

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

1

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

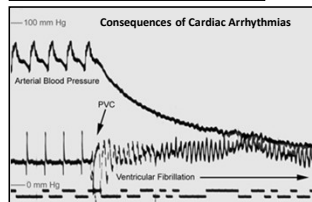
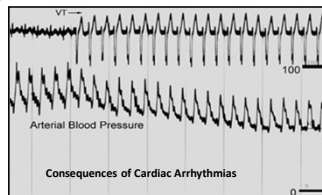
2

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

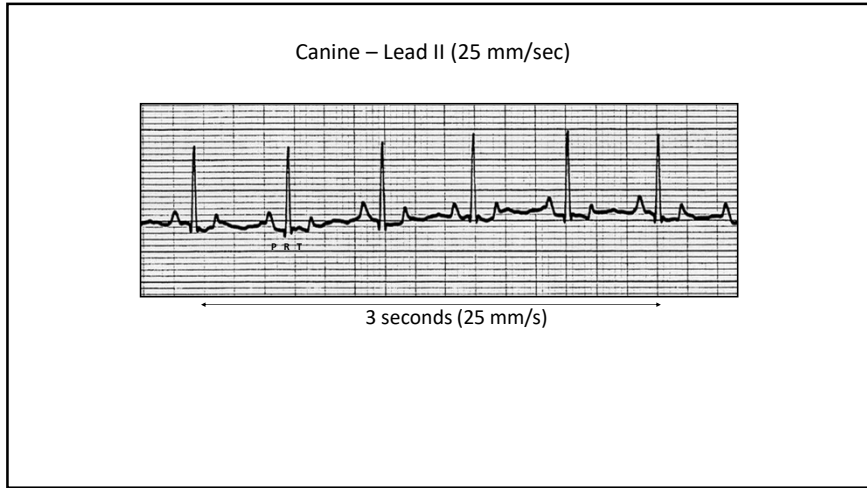
Slides Courtesy Dr. RL Hamlin, DACVIM

3

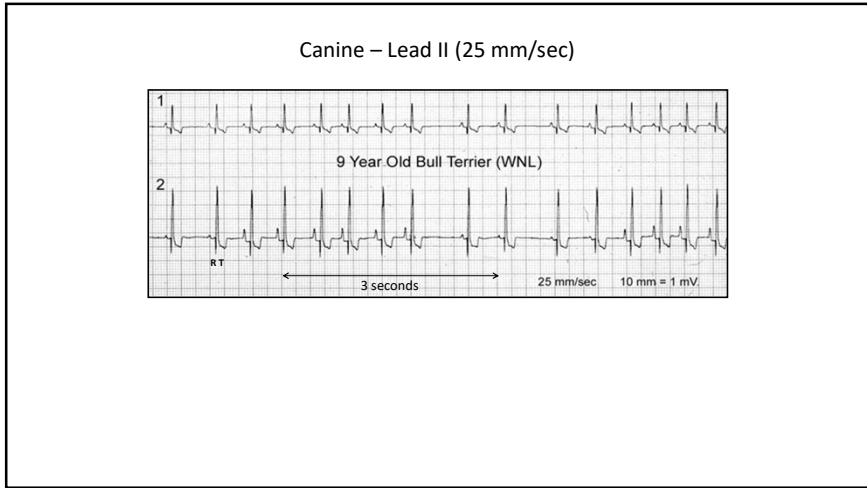
Approach to Rhythm Diagnosis

- 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
 - P-waves
 - QRS complexes
- Conduction intervals – P, P-R, QRS, Q-T

