CONTINUING EDUCATION

Body Cavity Centesis:
Techniques for the Pleural, Abdominal, and Pericardial Cavities

Body cavity centesis is a valuable and effective treatment for removal of large effusions. Although centesis is generally performed by veterinarians, it is important for veterinary technicians to be knowledgeable about the techniques used to properly prepare, assist with, and monitor these patients. Many methods of performing centesis exist, and the equipment used may vary, but the fundamental concepts remain the same. This article presents those fundamental concepts, examples of equipment, and important details for avoiding complications. Although specific examples are given, other, equally valid methods may be used.

All body cavity centesis procedures should be performed using aseptic technique, including proper hair removal and disinfection of the skin with chlorhexidine or povidone–iodine scrub before entering the body cavity. Failure to do so can lead to serious infections. Samples of all fluid removed from body cavities should be submitted for fluid analysis and histopathologic examination to determine the cause of the effusion.

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DEMONSTRATION of the proper way to hold the catheter for abdominocentesis.

THORACENTESIS

Indications for thoracentesis, also called *thoracocentesis*, include pleural effusion (chylothorax, hemothorax, pyothorax) and pneumothorax. Both pleural effusion and pneumothorax impair respiration, and dyspnea is the primary clinical sign. Pleural effusion impairs respiration as fluid builds up in the pleural space, limiting expansion of the lungs. In the case of pneumothorax, air trapped in the pleural space obliterates the normal negative pressure of the thorax, again making it difficult to expand the lungs.

Thoracentesis either restores the pleural space by removing the fluid or recreates negative pressure by evacuating the trapped air from the thorax. In both cases, full expansion of the lungs can be restored, and breathing becomes easier for the patient.

Equipment typically used for thoracentesis is listed in **BOX 1**.

Procedure

Compartmentalization or a complete mediastinum may prevent complete removal of the effusion from just one side; therefore, thoracentesis is often needed on both sides of the chest. Thoracentesis is generally performed with the patient in sternal recumbency. Two operators are required to safely perform thoracentesis: one to restrain the patient and another to perform the procedure. Having a third person present to assist with the procedure is ideal.

1. Clip both sides of the chest from the 5th to the 11th intercostal space and from at least the costochondral junction to about 65% of the way up the chest wall. If a pneumothorax is suspected, clip the thorax dorsally to the spine. If the patient is in sternal recumbency, fluid will be ventral in the thoracic cavity, but air will be dorsal.
2. After the thoracic wall is properly prepped, palpate the 7th to 9th intercostal space while wearing sterile gloves. Lidocaine may be used for a local anesthetic at the puncture site. If available, ultrasonography may be used to identify the optimal location for

BOX 1 Equipment for Thoracentesis

1. Sterile gloves suitably sized for the sterile operator
2. ~1.5 mL 2% lidocaine for skin block as needed
3. Needle or catheter of suitable length to penetrate the chest wall
4. 3- or 4-way stopcock
5. IV extension tubing
6. 10–60 mL syringe, depending on the size of the patient and volume of effusion expected
7. EDTA tube and plain red top tube for sample collection
8. Basin to hold evacuated effusion
9. Sterile probe cover/sterile gel/elastic band as needed for ultrasonography

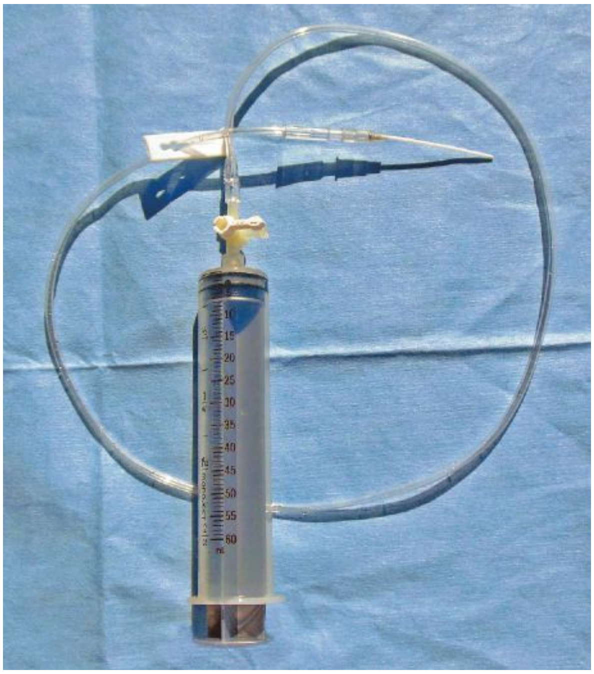

FIGURE 1. Example of how to connect the syringe, stopcock, extension set, and catheter to prepare for any type of body centesis. The assembly is made using aseptic technique. Once completely assembled, the syringe can be handed to a nonsterile assistant who can operate the stopcock during the centesis. This basic configuration can be used for all procedures described in the text and can be easily modified depending on operator preference and available supplies.

