Partner Veterinary
EMERGENCY & SPECIALTY CENTER

Friends Don’t Let Friends Call Everything VTAC

Taryn Powell, LVT,CPEP

About Me

Taryn Powell, LVT, CPEP

Licensed Veterinary Technician at

Partner Veterinary Emergency and Specialty Center

Richmond, VA

Objective

Understand ECG basics & lead placement

Recognize common arrhythmias

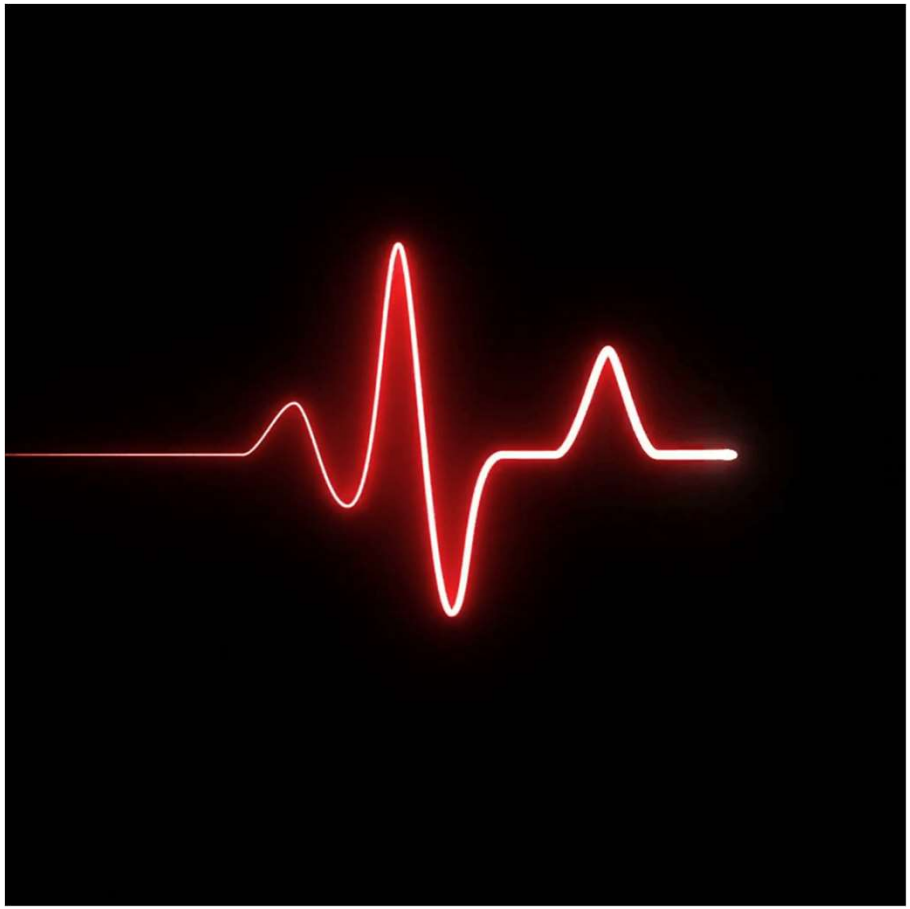
Learn systematic ECG interpretation

Technician utilization for cardiac patient

Apply findings to clinical practice

Special Acknowledgements:

Dr. Rachel Van Zile, Cardiologist



Why ECGs Matter in Veterinary Medicine

Role of the technician in ECG acquisition & interpretation

Common clinical scenarios (anesthesia, emergency, cardiology)

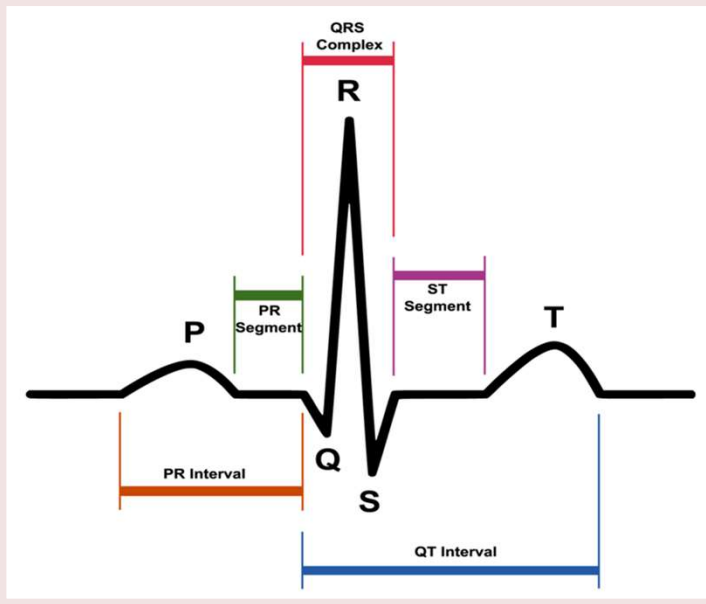
ECG Definitions & Concepts

Electrocardiogram vs. Elektrokardiogramm

- **ECG** = English vs. **EKG** = German
- "Graphic representation of summed electrical activity of the heart"

Waveform Nomenclature:

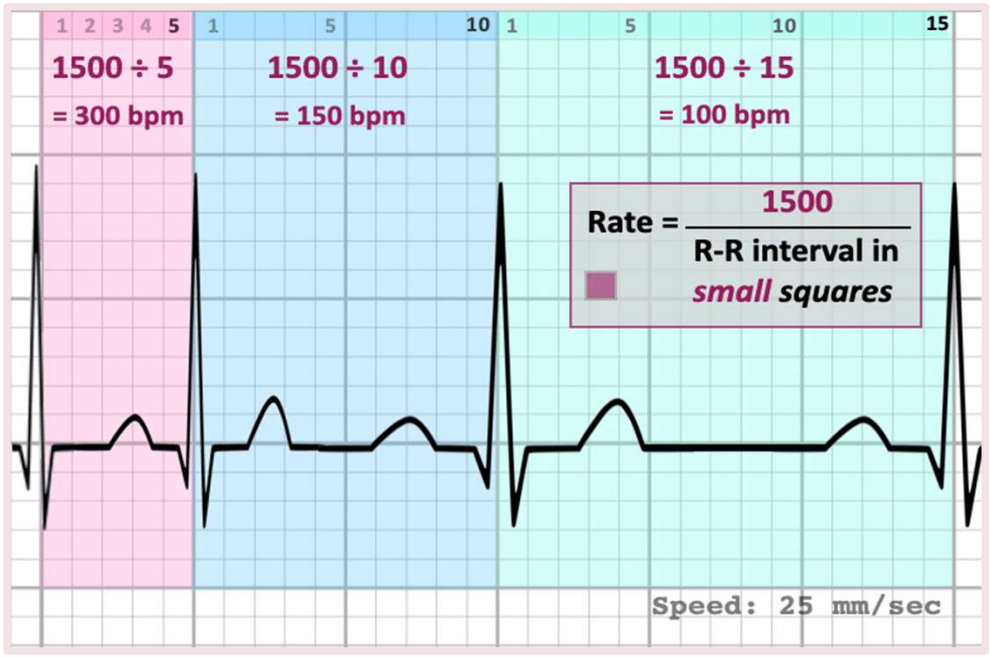
- **P wave 'Prepare'** = atrial depolarization
  - PR interval "Pause & Relay" = Total time for atrial + AV nodal conduction
- **QRS complex 'Quick, Really Strong Squeeze'**= ventricular depolarization
  - Obscures atrial repolarization
- **T wave 'Time to recover'** = ventricular repolarization
  - QT interval 'Whole venctricular cycle' = Total time for ventricular depolarization & repolarization



