Responding to a Cardiac Emergency:

PERICARDIAL EFFUSION IN CANINE PATIENTS

Oriana D. Scislowicz, BS, LVT
CVCA - Cardiac Care for Pets, Richmond, Virginia

Pericardial effusion is considered a cardiac emergency situation that is most commonly seen in canine patients. It is very important, especially for veterinary technicians in emergency care facilities, to be able to recognize the signs of pericardial effusion and quickly respond.

PATHOPHYSIOLOGY
The normal pericardium has an outer fibrous pericardium and inner serous pericardium, which consists of a parietal and visceral layer (Figure 1). The pericardial cavity—the area between these two layers of the serous pericardium—normally contains 1 to 15 mL of a plasma ultrafiltrate.1

Even though animals can survive and function normally without an intact pericardium, the pericardium serves many important purposes. The pericardium:

• Structurally supports the heart in the thorax, preventing excessive motion of the heart
• Protects the heart from neoplasia and infections.

Pericardial Effusion
Excessive fluid in the pericardial space is called pericardial effusion. When effusion accumulates slowly, the pericardium can enlarge to accommodate this increase in volume and, if intrapericardial pressure is low, clinical signs may not be present and cardiac function remains relatively normal.

When effusion accumulates quickly or intrapericardial pressure rises quickly, intrapericardial pressure surpasses the normal diastolic pressure in the right ventricle and cardiac tamponade occurs.2 Pericardial effusions of large volumes can also compress the lungs and trachea, causing respiratory difficulties and coughing. When the esophagus is compressed by excess fluid buildup, dysphagia or regurgitation may occur.3

Cardiac Tamponade
Cardiac tamponade results in a decrease in venous return, stroke volume, cardiac output, and ventricular filling. Therefore:

• The body tries to compensate by increasing heart rate and peripheral vascular resistance to help maintain normal blood pressure.
• As intrapericardial pressure continues to rise, it causes collapse of the right side of the heart, preventing cardiac output into the pulmonary artery.
• Since blood is no longer leaving the right side of the heart, there is no venous return to the left atrium and ventricle,2 eventually resulting in cardiogenic shock manifested by lethargy, hypotension, poor pulse quality, and tachycardia.

CAUSES
Congenital Causes
Congenital causes of pericardial effusion may include:1

• Peritoneopericardial diaphragmatic hernia: A condition in which the septum transversum fuses with the pleuroperitoneal folds, creating an incomplete separation of the abdominal and thoracic cavities and usually resulting in a small amount of fluid accumulation. However, gastrointestinal signs are more commonly noted due to the presence of abdominal organs within the pericardial cavity.
• Pericardial cysts: Another congenital cause of pericardial effusion, but they are much rarer and often asymptomatic.

Acquired Causes
An acquired cause of pericardial effusion is pericarditis, which stems from neoplastic, immune, inflammatory, and, occasionally, infectious disease processes.

• Neoplastic processes are the most common cause of pericardial effusion and cardiac tamponade:
  » Hemangiosarcoma is commonly found in

FIGURE 1. Diagram depicting relationship between the pericardium and heart.
Chemodectomas are often found at the heart base, and mesotheliomas and metastatic tumors may be identified. Idiopathic pericardial effusions are linked to inflammatory or immune processes. Thickening of the epicardium and pericardium may be seen during histologic examination, along with associated inflammation. Infectious processes occur least commonly, but can include fungal disease, such as coccidiomycosis, and, rarely, bacterial pericarditis. Congestive heart failure, uremia, and decreased oncotic pressure can result in small-volume pericardial effusion, usually without cardiac tamponade.1

PRESENTATION

Prevalence
Pericardial effusion is commonly seen in golden retrievers and other medium to large breed dogs. Any age dog can be affected, although one study noted the median age of dogs with idiopathic pericardial effusion was 7 years, while in dogs with nonidiopathic effusions, the median age was 9 years.4 This same study found a higher prevalence of pericardial effusions in male dogs.

Clinical Signs
Patients experiencing chronic pericardial effusion may demonstrate weakness, abdominal enlargement, cough, tachypnea, and episodes of syncope. In those with acute pericardial effusion, acute episodes of collapse and weakness may be evident.2 As pericardial fluid accumulates, shock and death can occur.

Physical Examination

Table 1 lists cardiac signs that may be noted upon physical examination of patients with pericardial effusion. The patient frequently has a decreased level of consciousness due to a decrease in oxygen delivery to the brain,1 and patients with infectious pericarditis may be febrile.2

TYPES OF FLUID
While it is important to understand which types of pericardial effusion are more likely to be seen with certain conditions, cytology of pericardial effusions is rarely able to differentiate between neoplastic and idiopathic causes. The etiology of pericardial effusions is most commonly determined by echocardiography (see Management, page 72).