• TECHPOINT •

In veterinary medicine, patients often jump not when the needle enters the skin, but when it passes into the pleural space. Therefore, it is good practice to provide some pain control for thoracentesis.

needle insertion. The ultrasound probe should be covered with a sterile probe cover.

3. Attach the needle or catheter to the extension tubing, the extension tubing to the stopcock, and the stopcock to the syringe (**FIGURE 1**). Sterility should be maintained throughout this procedure. Once everything is connected, the syringe can be handed to a second operator, who does not need to be sterile. This person applies gentle negative pressure to the syringe while the first (sterile) operator advances the needle through the thoracic wall.
4. The first operator can now position the needle in the chosen site (7th to 8th or 8th to 9th intercostal space). Advance the needle through the chest on the cranial aspect of the rib to avoid puncturing the intercostal vessels. If effusion is suspected, the needle is positioned ventrally; if pneumothorax is suspected, the needle is placed dorsally. As the needle is advanced into the chest, the second operator keeps a small amount of suction in the system to allow immediate aspiration of any effusion and help avoid inducing a pneumothorax during the procedure.
5. Once fluid (or air, in the event of a pneumothorax) begins flowing into the extension tubing, the first operator must manually secure the needle while the second operator gently aspirates the effusion into the syringe. Samples for histopathology can be collected by turning the stopcock "off" to the patient and expressing a sample into the collection tube. Excess fluid can be emptied into the basin for disposal as needed by turning the stopcock "off" to the patient. Turning the stopcock back to "off" toward the outside will allow resumption of aspiration.
6. The second operator continues aspiration until fluid stops flowing and negative pressure is felt. If the thoracentesis is for pneumothorax, evacuation continues until negative pressure is once again achieved. During aspiration, the second operator should never apply more than 5 mL of negative pressure. Excessive suction may induce a pneumothorax by "pulling" air through the lung tissue.
7. Once the second operator feels only negative pressure, the first operator may try repositioning the needle by changing the angle to determine if any further fluid can be removed at that site. If the first operator is satisfied that no more fluid is available, they may begin withdrawing the needle. Again, the second operator should maintain slight negative pressure during withdrawal.
8. Repeat the above procedure on the other hemithorax, using new supplies.

Ultrasonography is a very useful way of assessing the amount of remaining fluid; thoracic radiographs can also be used to assess the results. In some cases, thoracentesis may need to be repeated every few weeks as part of a therapeutic plan. In such instances, mild sedation may be considered as a gentler approach than simple physical restraint. The pleural lining does have sensory nerve supply, and in human medicine, patients report that thoracentesis is quite painful. In veterinary medicine, patients often jump when the needle is inserted into the thorax. Therefore, it is good practice to provide some pain control for thoracentesis.

Complications

After thoracentesis, the patient should be monitored for dyspnea. Inadvertent puncture of a thoracic or intercostal blood vessel may lead to hemothorax. It is also possible that during the thoracentesis, air may enter the thoracic cavity and induce pneumothorax. Until the cause of the effusion is corrected, a return of the effusion is possible. Signs of hemothorax, pneumothorax, and, in the longer term, infection should be monitored. Provided that aseptic technique was maintained, postprocedural antibiotics are not necessary.

ABDOMINOCENTESIS

Abdominocentesis may be indicated when abdominal distention caused by an effusive fluid, or *ascites*, is present. Importantly, not all patients with large abdomens have effusion. The "5Fs" of abdominal distention are a useful memory device for common causes of enlarged abdomen: *fluid, flatulence, fat, fetus*, and *feces*.

Ascites of sufficient quantity to cause difficulty breathing and results of diagnostic sample analysis are the primary indications for abdominocentesis. Generally, unless the ascites is significant enough to cause dyspnea, treating the cause (e.g., uroabdomen, hemoabdomen) often resolves the problem, and therapeutic abdominocentesis is not necessary. Collection and analysis of diagnostic samples of ascites enable determination of the source of the fluid.