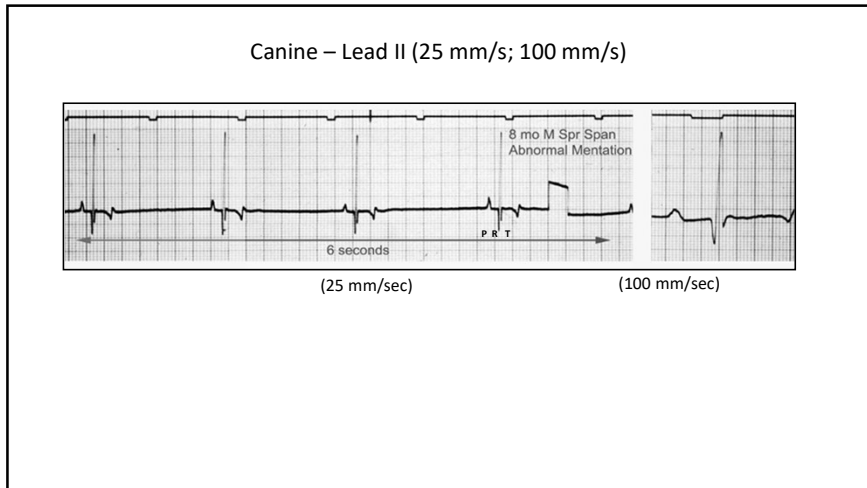
4



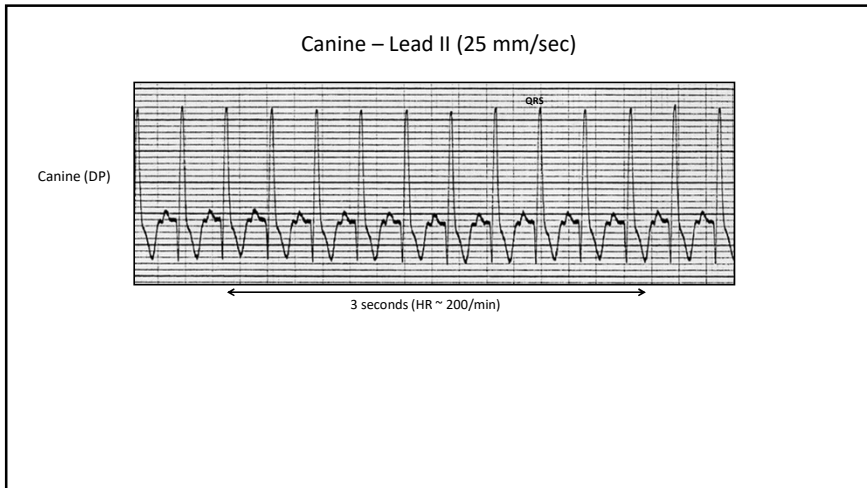
5



6

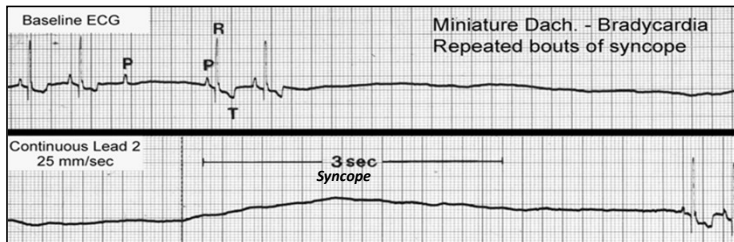


7



8

Canine ECG – Lead II at 25 mm/s



9

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

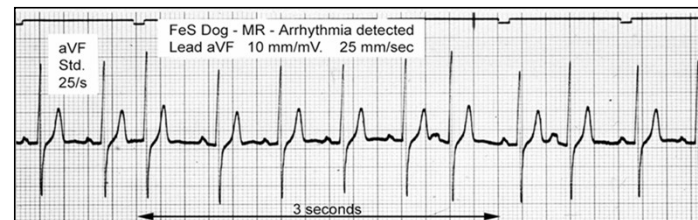
10

Management of Sinus Rhythm Disturbances

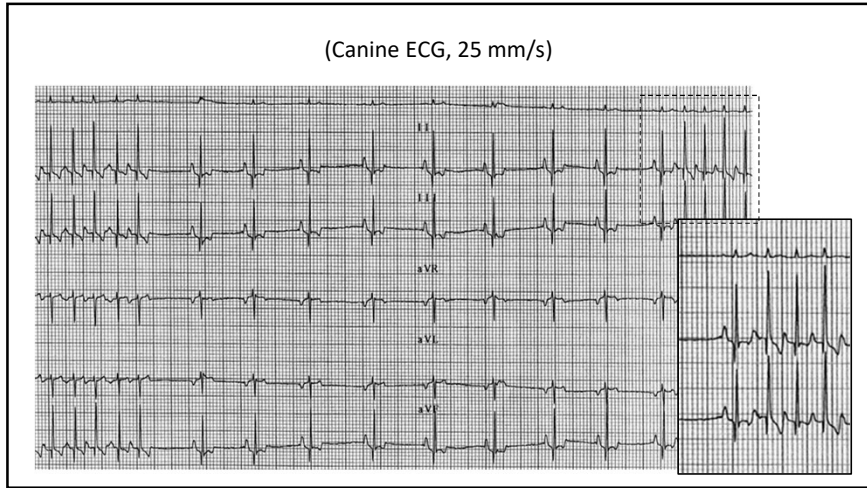
- Sinus tachycardia
 - Identify underlying cause of ↑ sympathetic activity
 - Manage any pain, hypotension (fluids) or heart failure (drugs)
- Sinus bradycardia
 - Identify underlying reasons for high vagal tone
 - Consider endocrine & sinus node diseases
 - Treat with atropine or catecholamine if needed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

