ECG Reading: Diagnosis & Management of Cardiac Arrhythmias

John D Bonagura, DVM, DACVIM
Adjunct Professor, Cardiology
College of Veterinary Medicine
Professor Emeritus
The Ohio State University CVM

No Disclosures for this Presentation
Relatively Extensive Reference notes in Proceedings

ECG in Cardiac Disease: Arrhythmias

- Disorders of rate, rhythm or conduction
- Related to abnormal electrical impulse formation or conduction of current in the heart
- Categorization: sinus, atrial, AV, ventricular
- Some operational definitions
  - Bradycardia (slow) tachycardia (fast) heart rate
  - Escape – “rescue” complex from subsidiary pacemaker
  - Ectopia – impulse arising outside of SA node
  - Block – delay or interruption of current flow
  - Fibrillation – rapid, disorganized electrical activity affecting atria or ventricles ⇒ disorganized activation & ineffective myocardial contraction
  - Asystole – absence of electrical & mechanical activity

Potential Consequences of Arrhythmias

Why we treat

Hemodynamic
- Reduced Cardiac Function
- Decreased BP
- Reduced Tissue perfusion
- Limited exercise capacity
- Syncope

Electrical instability
- Myocardial fibrillation
- Asystole
- Sudden cardiac death

Approach to Rhythm Diagnosis

- Rate: normal, slow (bradycardia) or fast (tachycardia) for the species & physiologic state
- Regularity of the rhythm
  - If irregular: Patterns or cyclical nature
- P-QRS relationship
- Changes in complex morphology
  - P-waves
  - QRS complexes
- Conduction intervals – P, P-R, QRS, Q-T

Slides Courtesy Dr. RL Hamlin, DACVIM
Canine – Lead II (25 mm/sec)

3 seconds (25 mm/s)

Canine – Lead II (25 mm/sec)

3 seconds

Canine – Lead II (25 mm/sec; 100 mm/s)

6 seconds (25 mm/sec)

100 mm/sec

Canine – Lead II (25 mm/sec)

9 Year Old Bull Terrier (WNL)

3 seconds 25 mm/sec 10 mm = 1 mv

Canine – Lead II (25 mm/sec)

Canine [DP]

3 seconds (HR ~ 200/mm)
Canine ECG – Lead II at 25 mm/s

Sinus Rhythms – Summary

• Normal (regular) sinus rhythm
• Sinus arrhythmia – vagal
  • Often respiratory + wandering pacemaker
• Sinus bradycardia
• Sinus tachycardia
• Sinus arrest
  • Sick sinus syndrome – sinus arrest with insufficient escape activity ± other rhythm abnormalities
  • Miniature schnauzers, WHWT, Cocker spaniels

Management of Sinus Rhythm Disturbances

• Sinus tachycardia
  • Identify underlying cause of ↑ sympathetic activity
  • Manage any pain, hypotension (fluids) or heart failure (drugs)
• Sinus bradycardia
  • Identify underlying reasons for high vagal tone
  • Consider endocrine & sinus node diseases
  • Treat with atropine or catecholamine if needed
• Sinus arrest – sick sinus syndrome
  • No good medical therapy | Pacemaker best
  • Theophylline Long-acting; Terbutaline; Hycosamine
Summarizing the Supraventricular Tachycardias

- Sinus tachycardia
- Premature atrial complexes
- Focal atrial tachycardia (FAT)
- Atrial flutter (macro-reentry AT)
- Atrial fibrillation
- Re-entrant atrioventricular tachycardia

Using an accessory AV pathway
**Role of AV node in Ventricular Rate Response**

- AV nodal conduction influences the ventricular rate but not the atrial arrhythmia
- Any sinus or atrial rhythm depends on AV nodal conduction in order to achieve a QRS complex
- Drugs that block AV conduction can ↓ heart rate

