Veterinary nurses are tasked with understanding how to identify ECG waves so they can alert the veterinarian to potentially life-threatening cardiac arrhythmias and to monitor disease processes in their patients. It is important to start with the basics in order to understand why some arrhythmias are more dangerous than others and expected clinical signs from cardiac abnormalities. Review the path that blood takes through the heart:

Blood comes from the body to the vena cava
↓
From the vena cava it enters the right atrium
↓
From the right atrium it passes through the tricuspid valve into the right ventricle
↓
From the right ventricle it goes to the pulmonary artery
↓
The pulmonary artery takes it to the lungs where it picks up oxygen
↓
From the lungs it goes to the pulmonary vein
↓
The pulmonary vein takes it to the left atrium
↓
From the left atrium it passes through the bicuspid valve to the left ventricle
↓
From the left ventricle it travels via the aorta to the body

This understanding explains why patients in right sided heart failure experience ascites and patients in left sided failure experience pulmonary edema. As the heart is responsible for delivering blood and oxygen to all of the body’s tissues, failure of the heart muscle or arrhythmias can create systemic emergencies for these patients. When a cardiac patient or an animal in respiratory distress is presented to the hospital it is important to supply them first with oxygen and take extra time with them. A mild sedative, such as butorphanol (0.2 mg/kg) is safe to use in these patients and often provides enough sedation to allow for treatment. Treatments should be prioritized and performed in a stepwise fashion allowing the patient time to recover prior to the next stressful event.

Cardiac drugs come in many different classes and it is very important that the nursing team understands why a patient is receiving the medication and the intended and unintended side effects. It is also important to monitor drug interactions as many patients will be on multiple classes of medications while hospitalized.

Again, the role of the nursing team is not to diagnose disease but to recognize abnormalities on ECG and the resulting clinical signs in the patient. Nurses also should understand which disease processes can result in cardiac abnormalities. Listen to the patient and compare the heart rate to the pulse rate, learn to interpret the pulse quality, and rely on perfusion parameters such as mucous membrane color, capillary refill time, blood pressure, mentation, and pulse quality to determine patient stability.
To interpret an ECG, begin by understanding what each wave represents:

- P wave: atrial contraction
- QRS complex: ventricular contraction
- T wave: ventricular repolarization

Start interpretation by looking at the heart rate to determine a tachy- or bradyarrhythmia. Then look at the QRS complexes and decide if they are rhythmic or not. Then examine each complex, looking to see if each P wave has a QRS complex and each QRS complex has a P wave. Treat the patient, not the arrhythmia; always go back and examine the patient’s perfusion parameters to help determine next steps.

- **VPC (Ventricular Premature Contraction)** – the left ventricle contracts prematurely, leading to a large T-wave that goes the opposite direction of the QRS complex, with a wide appearance. Can result from hypoxia, ischemia, acid-base disturbances, electrolyte imbalances, pain, reperfusion injury, trauma, and some medications. Can lead to pulse deficits and decreased perfusion. Treatment includes oxygen therapy, lidocaine as a bolus or CRI, fluid therapy to correct shock, and time (in the case of trauma or thermal damage).

Patients experiencing hyperkalemia will have tall tented T-waves and often will not have a P wave. As the potassium level increases, the T waves will get wider until the ECG looks like all VPCs. If not treated this will become fatal. As potassium levels decrease the T wave will get smaller until the ECG appears normal again.

- **Ventricular Tachycardia** – a high number of VPCs strung together with a heart rate > 180. If this is seen at any time treatment is warranted with lidocaine (bolus and/or CRI). Seeing ventricular tachycardia means the patient has poor perfusion and often low blood pressure; watch these patients very carefully as they can arrest during ventricular tachycardia.
• **Ventricular Fibrillation** – caused by the activation of too many circuits in the heart, everything is firing out of control. This is a fatal arrhythmia. On ECG – undulation of baseline, no P waves or QRS complexes can be discerned. Treatment is defibrillation (electrical shock to the heart to repolarize and get everything firing back on schedule).

![Ventricular Fibrillation ECG](image)

• **Supraventricular Tachycardia** – usually seen secondary to heart disease or other systemic disease. Clinical signs (weakness, collapse, poor pulses, poor mm color) are not always seen unless the heart rate is >250bpm. ECG findings are a tall, skinny QRS complex, not necessarily always following a P wave. P waves are very difficult to differentiate from T waves.

![Supraventricular Tachycardia ECG](image)

• **Atrial Fibrillation** – Poor atrial contractions and a high atrial rate. May auscultate a “tennis shoes in the dryer” sound and feel pulse deficits. On ECG – P waves are replaced by small fibrillations, and QRS complex varies in height and width. Tachycardia, regularly irregular, and P waves not always connected to a QRS complex are characteristic of this arrhythmia. Treatment is aimed at lowering the heart rate with beta blockers or Ca++ channel blockers.

![Atrial Fibrillation ECG](image)

• **1st Degree Heart Block** – is usually asymptomatic; it can be seen in the very old, very young, and brachycephalic breeds. ECG – prolonged distance between each P wave and the start of the QRS complex. There are P waves for each QRS. Treatment is usually not necessary.

• **2nd Degree Heart Block** – patients may present with exercise intolerance, weakness, syncope or heart failure. It can be seen during anesthesia, especially if the patient is bradycardic. Treatment is necessary if the patient is symptomatic, and normally consists of an atropine trial. Some
patients can be maintained on atropine, or a pacemaker may be necessary. ECG – P waves are not always followed by QRS complexes.

- **3rd Degree Heart Block** – These patients are often symptomatic (exercise intolerance, collapse, syncope) and need treatment. ECG – P waves have no association with QRS complexes. The only reliable treatment is a pacemaker.

Treatment for any patient experiencing cardiac arrhythmias requires close monitoring by the nursing staff. Frequent patient assessment, even if the ECG appears normal, will help in developing a baseline for the patient. Any changes in mentation, respiratory rate and effort, activity level, and eating patterns can signal changes in cardiac tracings. With any abnormalities noted on ECG, the patient perfusion values must be immediately evaluated (heart rate, pulse quality, mucous membrane color, capillary refill time, blood pressure, mentation) and results reported to the veterinarian. Technicians must understand cardiac drugs and the expected effect of administering these drugs so that proper patient monitoring is carried out and proper client education occurs.

References: