Management of Emergent Cardiac Arrhythmias

Steven Epstein, DVM, DACVECC

Professor of Small Animal Emergency and Critical Care

UCDAVIS

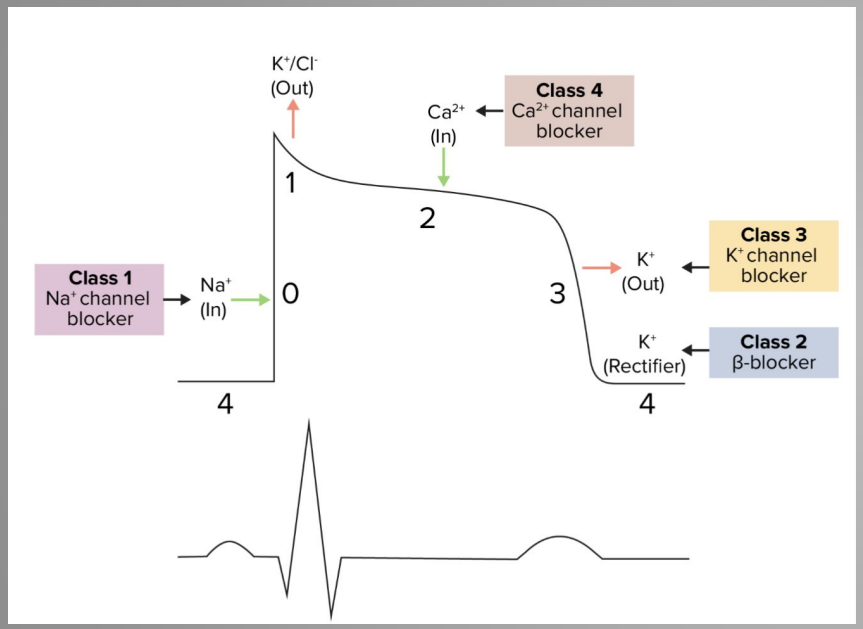
VETERINARY MEDICINE

Surgical and Radiological Sciences

Vaughan Williams Classification

- Originally conceived in 1970
- Based on main mechanism of drug action
- Four classes of drugs
  - 3 subclasses of Class I
- Not all inclusive
- Some drugs have more than one mechanism

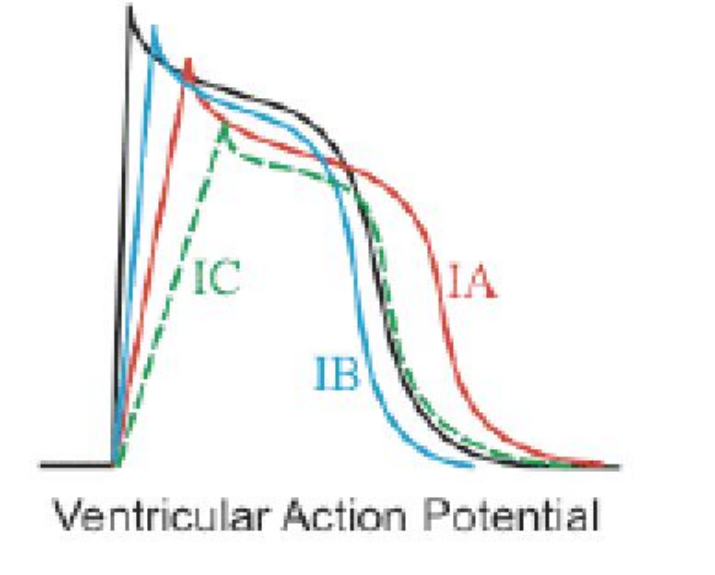
Ventricular Action Potential



- Phase 0 – Na inward
- Phase 1 – K, Cl outward
- Phase 2 – Ca inward, K outward
- Phase 3 – K outward
- Phase 4 – K inward

Class I Antiarrhythmics

- Selectively block fast sodium channels
- Depress phase 0 of action potential
- Prolongs action potential

