Let's Get Tachy: The Diagnosis and Treatment of Arrhythmias

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Objectives

- Identify common tachyarrhythmias on ECG
- Discuss predisposition & pathophysiology of arrhythmias
- Learn how to treat arrhythmias
  - Rate versus rhythm control

"It's got a nice beat and it's easy to dance to."

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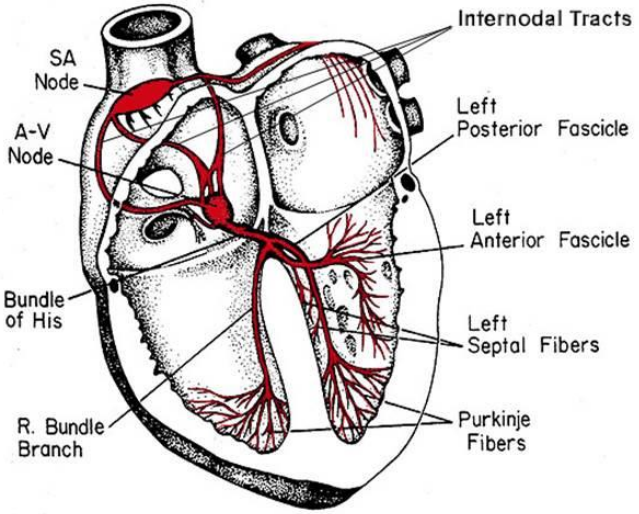
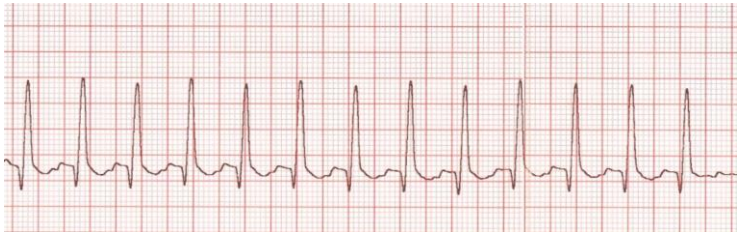
Supraventricular Tachycardias

- Narrow QRS tachycardia
  - “Normal appearance”
  - Utilize ventricular conduction system
- Physiologic response
  - Sinus tachycardia
- Pathologic
  - Atrial fibrillation
  - Atrial flutter
  - Atrial tachycardia
  - AV Nodal Dependent
    - Wolff Parkinson White
    - Junctional





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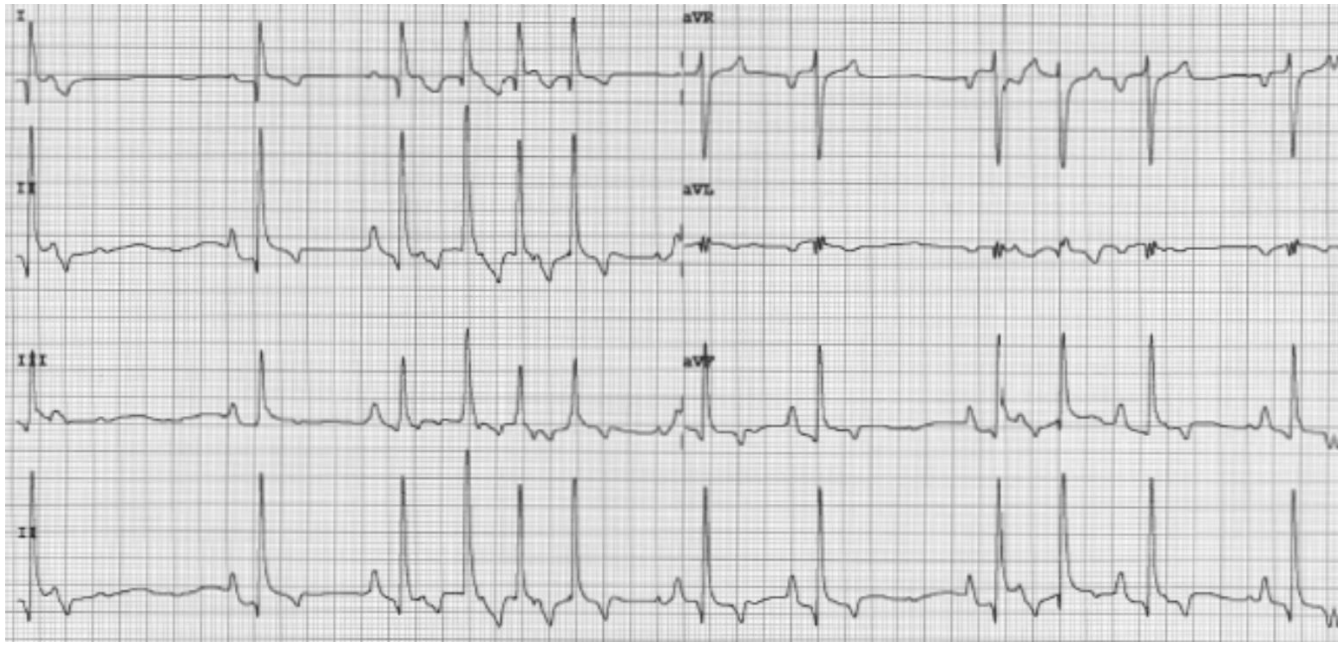
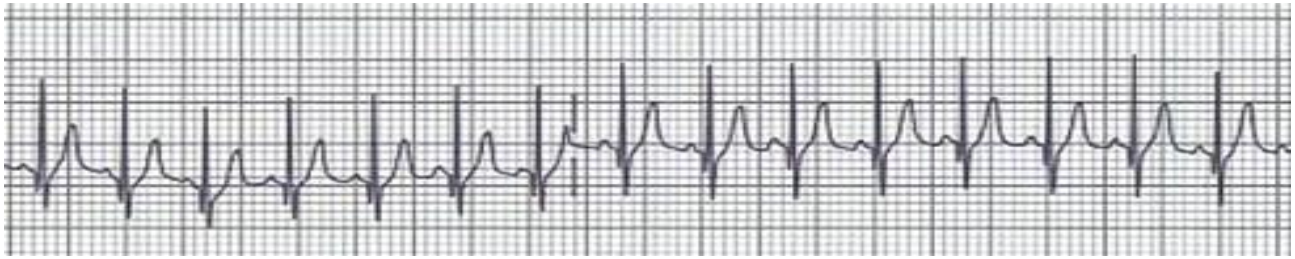
Normal QRS Morphology

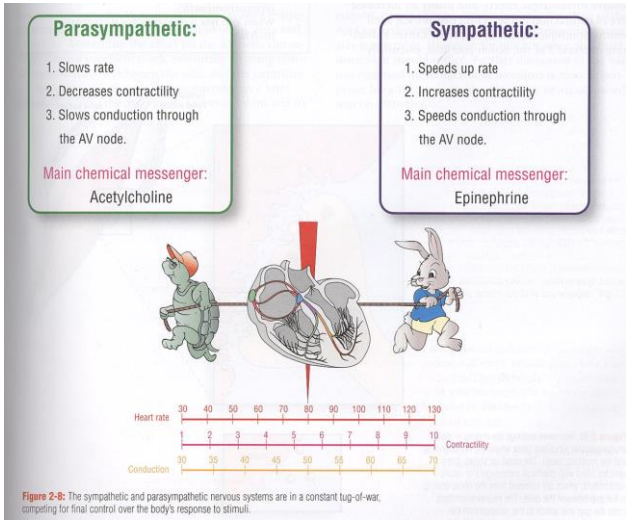


Electrical alternans is common with SVT

Sinus Tachycardia



- Often confused with pathologic supraventricular tachycardias
- Fast rate with normal appearing QRS complexes
  - Dogs < 200 BPM
  - Cats < 250 BPM
- P for every QRS and QRS for every P
  - P waves may be buried in preceding T wave
- Normal PR interval
- Exhibit gradual changes in rate
  - Never abrupt rate changes
- No therapy required



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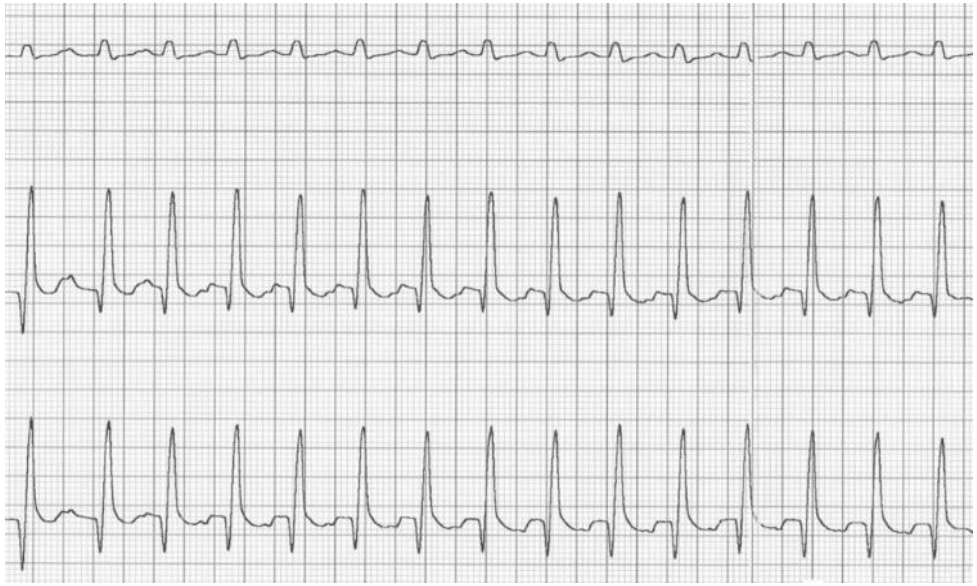
ECG diagnosis



What is this rhythm?

A) Too fast to be a sinus tachycardia

B) Sinus tachycardia

C) I can’t even find the p wave!

D) Ventricular tachycardia

E) Can I get more info?