BOX 2 Equipment for Abdominocentesis

1. Sterile gloves suitably sized for the operator
2. ~1.5 mL 2% lidocaine for skin block as needed
3. 18- to 14-gauge over-the-needle catheter (fenestrated or unfenestrated according to operator preference)
4. 3- or 4-way stopcock
5. Extension set
6. Basin to collect the ascites
7. Sterile probe cover/sterile gel/elastic band as needed for ultrasonography

To collect a diagnostic sample, a 21- or 20-gauge needle and a 3- to 5-mL syringe are all that is necessary. After prepping the abdomen, simply pass the needle into the abdomen approximately 1 to 2 cm caudal to the umbilicus on midline and aspirate. The collected sample is sterile and immediately available for analysis.

For therapeutic abdominocentesis, more supplies are required **(BOX 2)**.

Procedure

Several methods for performing abdominocentesis exist. In my experience, the one described below is the most effective.

1. Position the patient in either right or left lateral recumbency. Shave and aseptically prepare the ventral abdomen. If ultrasonography is available, the probe may be covered with a sterile cover and used to locate the largest pocket of fluid. Alternatively, the section of abdomen 1 to 2 cm caudal to the umbilicus is typically a good location. Inserting the catheter directly into the

FIGURE 2. Demonstration of the proper way to hold the catheter for abdominocentesis. The right hand is used to drive the catheter forward while the left hand provides a "stop" to prevent overpenetration. Note that the catheter is placed directly on the midline of the abdomen and will be passed through the *linea alba*. No cap is placed on the catheter, allowing the free flow of ascites once the needle and catheter have penetrated the abdominal wall. Once a flash of ascites is seen, the catheter will be advanced over the needle into the abdomen, the needle discarded, and an IV extension set attached to begin the fluid removal process.

• TECHPOINT •

The "5Fs" of abdominal distention are a useful memory device for common causes of enlarged abdomen: *fluid, flatulence, fat, fetus,* and *feces.*

linea alba in this location seems to provide for the least leakage of fluid after the procedure and avoiding soft abdominal organs. Lidocaine may be used for a local block at the puncture site.

2. Insert the catheter and needle assembly until fluid ("flash") appears in the needle hub **(FIGURE 2)**. Advance the catheter off the needle into the abdomen and discard the needle. Attach the extension tubing to the catheter and place the distal end in the basin. Position the basin lower than the patient. The positive pressure of the abdomen and gravity will allow the fluid to flow from the abdomen through the extension set to the basin. Systems using suction, such as syringes or suction pumps, may be employed; however, in my experience, these methods are more likely to aspirate omentum or organs to the tip of the catheter, thereby necessitating chronic manipulation and potentially increasing the chance of infection, catheter dislodgment, or kinking of the catheter.
3. Allow the fluid to flow passively out of the abdomen until it ceases. Gentle pressure on the abdomen may evacuate more fluid. In patients with transudative ascites from congestive heart failure, removing as much fluid as possible is acceptable. Removal of large volumes of protein-rich effusion may result in hypoproteinemia.[1] Because the goal of abdominocentesis is to improve respiration by relieving pressure on the diaphragm, it is not necessary to remove all the fluid. Once respiration is improved, the cause of the ascites should be addressed directly.
4. Once the fluid is removed, withdraw the catheter and hold dry gauze over the puncture site for 3 to 5 minutes. A small amount of leakage is possible after the gauze is removed. One advantage of entering the abdominal cavity on the *linea alba* is that postprocedural leakage will exit the patient completely, rather than pooling in the ventral subcutaneous tissue. A light belly wrap may be placed for 30 to 45 minutes to absorb any extra abdominal fluid.

If abdominal distention is due to hemoabdomen from trauma or hemorrhage of a soft tissue tumor, abdominocentesis is not always the best treatment. Emergency surgery is indicated in these cases to stop the source of the hemorrhage, and hemoabdomen may in fact slow the bleeding until surgery is performed by creating increased abdominal pressure.[2]

Complications

Complications of abdominocentesis include infection from breaks in aseptic technique, hemorrhage from organ puncture with the catheter needle, and insufficient removal of fluid. Insufficient fluid removal may be the result of the omentum occluding the catheter tip, compartmentalization of fluid, or incompletely passing the needle through the abdominal wall. Because the needle tip extends beyond the catheter tip, a flash may be seen from the needle tip while the catheter tip is still in the tissue of the abdominal wall. In this situation, the catheter tip may track between the layers of the abdominal wall and not pass into the abdominal cavity. This complication can be avoided by *linea alba* placement and by advancing the catheter and needle together another 1 to 2 mm after the flash is seen.