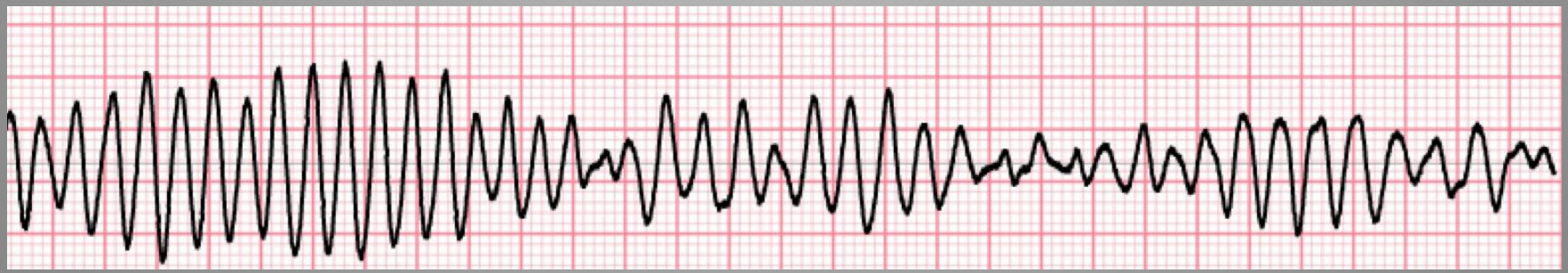


Class I subclasses

- IA
  - Moderate sodium channel blockade
  - Procainamide, quinidine
- IB
  - Weak sodium channel blockade
  - Lidocaine, mexiletine
- IC
  - Strong sodium channel blockade
  - Not used in Vet Med

Class IA

- Block any open sodium channel
- Mild blockade outward potassium channel
- Can be used for both supraventricular and ventricular arrhythmias
- Side effect: can induce torsades de pointes

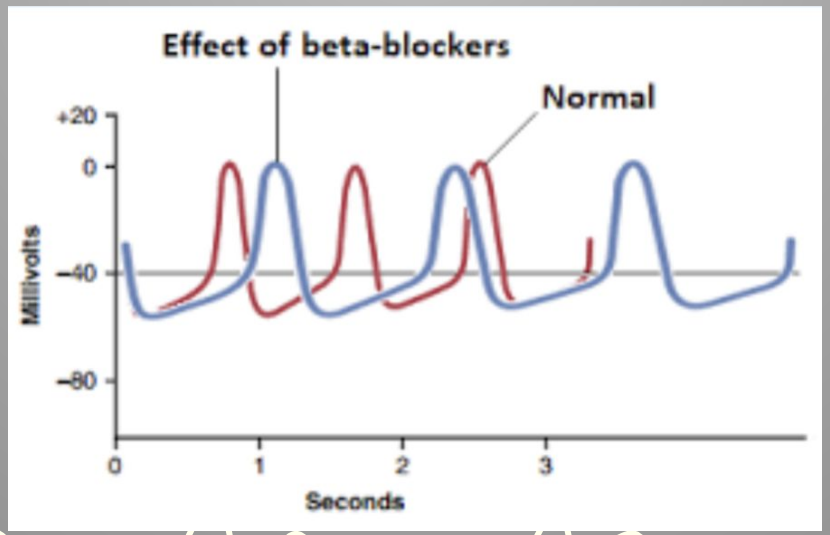


Class IB

- Preferentially affect cardiac tissue with long action potential
  - More effective at diseased myocardium
  - Hypoxic, ischemic, or traumatized cells
- Minimally affect atrial cells

Class II

- ß(beta)-adrenergic blockers
- Decreases potassium and chloride efflux
- Inhibit spontaneous depolarization during phase 4
- Increase atrioventricular node refractory period