Vagal Maneuvers

- Non-pharmacologic interventions that increase vagal stimulation to the heart
  - Slows (gradually) rate of SA nodal discharge
  - Slows AV nodal conduction
  - Little effect else where (atrial & ventricular myocardium)

- Methods
  - Carotid sinus massage
    - Pressure applied to angle of mandible
  - Breath hold
  - Diving Reflex
  - Ocular pressure

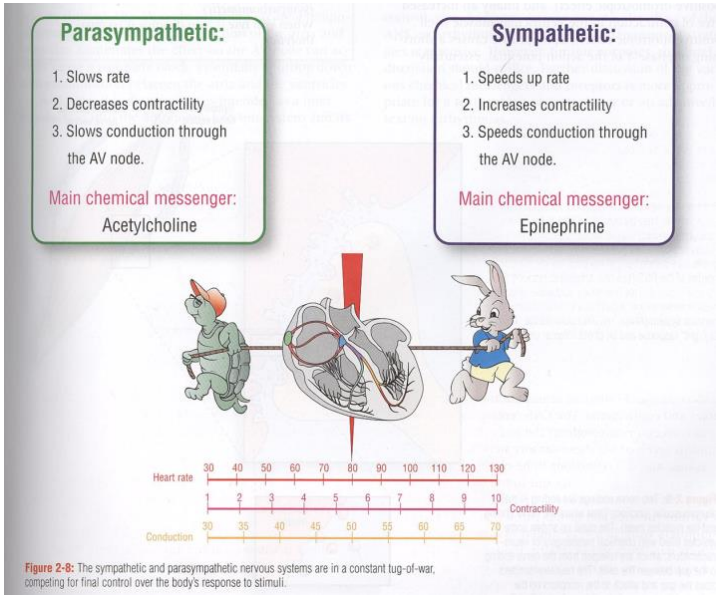


Figure 2-8: The sympathetic and parasympathetic nervous systems are in a constant tug-of-war, competing for final control over the body's response to stimuli.

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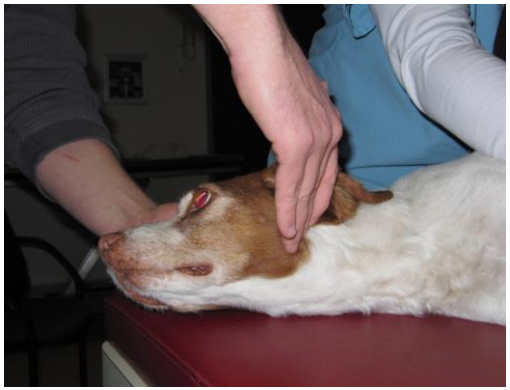
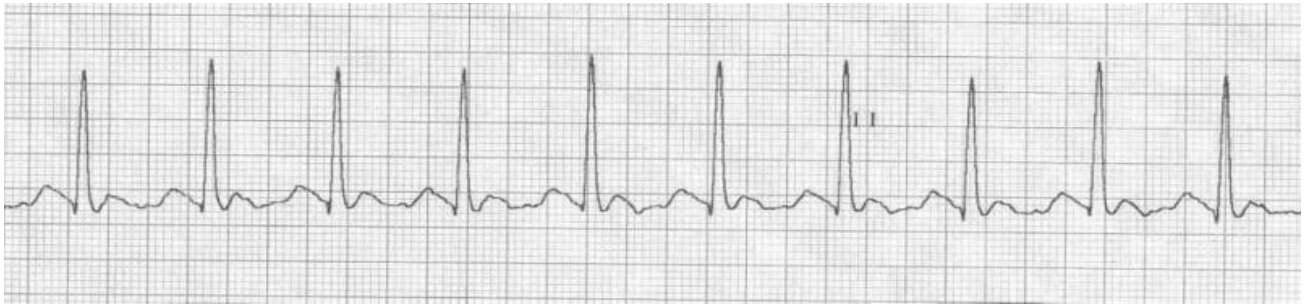
Vagal Maneuvers



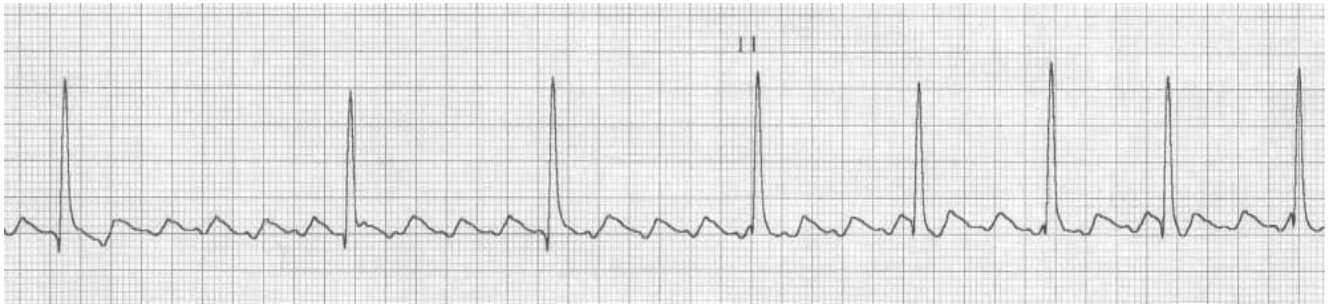



Images courtesy of KE Schober

Why Vagal Maneuvers are Important



A) A sinus tachycardia again…duh!
B) Is this a trick question?



What is the arrhythmia?

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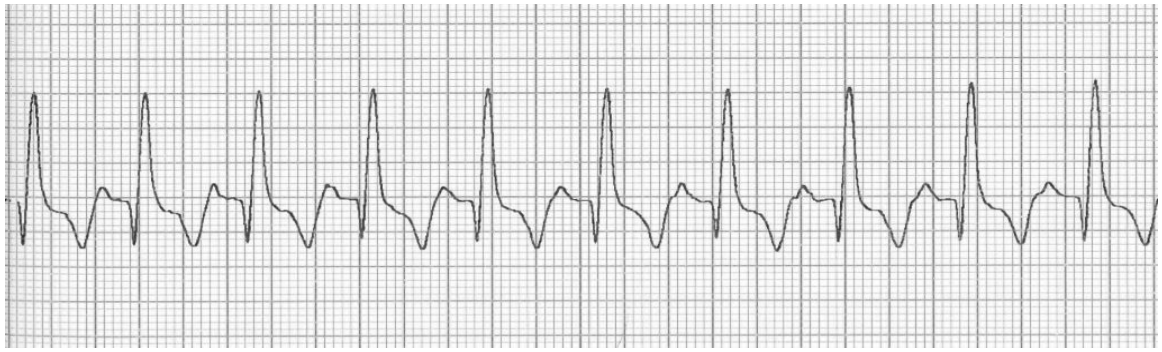
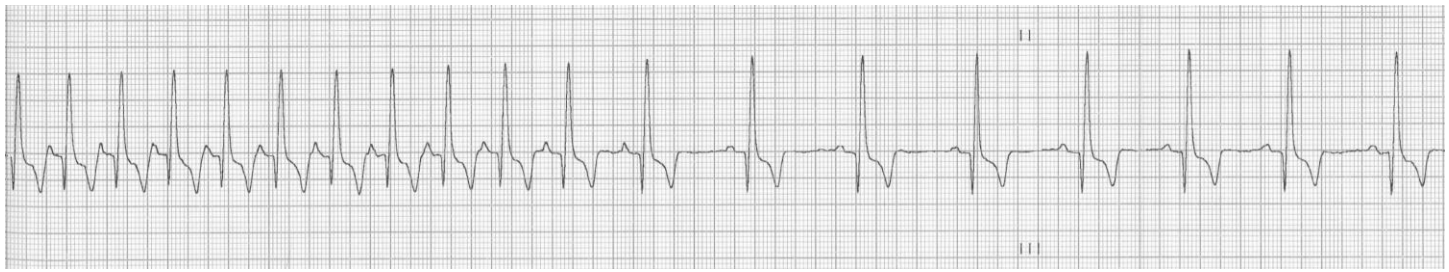
Vagal Maneuvers

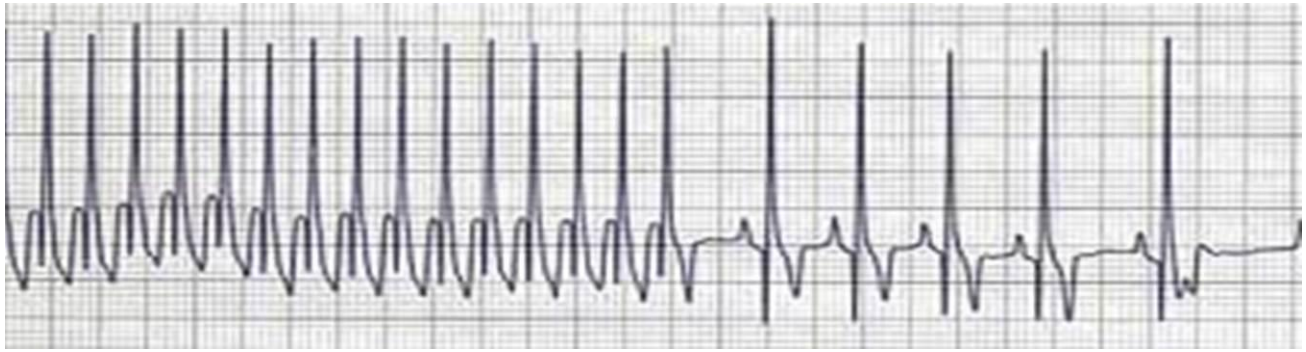


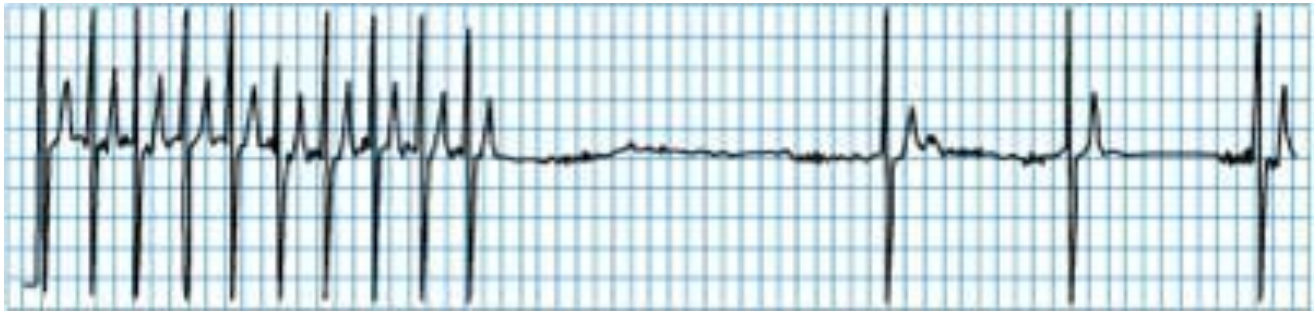
What is the arrhythmia?

