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The ECG is a visual representation of the electrical activity of the heart. Electrocardiographic electrodes - called "leads" record the electrical signal at the surface of the skin. The leads can be arranged in a variety of ways to produce visual patterns (the ECG) that we use to "see" the electrical activity of the heart. Cardiologists may use up to twelve leads to completely evaluate the heart but most veterinarians in emergency and general practice only look at a one or two leads. Each arrangement produces a characteristic visual pattern. We are going to focus on the most commonly used arrangement in small animal and exotic species, called Lead-II ('lead-two').

The standard color coding arrangement for a 3-lead ECG (the most commonly used arrangement in veterinary medicine) consists of a white, black, and red lead. The white lead should be attached on the right thoracic limb ("right arm" or RA lead) near the elbow or on the foot, the black lead on the left thoracic limb ("left arm" or LA lead) near the elbow or on the foot, and the red lead on the left pelvic limb ("left leg" or LL lead) - but check your system because not all manufacturers follow the standard convention.



There are many catchy phrases to help you remember the correct arrangement. "White on right, smoke (black) before fire (red)" is a popular phrase.

To use the ECG, connect the leads to the patient in the proper locations using electrode coupling gel or paste. This is an electrolyte gel/paste that conducts electricity and will help you to get a "clean" ECG tracing. Ultrasound gel should not be used - it is designed to conduct sound waves, and is not a good electricity conductor. Alcohol should be avoided - it may catch fire if the patient is defibrillated. The stick-on adhesive leads need to be attached to bare skin, and in patients who are asleep can be attached to the paw pads instead of shaving the fur (you may need to use tape to lightly secure them on the paw pads). The alligator clip style attachments should not be left attached to the skin for more than a few minutes - they are

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painful and if the spring is tight can cause pressure necrosis of the skin where attached. Instead use stick-on pads or clips that are designed to be left in place for longer periods of time. If the patient needs to have the ECG attached for more than about an hour, stick-on pads should be used instead of clips.

The most important thing to remember is that the ECG tells us if the heart has electricity moving through it, and what direction the electricity is traveling through the heart. It does NOT mean the heart is actually beating!!! ALWAYS confirm the heart is beating by listening for a heart beat or feeling for a pulse.

Important lead-attachment tips:

- Use coupling gel (not ultrasound gel there is a difference)
- Get good skin contact
- If using alligator clips time should be limited, these are painful (attach them to yourself to see what it feels like), and if the clamps are strong/tight can cause crush injury and ischemic necrosis of the skin
 - · Don't use these clamps on patients with thin or fragile skin
- If using adhesive pads clip fur; can also place on paw pads in animals who are asleep; if securing with tape, don't make the tape too tight
- · Avoid alcohol as a coupling agent will catch fire if defibrillate the patient

Troubleshooting:

- Poor skin contact shave fur and/or add coupling gel; clean the electrodes
- Leads plugged into incorrect receptacle
- · Leads attached to wrong body parts/location



- A. Leads connected to corresponding color-coded insertion point
- B. Leads incorrectly connected



How electricity moves through the heart The sinoatrial (SA) node it the normal pacemaker of the heart. It sends out a regular, repeating electrical impulse. The electricity spreads across the left and right atrium triggering contraction of the atria. The electrical signal reaches the atrioventricular (AV) node which causes a very slight pause before sending the signal down the Bundle of His. The Bundle of His and the left and right bundle branches are a high-speed electrical conduction system. They carry the

electrical signal down into the ventricles, allowing the ventricles to squeeze in a coordinated way delivering blood to the lungs and to the body.

When this electrical system is working correctly, it results in the "normal" P-QRS-T complex on the ECG screen that we are used to seeing. Some diseases can cause disruption of this conducting system - the SA or AV node can stop working, or not work well; or the conducting system can be damaged causing the electricity to spread through the cells instead of using the high-speed conducting system. Any of these problems will cause the ECG shape to change. This shape change can help us to make a diagnosis of where the problem is in the electrical system, and guide our testing and treatments.

Reading the ECG

Reading ECGs is all about pattern recognition. The Lead II ECG should produce a characteristic pattern in a patient with normal electrophysiology that looks like the image to the right.

The ECG tells us about the rate and rhythm of the heart's electrical pattern.

The main parts you will see on the devices we have in the clinic, and what we will talk about today: P wave = atrial depolarization QRS complex = ventricular depolarization T wave = ventricular repolarization



Questions to ask when you look at an ECG:

- 1. What is the QRS shape? Is it tall and skinny, or wide and bizarre looking?
- 2. Do all of the QRS complexes look the same? If not, how many different shapes do you see? Two different QRS shapes, or more than two different QRS shapes?
- 3. If the QRS complexes are all, or mostly tall and skinny: does every QRS complex have a P wave in front of it? Does every P wave have a QRS complex after it? Is the rate fast, normal, slow, or very irregular?
- 4. If the QRS complexes are wide and bizarre is it all of the QRS complexes, or just some of the QRS complexes that are abnormal? Is the rate fast, slow, normal, or very irregular? Do the wide and bizarre complexes all look the same, or do they have many different shapes?



Heart Rate Guidelines for Normal Animals

Heart Rate	Critical High
110-130	180
100-120	160
80-100	160
60-90	160
	Heart Rate 110-130 100-120 80-100 60-90

Cats Any weight

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160-200

240 www.eccvetmed.com



References

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