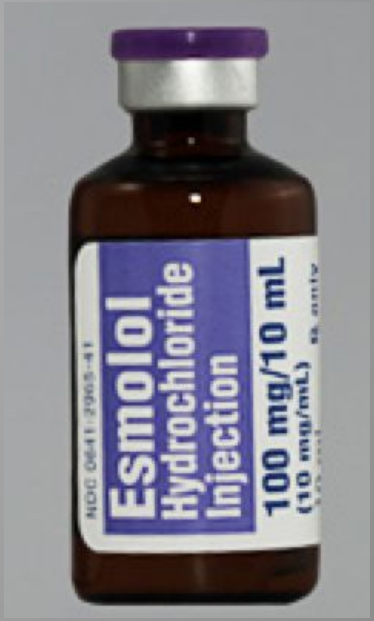


Class II

- Examples: esmolol, propranolol, atenolol
- Side effects: decreased myocardial contractility, bradycardia, hypotension
- If ß1 and ß2 blocked (propranolol) can cause bronchoconstriction

Class II

- Esomolol (IV only)
  - ß1 specific
  - Metabolized by plasma esterases
  - Very short half life (seconds)

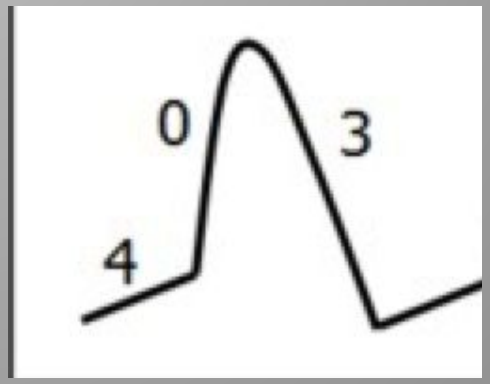


Class III

- Potassium channel blockers
- Increases duration of action potential and refractory period
- Often work on other channels (Ca or Na)
- Examples: sotalol or amiodarone
- Side effects: decreased myocardial contractility

Class IV

- Calcium channel blockers
- Most effective when calcium channel is responsible for phase 0
  - Sinoatrial node
  - Atrioventricular node



Class IV

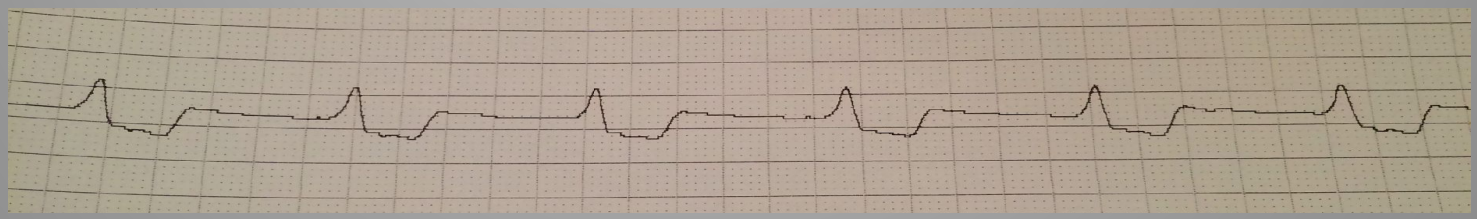
- Example – diltiazem
- Side effects: bradycardia, hypotension
- Some calcium channels blockers only act at vasculature and are not antiarrhythmic
  - Amlodipine

Ventricular Arrhythmias

- Ventricular Premature Complex (VPC)
- Accelerated idioventricular rhythm
- Ventricular tachycardia
- Ventricular fibrillation

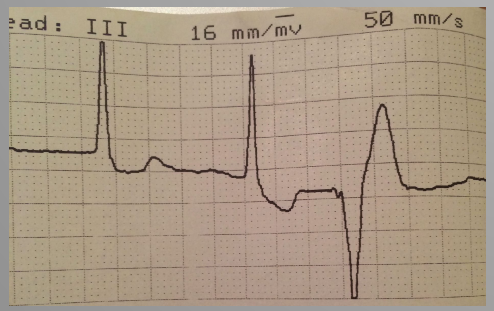
Accelerated Idioventricular Rhythm

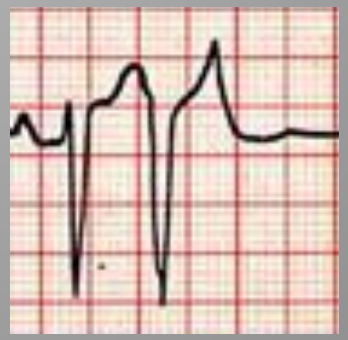
- Any ventricular origin rhythm >60 beats per minute and < 160 beats per minute
- Treatment not usually needed
  - Indicated if patient is hypotensive or poor cardiac output



