

## VIDEOS IN CLINICAL MEDICINE

## Emergency Pericardiocentesis

Michael T. Fitch, M.D., Ph.D., Bret A. Nicks, M.D., Manoj Pariyadath, M.D.,  
Henderson D. McGinnis, M.D., and David E. Manthey, M.D.

**OVERVIEW**

This supplement provides a summary of the teaching points that appear in the accompanying video, which demonstrates the equipment and techniques used to perform emergency pericardiocentesis in adults.

**INDICATIONS**

Pericardiocentesis is indicated as an emergency procedure in patients with cardiac tamponade. Accumulation of fluid in the pericardial sac can increase the pressure around the heart. The intrapericardial pressure then increases until it equals the right ventricular diastolic pressure and then the left ventricular diastolic pressure, which leads to impaired cardiac filling and decreased cardiac output.<sup>1</sup> The drop in cardiac output resulting from this increased pressure can be severe enough to cause pulseless electrical activity. Because of the distensibility of the pericardial sac, large amounts of fluid can accumulate gradually without hemodynamic effects. However, rapid accumulation of a small amount of fluid may overwhelm the distensibility of the pericardium with a rapid increase in intrapericardial pressure, leading to hemodynamic compromise.<sup>2</sup>

The classic presentation of patients with pericardial tamponade includes Beck's triad of jugular venous distention from elevated systemic venous pressure, distant heart sounds, and hypotension.<sup>3</sup> Most patients will have at least one of these signs; all three rarely appear simultaneously, and then only briefly before cardiac arrest. Jugular venous distention can be difficult to assess in obese or hypovolemic patients. Distant heart sounds may signify a pericardial effusion but can also occur in response to obesity or chronic obstructive pulmonary disease. A pericardial friction rub may or may not be present, regardless of the size of the effusion,<sup>1</sup> but is often present with an inflammatory effusion.<sup>2</sup> Tachypnea is a common clinical finding in patients with cardiac tamponade,<sup>1</sup> and dyspnea is the most frequently reported symptom on presentation,<sup>4</sup> with a sensitivity of about 87 to 88% for cardiac tamponade.<sup>1,5</sup>

Other signs of cardiac tamponade include a pulsus paradoxus (a drop in systolic pressure greater than 10 mm Hg during normal inspiration), an electrocardiogram with a low-voltage QRS or electrical alternans, and Kussmaul's sign, in which there is increased jugular venous distention on inspiration. In most cases, acute pericardial fluid collection is not detected on chest radiography unless more than 200 ml of fluid has accumulated. Enlarged cardiac silhouettes are more likely to be seen in cases of postsurgical or chronic pericardial fluid collections. In such patients, the detection of cardiomegaly on chest radiography has a sensitivity of about 89% for cardiac tamponade.<sup>1</sup>

The rate of pericardial fluid accumulation has a sizable effect on the rate of clinical decompensation. The pericardial sac normally contains 15 to 30 ml of serous fluid.<sup>1</sup> A patient with a rapidly accumulating pericardial effusion may present with severe respiratory distress, agitation, tachycardia, and hypotension, followed by quick progression to obtundation, bradycardia, and pulseless electrical activity.

From Wake Forest School of Medicine, Winston-Salem, NC. Address reprint requests to Dr. Fitch at the Department of Emergency Medicine, Wake Forest School of Medicine, Medical Center Blvd., Winston-Salem, NC 27157, or at mfitch@wakehealth.edu.

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Pericardial tamponade can result from the accumulation of effusion fluids, blood, infectious purulent material, or gas within the pericardial space. Simple pericardial effusions with a single collection of serous fluid may be amenable to uncomplicated pericardiocentesis, but drainage of more complex effusions, such as loculated collections of infectious material, may be more difficult.

Patients at risk for pericardial tamponade include those with metastatic cancer, a history of mediastinal radiation, end-stage renal disease, recent cardiac surgery, or traumatic injury. Other causes of pericardial tamponade may include pericarditis, myocardial infarction, congestive heart failure, collagen vascular disease, and tuberculosis.<sup>1</sup> Pericardial tamponade should be considered as a possible cause of cardiac arrest with pulseless electrical activity.