A) Atrial fibrillation
B) Atrial tachycardia
C) Sinus tachycardia
D) Can we talk about something besides arrhythmias?



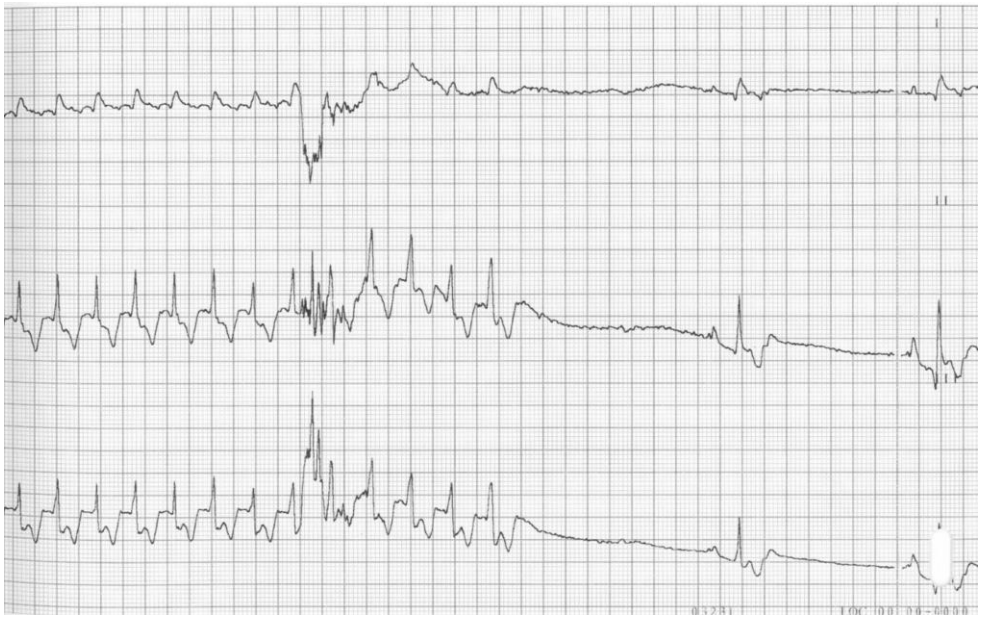
Supraventricular Tachycardia

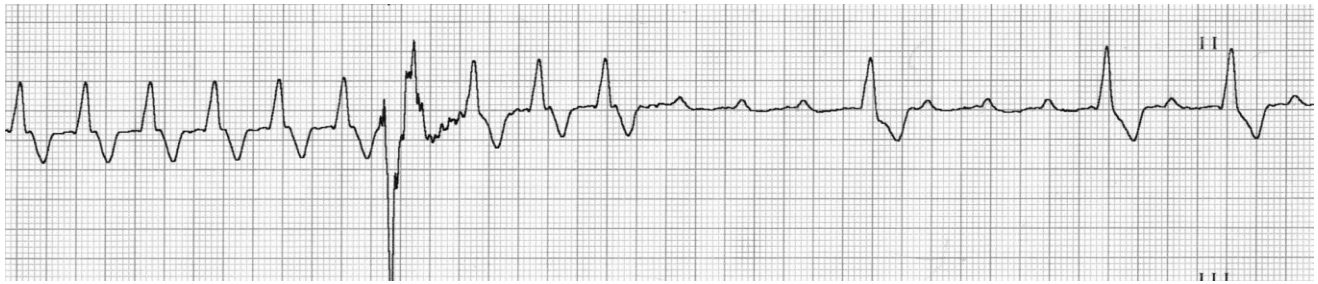




Abrupt breaks = pathologic

Precordial Thump





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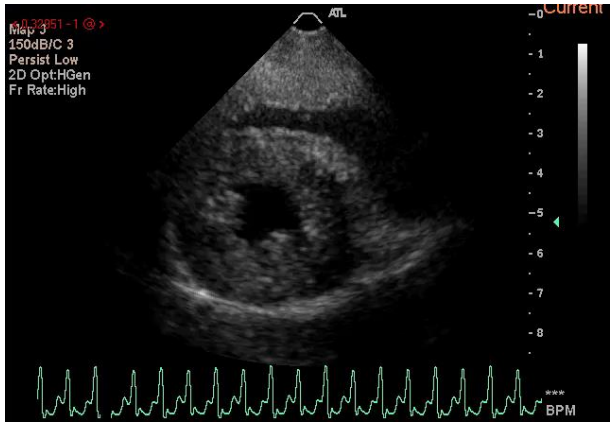
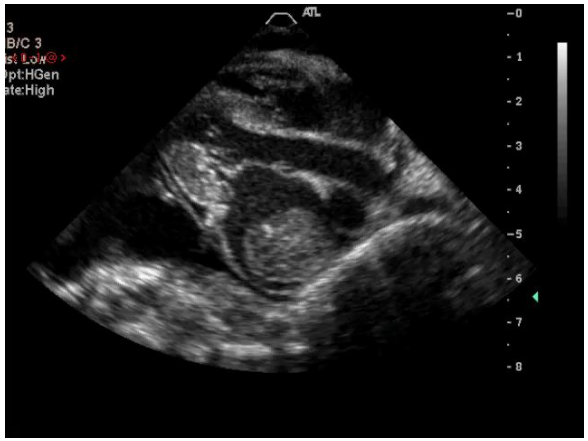
Pathophysiology

- Tachycardia
  - Decreases cardiac output
  - Decreases contractility
- Loss of atrial contraction
  - 20% decrease in cardiac output
  - Increase in atrial pressures
  - Increased risk of luminal thrombosis (cats)
- Sudden deterioration in clinical status
  - Perfusion abnormalities
  - CHF





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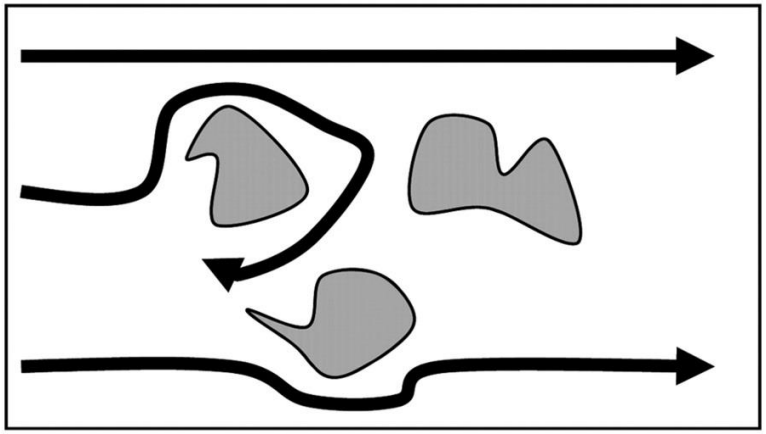
Predisposing Factors

- Atrial enlargement
  - Larger atria have increased risk of development
  - Atrial chamber dilation in heart disease
  - Lone atrial fibrillation
- Atrial fibrosis
  - Promotes re-entry
    - Areas of conduction block
    - Slow conduction
  - Endothelial disruption
    - Jet lesions
    - Chamber dilation
- Electrolyte abnormalities
- Pericarditis



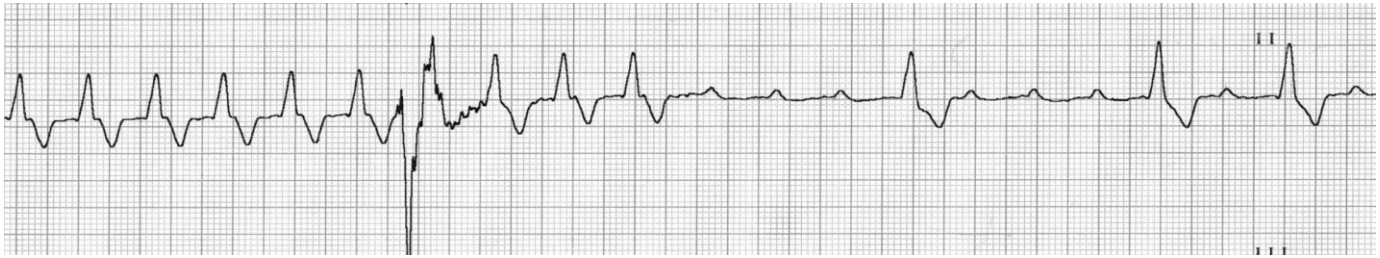
Clinical Signs

- Signs of CHF
  - Respiratory
  - Ascites
- Classic arrhythmia signs
  - Lethargy
  - Exercise intolerance
  - Syncope
  - Ptyalism
  - Agitation/anxiety

Physical Exam

- Arrhythmia
  - Extrasystole
  - Chaotic
  - Paroxysmal
  - Regular & sustained
- Femoral pulse
  - Variable pulse quality
  - Pulse deficits
  - Poor perfusion