Ventricular Tachycardia (V-Tach)

- When to treat:
- HR>180 bpm >1 minute
- Multifocal ventricular ectopic beats
- R on T phenomena
- Impairing perfusion to tissue





V-tach

- When to treat stable patient
  - Patient is symptomatic (syncope, weakness, tachycardia induced cardiomyopathy)
  - Patients with high risk of sudden death (arrhythmogenic right ventricular cardiomyopathy, dilated cardiomyopathy)

Treatment of V-Tach – Dog (in-hospital)

- Lidocaine 2 mg/kg IV bolus over 30-60 seconds
- Can repeat up to total dose of 8 mg/kg
- Then start constant rate infusion of 25-100 microgram/kg/min IV
- Very efficacious

Treatment of V-Tach – Cats (in-hospital)

- Ventricular tachycardia very rare in cats
- May be associated with hyperkalemia so check serum electrolytes first
- Lidocaine highly toxic to cats so can consider 0.25 mg/kg IV, or esmolol at 0.1 mg/kg
- Can consider amiodarone

Treatment of V-Tach - Dog

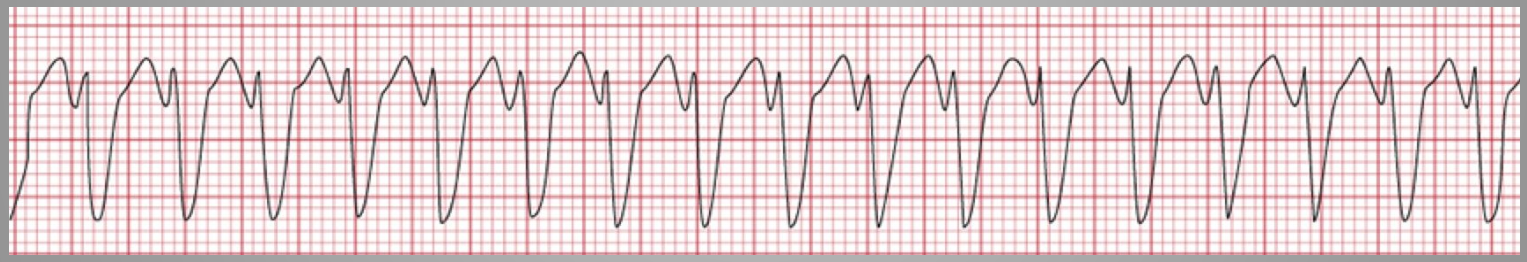
- If lidocaine does not work measure serum electrolytes
- Decreased efficacy found in hypokalemic patients
- Treat hypokalemia if present

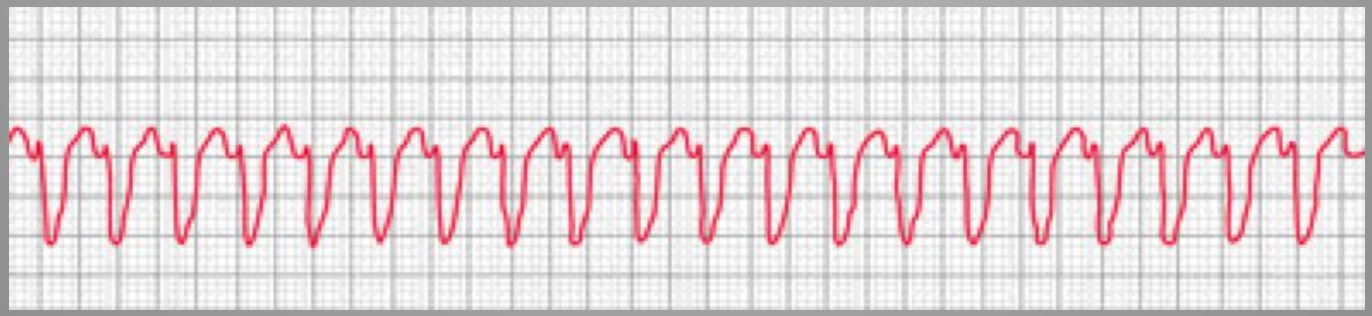
V-tach refractory to lidocaine

- Magnesium?
- 30 mg/kg IV bolus over 1-2 minutes
- Procainamide?
- 2 mg/kg bolus over 1-2 minutes; can repeat up to 10 mg/kg then constant rate infusion of 10-40 microgram/kg/min
- Amiodarone 1-5 mg/kg IV*