ECG Definitions & Concepts

Paper speed: must be known to calculate HR

- **25 mm/sec** = 0.04 sec (40 ms)
  - Instantaneous HR:
    - **1500** / # small boxes within R-R interval
- **50 mm/sec** = 0.02 sec (20 ms)
  - Instantaneous HR:
    - **3000** / # small boxes within R-R interval



- **Voltage** (amplitude):
  - Standard: 10 mm = 1 mV
  - Settings adjustable

Partner Veterinary
EMERGENCY & SPECIALTY CENTER

The Heart's Conduction System

The conduction system:

Sinoatrial (SA) node

Atrial myocardium / interatrial pathways

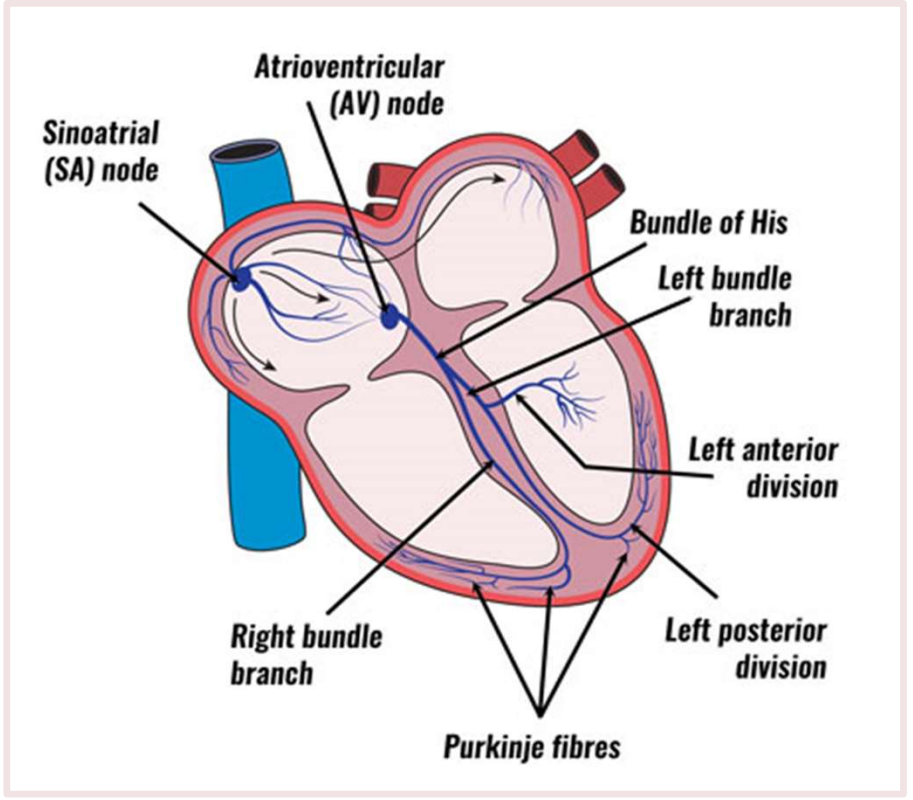
Atrioventricular (AV) node
"The Gatekeeper"

Bundle of His

Bundle Branches
(left & right)

Purkinje Fibers

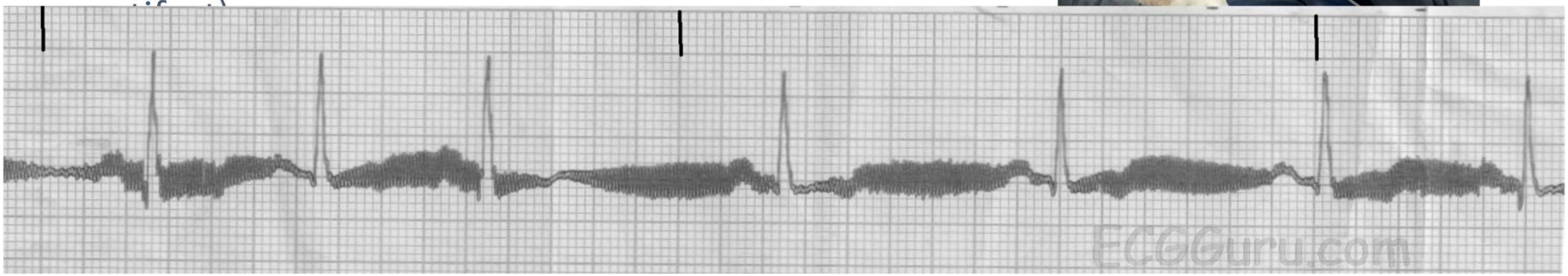
Ventricular myocardium



Partner Veterinary
EMERGENCY & SPECIALTY CENTER

Patient Positioning and Set up

- Place patient in right lateral recumbency with legs perpendicular
  - Consistency in the way the ECG is performed
  - Exception - standing in giant breed dogs
- Properly grounded equipment
  - Reduces electrical interference (60-cycle



ECG: Mean Electrical Axis

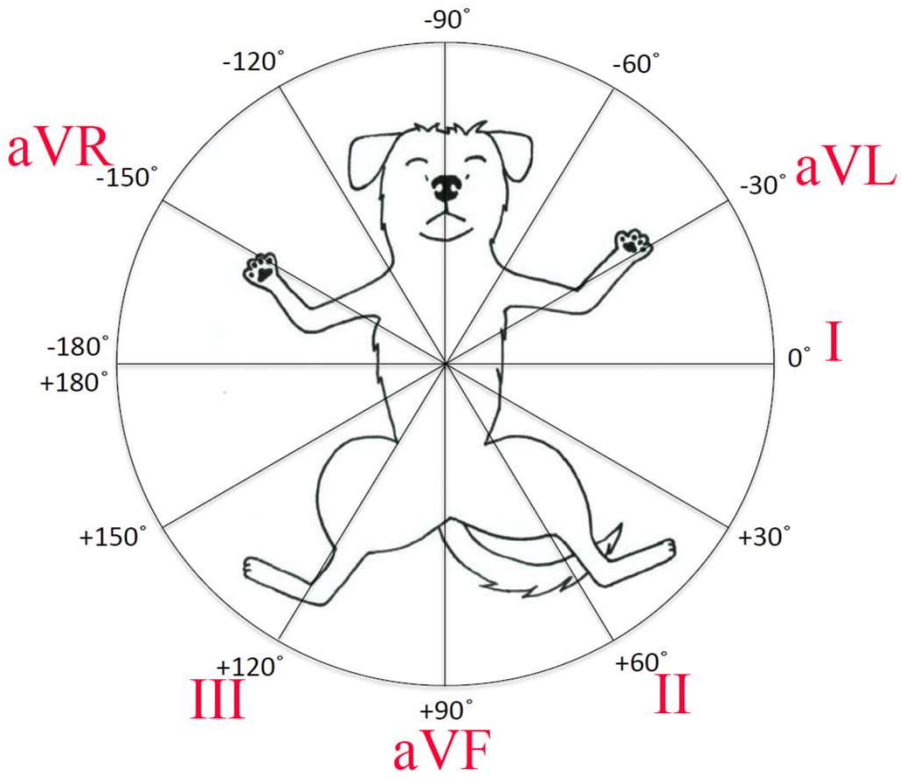


Image courtesy of Dr. Robert Hamlin

ECG: Arrhythmia Categories

Tachyarrhythmias

- **Supraventricular (SVT)**
  - Atrial fibrillation / flutter (AF)
  - Focal atrial tachycardia (FAT)
  - Nodal reentry (AVNRT)
  - Accessory Pathways (AP)
- **Ventricular**
  - Ventricular tachycardia (VT)
  - Ventricular Flutter / fibrillation (VF)