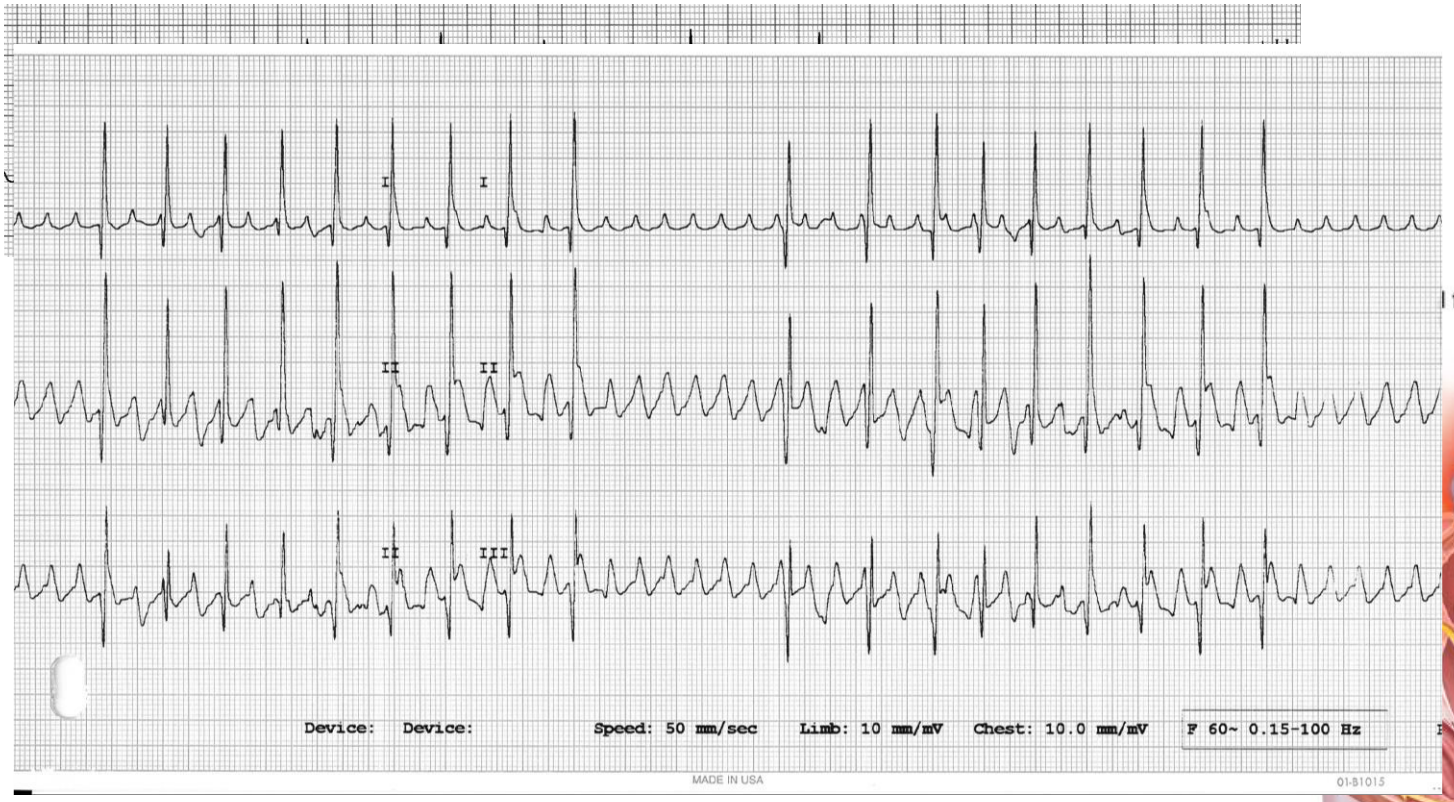
Atrial Tachycardia

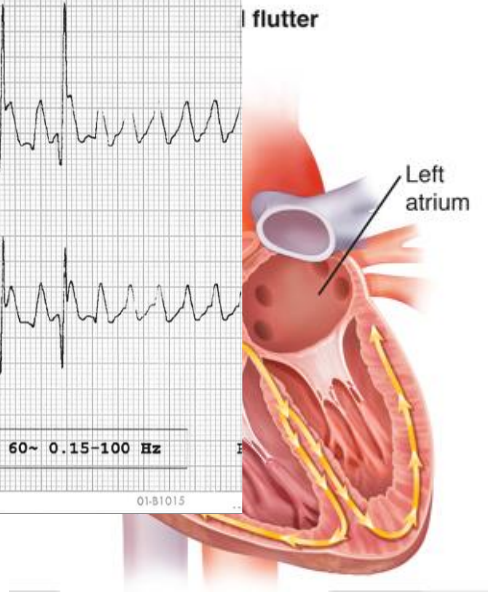


P wave rate unaffected, decreased ventricular rate

- Atrial origin
  - P waves usually buried in proceeding T wave
  - P waves of different morphology
  - Baseline between subsequent P waves
- QRS rhythm generally regular and rapid
- Vagal maneuver slows ventricular rate
  - Easier to see P waves
  - P waves occurring at initial QRS rate
    - P waves unaffected by vagal maneuver

Atrial Flutter





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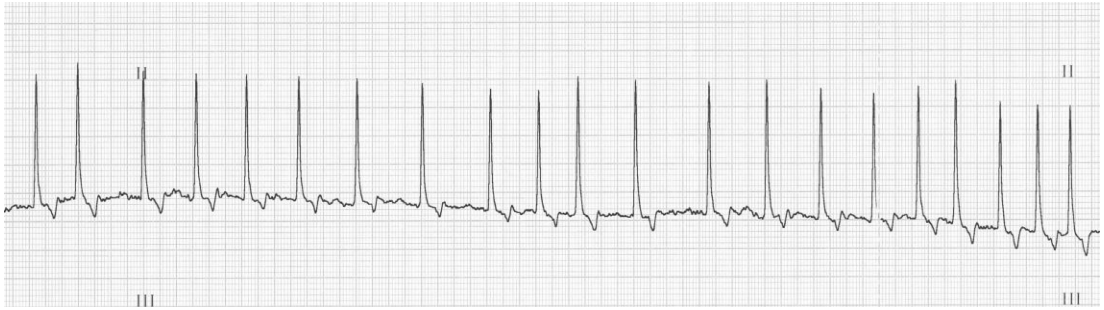
Atrial Fibrillation



- Supraventricular origin
  - Normal QRS complexes
- (+/-) tachycardia
- Marked irregularity between subsequent QRS complexes!!
- No P waves
- Baseline undulations
  - f waves
- Generally sustained

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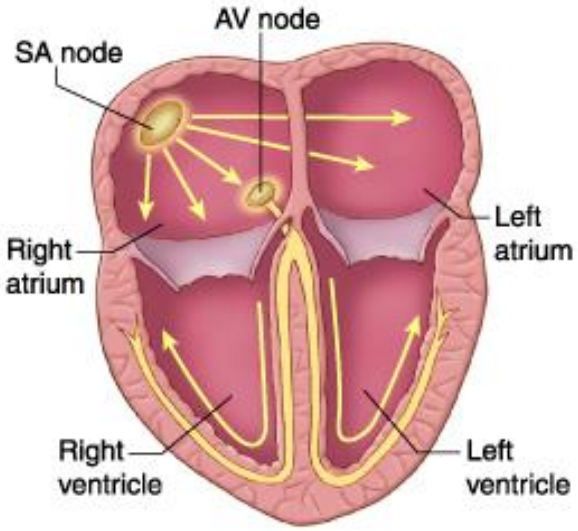
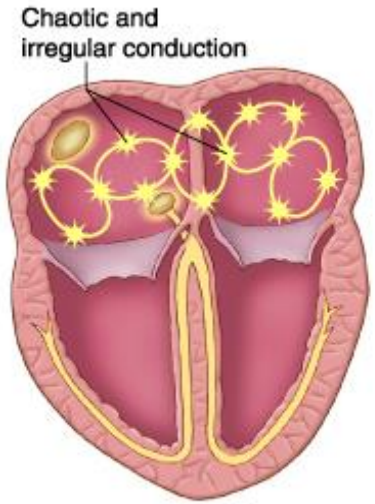
Atrial Fibrillation

- **Most** common type of SVT
  - Seen predominately with heart disease
    - DCM
    - Mitral valve disease
  - May occur in normal heart
    - Lone AF
      - Giant breeds of dogs, horses
  - May also be triggered by pericarditis

Atrial Fibrillation



Normal condition



Atrial fibrillation

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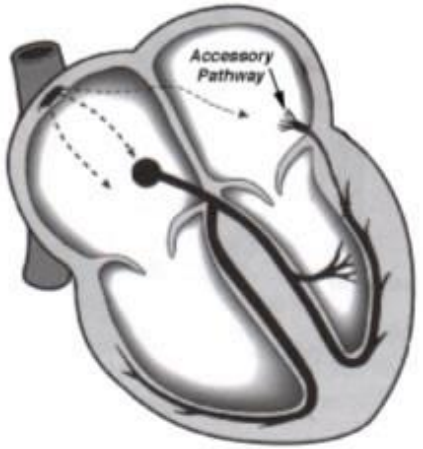
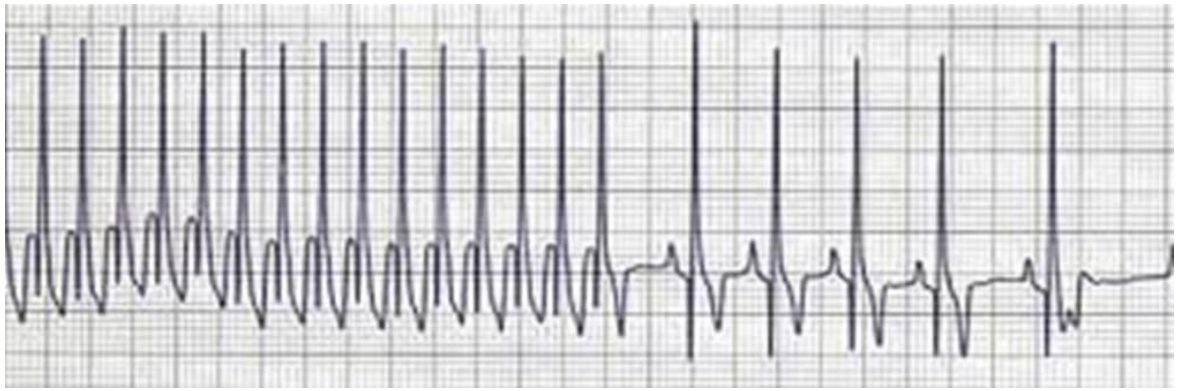
Wolff-Parkinson White Syndrome

- SVT due to re-entry across an accessory pathway

- Accessory pathway
  - Aberrant myocardium that connects atria to ventricles
  - Impulse travel bidirectionally

