ECG Interpretation for Veterinary Technicians

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About CVCA

- Founded in 1987
- Largest veterinary cardiology practice in the world
- 12 board certified cardiologists, Residency program
- Over 120 years combined experience
- Weekly rounds to optimize case management
- 1 hour appointments
- Client stay present for echocardiogram
- Cardiologist on-call at all times
Outline

- Conduction system of the heart
- ECG lead system
- Genesis of ECG tracing
- Steps for ECG interpretation
- Example arrhythmias
- Questions
Conduction System of the Heart

- Cardiac contraction is initiated by a wave of electrical activity traveling through the heart.
- This process starts with SA node located in the right atrium.
- First, the electrical impulse travels through the atria causing atrial contraction.
- Then, the impulse travels through the AV node in the middle of the heart.
- Finally, the impulse travels through the bundle branches and Purkinje fibers to reach the ventricles and cause ventricular contraction.
The electrocardiogram (ECG or EKG) lead system consists of several electrodes placed on specific locations of the body.

- Animals are placed in right lateral.
- Front limb leads are placed at level of elbow, hind limb leads are placed at level of stifle.
- The limb leads are color coded:
- Grass & snow on the ground, Christmas comes at the end of the year, white on right, etc…
ECG Lead System
ECG Lead System
ECG Lead System

- The ECG leads compare the electrical activity at one electrode compared to another electrode.
- Each lead has one electrode designated as positive and another designated as negative.

- Lead I: LFL (+) compared to RFL (-)
- Lead II: LHL (+) compared to RFL (-)
- Lead III: LHL (+) compared to LFL (-)

- Lead aVR: RFL (+) compared to average of LFL & LHL (-)
- Lead aVL: LFL (+) compared to average of RFL & LHL (-)
- Lead aVF: LHL (+) compared to average of RFL and LFL (-)
ECG Lead System
ECG Lead System

- A wave of electrical energy traveling toward the (+) electrode creates an upward tracing.
- A wave of electrical energy traveling toward the (-) electrode creates a downward tracing.
- A wave of electrical energy traveling at right angles to a given lead creates a small/absent tracing.
- The size of the ECG tracing in each lead depends on how well the lead lines up with the wave of electrical energy traveling through the heart and the amount of heart muscle activated.
Genesis of the Normal ECG
Genesis of the Normal ECG

- SA node initiates electrical impulse; This is not seen on ECG
- Wave of electrical activity travels through atria causing contraction; This creates P-wave
- Wave of electrical activity travels through AV node; This does not produce a deflection and the ECG is flat (P-R interval)
- Wave of electrical activity travels through the ventricles causing contraction; This creates QRS complex
- Ventricles repolarize (reset) to get ready for next impulse; This creates the T-wave
Steps for ECG Interpretation

- **What is the heart rate?**
  - Pen times 10 on 25 mm/s
  - Pen times 20 on 50 mm/s
  - Instantaneous rate:
    - R-R divided into 1500 for 25 mm/s
    - R-R divided into 3000 for 50 mm/s

- **Is the rate too fast or too slow?**
  - Normal is 70-160 for dogs and 150-240 in cats
Steps for ECG Interpretation

- What is the heart rate?
- What is the configuration of the QRS complexes?
- Is the rhythm regular or irregular?
- Are there complexes that appear to come too early or too late?
- Is every P-wave followed by a QRS complex?
- Is every QRS complex preceded by a P-wave?
Example Arrhythmias
Example Arrhythmias

- Sinus rhythm: normal rhythm in dogs and cats
- Normal rate, regular rhythm, normal QRS complexes
- No treatment needed
Example Arrhythmias
Example Arrhythmias

- Sinus arrhythmia: normal variation in dogs
- Normal rate, normal QRS complexes
- Irregular rhythm: speeds up and slows down
- Speeds up on inspiration slows down on expiration = Respiratory sinus arrhythmia
- Wandering pacemaker: variation in P-wave configuration
- No treatment needed
Example Arrhythmias
Example Arrhythmias