Hemorrhagic effusions are common in dogs, while transudates are moderately frequent in dogs and cats. Exudative effusions are fairly rare in small animals.

Hemorrhagic Effusions
Hemorrhagic effusions appear dark red, with a:

- Packed cell volume > 7%
- Specific gravity > 1.015
- Protein concentration > 3 g/dL.

Hemorrhagic pericardial effusions in canine patients are commonly caused by hemangiosarcoma. Heart base tumors, pericardial mesotheliomas, malignant histiocytosis, lymphoma, and metastatic carcinomas may also cause hemorrhagic pericardial effusion.

<table>
<thead>
<tr>
<th>CLINICAL SIGN</th>
<th>FURTHER DESCRIPTION</th>
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<tbody>
<tr>
<td>Increased heart rate</td>
<td>• Results from decreased cardiac output</td>
</tr>
<tr>
<td></td>
<td>• Due to sympathetic nervous system activation</td>
</tr>
<tr>
<td>Jugular distention</td>
<td>Results from decreased output from right side of the heart, which causes a backup of blood into the cranial vena cava and jugular veins</td>
</tr>
<tr>
<td>Muffled heart sounds</td>
<td>Noted on auscultation</td>
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<tr>
<td>Pale mucous membranes</td>
<td>Result from vasoconstriction and decreased peripheral perfusion</td>
</tr>
<tr>
<td>Poor pulse quality</td>
<td>Due to lower stroke volumes and blood pressure</td>
</tr>
<tr>
<td>Pulsus paradoxus</td>
<td>• Decrease in systolic blood pressure (&gt; 10 mm Hg) during inspiratory phase of breathing</td>
</tr>
<tr>
<td></td>
<td>• Seen in instances of cardiac tamponade</td>
</tr>
<tr>
<td></td>
<td>• Detected by palpating pulse pressure in a peripheral artery (ie, the femoral artery)</td>
</tr>
<tr>
<td>Slower capillary refill time</td>
<td>Results from decreased cardiac output</td>
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Note: While pericardial effusion itself does not create a murmur, concurrent cardiac disease may result in one.
Idiopathic pericardial effusion is another cause of hemorrhagic pericardial effusions, most commonly seen in medium to large breed dogs, such as golden retrievers, Labrador retrievers, and Saint Bernards. Male dogs of a median age of 7 years are commonly affected. Less common causes of hemorrhagic pericardial effusion include left atrial rupture, coagulopathy, penetrating trauma, and uremic pericarditis.

Transudative Effusions
Pure transudative fluids are typically clear, with a specific gravity < 1.012 and protein concentration < 2.5 g/dL. In contrast, modified transudates often appear slightly cloudy or have a pink tinge, with a specific gravity of 1.015 to 1.030 and protein concentration of 2.5 to 5 g/dL.

Causes of transudative effusions include congestive heart failure, hypoalbuminemia, peritoneopericardial diaphragmatic hernia, pericardial cysts, and certain toxemias.

Exudative Effusions
Exudative effusions appear cloudy to opaque, with a protein concentration > 3 g/dL and specific gravity > 1.015. Although not common in small animals, sterile exudative effusions have been seen in dogs with leptospirosis, distemper, bacterial pericarditis, and idiopathic pericardial effusion, and in cats with feline infectious peritonitis and toxoplasmosis.

DIAGNOSTICS
Imaging
Although less sensitive than echocardiography, radiography can be a useful start for primary care facilities. The overall cardiac silhouette appears enlarged, and excessive amounts of fluid can cause a globoid-shaped heart on both the ventrodorsal and lateral views (Figure 2).

Advanced imaging, such as magnetic resonance imaging, is now being used more often to diagnose the presence of cardiac masses in patients with pericardial effusion.

Echocardiography
Echocardiography is the most frequently used test for detection of pericardial effusion and diagnosis of pericardial masses.

Pericardial Effusion. Smaller effusions are first seen over the posterobasal part of the left ventricle. The effusion appears as a sonolucent, echo-free void between the parietal pericardium and the epicardium (Figure 3). In patients with large quantities of fluid, the heart may appear to be swinging back and forth during echocardiography. When the effusion has increased and is circumferential, it may be graded as small, moderate, or large (Table 2).