- Congenital abnormality

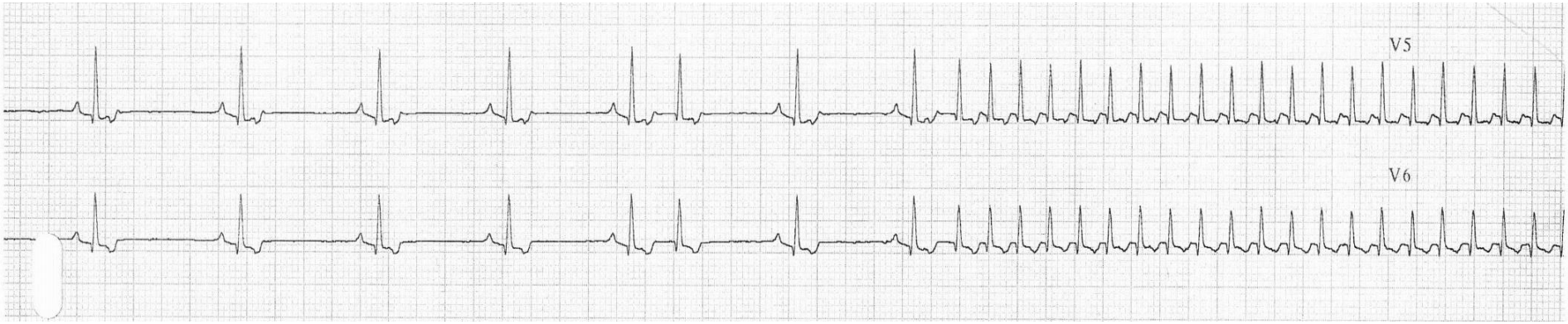




Wolff-Parkinson White Syndrome

- **What abnormality would indicate the presence of an accessory pathway?**

A) Prolonged P wave duration
B) Abnormally short PR interval
C) Lack of PR interval
D) Second degree AV block



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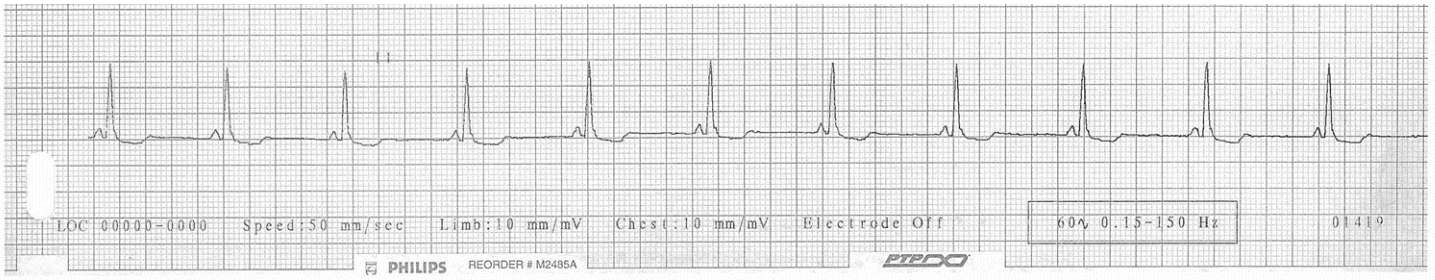
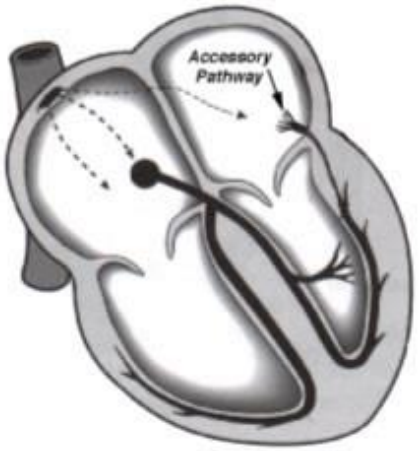
Wolff-Parkinson White Syndrome



- Ventricular pre-excitation
  - Abnormally short PR interval



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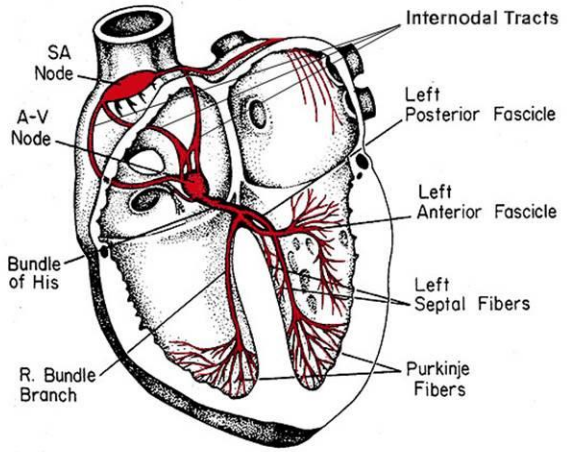
SVT Guidelines for Therapy

- Sudden death unlikely
- Heart rates
  - Rates > 180 BPM for 3 weeks results in cardiomyopathy and heart failure
    - Refractory CHF
  - Average rate > 120 BPM associated with decreased survival times
- Hemodynamic significance
  - Most SVT's associated with underlying heart disease
  - Detriment to cardiac function
  - Likely associated clinical signs
    - Exercise intolerance
    - Syncope
    - Progressive CHF

SVT Therapy

- Rate control
  - Medical therapy aimed at blocking AV nodal conduction
    - Slowing the ventricular rate
    - Arrhythmia persists
  - Benefits
    - Easy to accomplish & maintain
      - Atrial fibrillation
      - Atrial flutter
    - Well tolerated medications
    - Inexpensive
  - Negatives
    - Loss of atrial contraction
      - Decreases cardiac output
      - Clot potential
    - Difficult
      - A tachycardia



Which anti-arrhythmic used to treat SVTs also decreases contractility?

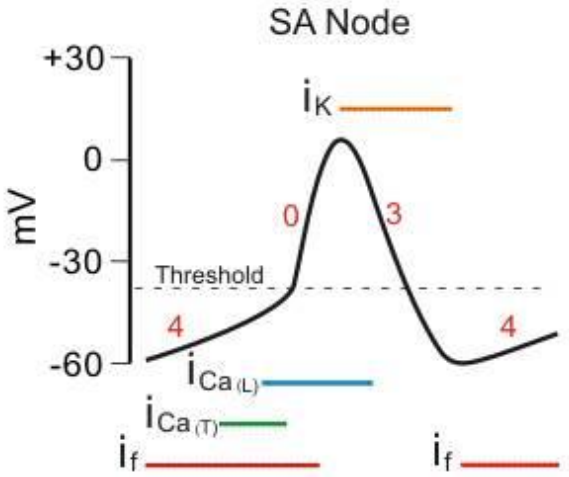
A) Atenolol
B) Lidocaine
C) Sotalol
D) Digoxin
E) Diltiazem
F) More than one of these

Medical Treatment – Rate Control

- Digoxin
  - Dosing
    - <20 kgs: 0.03 mg/kg
    - >20 kgs: 0.22 x lean meters squared body weight
  - Toxicity
    - GI signs

- Class 2 antiarrhythmics
  - Atenolol (1 mg/kg PO BID)
  - Metoprolol
  - Propranolol
  - Esmolol

- Class 4 antiarrhythmics
  - Diltiazem (2-4 mg/kg PO BID*)
    - Extended release



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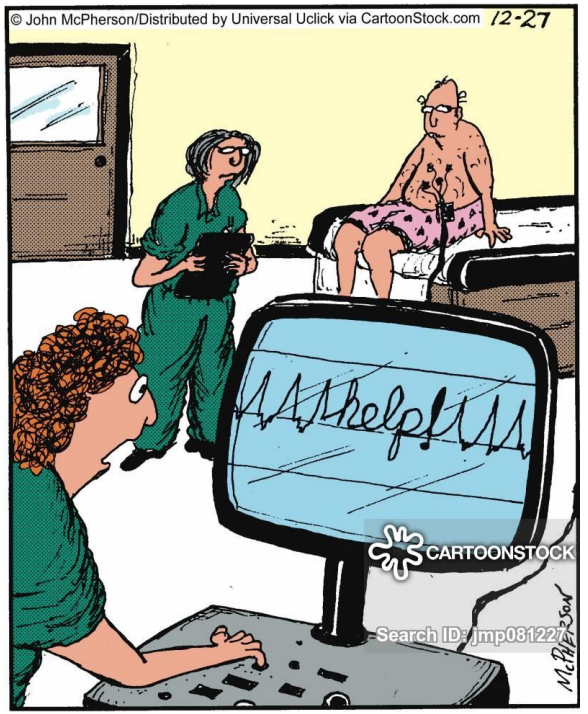
Medical Treatment – Rhythm Control

- Restore sinus rhythm
  - Abolish arrhythmia
- Benefits
  - SA nodal control of heart rate
  - Restore atrial contraction
    - Improved cardiac output
  - Avoid the need of lifelong medication
- Negatives
  - Expensive
  - Redevelopment of arrhythmia
    - Heart disease
    - Chronicity
      - Electrical remodeling



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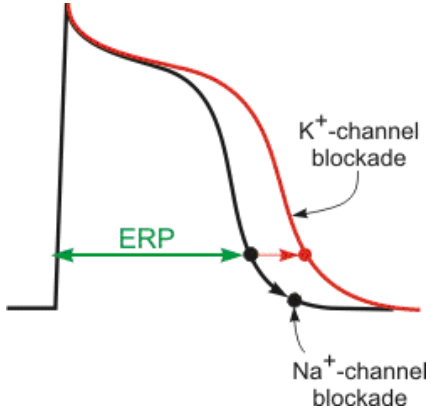
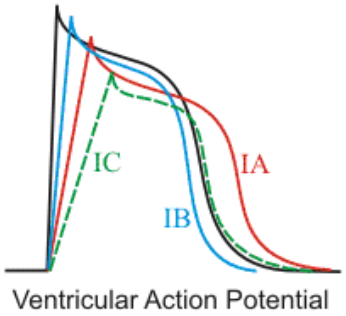
Medical Therapy - Rhythm Control

- Diltiazem
  - AV Nodal dependent tachycardia
- Class 3 (K+ channel blocker)
  - Sotalol
    - Concurrent beta-blockade
  - Amiodarone
    - Ventricular and atrial efficacy
- Class 1C (Na+ channel)
  - Flecainide
  - Propafenone