11

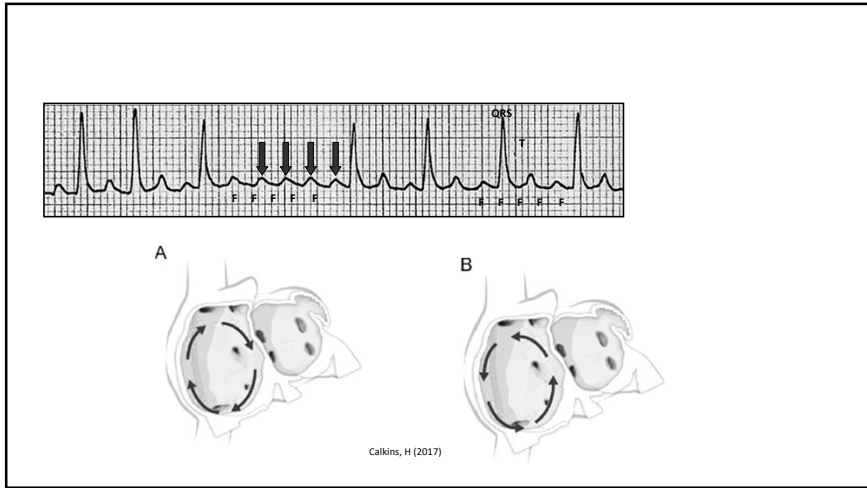
Canine Lead aVF (25 mm/sec)



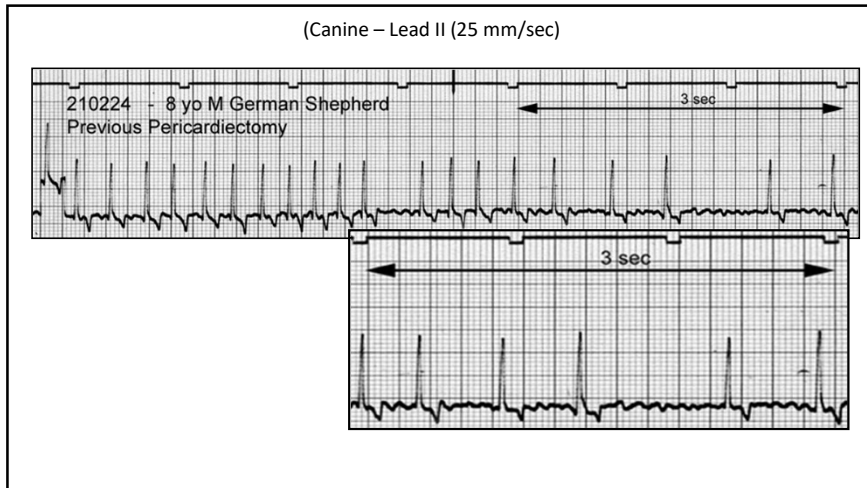
12



13



14



15

Summarizing the Supraventricular Tachycardias

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

Re-entrant atrioventricular tachycardia
Using an accessory AV pathway

16

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

Sinus
 A Tachy
 A Flutter
 A Fib

AVN

17

Canine ECG – Lead II (25 mm/sec)

167055 1 yo FeS English Pointer Vomiting & Collapse 25 mm/sec

3 sec

Canine ECG – Lead II (25 mm/sec)

18

Atrial Fibrillation: Heart Rate Control

St. Bernard - DCM - CHF HR = 205/min Baseline

HR = 120/min Post-Rx

50 mm/s Dig + BB 3 sec

- **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)

19

Biphasic, Direct-current Electrocardioversion (Baseline)

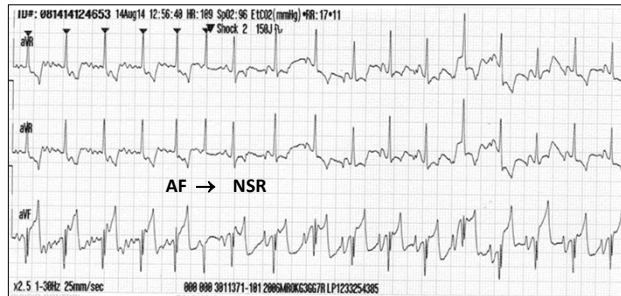
Atrial Fibrillation

Canine ECG

ID#: 0
aVR
aVF
x1.5 1-

20

Biphasic, Direct-current Electrocardioversion (Shock)