Organ puncture is a common complication. Long-term consequences are rare, but the patient must be monitored closely for onset of anemia. Overadvancing the catheter/needle can be avoided by "choking up" on the needle, leaving only 2 to 3 cm of needle exposed in front of the fingers. Because the abdominal wall is fibrous and tough, a significant amount of pressure is required to pass the needle into the abdominal cavity. Without gripping the catheter and needle near the tip, the operator can easily advance the entire needle length into the patient suddenly when the wall yields.

PERICARDIOCENTESIS

Any abnormal effusion in the pericardium that is significant enough to cause cardiac tamponade warrants pericardiocentesis. *Cardiac tamponade* describes a condition in which the pericardial effusion creates pressure in the pericardium greater than that of the right atrium (RA). The increased pressure causes the RA wall to collapse during diastole, limiting filling of the RA and reducing the amount of blood delivered to the right ventricle and, thus, to the lungs and left heart. This leads to a decrease in cardiac output to the whole body. An echocardiogram is needed to diagnose cardiac tamponade (**FIGURES 3 and 4**).

If cardiac tamponade is not present and cardiac output is not compromised, pericardiocentesis may not be indicated. Clinical signs such as collapse, muffled heart sounds, ascites, and/or tachycardia should raise suspicion of acute pericardial effusion. An electrocardiogram may show diminished QRS amplitude, electrical alternans, and possibly ventricular premature complexes. Paroxysmal ventricular tachycardia may also be noted.

Emergency treatment of pericardial effusion includes intravenous fluid therapy. It should be noted that furosemide is contraindicated in cases of pericardial effusion. Diuretics remove volume from the circulatory system, thereby decreasing cardiac output even more and worsening systemic hypotension.[3] Intravenous fluids are administered to expand blood volume and increase cardiac output. Some patients with pericardial effusion have ascites, and the temptation to use furosemide can be great, but until the pericardial effusion is removed it does more harm than good.

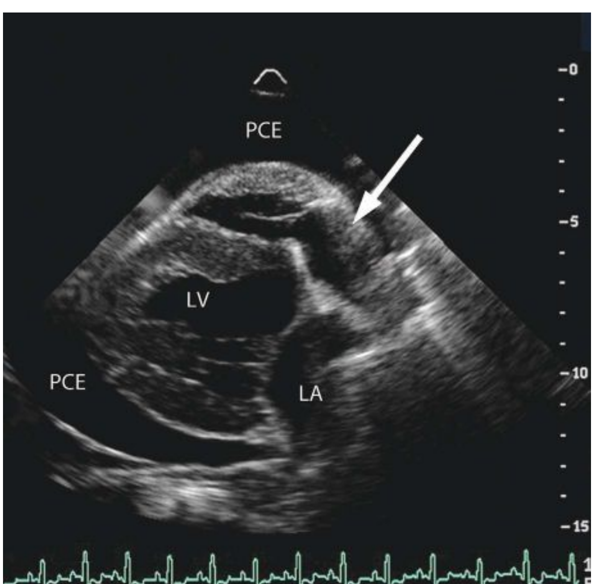

FIGURE 3. Long-axis view of the heart on an echocardiogram. The apex of the heart is to the left of the image, and the atria are toward the right. The left ventricle (LV) and left atrium (LA) are toward the bottom of the image. The pericardial effusion (PCE) can be seen as a large, fluid-filled space around the heart. The bright white line outside the fluid is the pericardium. The right atrium (arrow) is noticeably smaller than the LA, indicating decreased filling due to the pressure of the PCE.