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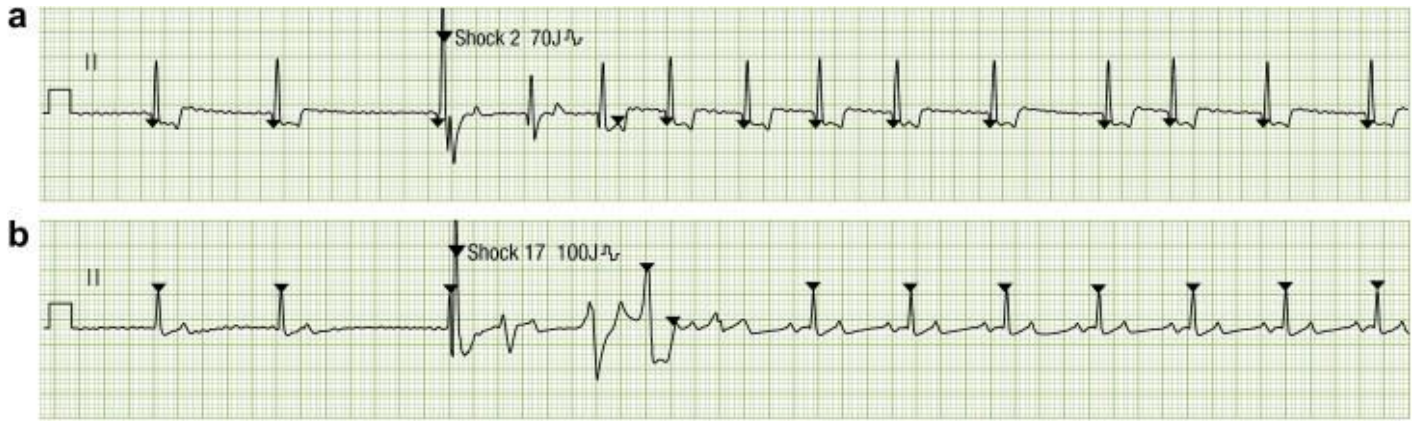
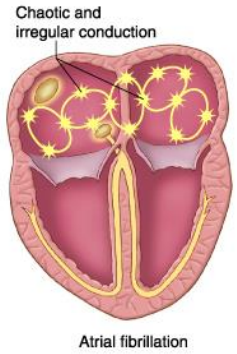
Rhythm Control





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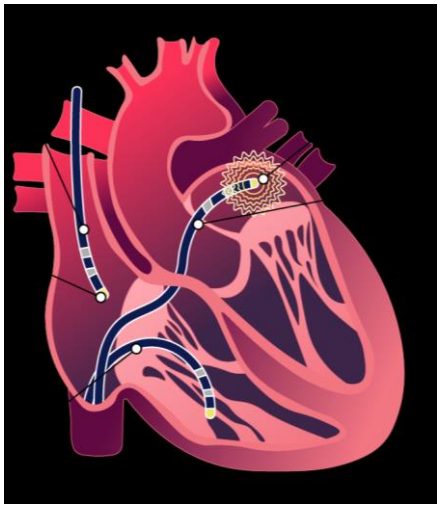
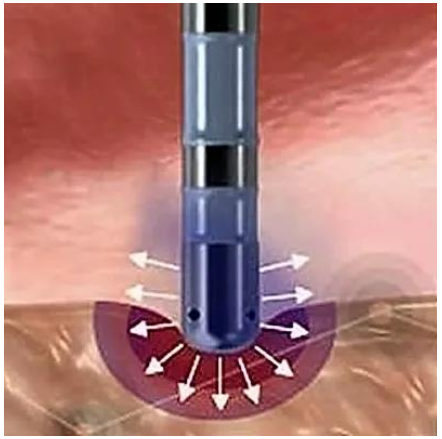
Ablation

- Radiofrequency necrosis of arrhythmia site
  - Identification with catheter mapping
- Permanent cure
  - Wolff Parkinson White
  - Atrial tachycardia
  - Atrial flutter





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Ventricular arrhythmias

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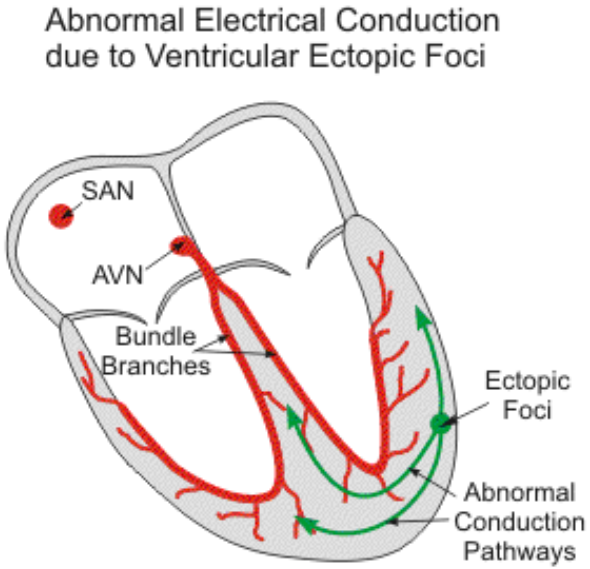
What are ventricular arrhythmias?

- Abnormal, rapid, heart beats that originate in the bottom chamber of the heart



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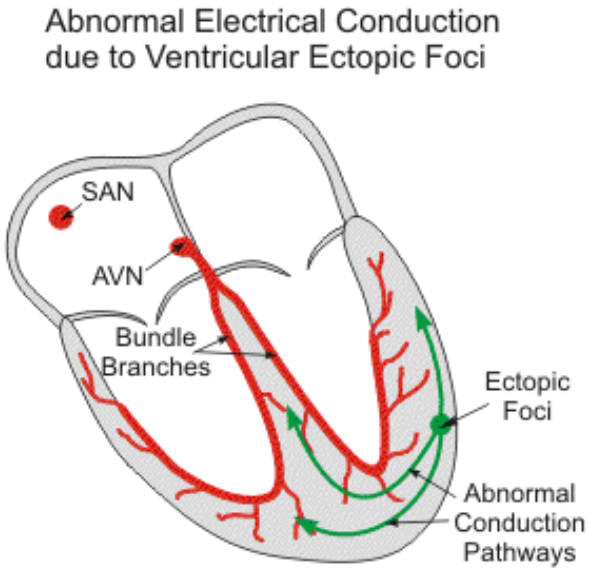
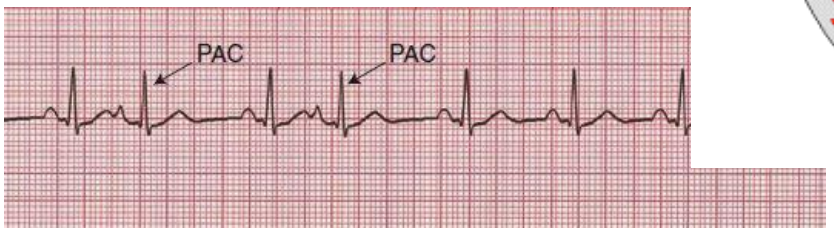
Ventricular arrhythmias TIP

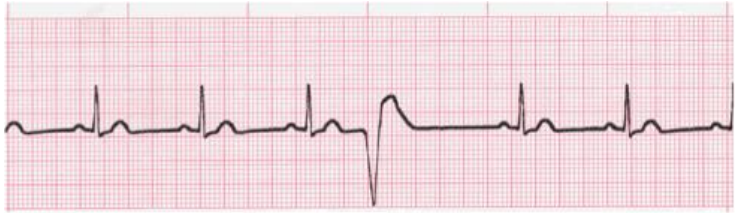


Remember that morphology of the ventricular complex is th
between a supraventricular ectopic focus and a ventricular

- A supraventricular focus almost invariably results in a norm



- A ventricular focus almost invariably results in a wide, bizarre, complex associated with ventricular depolarization and repolarization.



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What causes ventricular arrhythmias?

A. Can be found in normal dogs
B. Primary cardiac disease → b. Dilated cardiomyopathy, degenerative valve disease, congenital disease
C. Drug effects → c. digitalis, catecholamines, anesthetic agents (ketamine, barbiturates)
D. Neoplasia
E. Changes in autonomic tone → e. hypoxia, anemia, uremia, GDV, pancreatiis, electrolyte disturbances, metabolic, infectious conditions, trauma

F. All of the above

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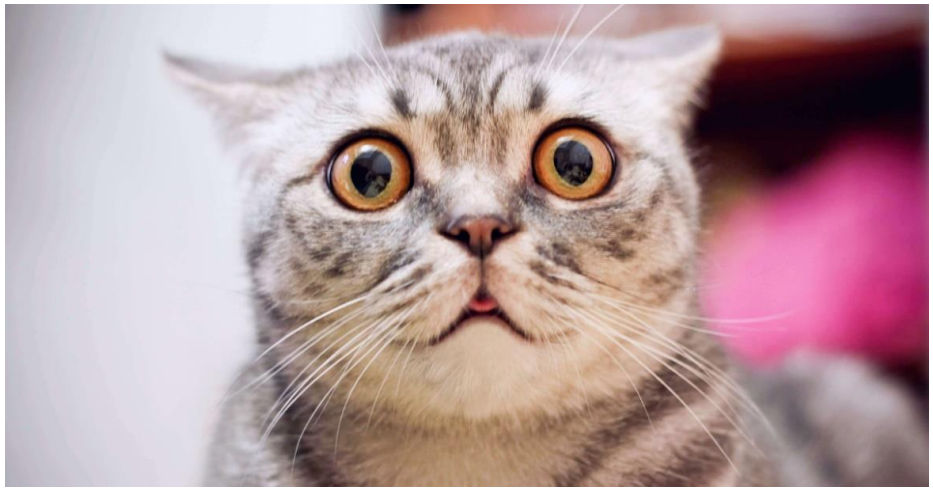
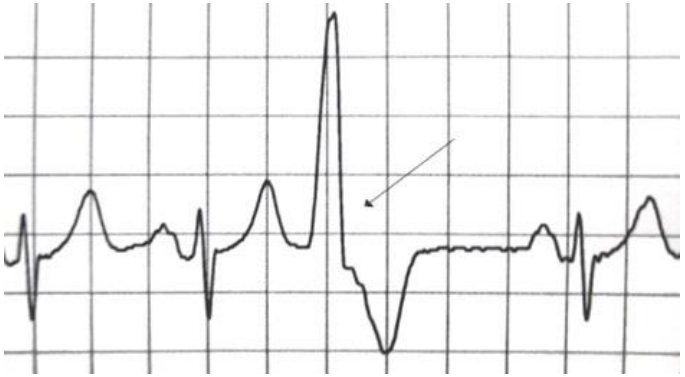
Ventricular arrhythmias TIP

- Anything and everything may result in VPCs in dogs !
- In cats, VPCs are almost always (96%) secondary to underlying heart disease.