2

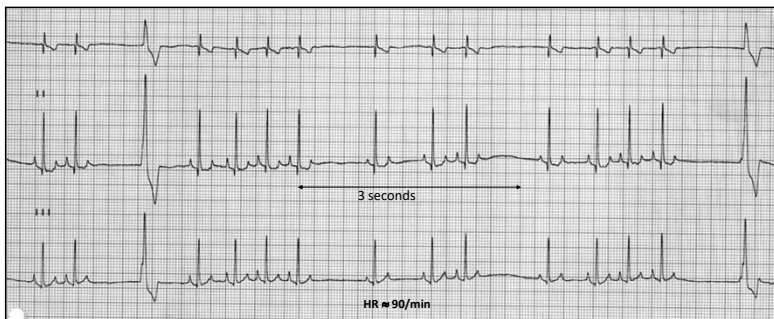
21

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
- $\uparrow K^+(AS) \Rightarrow NaCl, Ca^{++}$ salt, Dextrose & insulin, β -agonist, $NaHCO_3$

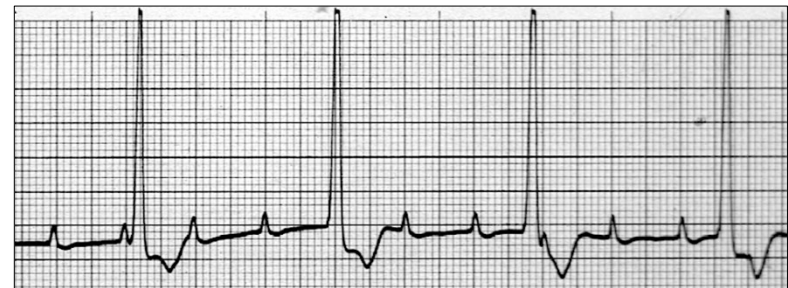
22

Canine – Leads I, II, III (25 mm/sec)



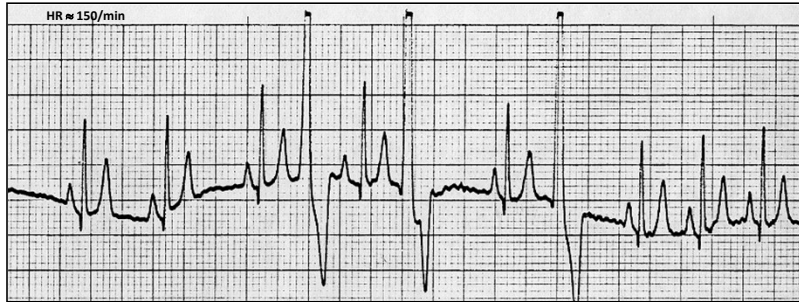
23

Canine ECG 25 mm/s 10 mm/mV.



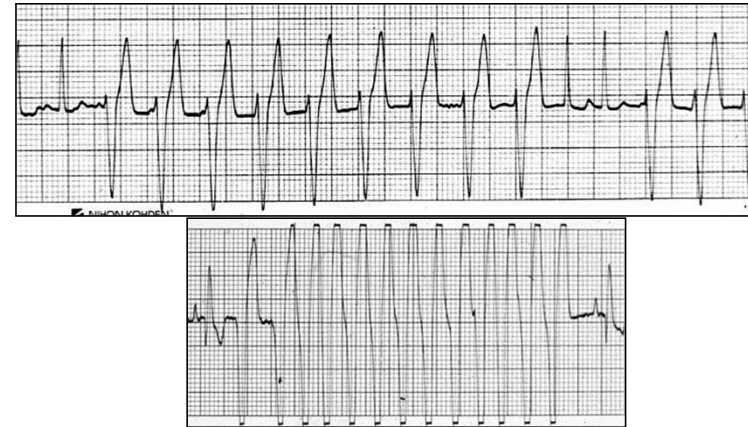
24

Canine – Lead II (25 mm/sec)



25

Two canine ECGs – Lead II (25 mm/sec)