Beside ultrasonography can be used to detect the presence of pericardial fluid and features of pericardial tamponade. Practitioners without ultrasound expertise should consider consultation with a qualified radiologist or cardiologist for assistance in interpreting diagnostic studies, depending on a patient's clinical circumstances. The presence of pericardial fluid and the diastolic collapse of the right atrium or ventricle are diagnostic of pericardial tamponade.<sup>1,2,5,6</sup> Other findings that may further support this diagnosis include a dilated inferior vena cava without respiratory variations in size or changes in flow velocities across the tricuspid and mitral valves.<sup>1,2,6</sup>

In patients with pericardial tamponade, emergency pericardiocentesis to aspirate pericardial fluid can restore normal cardiac function and peripheral perfusion. It can be a lifesaving procedure.

#### CONTRAINDICATIONS

Emergency pericardiocentesis is not indicated for a patient with a pericardial effusion and stable vital signs. This condition should be monitored and further evaluated with echocardiography, and appropriate medical management should be initiated; this may include a scheduled nonemergency drainage procedure.

The combination of a traumatic pericardial effusion and unstable vital signs is a relative contraindication to emergency pericardiocentesis, since these circumstances are an indication for emergency thoracotomy. Although pericardiocentesis can be used as a temporizing measure, the patient will still require an urgent thoracotomy or creation of a pericardial window, since ongoing bleeding can cause a rapid reaccumulation of blood within the pericardium.<sup>7</sup>

Other relative contraindications to emergency pericardiocentesis include myocardial rupture, aortic dissection, and a severe bleeding disorder. The first two conditions are cause for immediate surgery, which should not be delayed by the performance of pericardiocentesis. Severe bleeding disorders will predispose patients to continued bleeding and a rapid reaccumulation of pericardial fluid; they require coordinated medical and surgical efforts. However, in a patient whose condition is unstable and in whom emergency pericardiocentesis could be used to relieve a life-threatening pericardial tamponade, there are no absolute contraindications for the procedure.

#### EQUIPMENT

Appropriate universal precautions for potential exposure to bodily fluids should be used when performing this invasive procedure. Hand washing before beginning patient care is an important part of every procedure. The physician should wear a gown, gloves, and a face mask with shield. Sterile technique should be observed as time allows, including the use of an antibacterial skin cleanser. Hemodynamic monitoring is warranted. Because the procedure is being performed in emergency conditions, there may be a need for cardiac resuscitation; therefore, a code cart,

resuscitation equipment, and appropriate medications, including atropine, should be immediately available.

Pericardiocentesis should be performed with ultrasound guidance whenever a bedside ultrasound machine is available. Otherwise, a wire with alligator clips and an electrocardiograph machine can be used to watch for the pattern of ST-segment injury that occurs when the myocardium is contacted.

Materials needed for the actual emergency pericardiocentesis procedure include an 18-gauge spinal needle, a polytef-sheathed needle, or another suitable needle, a three-way stopcock, and a 20-ml syringe.<sup>7</sup> Depending on the urgency and the equipment at hand, it may be necessary to proceed with a modified list of materials.

#### PREPARATION

Rapidly assemble the materials needed for pericardiocentesis and place them within easy reach at the bedside. Continuous hemodynamic monitoring should be used to watch for signs of decompensation during pericardiocentesis.

Before beginning the procedure, locate the appropriate surface landmark by palpating the xiphoid process. After donning sterile gloves, quickly wash a wide area of the patient's anterior chest wall and upper abdominal area with an antibacterial skin cleanser. If the patient's clinical condition allows, raise the head of the bed 30 to 45 degrees, which will give you more direct access to the pericardial fluid collection. Drape the area with sterile towels. Because of the time-sensitive nature of this procedure during an emergency, local anesthesia is not typically used. Local anesthetic is appropriate when the patient is awake and alert and emergency pericardiocentesis is not required.

