be considering to augment cardiac contractility. A formal echocardiogram, cardiac workup, and cardiology consult should be considered in the care of this patient. Fluids should be minimized in this patient.