Bradyarrhythmia

- Sinus node dysfunction / arrest
- Atrial standstill
- Atrioventricular block (1^{st}-3^{rd})

Sinus

- **Sinus arrhythmia**
  - Respiratory sinus arrhythmia
  - Wandering pacemaker
- **Sinus tachycardia (physiologic)**
  - Up to 280 bpm?
  - Increased SNS tone:
    - Stress/fear, pain, dehydration/hypotension, heat
- **Sinus bradycardia (physiologic)**
  - Increased vagal tone (vagotonia)
    - GI, resp, neuro, ocular dz
  - Hypoxia, hypothermia
  - Hyper/hypokalemia

ECG: Arrhythmia DDX

H.E.A.D.S.

- **H** = Heart: primary cardiac disease
  - Cardiomyopathies, valvular, congenital, endo/myocarditis
- **E** = Electrolytes: metabolic & endocrine disturbances
  - K+, Mg2+, Ca2+, Addison's DZ, hyper/hypothyroidism
- **A** = Autonomic Nervous System
  - High SNS tone (pain, fear, hypotension), high vagal tone (GI, resp, neuro, eyes)
- **D** = Drugs
  - Nearly all sedatives and anesthetics
- **S** = The 'usual Suspects' ("stuff surgeons like to cut")
  - Splenic disorders, GDV, pheochromocytoma, pancreatitis, systemic inflammation

Your ECG Checklist: 4 Questions to Ask

1. Heart rhythm?

2. Heart rate?

3. Is there a QRS complex for every p wave?

4. Is there a p wave for every QRS complex?

ECG: Arrhythmia DDX

1. Heart rhythm?

- Regular vs. irregular
  - Regularly irregular rhythm?
    - Respiratory sinus arrhythmia
  - Irregularly irregular rhythm?
    - Atrial fibrillation

HR: 100 – 150 bpm

HR: 180 – 300 bpm

2. Heart rate?

- 25 mm/sec: 1500 / # small boxes
- 50 mm/sec: 3000 / # small boxes
  - If irregular rhythm: give range (longest R-R to shorted R-R)

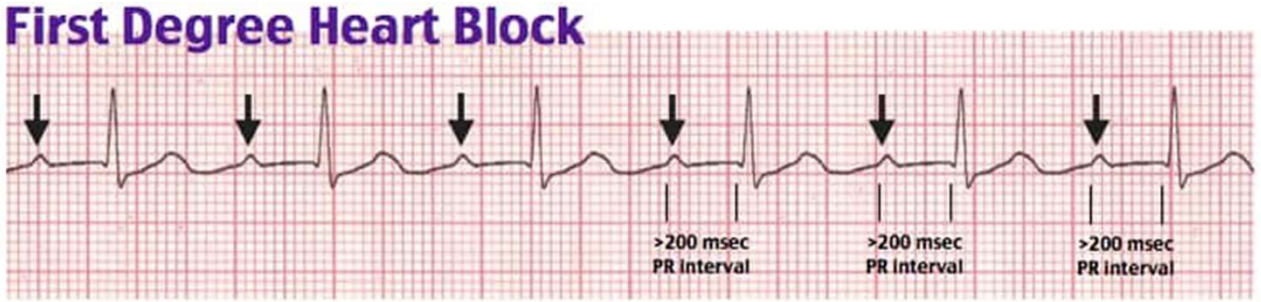
ECG: Arrhyth

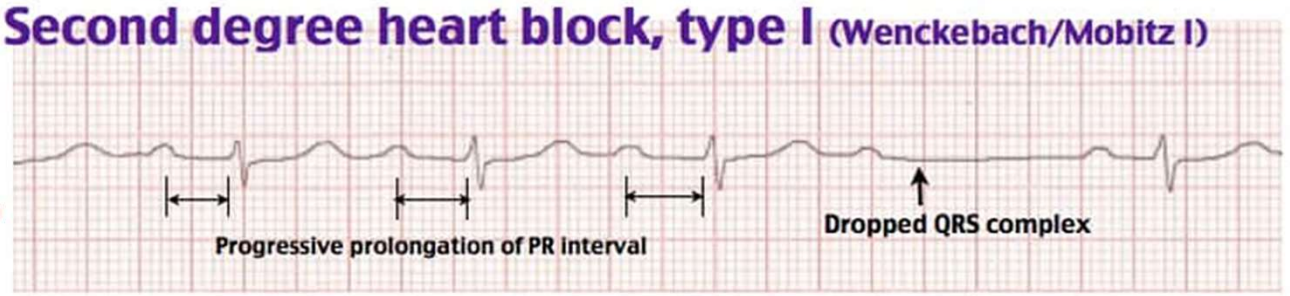
3. QRS complex

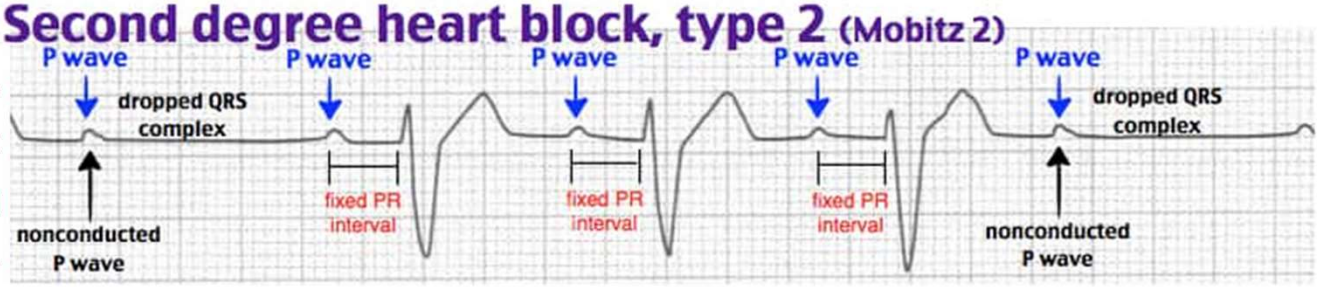
If your answer i

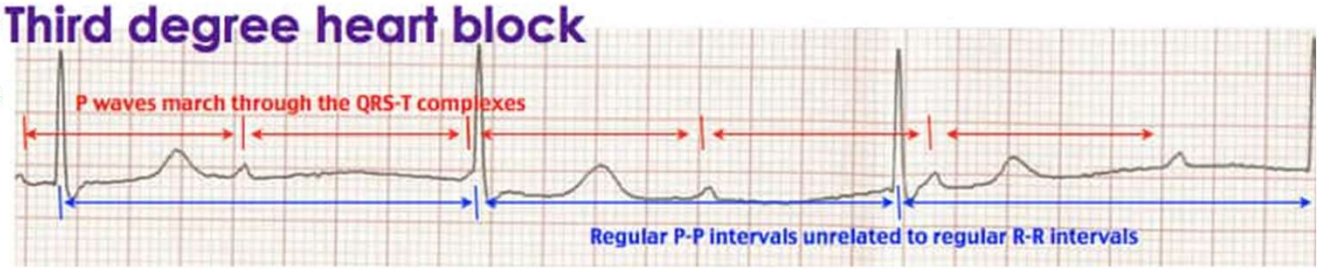
Atrioventricular

- (**1st degree:** Condu
  by QRS)
- **2nd degree:** Interm
  - *Mobitz Type I (Wer*
    complete block (n
    - Less pathologic; l
  - *Mobitz Type II:* Cor
    - Higher risk for pr
- **3rd degree:** Comple
  rhythm/rate