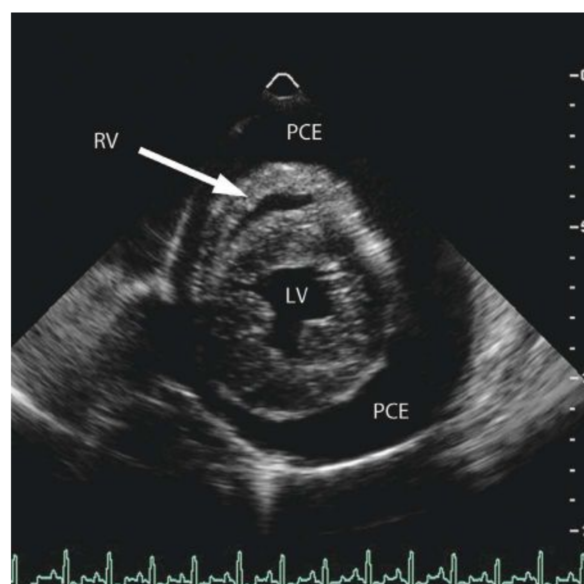

FIGURE 4. Short-axis view of the heart on an echocardiogram. In this plane the heart is transected across the body of the left ventricle (LV), similar to a pineapple slice. The LV is in the center, with the right ventricle (RV) seen as a sliver above it. The pericardial effusion (PCE) is noted around the entire heart. The pericardium is seen as the bright white line outside the PCE.

• TECHPOINT •

Pericardiocentesis is perhaps the most challenging centesis procedure because of the proximity to the heart.

Equipment typically used for thoracentesis is listed in **BOX 3**.

Procedure

Placement of a peripheral indwelling catheter is highly recommended. As stated, cardiovascular support is necessary. Venous access allows for rapid intravenous infusion of lidocaine in the event of significant ventricular arrhythmias. It is a good plan to have one dose of 2 mg/kg lidocaine ready in the event of ventricular tachycardia. Continuous electrocardiography monitoring is recommended to watch for ventricular arrhythmias during the procedure. As for thoracentesis, 2 operators are required to perform a pericardiocentesis; 3 is ideal.

Pericardiocentesis is performed from the right hemithorax to avoid the coronary arteries, which course around the left ventricle.

1. Place the patient in left lateral recumbency, using sedation as necessary to ensure it does not move during the pericardiocentesis.
2. Wearing sterile gloves, and after proper aseptic scrub, the first operator locates the optimal location for the procedure. If available, ultrasonography is useful for this determination, using a sterile probe cover over the probe. Typically, the puncture site is in the 3rd to 5th intercostal space, approximately 1 to 2 cm dorsal to the costochondral junction. Lidocaine is administered at the insertion site and injected into the skin, intercostal muscles, and to the pleura.
3. After final aseptic scrub prep, the patient is draped and a small stab incision is made with the #11 blade. This incision is only about 5 mm long and penetrates the full thickness of the skin to prevent the catheter from becoming burred when passing through the skin. The second operator can attach the stopcock and extension set to the syringe; these connections need not be sterile. The distal end of the extension tube must be kept sterile so that the first operator can handle it without contaminating the field.
4. Using the 14-gauge catheter, the first operator advances the catheter–needle assembly at a 90° angle to the skin into the thoracic wall on the cranial edge of the rib,

BOX 3 Equipment for Pericardiocentesis

1. #11 surgical blade
2. 3- or 4-way stopcock
3. Sterile probe cover/sterile gel/elastic band as needed for ultrasonography
4. Sample tubes
   a. EDTA tube
   b. Plain tube
   c. Activated clotting time tube (gray top) warmed to body temperature
5. 14-gauge × 3.25" catheter or 14-gauge × 2" over-the-needle catheter (length suitable for patient; fenestrated or unfenestrated according to operator preference)[a]
6. 30- or 60-mL syringe
7. Sterile gloves suitably sized for the sterile operator
8. 30" IV extension set
9. Sterile 24 × 24" fenestrated drape
10. Sterile lube packets
11. ~1.5 mL 2% lidocaine for skin block
12. Basin to collect the effusion

[a]Many types of catheters are available for pericardiocentesis. The method described in this article is effective and reasonably priced. Special pericardiocentesis catheters are available with a pigtail configuration to help maintain placement in the pericardium.

and through the pleura to the pericardium (**FIGURE 5**). Pericardial effusion is identical in appearance to blood and will flow freely from the catheter–needle assembly.