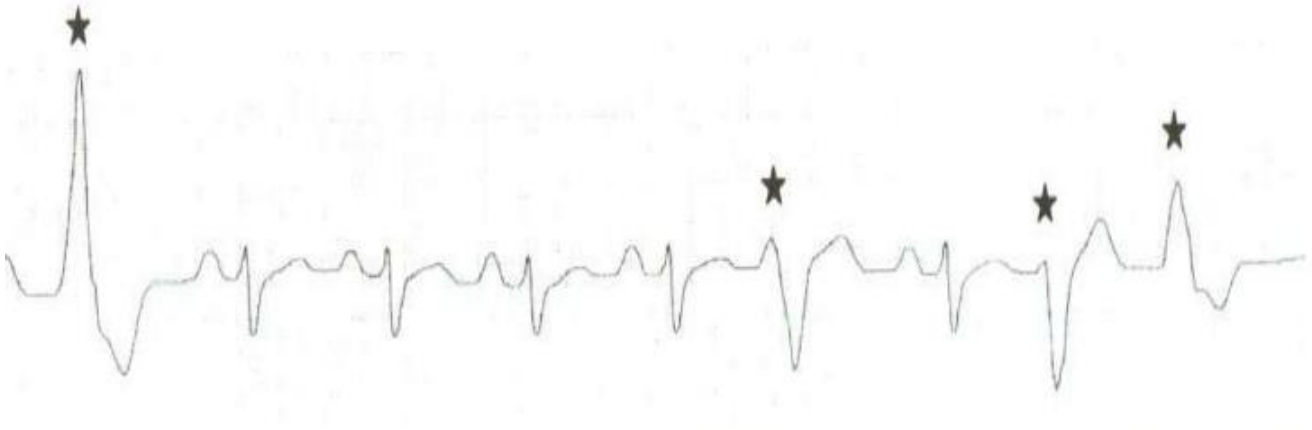
Naming ventricular arrhythmias

- Ventricular premature complexes (VPC) are named by the pattern they appear in.
- Most VPCs are single and by themselves.



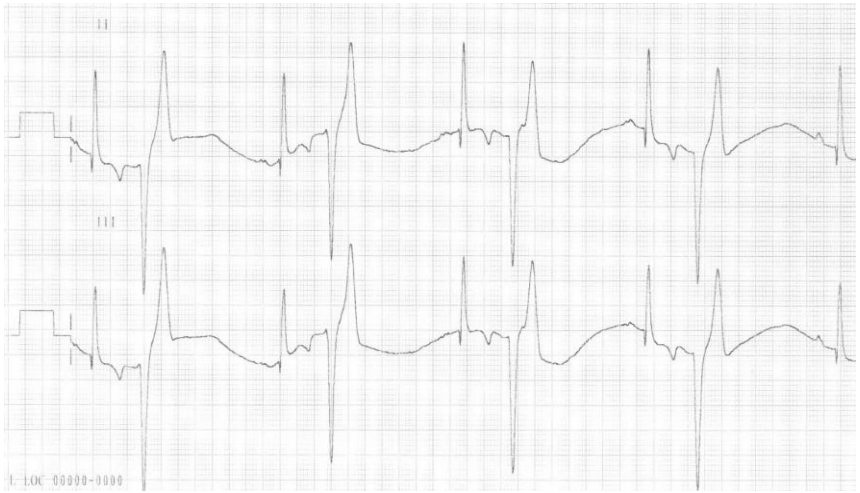
Isolated VPC

Uniform v. multifocal VPCs

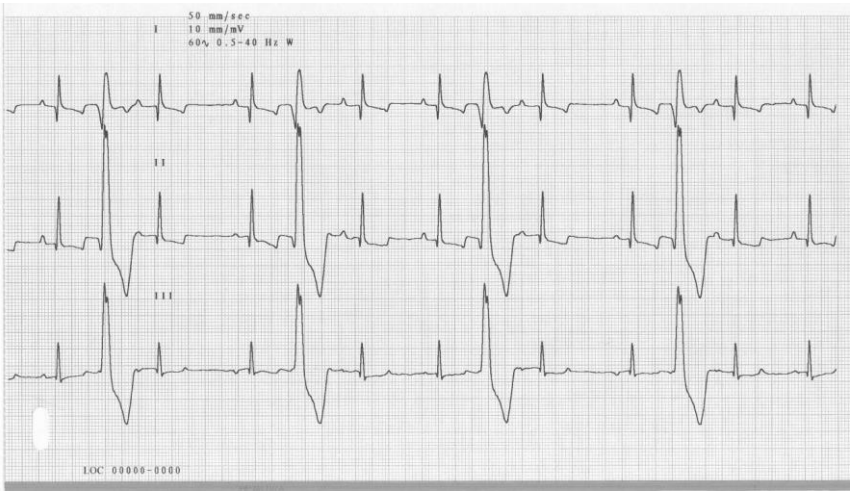


Multifocal VPCs: from 2 or more foci within the ventricular wall

Naming ventricular arrhythmias



Ventricular bigeminy



Ventricular trigeminy

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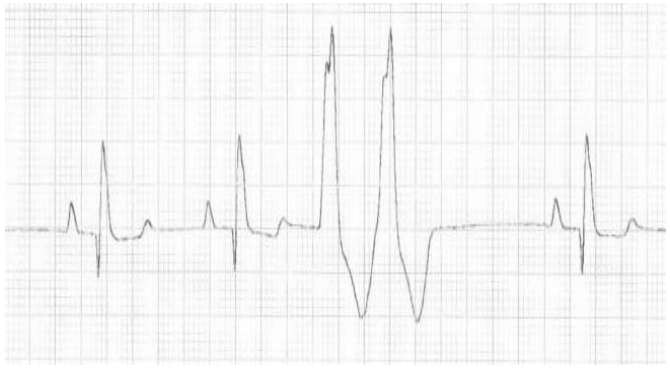
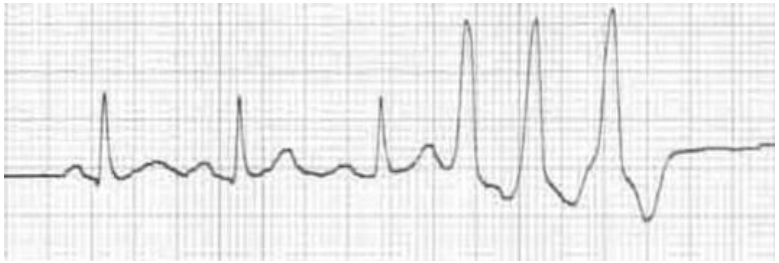
Naming ventricular arrhythmias

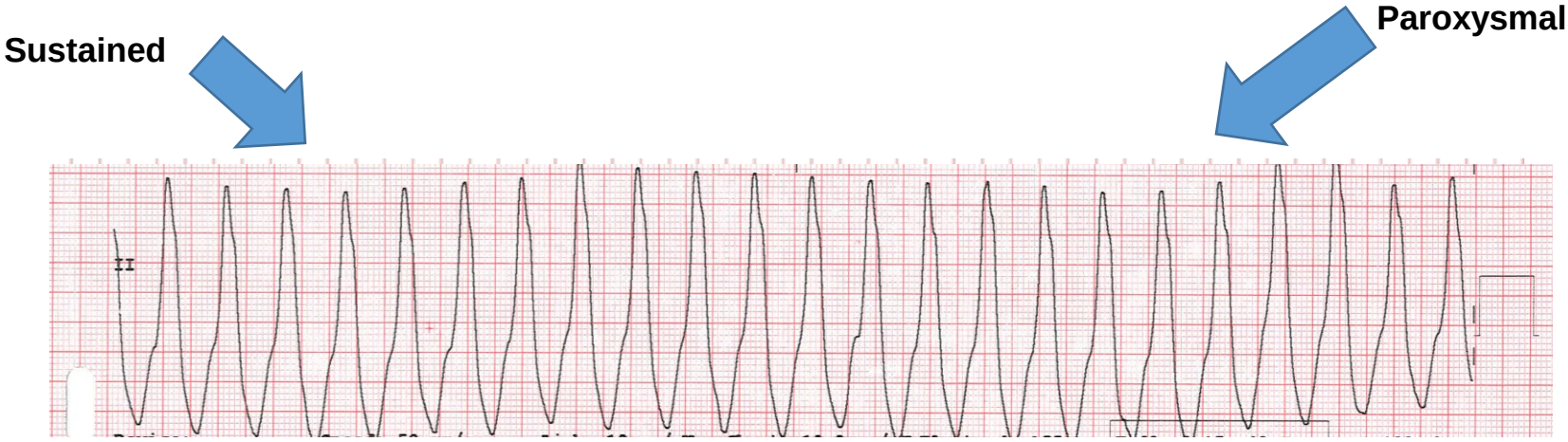


Ventricular couplet



Ventricular triplet

Naming ventricular arrhythmias



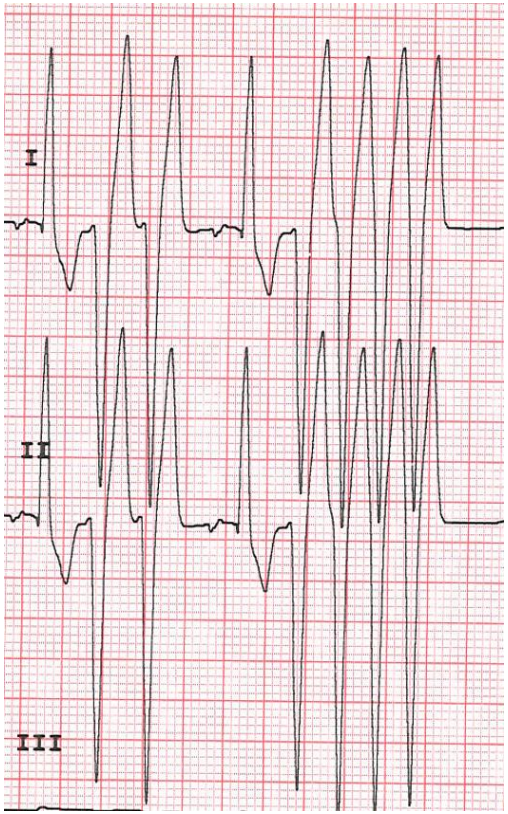
Ventricular tachycardia !!!

R-on-T phenomenon

J Vet Cardiol. 2017 Oct;19(5):455-461. doi: 10.1016/j.jvc.2017.08.003. Epub 2017 Sep 19.