Cardiac Tamponade. When cardiac tamponade occurs, diastolic collapse of the right atrium and, sometimes, the right ventricle may be seen during the echocardiogram. The heart may also “swing,” because it floats within the pericardial space in a phasic fashion. In these patients, right atrial collapse may last longer during the systolic phase. Lastly, hepatic vein distension and ascites can help support the presence of cardiac tamponade as well.

<table>
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<tr>
<th>GRADES</th>
<th>ECHO-FREE SPACE IN DIASTOLE</th>
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<tbody>
<tr>
<td>Small effusions</td>
<td>&lt; 10 mm</td>
</tr>
<tr>
<td>Moderate effusions</td>
<td>Usually 10–20 mm</td>
</tr>
<tr>
<td>Large effusions</td>
<td>&gt; 20 mm</td>
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Electrocardiography
Electrocardiography (ECG) can also be a useful diagnostic tool, especially when determining the presence of cardiac tamponade.
• Low-voltage (small) QRS complexes are common. Reduced voltage can also be caused by pneumothorax, emphysema, and infiltrative myocardial disease.5
• Electrical alternans occurs when the size or configuration of the QRS complex, and occasionally the T wave, changes beat-to-beat. This ECG finding may suggest a large volume of pericardial effusion, and results from the heart moving back and forth within the pericardium (Figure 4).
• Sinus tachycardia is common in cardiac tamponade; while less frequent, atrial or ventricular tachyarrhythmias may occur as well.2

MANAGEMENT
Pericardiocentesis
When cardiac tamponade is present, immediate pericardiocentesis is indicated. Reduction of pericardial pressure by removal of fluid results in greater cardiac output and a decreased heart rate, which should improve the clinical condition of the patient. Diuresis—which takes place after cardiac tamponade is relieved—typically resolves any ascites. If ascites is severe, it can be removed to make the patient more comfortable and relieve ventilatory compromise.6

To assist with performing pericardiocentesis, the veterinary technician:
• Positions the patient in left lateral recumbency (procedure ideally performed on right side)
• Provides sedation with a benzodiazepine and opioid, if necessary
• Can provide oxygen supplementation via flow by or mask
• Places a peripheral IV catheter in the cephalic vein (Table 3)
• Shaves and scrubs a square over the fourth and fifth intercostal space, where the cardiac apex beat is palpated

TABLE 3. Equipment Needed for Pericardiocentesis

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<tr>
<th>Item</th>
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<tr>
<td>14–18 gauge polypropylene catheter</td>
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<tr>
<td>3-way stopcock</td>
</tr>
<tr>
<td>2% lidocaine</td>
</tr>
<tr>
<td>Clippers</td>
</tr>
<tr>
<td>Collection vessel</td>
</tr>
<tr>
<td>EDTA and plain test tubes</td>
</tr>
<tr>
<td>Intravenous extension set</td>
</tr>
<tr>
<td>Large syringes (appropriately suited for patient size)</td>
</tr>
<tr>
<td>Scalpel blade</td>
</tr>
<tr>
<td>Scrub</td>
</tr>
<tr>
<td>Sterile gloves</td>
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</table>

FIGURE 4. Electrocardiogram demonstrating electrical alternans, in which the height of the QRS complex alternates with each beat due to the heart swinging within the pericardium. This finding is rate dependent and more commonly seen at a normal heart rate.
Percutaneous balloon pericardiotomy requires only minimal sedation, usually a narcotic and benzodiazepine, and a local anesthetic, making it relatively safe for unstable or critical patients. However, it doesn't allow exploration or biopsy of the heart or pericardium.  

This procedure was reported to be successful in 4 out of 6 canine patients with recurrent pericardial effusion, and may be considered in patients with a poor long-term prognosis as a result of neoplasia.  

**IN SUMMARY**

The ability to recognize potential history and clinical signs consistent with pericardial effusion can greatly improve the technician’s triage skills. Rapid detection of clinical signs of pericardial effusion, along with swift implementation of treatment, can lead to a more successful outcome for the patient.

**ECG** = electrocardiography

**References**


**Suggested Reading**


**ORIANA D. SCISLOWICZ**

Oriana D. Scislowicz, BS, LVT, is Team Leader of CVCA - Cardiac Care for Pets, Richmond, Virginia. She currently serves on the editorial advisory board of *Firstline*, and has served on the executive board of the Virginia Association of Licensed Veterinary Technicians. Ms. Scislowicz writes for publications, such as *NAVTA Journal, Firstline, VetTechLife*, and *Today’s Veterinary Practice*. She received her BS in psychology from Virginia Commonwealth University and her AAS in veterinary technology from Blue Ridge Community College.