- Sinus tachycardia
- Regular rhythm, normal QRS complexes, but faster than normal
- Seen with excitement, fear, pain, shock, systemic illness
- Often does not need treatment; Focus on underlying condition
Example Arrhythmias
Example Arrhythmias

- Sinus bradycardia
- Regular rhythm, normal QRS complexes, but slower than normal
- Seen in anesthetic overdose, hypothermia, increased vagal tone
- Often does not need treatment, but will likely respond to Atropine
Example Arrhythmias
Example Arrhythmias

- Marked sinus arrhythmia with episodes of sinus arrest
- Called Sick Sinus Syndrome
- May improve with Atropine, but many cases require pacemaker implantation
Example Arrhythmias
Example Arrhythmias

- Supraventricular premature contraction
- May originate from atria or AV node
- Similar to normal complexes but comes early
- May or may not see P-wave
- Can be seen in animals with atrial enlargement, or in animals with normal hearts
- Does not require treatment
Example Arrhythmias
Example Arrhythmias

- Supraventricular tachycardia
- Normal QRS complexes, regular rhythm, rate is too fast
- May or may not see P-waves
- Often cause weakness or collapse
- Treatment options include: Digoxin, Diltiazem, Atenolol
Example Arrhythmias
Example Arrhythmias

- Atrial fibrillation
- Rapid, irregular rhythm, normal QRS complexes
- No P-waves; Baseline may be flat or have f-waves
- Most often seen in dogs with cardiac diseases such as degenerative valve disease and dilated cardiomyopathy
- Sounds like tennis shoes in a dryer on auscultation
- Treated with Digoxin, plus Diltiazem or Atenolol
Example Arrhythmias
Example Arrhythmias

- AV Block: slowed or blocked conduction through AV node
- First degree: prolonged P-R interval
- Second degree: some P-waves are not followed by QRS complexes
- No treatment needed for 1\textsuperscript{st} degree AV block
- 2\textsuperscript{nd} degree AV block may require treatment if severe; May improve with Atropine, but may need pacemaker implantation
Example Arrhythmias
Example Arrhythmias

- Third degree AV block: none of the P-waves are conducted through AV node
- Two separate and independent rhythms: atrial and ventricular
- Heart rate is typically very slow; 30-40 beats per minute in dogs
- Causes weakness or collapse
- Requires pacemaker implantation
Example Arrhythmias
Example Arrhythmias

- Ventricular premature contractions
- QRS complexes come early, are not preceded by a P-wave
- QRS complexes are wide and bizarre
- Wide T-wave opposite in polarity to QRS complex
- VPCs can go downward or upward in Lead II
- Downward = LV origin  Upward = RV origin
- Can be seen in heart disease, abdominal neoplasia, GDV, systemic disease
Example Arrhythmias
Example Arrhythmias

- Ventricular tachycardia: 3 or more VPCs in a row
- Instantaneous heart rate can be over 400 bpm
- Sustained ventricular tachycardia is life-threatening
- Emergency treatment with IV Lidocaine
Example Arrhythmias
Example Arrhythmias

- Ventricular fibrillation: seen during CPR
- Lethal arrhythmia, no ventricular contractions occur
- Requires electrical defibrillation
Example Arrhythmias
Example Arrhythmias

- Marked sinus arrhythmia with episodes of sinus arrest and ventricular escape beats
- Wide QRS complexes which originate from the ventricles following long pauses in rhythm
- Normal, life-saving physiologic response = NOT a VPC
- Treatment should focus on the pauses
Example Arrhythmias
Example Arrhythmias

- Sinus tachycardia with left bundle branch block
- Wide QRS complexes which look like VPCs, but are all preceded by a P-wave
- Rare arrhythmia which can be confused for ventricular tachycardia
Questions?