V-tach refractory to therapy

- Consider ß-blocker or calcium channel blocker
- Sinus tachycardia with a bundle branch block can look like ventricular tachycardia



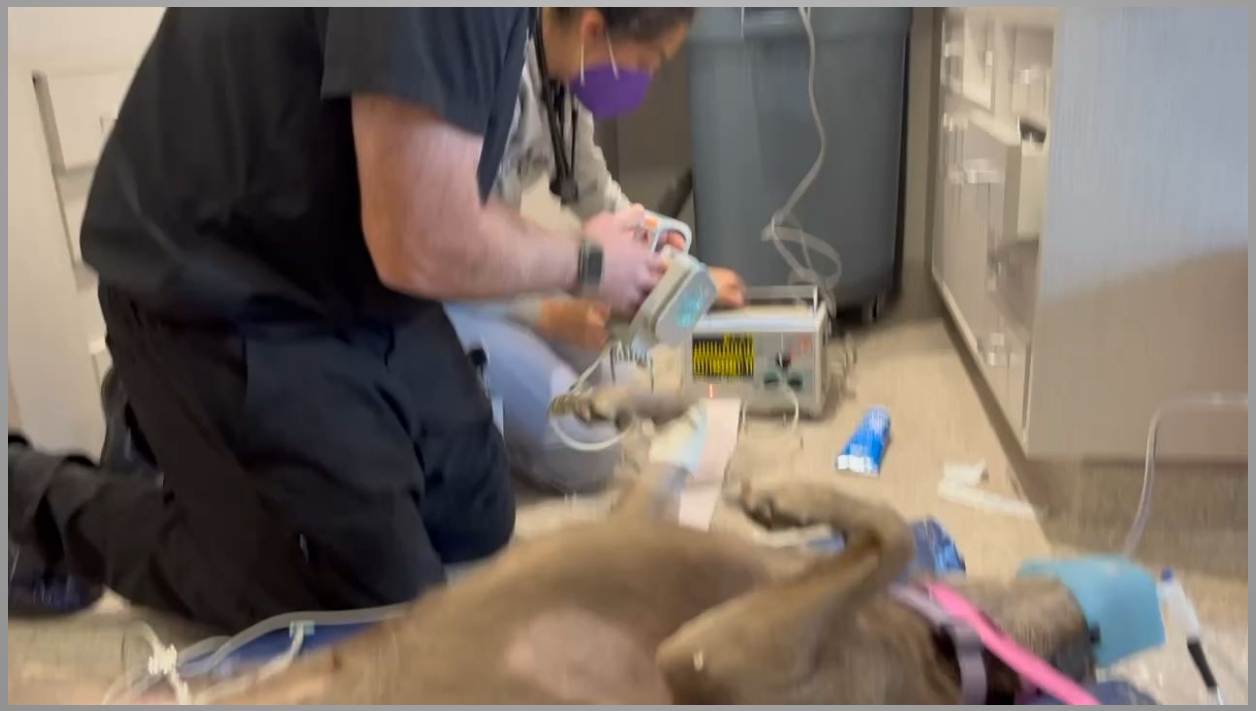


V-tach refractory to therapy

- Test dose of esmolol
- 0.1 mg/kg IV over 10-30 seconds up to 0.5 mg/kg
- Evaluate ECG for slowing of heart rate so that you can see p waves
- If so treat as if supraventricular arrhythmia

V-tach refractory to therapy

- Electrical defibrillation?



