Pericardial effusion (PE) is the accumulation of fluid within the pericardial sac (Figure 1). Investigation as to the cause of the PE, as well as its drainage, are essential to allow specific treatment and accurate assessment of prognosis. Most commonly, the fluid appears serosanguineous, although in some cases it may be a clear transudate, whole blood, chyle, or a septic exudate. In dogs, PE is primarily caused by neoplastic disease, with right atrial haemangiosarcoma (Figure 2) representing the most common tumour.

Other neoplastic causes of PE in dogs are heart base tumours (chemodectomas), mesothelioma and lymphoma. Left atrial tears, infections, haemorrhage, trauma and foreign bodies are other less common causes of PE. When a primary cause cannot be identified, the effusion is termed ‘idiopathic’. In cats, PE is less commonly observed and is usually the result of congestive heart failure or feline infectious peritonitis, although other more rare aetiologies have also been reported.

When to perform pericardiocentesis
As fluid collects in the pericardial sac, it markedly impedes the filling ability of the heart (diastolic dysfunction). Since the right side of the heart tends to “suffer” most because of its thinner wall, PE normally results in signs of right-sided congestive heart failure, with pleural effusion, jugular pulsation–distension, liver congestion and ascites. Pericardial effusion causing these clinical signs is also referred to as cardiac tamponade.

The fluid accumulated in the pericardial sac needs to be removed (pericardiocentesis) as soon as possible, using one of the several techniques available. Many dogs and cats tolerate pericardiocentesis unsedated, although mild sedation may be necessary in some cases. The withdrawal of even a small amount of pericardial fluid may dramatically and rapidly improve the patient’s haemodynamic status.

How to prepare the patient for the procedure
Most clinicians prefer to restrain the animal in left lateral recumbency in order to approach the pericardium from the right side of the chest, therefore avoiding the risk of puncturing the branches of the left coronary artery. However, other clinicians prefer a right-sided approach with the patient in sternal recumbency. The cranioventral part of the right hemithorax (see Figure 3) should be...
surgically prepared and a surgical drape placed on the chest to avoid any hair contamination. The operator should wear surgical gloves and maintain the sterility of the operational area and instruments throughout the procedure.

Electrocardiographic (ECG) monitoring allows identification of rhythm abnormalities during pericardiocentesis; these are usually represented by ventricular ectopics that may occur when the needle or the catheter touches the epicardial surface of the heart. The amplitude of the ECG complexes tends to increase as soon as the pericardial fluid drainage is started, reaching a normal amplitude after successful completion of the procedure. Some clinicians prefer to perform the procedure under ultrasound guidance, in order to visualise the penetration of the needle in the pericardial sac and assess the amount of residual fluid during drainage. However, ultrasonographic guidance is not crucial for pericardiocentesis and it requires additional precautions to maintain the sterility of the surgically prepared area and operator’s hands.

Anecdotal recommendations advocate a rapid intravenous infusion of an isotonic crystalloid solution prior to pericardiocentesis in an attempt to restore the systemic blood pressure. However, it is unclear whether this intervention is really beneficial, since most of the infused fluid may be retained within the venous bed due to the reduced venous return caused by cardiac tamponade.

A clotting profile should be considered prior to pericardiocentesis in all cases when rodenticide poisoning cannot be completely ruled out in the patient’s history.

**Where and how to insert the needle**

Several different pericardiocentesis techniques are possible depending on personal preference and the equipment available. The general principles behind them are similar and are discussed below, with three specific techniques described later in more detail.

- Regardless of the chosen pericardiocentesis technique, the needle needs to be inserted at the level of the 5th or 6th right ventral intercostal space (Figure 3).
- Before inserting the needle, local anaesthetic (e.g. lidocaine) is infiltrated under the skin at the insertion point.
- After approximately one minute, an equal volume of local anaesthetic is injected deeper, at the level of the intercostal muscles and parietal pleura (Figure 4A).
- A small stab incision is made through the skin with a No. 11 scalpel blade (Figure 4B).
- The needle is then inserted through the needle tip and the heart notch where there is no lung tissue between the pleural triangle (often called the cardiac notch) and advanced through the 5th or 6th right ventral intercostal space (costochondral junction) and advanced through the pleural triangle (often called the cardiac notch) where there is no lung tissue between the needle tip and the heart.

<table>
<thead>
<tr>
<th></th>
<th>Technique 1 (Intravenous catheter)</th>
<th>Technique 2 (Urinary catheter)</th>
<th>Technique 3 (Seldinger wire)</th>
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<td>Surgical gloves</td>
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<td>Surgical drape</td>
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Table 1: Pericardiocentesis equipment checklist
Plain tube A: for monitoring signs of clotting; plain tube B: for laboratory biochemistry; plain tube C: for bacterial culture; EDTA tube: for cytological evaluation; (*) injectable lidocaine; (**) as shown in Figure 8

![Figure 3: The ideal point of needle insertion for pericardiocentesis in dogs and cats is indicated with an asterisk (*). The needle is inserted at the 5th or 6th right ventral intercostal space (costochondral junction) and advanced through the pleural triangle (often called the cardiac notch) where there is no lung tissue between the needle tip and the heart](image-url)
How to perform pericardiocentesis

Technique 1 (over-the-needle intravenous catheter)