ECG: Arrhythmia DDX

4. P wave for every QRS complex?

If your answer is **no**…

Rhythm	P Wave	QRS	Quick Cue / Tip
Atrial Fibrillation (AF)	None / chaotic	Narrow, irregular	"Irregularly irregular—atria quivering"
Ventricular Tachycardia (VT)	None / dissociated	Wide, regular	"Ventricles take over—emergency rhythm"
Accelerated Idioventricular Rhythm (AIVR)	May be absent / dissociated	Wide, moderate rate	"Ventricles pace themselves—usually transient"
Atrial Standstill	None	Slow escape rhythm	"Atria silent—look for hyperkalemia or atrial disease"

ECG: Arrhythmia DDX

4. P wave for every QRS complex?

If your answer is **no**…

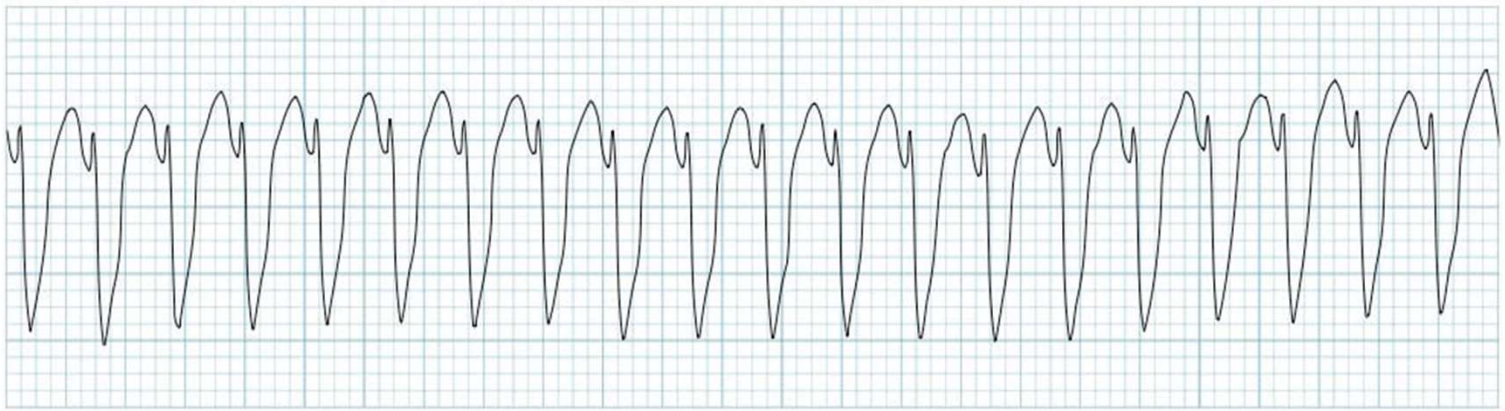
Rhythm	P Wave	QRS	Quick Cue / Tip
Atrial Fibrillation (AF)	None / chaotic	Narrow, irregular	"Irregularly irregular—atria quivering"

ECG: Arrhythmia DDX

4. P wave for every QRS complex?

If your answer is **no**…

Rhythm	P Wave	QRS	Quick Cue / Tip
Ventricula Tachycardia (VT)	None / dissociated	Wide, regular	"Ventricles take over—emergency rhythm"



ECG: Arrhythmia DDX

4. P wave for every QRS complex?

If your answer is **no**…

Rhythm	P Wave	QRS	Quick Cue / Tip
Accelerated Idioventricular Rhythm (AIVR)	May be absent / dissociated	Wide, moderate rate	"Ventricles pace themselves—usually transient"

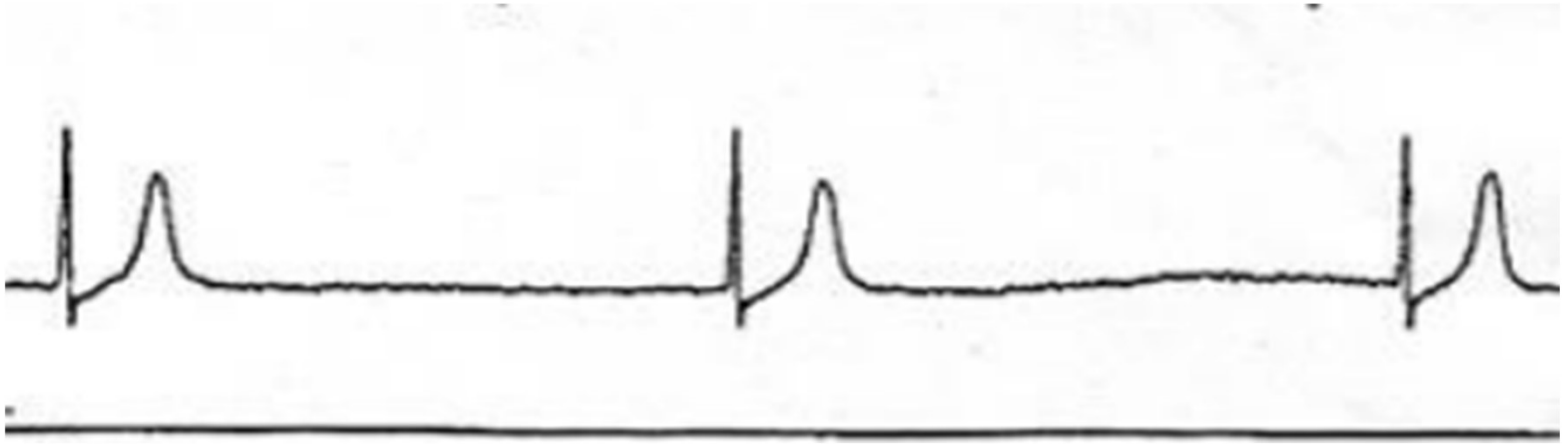
Figure 6. Accelerated idioventricular rhythm (dog).