Sudden cardiac death in a dog during Holter recording-R on T phenomenon.

Gunasekaran T[1], Sanders RA[2].



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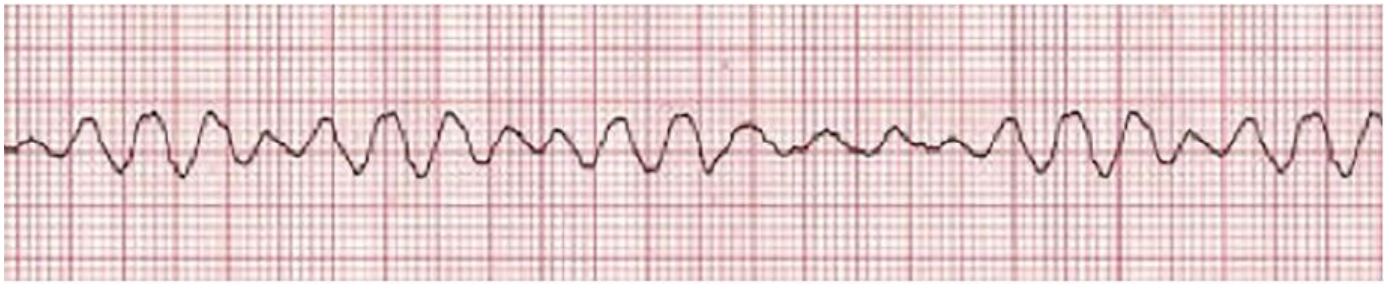
Ventricular fibrillation



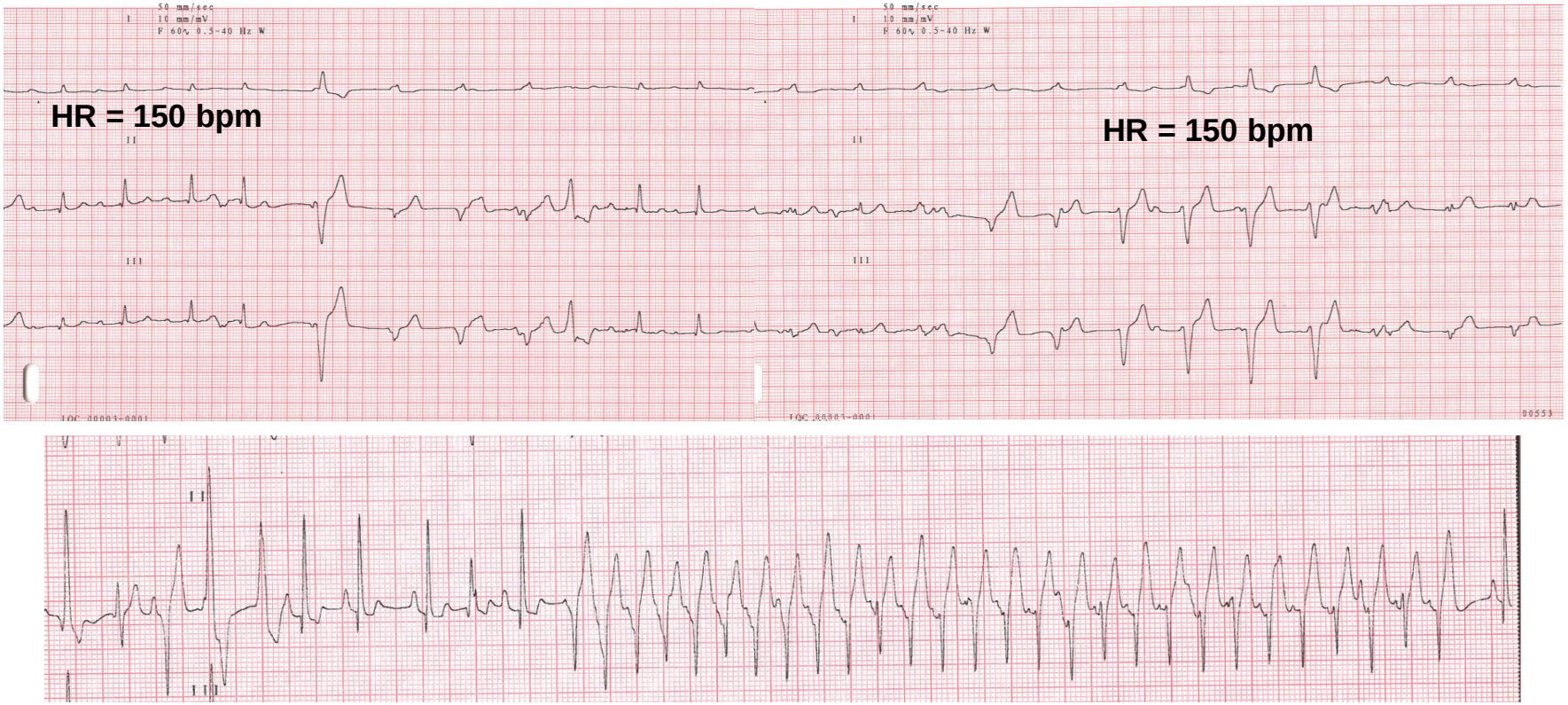
Severity of ventricular arrhythmias

Grade	Description
1	Single VPCs
2	Ventricular bigeminy, trigeminy
3	Couplets, triplets
4	R-on-T, multifocal ventricular arrhythmias, ventricular tachycardia

Accelerated idioventricular rhythm

- Cause: unknown
  - Seen with dogs that are acutely ill from an array of systemic disorders
- Control of the cardiac rhythm is intermittently exchanged between a ventricular focus and the SA node
- Ventricular beats occur in long paroxysms with a rate no more than ~10% higher than the normal rhythm – NO TACHYCARDIA!
  - Beats are wide, bizzare, biphasic, not premature
- Treatment: not required
  - Resolves spontaneously 2-3 days
  - Is not hemodynamically significant
  - Impossible to suppress

Accelerated idioventricular rhythm



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Patient presentation

- Predisposed canine breeds: Boxer dogs, Doberman Pinschers
- Predisposed feline breeds: cats with hypertrophic cardiomyopathy

- History
  - Depends on severity of arrhythmia
  - Varies from normal at home to sudden death
    - Syncope
    - Weakness
    - Lethargy
    - Exercise intolerance

- Physical exam
  - Irregular rhythm
  - Tachycardia
  - Asynchronous pulses
  - Prolonged CRT

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Diagnostic work up

- May or may not proceed treatment

- General practice work up should include:
  - **A thorough physical exam!**
  - CBC, Chemistry, UA, T4
  - ECG
  - Chest radiographs

- Cardiac work up may include:
  - **A thorough physical exam!**
  - Echocardiogram
  - ECG (6 or 10 lead)
  - Telemetry or Holter monitor
  - +/- Abdominal ultrasound

Severity of ventricular arrhythmias

Grade	Description
1	Single VPCs
2	Ventricular bigeminy, trigeminy
3	Couplets, triplets
4	R-on-T, multifocal ventricular arrhythmias, ventricular tachycardia

Investigate!

Controversial, in my opinion – treat!

Treat!

Justification to treat is usually to prevent progression to more serious arrhythmias such as ventricular tachycardia and ventricular fibrillation, which may result in sudden death.

Treatment

- Intravenous options
  - Lidocaine
    - Should stock in GP!
  - Procainamide
  - Magnesium sulfate
  - Nexterone (Amiodarone)

Stupid vet tricks.

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Lidocaine

- Mechanism of action: class Ib sodium channel blocker

- Dosage
  - Canine: 2 mg/kg IV slowly up to three times (6 mg/kg)
    - If effective start a CRI at 50 mcg/kg/min (25-75 mcg/kg/min)

  - Feline: 0.25 mg/kg IV slowly up to 2 mg/kg

- Side effects
  - Acutely: GI upset (vomiting) – give slowly over 1 minute
  - If toxic dose reach: neurologic (seizures)

- Dosing trick (2% lidocaine or 20 mg/mL)
  - IF a patient weighs **33** kgs (and we are giving 2 mg/kg) - they need **3.3** mls
  - IF a patient weighs **15** kgs (and we are giving 2 mg/kg) - they need **1.5** mLs

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What if IV medications don’t work?

Electrical cardioversion

Oral options

- Class I antiarrhythmics
  - Mexiletine

- Class III antiarrhythmics
  - Sotalol
  - Amidoarone

Sotalol

- Dose (canine) 1-2 mg/kg PO BID, feline 1-2 mg/kg BID or 10 mg PO BID/cat
- Side effects
  - Negative inotropic and chronotropic effect
    - *BE CAUTIOUS IN PATIENTS WITH SYSTOLIC DYSFUNCTION OR HEART FAILURE
  - Proarrhythmic

Mexiletine

- Dose (canine) 5-7 mg/kg TID, feline ???
- Side effects
  - Anorexia, vomiting, tremors (neurologic signs), hepatic toxicity, urine dribbling

Amiodarone

- Dose (canine) 12-15 mg/kg SID x 14 days; then 5-7 mg/kg SID; feline ???
- Side effects
  - Increase in liver enzymes, thyroid dysfunction, GI signs, neutropenia, pro-arrhythmic

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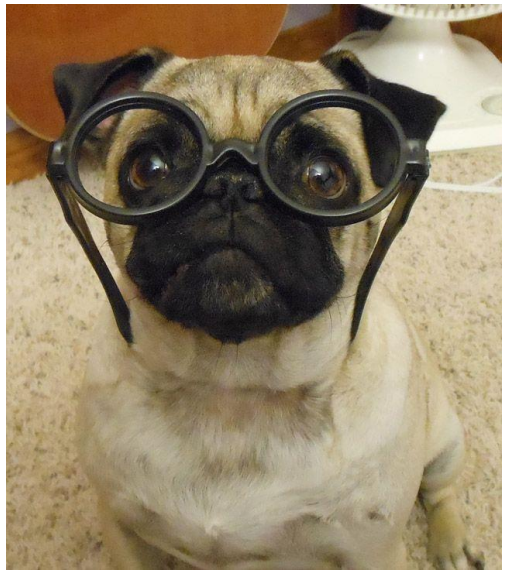
Remember…

When treating arrhythmias…

- Take a deep breath!
- Assess severity and risk factors
- Formulate a diagnostic and treatment plan
- Re-evaluate as needed



Questions?

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