- The equipment needed is listed in Table 1.
- Additional side holes can be made in the intravenous catheter with the scalpel blade prior to its insertion, to increase the suction capacity and fluid flow (Figure 5).
- After needle insertion into the pericardial sac, fluid (usually bloody) starts flowing through the needle hub (Figure 6A, B & C). Fluid samples are collected for monitoring clotting and other laboratory tests.
- A kidney dish should be positioned underneath to collect the initial flow of fluid. In some cases, the pressure of the pericardial fluid is not sufficient to cause a spontaneous flow and gentle suction with a 2 ml syringe might be necessary to verify the presence of the needle in the pericardial sac.
- At this point, the stylet is held firmly with two fingers while, using the opposite hand, the catheter is slid gently a few centimetres over the stylet into the pericardial sac.
- The stylet is then removed and an extension set attached to the catheter (Figure 6D & E).
- A three-way stopcock is subsequently attached to the other end of the tube (Figure 6F).
- The second port will be connected to the syringe and the third port will be positioned above the collecting vessel. The port connected to the syringe will be open at all times. The port connected to the patient will be open during suction. Once the syringe is filled with fluid, the patient port is closed and the plunger of the syringe is pushed to empty the fluid into the graduated collecting vessel.
- The cyclic suctions should continue until there is no more fluid flowing in the syringe. At this point, gentle small advancements and withdrawals of the catheter may allow removal of residual fluid pockets.
- At the end of the procedure, the catheter is slowly withdrawn with gentle rotatory movements.
- The amount of fluid that can be drained depends on several factors, including the size of the patient and the severity and duration of the underlying condition. This can vary from 10–20 ml in a cat to more than one litre in a large breed dog (Figure 6G).
- After the procedure, an ultrasonographic assessment can reveal if the pericardiocentesis has been successful or whether there is significant residual PE that may warrant a second intervention.

Figure 4: (A) A small amount of local anaesthetic is infiltrated under the skin and deeper, at the level of the intercostal muscles and parietal pleura, at the insertion point. (B) A small stab incision is made through the skin with a No. 11 scalpel blade. (C) The catheter is inserted through the incision, perpendicular to the chest wall, and directed medially and slightly dorsally.

Figure 5: How to create side holes in an intravenous catheter. (A) A 14G 5.25" intravenous catheter; (B) and (C) 2–3 side holes are created with a No. 11 scalpel blade. This will increase the suction capacity and fluid flow.
Marked abdominal effusions can also be drained following pericardiocentesis. However, ascites normally resolves spontaneously in a day or two following the normalisation of the cardiac preload.

There is no need to suture the skin at the level of the stab lesion; however, a small adhesive dressing can be placed to avoid further bleeding and reduce the risk of post-procedure infections.

**Technique 2 (urinary catheter)**

This technique can be considered for large breed dogs where the catheter may not be long enough to remain in situ as the pericardial sac shrinks as a result of fluid drainage. It helps to increase the rigidity of the catheter, which may otherwise be compressed by the intercostal muscles. The technique can be easily performed by inserting a sterile urinary catheter through an intravenous catheter (or needle) inserted as described above.

The equipment needed is listed in Table 1.

- It is good practice, before starting the procedure, to verify that the urinary catheter is thin enough to pass freely through the catheter/needle.
- Once the urinary catheter is in the pericardial sac, the needle can be removed and the catheter can be connected to the three-way stopcock (Figure 7).
- The procedure is then continued as described for the IV catheter technique.

The major advantage of using a urinary catheter is that it will stay in the pericardial sac even after its reduction in size following drainage. Furthermore, the catheter tip is very smooth and rarely causes damages to the epicardium even after several ‘to-and-fro’ movements.

**Technique 3 (Seldinger wire)**

There are several commercial pericardiocentesis kits available based on the Seldinger technique. One of these kits is shown in Figure 8.

The needle is placed as described above. Once it has penetrated the...
pericardial sac (Figure 9A), the flexible tip of the guide wire is advanced through the needle into the pericardial space (Figure 9B).

- The needle is then withdrawn (Figure 9C) and replaced with a soft, multi-side hole catheter (Figure 9D) which is advanced over the guide wire with a gentle rotatory movement through the skin and into the pericardial space (Figure 9E).

- An instrument called a ‘dilator’ is available in these kits to dilate the needle track, although this operation is often unnecessary due to the previous stab incision with the scalpel blade and the rigid tapered nature of the catheter.

- Once the catheter is in position, the guide wire is removed (Figure 9F) and fluid is aspirated as described for the other techniques above (Figure G, H & I).

Potential complications
Complications are uncommon but may include laceration of a coronary artery, perforation of the right atrium or right ventricle, and pneumothorax secondary to lung lesions. Ventricular arrhythmias and atrial fibrillation are occasionally observed but they are usually self-limiting and spontaneously reversible. Dissemination of tumorous cells in the chest cavity and rapid relapse of fluid accumulation, even within minutes or hours, is expected in cases of malignant PE, especially when caused by cardiac haemangiosarcomas.

Pericardiocentesis is an essential therapeutic technique for the small animal practitioner, as removal of even a small volume of pericardial fluid can alleviate cardiac tamponade dramatically, improving right-sided cardiac function. Ultimately the success of the procedure depends on the cause of the PE, which determines the long-term prognosis.

Figure 9: Seldinger wire pericardiocentesis technique. (A) Needle insertion. (B) A guide wire is fed through the hub of the needle. (C) The needle is withdrawn, leaving the guide wire in the pericardial space. (D) Multi-side hole catheter. (E) The side hole catheter is advanced over the guide wire into the pericardial space. (F) Once the side-hole catheter is in position, the guide wire is removed. (G) Fluid is flowing through the hub of the catheter. (H) The hub of the catheter is connected to an IV extension tube. (I) The other end of the tube is connected to 20 ml Luer lock syringe via a 3-way stopcock for suction.