ECG: Arrhythmia DDX

4. P wave for every QRS complex?

If your answer is **no**…

Rhythm	P Wave	QRS	Quick Cue / Tip
Atrial Standstill	None	Slow escape rhythm	"Atria silent—look for hyperkalemia or atrial disease"

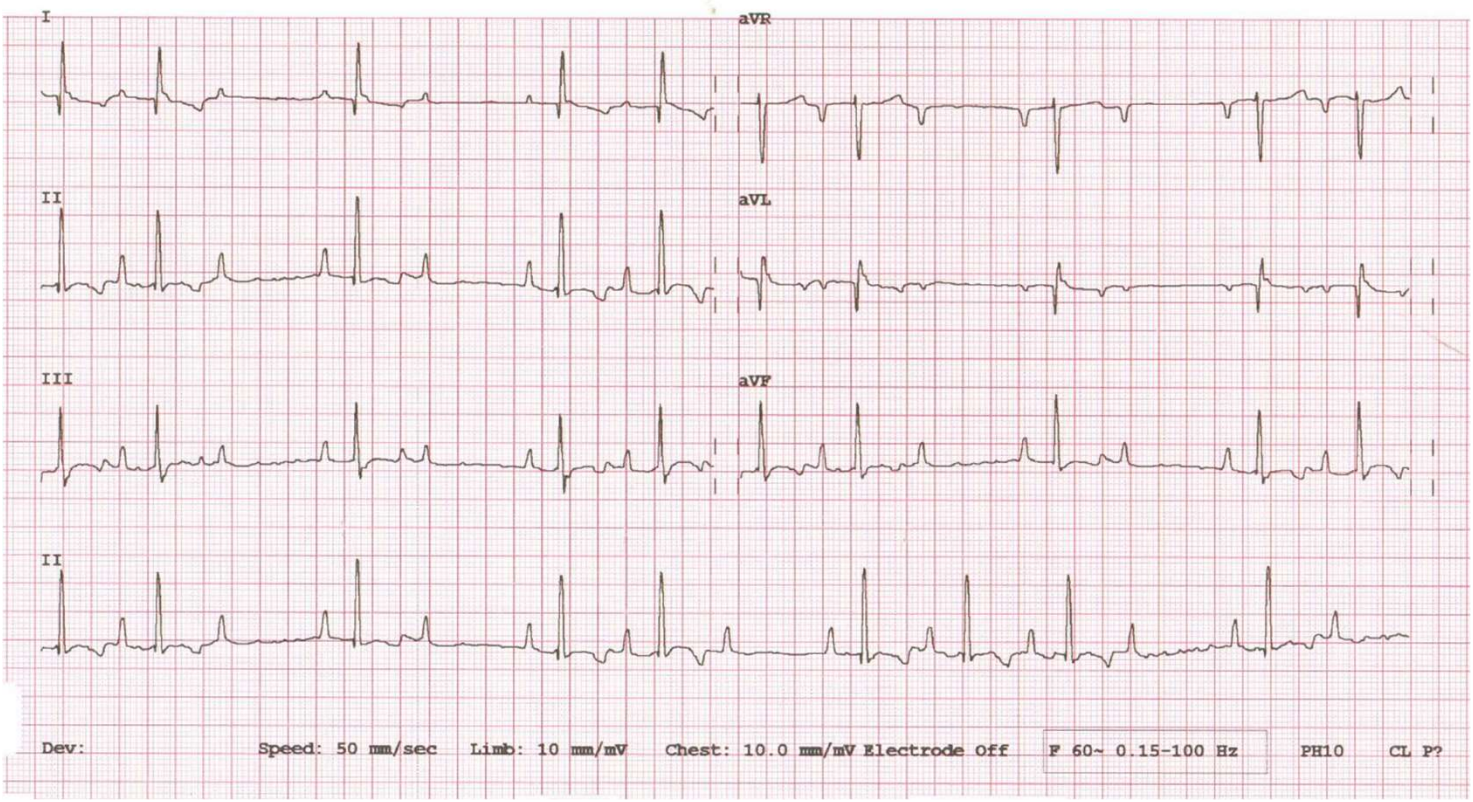


You Are Ready!

Partner Veterinary
EMERGENCY & SPECIALTY CENTER

ECG #1

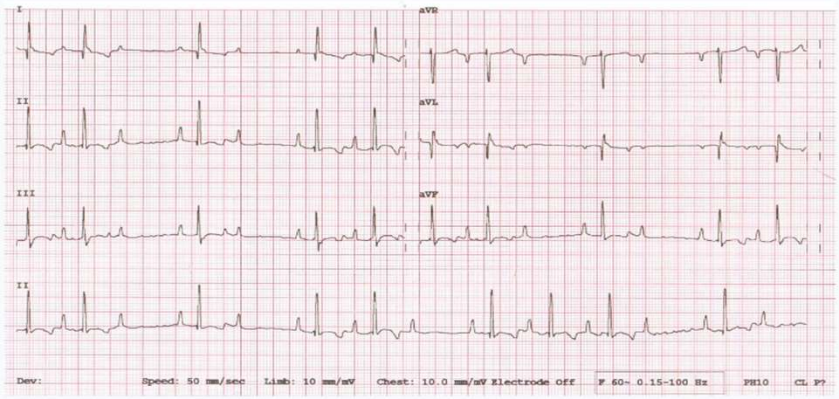
9 yo MC Cocker Spaniel presenting for laceration repair with an irregular rhythm on auscultation:



Partner Veterinary
EMERGENCY & SPECIALTY CENTER

Answer?

ECG #1 - Arrhythmia Diagnosis?



Respiratory sinus arrhythmia

1st degree AV block

2nd degree AV block - Mobitz Type II

3rd degree AV block

Partner Veterinary
EMERGENCY & SPECIALTY CENTER

Bonus Question: ECG #1

Before sedating this patient, you elect to give _____ to improve conduction through the AVN