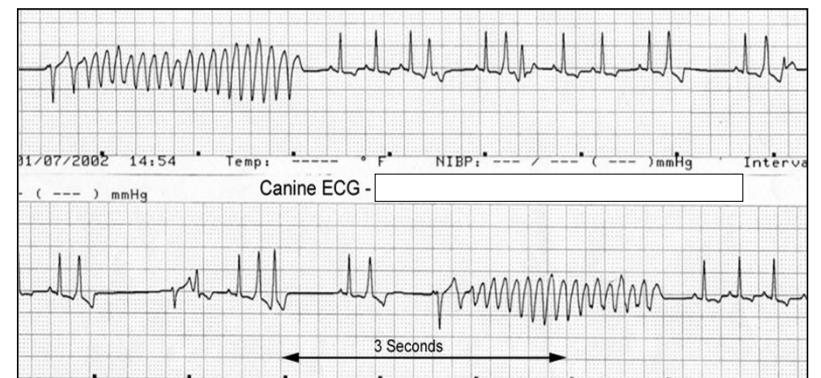
26

Canine – Lead II, 25 mm/sec

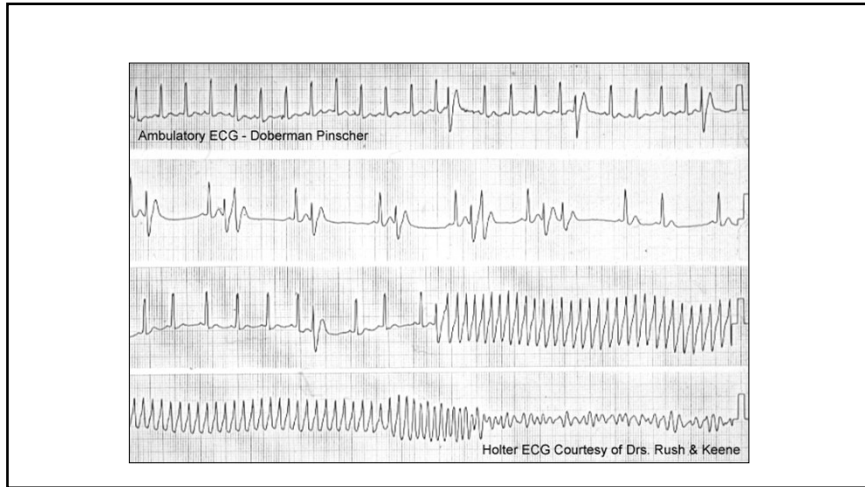


27

Canine ECG – Lead II (25 mm/sec)



28



29

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”)

30

General Causes of Ventricular Arrhythmias

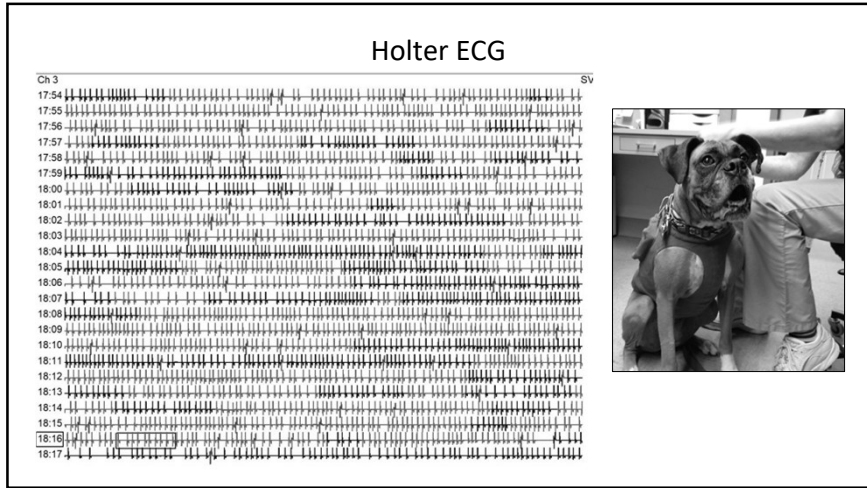
- Cardiac diseases
 - Structural diseases leading to cardiac remodeling
 - Primary electrical disorders (Boxer, Eng Bulldog, DP, others)
 - Heart failure
 - Ischemia – most often short-term
 - Cardiac neoplasia (often refractory)
- Metabolic & Endocrine disorders
- Autonomic nervous system
- Drugs &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

31

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
- Low-n-type criteria: Frequency, Timing (R on T), Morphology, Runs of VT, Rate of VT, Complexity

32



33



34

Hospital Therapy of VT in Dogs (see conference notes)

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

NO! →

Cardioversion – English Bulldog ARVC

35

Therapy of Ventricular Arrhythmias – Chronic

Lidocaine
Sotalol – Procainamide – 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**

36