Transitioning to oral medication

- Sotolol 1.5-3 mg/kg per os twice a day
  - Note drug of choice for “Boxer Cardiomyopathy”
- Mexiletine 4-8 mg/kg per os three times a day
  - May be synergistic with sotolol

Identify underlying disease

- Treatment may need to be lifelong if cardiomyopathy is present
- If due to systemic disease (splenic mass, gastric dilation and volvulus, systemic infection) resolving underlying disease is critical

Treatment of supraventricular tachycardia (SVT)

- When to treat?
  - Patient is symptomatic (syncope, weakness, tachycardia induced cardiomyopathy)
  - Anytime it is hemodynamically significant

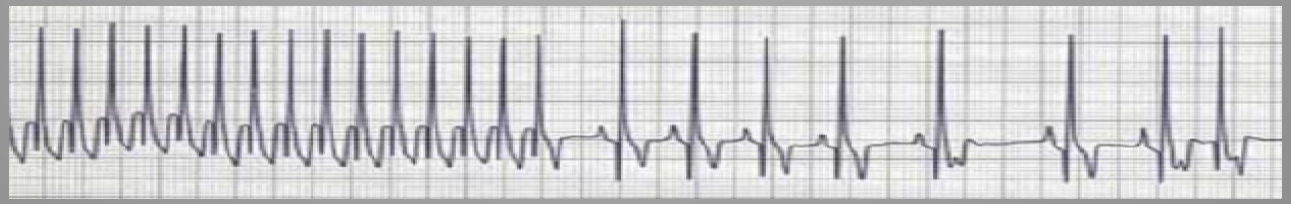
Atrial vs. Sinus tachycardia

- Atrial tachycardia - usually underlying pathology with heart or re-entry circuit in atrium
  - May need antiarrhythmic therapy

- Sinus tachycardia – usually physiologic process
  - Treat for pain control, hemodynamic shock, look for dilated cardiomyopathy

Treatment of SVT – in hospital

- Vagal maneuver
- IV diltiazem 0.25 mg IV over 1 minute, can repeat up to total dose of 1.0 mg/kg, then 5-15 microgram/kg/min IV
- IV esmolol 0.1 mg/kg IV over 10-30 seconds up to 0.5 mg/kg



SVT – refractory to therapy

- Consider IV procainamide 2-10 mg/kg IV in case it is ventricular tachycardia
- Must always look for structural heart disease
- SVT due to systemic disease is less common

SVT – at home management

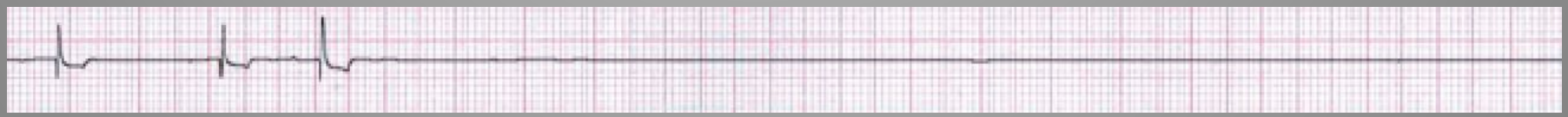
- Diltiazem 0.5 -1 mg/kg per os three times a day (dog) 7.5 mg per os twice to three times a day (cat)
  - Is negative inotrope, caution in patients with dilated cardiomyopathy
- Atenolol 6.25 mg/cat per os twice a day
  - Large negative inotrope
- Digoxin 0.003 – 0.005 mg/kg per os twice a day (dog)
  - Positive inotrope, small therapeutic index, large number of side effects

Treatment of atrial fibrillation

- Disease in dogs and cats is usually secondary to structural heart disease and enlarged atria
  - Goal is to lower ventricular rate to prevent tachycardia induced cardiomyopathy and provide better cardiac output
- In hospital treatment same as other SVT rhythms
- Oral therapy usually diltiazem +/- digoxin

Medical treatment of Sick Sinus Syndrome

- Pacemaker is definitive therapy
- If patient is symptomatic (collapse/syncope)
- Medication that increases sympathetic tone
  - Oral theophyline 10 mg/kg per os twice a day
  - Oral terbuatline 0.2 mg/kg per os twice to three times a day
- May work short term, but not indefinitely



Questions?