#### PROCEDURE

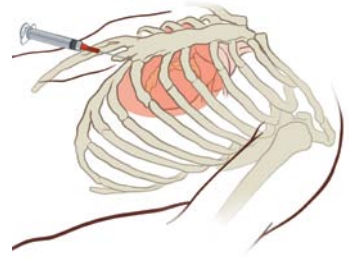
Three options for performing emergency pericardiocentesis are presented here. Other methods and variations used by advanced practitioners are not described in detail here; these include the use of a rightward needle direction during the subxiphoid approach and an apical approach. Ultrasound-guided pericardiocentesis is recommended, since it allows direct visualization of the needle as it enters the pericardial effusion and can assist the practitioner in determining which approach is most likely to successfully drain the pericardial fluid. Regardless of fluid location as visualized on ultrasonography, a subxiphoid or apical approach may be required if ongoing resuscitation efforts include cardiopulmonary resuscitation. If an ultrasound machine is not available, electrocardiographic monitoring is recommended to indicate when the needle makes contact with the myocardium. A blind approach can be attempted if neither electrocardiographic monitoring nor an ultrasound machine is immediately available, but this method is often associated with unacceptably high morbidity and mortality as compared with a method involving electrocardiographic or ultrasonographic monitoring.<sup>8</sup>

The subxiphoid approach to emergency pericardiocentesis begins just below the xiphoid process and the left costal margin.<sup>7,9</sup> Insert the spinal needle with the stylet in place to prevent dermal tissue from plugging the needle (Fig. 1).<sup>7</sup> Other needles with a steel core, such as a 16- to 18-gauge polytef-sheathed needle, may also be used.<sup>6</sup> If a needle with stylet is not available, an alternative technique is to nick the skin with a scalpel before inserting the needle.<sup>2</sup> Once the needle has punctured the skin, remove the stylet and attach a three-way stopcock and 20-ml syringe. Advance the needle toward the left shoulder while aspirating continuously (Fig. 2).

Using real-time ultrasound imaging, guide the needle toward the largest collection of pericardial fluid while watching the ultrasound screen and simultaneously recording video clips (Fig. 3). Withdraw fluid from the pericardial effusion by



**Figure 1.** Insertion of the Spinal Needle in the Subxiphoid Approach.



**Figure 2.** Advancement of the Needle toward the Left Shoulder.



**Figure 3.** Emergency Pericardiocentesis Performed with Real-Time Ultrasound Guidance.



**Figure 4.** Tubing Attached to a Three-Way Stopcock for Continued Drainage of the Pericardial Effusion.

aspirating with the syringe. Removing even a small amount of fluid can lead to dramatic improvements in cardiac output and blood pressure.

Once the needle is properly oriented to remove fluid easily, empty fluid from the syringe by attaching tubing to the three-way stopcock (Fig. 4), which will allow continued drainage of the pericardial effusion with no movement of the needle. Continue to remove pericardial fluid until vital signs normalize and no further fluid can be removed from the pericardium. If the removal of a small amount of pericardial fluid has the effect of stabilizing the patient's condition, drainage tubing may not be required.

The parasternal approach is an alternative method of performing emergency pericardiocentesis.<sup>7</sup> Insert the needle perpendicular to the chest wall in the fifth intercostal space, just lateral to the sternum (Fig. 5). Use ultrasonography to locate the largest portion of the effusion that is close to the body surface, and guide the needle into the pericardial sac to aspirate fluid. Another ultrasound-guided technique that is not described here is the apical approach, in which the needle is inserted in the intercostal space below and 1 cm lateral to the apical beat, aimed toward the right shoulder.<sup>7</sup>

If ultrasonographic guidance is not available, attach a sterile alligator clip and wire to the spinal needle and connect the wire to a precordial lead on a continuous electrocardiographic monitor (Fig. 6).<sup>7</sup> As you advance the needle, monitor the electrocardiographic tracing for ST-segment elevation, which indicates that the needle has been advanced too far and is in contact with the myocardial surface. If this occurs, withdraw the needle until ST-segment elevation resolves, then redirect the needle to obtain pericardial fluid.