Atenolol 1mg/kg PO

Atropine 0.04mg/kg SQ

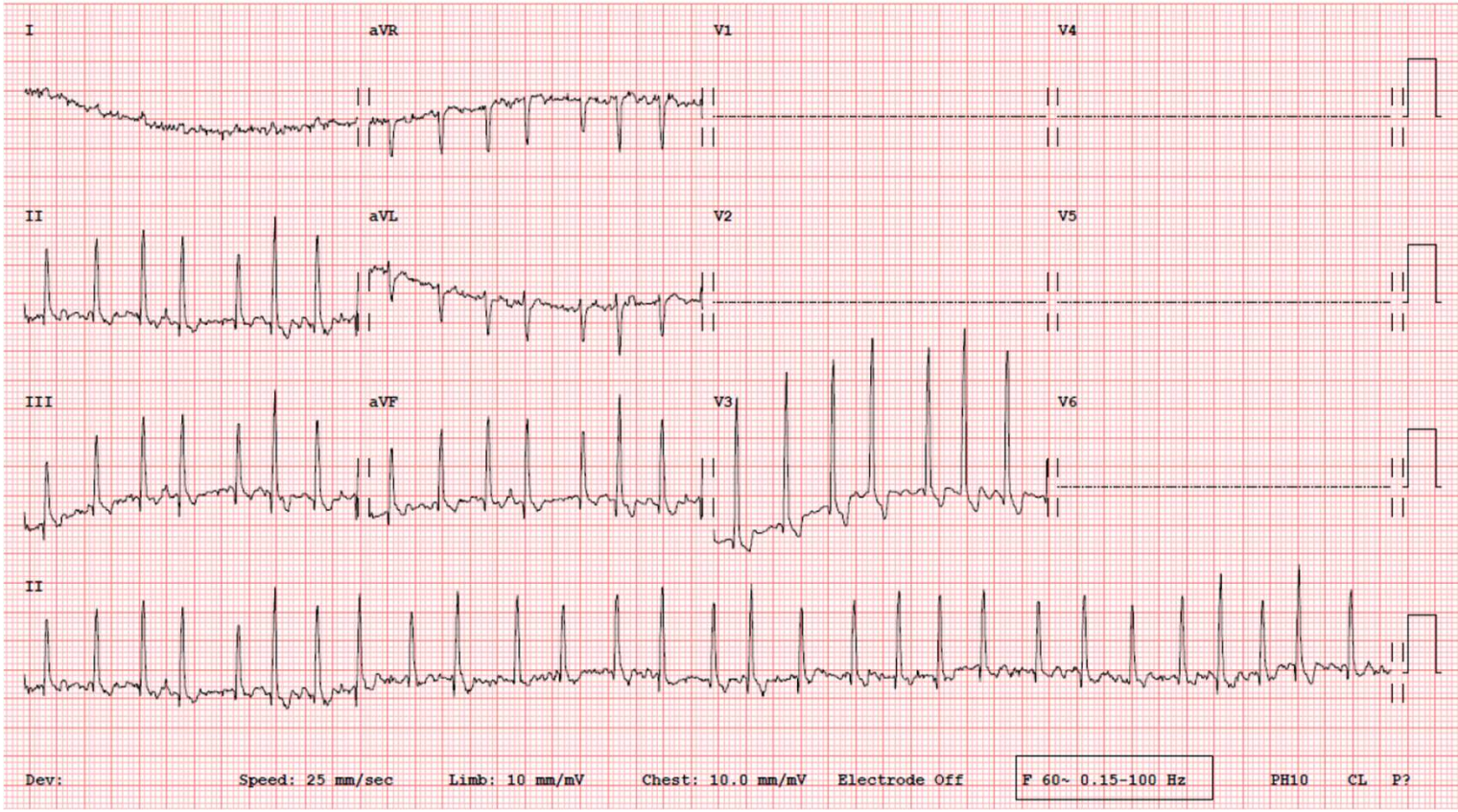
Naloxone 0.04mg/kg IV

Norepinephrine 0.01mg/kg IV

Partner Veterinary
EMERGENCY & SPECIALTY CENTER

ECG #2

6 yo MC Great Dane presenting for lethargy and “racing heart”



Partner Veterinary
EMERGENCY & SPECIALTY CENTER

Answer?

ECG #2 - Arrhythmia Diagnosis?

Sinus tachycardia

Atrial flutter

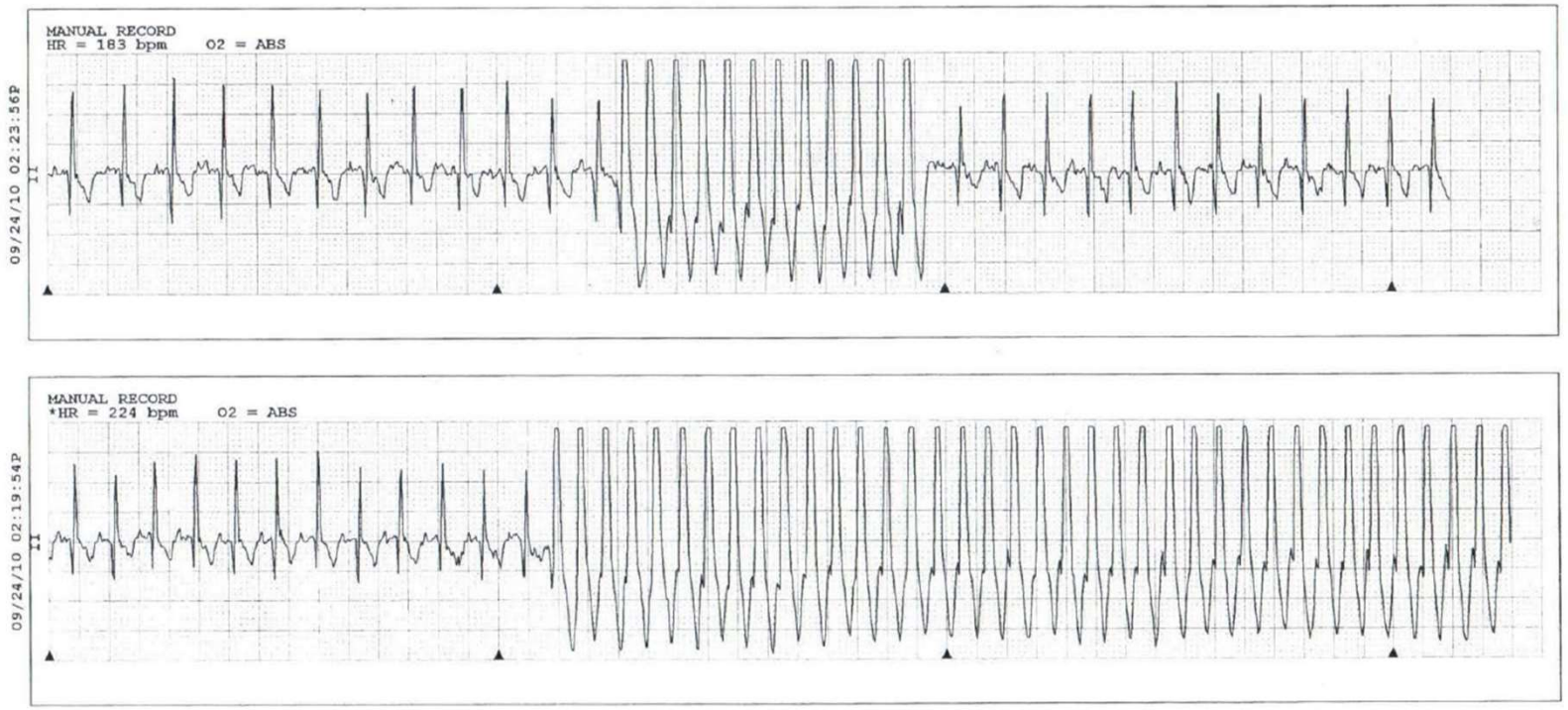
Atrial fibrillation

Ventricular tachycardia

Partner Veterinary
EMERGENCY & SPECIALTY CENTER

ECG #3

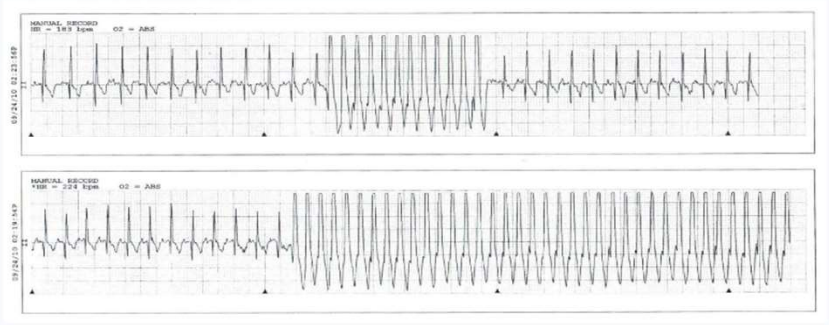
9 yo FS Boxer presenting for multiple episodes of collapse



Partner Veterinary
EMERGENCY & SPECIALTY CENTER

Answer?

ECG #3 - Arrhythmia Diagnosis?