**Atrial Fibrillation: Heart Rate Control**

- Digoxin (increases vagal tone through sensitization of baroreceptor reflex)
- Diltiazem – CCB – blocks the calcium entry into the AVN
- Beta-blockers – modulates (reduces) the calcium entry across the L-calcium channel
- In CHF: digoxin is often initiated with diltiazem as it is a positive inotropic agent (whereas, CCB and β-blockers depress ventricular function)
Summary: Management of Atrial Arrhythmias

- Rhythm control is a relatively nuanced and complicated subject
- Persistent PACs, especially focal atrial tachycardias, can be treated with drugs that suppress automaticity or modify conduction
  - Sotalol, beta-blockers, amiodarone, (?) flecainide
- Atrial flutter & fibrillation might be “converted” to NSR using similar drugs (including lidocaine for acute AF), additionally:
  - Electrocardioversion (referral) depolarize cells to NSR
  - Procainamide, amiodarone facilitate conversion
- Rate control (AVN): diltiazem, digoxin (CHF), β-blocker
- ↑K*(AS) ⇒ NaCl, Ca** salt, Dextrose & insulin, β-agonist, NaHCO₃
Canine – Lead II (25 mm/sec)

HR = 150/min

Two canine ECGs – Lead II (25 mm/sec)

Canine ECG – Lead II (25 mm/sec)

Canine ECG – Lead II (25 mm/sec)

1/07/2002 14:54 Temp: 38.8°C HR: 150 bpm HIBP: 120/70 mmHg Interv: 3 Seconds
Ventricular Arrhythmias – Summary

- Escape complexes & rhythms ("rescue" for SSS, AVB)
- Premature ventricular complex (PVC, VPC)
  - Monomorphic or multiform complexes
- Ventricular tachycardia (VT)
  - Nonsustained (paroxysmal) or sustained VT
  - Monomorphic, pleomorphic or polymorphic VT
    - Torsades de pointes
- Ventricular flutter
- Ventricular fibrillation (VF)
- Asystole ("ventricular standstill")

General Causes of Ventricular Arrhythmias

- Cardiac diseases
  - Structural diseases leading to cardiac remodeling
  - Primary electrical disorders (Boxer, Eng Bulldog, DP, others)
  - Heart failure
  - Ischemia – most often short-term
  - Cardiac neoplasia (often refractory)
- Metabolic & Endocrine disorders
- Autonomic nervous system
- Drugs & Toxins
- “Usual suspects” – noncardiac diseases often associated with rhythm disturbances (frequently short-lived)

How do we TRY to assess PVCs?

- Imperfect risk stratification
- Clinical Signs & Clinical Circumstances
- Affect on Blood Pressure
- Most likely underlying cause
  - K9 Breeds at high risk for PVCs – VT – SCD
  - Structural heart disease or CHF
  - Non-cardiac disorders – short-term or long-term
  - Holter (24h) ECG
- Lown-type criteria: Frequency, Timing (R on T), Morphology, Runs of VT, Rate of VT, Complexity
**ECG Reading Session – Presentation Outline – John Bonagura, DVM, DACVIM**

**Holter ECG**

**Antiarrhythmic Drugs**

- Lidocaine
- Magnesium ±KCl
- Sotalol (caveats...)
- Amiodarone (PFree!)
- Esmolol
- Procainamide ($$$)

**Hospital Therapy of VT in Dogs** (see conference notes)

- Lidocaine
- Magnesium ±KCl
- Sotalol (caveats...)
- Amiodarone (PFree!)
- Esmolol
- Procainamide ($$$)

**Cardioversion**

- English Bulldog ARVC

**Therapy of Ventricular Arrhythmias – Chronic**

- Lidocaine
- Sotalol – **Brocainamide**
- Atenolol – Amiodarone – Mexiletine
- Propafenone

These drugs are used in short- and long-term management of serious rhythm disturbances in dogs, including those with DCM and ARVC. Sotalol is most often used chronically; then Mexiletine.