Blind pericardiocentesis can be performed by entering the skin just below the xiphoid process and the left costal margin at a 45-degree angle and advancing the needle toward the left shoulder. This blind technique is associated with a higher rate of complications than the techniques guided by ultrasonography or electrocardiography and therefore should be performed only in an emergency, when neither of these two forms of monitoring is immediately available.<sup>8</sup>



**Figure 5.** The Parasternal Approach to Pericardiocentesis, in Which the Needle Is Inserted in the Fifth Intercostal Space, Just Lateral to the Sternum.

#### AFTERCARE

After pericardiocentesis is complete, visualize the heart with ultrasonography to confirm the removal of the pericardial fluid and adequate cardiac function. Continue resuscitation as needed, depending on the patient's hemodynamic response to the procedure.

Obtain a chest film after completing the procedure to assess for complications such as a pleural effusion or pneumothorax. Continue to monitor the patient for signs of hemodynamic instability and for physical findings that suggest fluid is continuing to accumulate in the pericardial sac. Definitive care may include placement of a soft catheter in the pericardial space or surgical placement of a pericardial window to allow for continuous drainage.<sup>2,7</sup> Consider consultation with an appropriate specialist to assist with the management of patient care after completing an emergency pericardiocentesis, as clinically indicated.

#### COMPLICATIONS

As with any invasive procedure, complications may occur. Those most often associated with this lifesaving procedure are cardiac dysrhythmias, cardiac puncture, pneumothorax, and coronary-vessel injury. Other complications associated with pericardiocentesis include peritoneal puncture (with the subxiphoid approach), liver or stomach injury (also with the subxiphoid approach), puncture of the internal thoracic artery (with the parasternal approach), and diaphragmatic injury (with the subxiphoid approach). Pericardiocentesis can also result in death.<sup>7,9</sup>



**Figure 6.** Pericardiocentesis Performed with Electrocardiographic Guidance, Recommended When Ultrasound Guidance Is Not Available.

**SUMMARY**

Emergency pericardiocentesis can be a lifesaving procedure when pericardial tamponade is present. Ultrasound guidance is recommended to minimize the potential complications of this procedure.<sup>10,11</sup> After completing the procedure, continue to monitor the patient for signs or symptoms of recurrent tamponade until definitive care can be provided.

No potential conflict of interest relevant to this article was reported.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

**REFERENCES**

1. Roy CL, Minor MA, Brookhart MA, Choudhry NK. Does this patient with a pericardial effusion have cardiac tamponade? *JAMA* 2007;297:1810-8.
2. Spodick DH. Acute cardiac tamponade. *N Engl J Med* 2003;349:684-90.
3. Beck C. Two cardiac compression triads. *JAMA* 1935;104:714-6.
4. Gandhi S, Schneider A, Mohiuddin S, et al. Has the clinical presentation and clinician's index of suspicion of cardiac tamponade changed over the past decade? *Echocardiography* 2008;25:237-41.
5. Cooper JP, Oliver RM, Currie P, Walker JM, Swanton RH. How do the clinical findings in patients with pericardial effusions influence the success of aspiration? *Br Heart J* 1995;73:351-4.
6. Pepi M, Muratori M. Echocardiography in the diagnosis and management of pericardial disease. *J Cardiovasc Med (Hagerstown)* 2006;7:533-44.
7. Harper RJ. Pericardiocentesis. In: Roberts JR, Hedges JR, eds. *Clinical procedures in emergency medicine*. 5th ed. Philadelphia: Saunders Elsevier, 2010:287-307.
8. Salem K, Mulji A, Lonn E. Echocardiographically guided pericardiocentesis — the gold standard for the management of pericardial effusion and cardiac tamponade. *Can J Cardiol* 1999;15:1251-5.
9. Kennedy UM, Mahony NJ. A cadaveric study of complications associated with the subxiphoid and transthoracic approaches to emergency pericardiocentesis. *Eur J Emerg Med* 2006;13:254-9.
10. Heller K, Joing S, Dolan B, Reardon R. Emergency echocardiography. *Acad Emerg Med* 2007;14:1157.
11. Garth AP, Hwang JQ, Schuur JD, Rosborough S. Ultrasound guided pericardiocentesis of cardiac tamponade. *Acad Emerg Med* 2009;16:811.

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