Ventricular tachycardia - originating from right ventricle

Ventricular tachycardia - originating from left ventricle

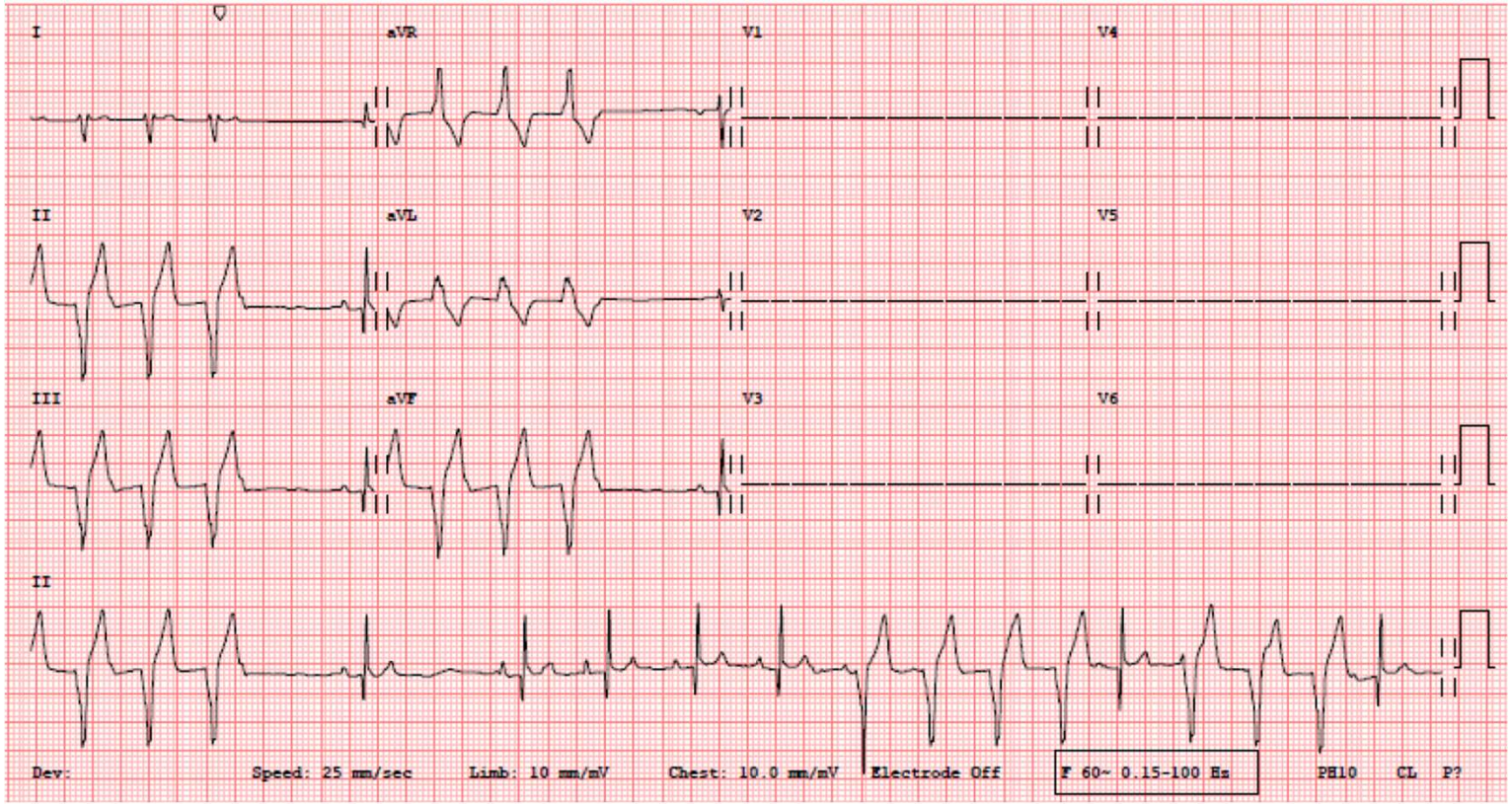
Supraventricular tachycardia - originating from right atrium

Supraventricular tachycardia - originating from left atrium

Partner Veterinary
EMERGENCY & SPECIALTY CENTER

ECG #4

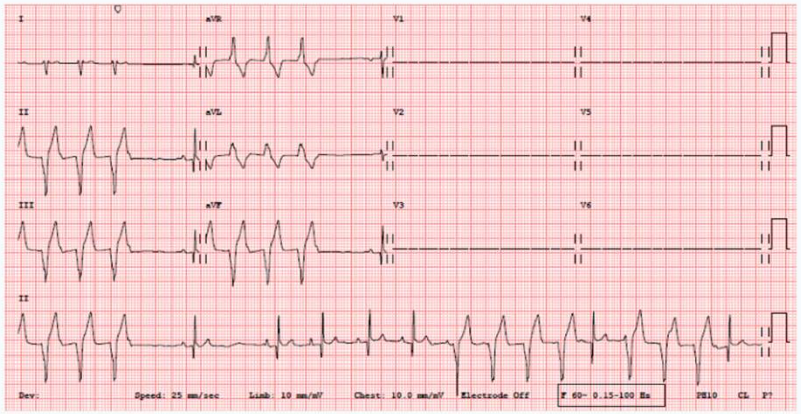
4 yo FS mixed breed dog hit-by-car and immediately post-op from splenectomy



Partner Veterinary
EMERGENCY & SPECIALTY CENTER

Answer?

ECG #4 - Arrhythmia Diagnosis & Treatment?



Ventricular tachycardia - Lidocaine 2mg/kg IV bolus

Atrial standstill - Calcium gluconate & IV dextrose for hyperkalemia

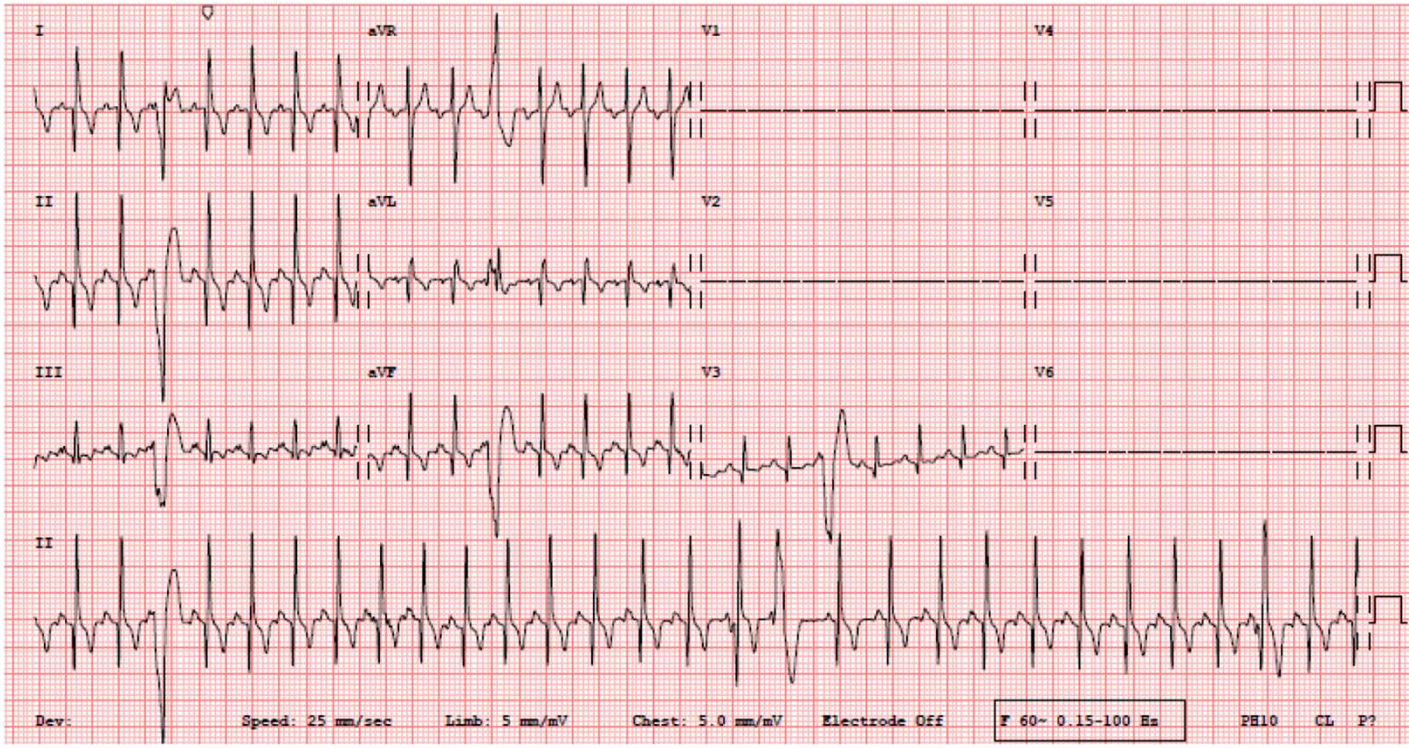
Accelerated idiopathic ventricular rhythm - Do nothing