5. Once the effusion has begun to flow from the catheter–needle assembly, the catheter is advanced over the needle into the pericardium and the extension set attached. The second operator begins aspirating while the first operator maintains the catheter position.
6. Because pericardial effusion has the same appearance as blood (**FIGURE 5**), it is not possible to tell by observation if the catheter–needle assembly has penetrated a chamber of the heart. Removing more volume from the circulatory system could be catastrophic, so before aspiration continues, correct placement of the catheter tip is confirmed by collecting a sample to perform a coagulation survey (**BOX 4**). Pericardial effusion is devoid of clotting factors because it is *defibrinated* (the fibrin has been broken down by the body); therefore, it does not clot. If the collected sample clots within a predetermined period, the right ventricle has been catheterized and the catheter must be removed and the procedure restarted.
7. Samples for histopathology can be collected by turning the stopcock "off" to the patient and expressing a sample into the collection tube. Excess fluid can be emptied into the basin for disposal as needed by turning the stopcock "off" to the patient. Turning the stopcock back to "off" toward the outside will allow aspiration to resume.
8. The second operator continues aspiration until fluid stops flowing and negative pressure is felt. It is common during the procedure for the first operator to feel the heart beating against the catheter and for premature ventricular contractions to occur as the volume in the pericardium diminishes. Once all available effusion has been removed, the first operator slowly withdraws the catheter while the second operator maintains gentle negative pressure.

A follow-up echocardiogram will confirm removal of the effusion. As the cardiac tamponade is released, the cardiac output increases, and the heart rate generally slows to a more normal rate.

FIGURE 5. Proper placement of the catheter for pericardiocentesis. The catheter is perpendicular to the chest wall. The effusion can be seen in the tubing attached to the back of the catheter. Note that it has the appearance of fresh blood. From this position the catheter is advanced over the needle, the needle discarded, and the drainage line quickly attached to the catheter for effusion evacuation.

FIGURE 6. An example of the supplies needed for pericardiocentesis prepackaged by a veterinary technician for quick access by the veterinarian. The contents of the package are sterile in their original packaging, but the outer package, which is simply to hold all the items together, has not been sterilized. A less-expensive alternative, such as a Ziploc bag, could also be used.

• TECHPOINT •

It is a good plan to have one dose of 2 mg/kg lidocaine ready in the event of ventricular tachycardia.

Complications

During pericardiocentesis, ventricular arrhythmias may be life threatening. If they occur, the catheter should be removed and/or lidocaine administered. Catheter dislodgment during the procedure may necessitate a second puncture, or the pericardial fluid may leak out into pleural space, relieving the clinical signs. In these cases, the pericardial effusion is usually of insufficient quantity to require thoracentesis, but thoracentesis may be performed as needed.

Overadvancement of the catheter into the heart can be a serious complication. Ventricular arrhythmias, palpation of a "bouncing" catheter, and coagulation of the aspirate are all signs of a catheter placed in the heart. Passing the needle into the heart usually causes ventricular premature complexes, but not always. If the heart is punctured, the only course is to remove the needle and start over. Typically, the heart can adapt to a single puncture without complication.

After the procedure, signs of hemothorax, pneumothorax, and, in the longer term, infection should be monitored. Provided that aseptic technique was maintained, postprocedural antibiotics are not necessary. Pericardial effusion may recur within 24 hours, and a second procedure may be necessary. Chronic effusion should be treated with surgical removal of the pericardium to prevent constrictive pericarditis resulting from frequent pericardiocentesis.

CONCLUSION

Veterinary technicians need to be proficient in understanding centesis procedures. Time is often an important factor in the overall outcome of these patients. By anticipating the needs of the veterinarian performing the procedure, the veterinary technician can save valuable time for the patient and improve outcomes. Some small steps the veterinary technician can take to aid the process are having the equipment necessary for the specific procedure collected and prepackaged together to save time (**FIGURE 6**), understanding the indications and clinical signs for conditions that would benefit from a centesis, and being able to monitor the patient after the procedure. Although veterinary technicians do not usually perform these procedures, they are a critical part of their success. ■

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BOX 4 Coagulation Survey During Pericardiocentesis

→ Warm an activated clotting time (ACT) tube (gray top) to body temperature. This can be accomplished using a warming block or water bath or by having one of the operators put the tube next to their skin under an elastic band.

→ Collect a sample from the catheter–needle assembly into the tube, mix, and keep the tube at body temperature.

→ If the collected sample is from the right ventricle, it will clot within 2 minutes. If a clot has not formed after 2 minutes, aspiration is safe and can resume until all available effusion has been removed.

Note: ACT tubes allow rapid assessment of clotting (<2 minutes). However, if an ACT tube is not available, it is possible to create one by adding 30 mg of diatomaceous earth (available at pool supply stores) to a 10-mL red top tube. The resulting tube can be used as described above. If a plain red top tube is used, clotting may take 4 to 5 minutes.