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The Benefits of Ambulatory ECG

The electrocardiogram (ECG) can be used to identify electrolyte abnormalities, criteria for chamber enlargement, and detection of myocardial ischemia. However, its primary function is to determine the cardiac rhythm. An ECG can now be performed using as many as 12 leads, or as a simple iPhone app. Most ECGs that are performed are in a clinic or hospital, and provide a small sample of the rhythm for a few minutes during an exam. This type of evaluation may not be sufficient to adequately represent the true day to day arrhythmia burden. The use of long term ambulatory ECG recordings improves the ability to identify intermittent/infrequent arrhythmias, as the cause of symptoms, or to more confidently exclude an arrhythmia as an explanation for clinical signs.

Before an electrocardiogram (ECG) is typically indicated, a thorough history and signalment must be obtained. The typical arrhythmias of the breed should always be considered first, and knowing the common findings of the breed often guide our decisions. Large breed dogs with syncope are usually more likely to have ventricular tachycardia, whereas smaller breeds tend to have bradyarrhythmias more commonly. This is half the battle with almost any form of cardiac disease.

The physical examination is very important and is often the source of discovery of asymptomatic cardiac disease. Auscultation of the heart is usually the most effective way to identify a rhythm abnormality during the physical examination. Identifying a cardiac murmur can often be done quickly, but an arrhythmia often requires a longer auscultation. Abnormalities to listen for include: premature beats, extended pauses, excessively slow or fast heart rates, bigeminal rhythms, and irregular rhythms with no pattern. If one of these physical examination abnormalities exists, an ECG is a relatively inexpensive next step.

A simplified version of arrhythmia classification can be summarized into two main groups: tachyarrhythmias and bradyarrhythmias. Common tachyarrhythmias include ventricular tachycardia, supraventricular tachycardia, sinus tachycardia, and atrial fibrillation. These arrhythmias often require pharmacologic intervention to prevent symptoms such as syncope, hypoxic seizure, weakness, excessive panting, congestive heart failure symptoms, and progressive cardiac



dysfunction such as a rate induced cardiomyopathy. Common bradyarrhythmias include atrioventricular block, sick sinus syndrome, persistent atrial standstill, sinus bradycardia, and sinoventricular rhythm. Bradyarrhythmias can respond to stimulant therapy, but often require artificial pacing to relieve symptoms such as syncope, hypoxic seizure, weakness, exercise intolerance, and congestive heart failure symptoms. Therefore, determining the heart rate is often the first step in narrowing the possible rhythm diagnoses in an individual patient.

However, many symptoms occur intermittently, and only in the home environment. An in-hospital ECG may not be able to detect many of the arrhythmias responsible for these symptoms. Ambulatory (Holter) electrocardiography was developed in order to overcome some of the limitations of a traditional ECG. Holters were first introduced in human medicine in the 1960s. It is named after its creator Dr. Norman Holter MD, and records 24 hours of continuous ECG, while the dog goes about its normal daily activity in a home environment. Holter monitoring is a valuable noninvasive tool for the monitoring of the cardiac rhythm over a prolonged period during normal daily activities. The advent of this diagnostic test has demonstrated that the incidence of serious arrhythmias is much greater than previously determined using routine electrocardiography. A resting electrocardiogram is typically recorded for several seconds to several minutes and is likely to miss or underestimate an intermittent arrhythmia.

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A Holter monitor has several uses which include: Detecting or ruling out an arrhythmic cause of syncope, detecting occult dilated cardiomyopathy or arrhythmogenic right ventricular cardiomyopathy, assessing the response to antiarrhythmic therapy (atrial fibrillation, ventricular or atrial arrhythmias), or rule out arrhythmogenic causes of atypical behavior.

For instance, Ambulatory ECG has been shown to implicate or definitively exclude an arrhythmia as the cause of syncope or result in a change in therapy over 40% of the time. This suggests Holter monitoring can be a very effective tool in determining the cause of syncope.



Another study in Dobermans showed a low sensitivity but high specificity of a 5-minute ECG to predict >100 VPCs/24 hours, if at least 1 VPC is detected within 5 minutes. However, the absence of VPCs in the 5-minute ECG should not lead to the assumption that the dog has a normal rhythm, because false negative cases were found in 35.8% of the examinations. This leads us to the conclusion that a 5-minute ECG cannot replace a 24-hour ECG examination for the purpose of detecting the occult phase of dilated cardiomyopathy (DCM) in Doberman Pinschers. Performing a 24-hour ECG remains essential to screen for DCM.

Several studies have shown the effectiveness of a Holter monitor in determining how treatment could reduce the number of VPCs in arrhythmogenic right ventricular cardiomyopathy Boxers, and still another study showed the usefulness of using Holters to titrate antiarrhythmic therapy for optimal heart rate control in atrial fibrillation patients.

Management of syncope resulting from a ventricular arrhythmia is as follows: Patients experiencing syncope are generally treated until we eliminate all syncopal behavior,

or nearly eliminated. In asymptomatic patients we often use paired Holter (24hours ECG) monitoring to guide therapy. A baseline Holter is first performed, and then the antiarrhythmic therapy is initiated. The patient is then presented for physical examination and in-house ECG within 7 days, to observe for adequate rhythm control. Changes to the medication may need to be made at this visit. Once appropriate therapy is suspected, a follow-up Holter monitor is performed. Goals of therapy with Holter monitoring should be to reduce or eliminate the frequency of sustained ventricular tachycardia, reduce the number of runs of v-tach, ventricular triplets, and couplets.

The problem with the Holter is the same limitation found with a standard 5 minute ECG: arrhythmias can be, and often are intermittent. Even 24 hours may not be long enough to monitor the cardiac rhythm in order to determine the cause of syncope..The event monitor was developed for this purpose. Event monitors can be used for 14-30 days, depending on the model used. I personally have not had good luck keeping the electrodes in place for more than 10 days, without rewrapping the bandage. These often have a button on the device, or a remote that can tag the time recording if an event is observed while wearing the event monitor. This has been useful in my practice to determine the cause of syncope that was missed on a Holter monitor.

What if the symptom is very infrequent? What if repeated Holter monitors are expected to be necessary to appropriately treat the arrhythmia? A newer technology is emerging to address these situations, and has a particularly important application in veterinary medicine by alleviating the need to keep a bandage in place and electrodes secured. This is an implantable loop recorder, also called an implantable cardiac monitor (ICM). Medical literature reports that a diagnosis is possible in up to 90% of patients with syncope using an implantable cardiac monitor. Advantages of the ICM include:

- Small size – as small as 1 cc in volume, 1/3 the size of AAA battery
- Excellent longevity – three years battery life, with unlimited frequency of testing
- Subcutaneous electrodes for simplified recording
- Client-triggered and automatic activation for ECG storage
- Additional programming options – tachycardia, bradycardia, asystole, premature beats
- 57 minutes of stored electrograms (over 150 episodes)
- Relatively inexpensive

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The advantage of the ICM is that we can place this device with sedation combined with a local block in a brief procedure involving a very small incision. The device can be read remotely without any further sedation. We can do monthly data downloads or just wait until the symptom is seen. Once the diagnosis is made, the device can stay in place and help guide therapy by monitoring the rhythm long term. This most certainly is the future of ambulatory ECG monitoring.



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