Ventricular premature complexes - Sotalol 2mg/kg PO

Partner Veterinary
EMERGENCY & SPECIALTY CENTER

ECG #5

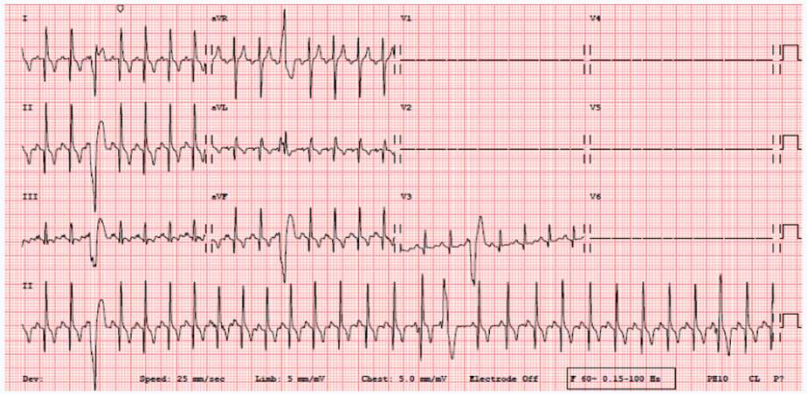
8 yo MC Doberman presenting for respiratory distress, coughing; cardiopulmonary auscultation: grade II/VI left apical systolic murmur, femoral pulse deficits, tachypnea, inspiratory crackles



Partner Veterinary
EMERGENCY & SPECIALTY CENTER

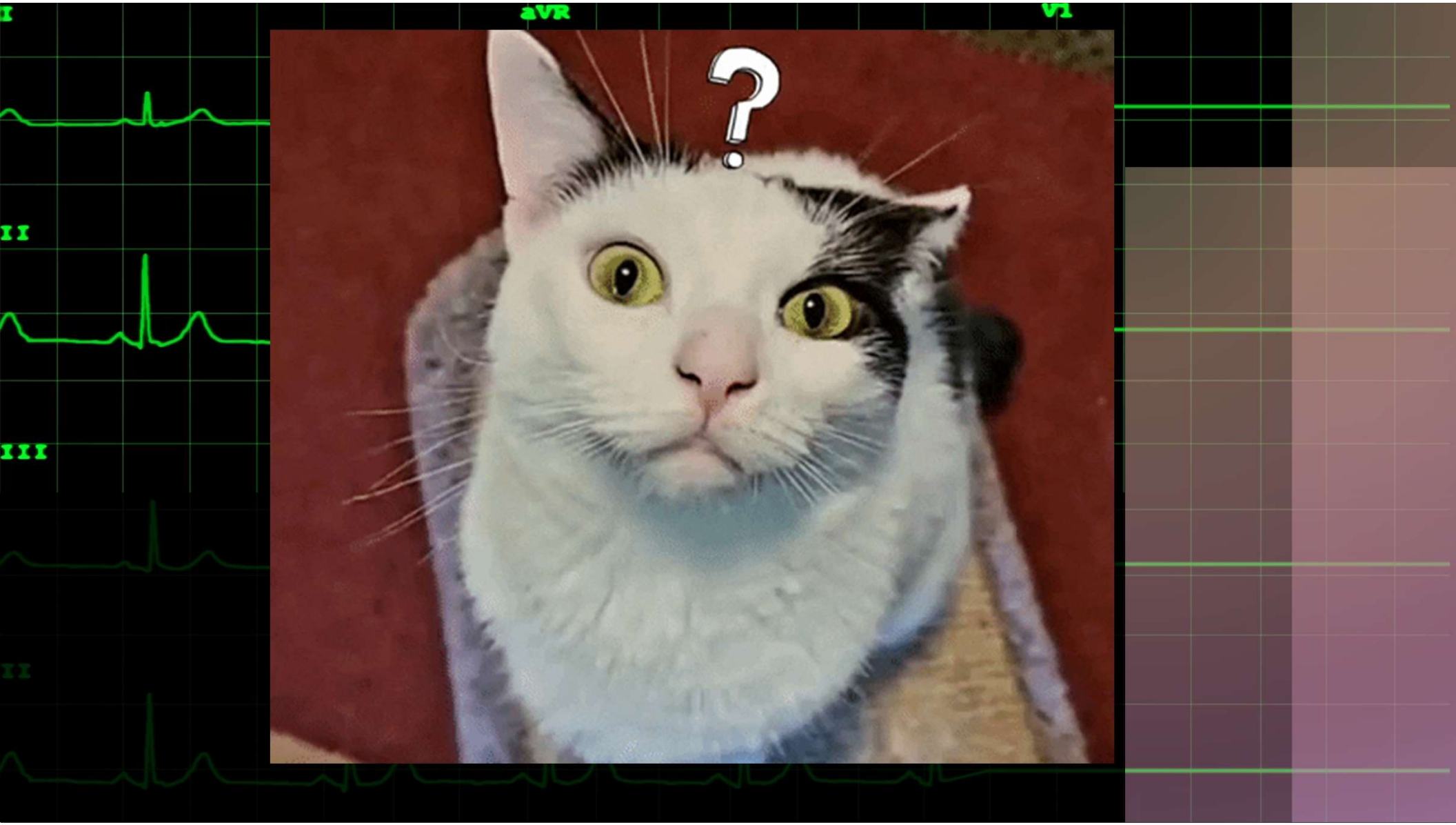
Answer?

ECG #5 - First line treatment?



- Lidocaine 2mg/kg IV bolus
- Furosemide 2mg/kg PO + Pimobendan 0.3 mg/kg PO
- Lidocaine 0.2 mg/kg IV bolus
- Diltiazem 3mg/kg PO

You’ve Mastered the basics of ECG interpretation!


I
aVR
V1
II
III
?

Partner Veterinary
EMERGENCY & SPECIALTY CENTER

Resources

Gomella, L. G., & Haist, S. A. (Eds.). (2022). *Basic ECG interpretation*. McGraw Hill.

Zimmerman, F. H. (Ed.). (2023). *ECG core curriculum: A step-by-step method of interpretation*. McGraw Hill.

Wilcox, S. R., & Brown, D. F. (2024). *A visual guide to ECG interpretation* (3rd ed.). Lippincott Williams & Wilkins.

Pourmand, A., Tanski, M., Davis, S., Shokoohi, H., Lucas, R., et al. (2015). Educational technology improves ECG interpretation of acute myocardial infarction for medical students and emergency medicine residents. *Western Journal of Emergency Medicine, 16*(1), 133–137.