The Collapsed Patient

Syncope and Look-a-Likes

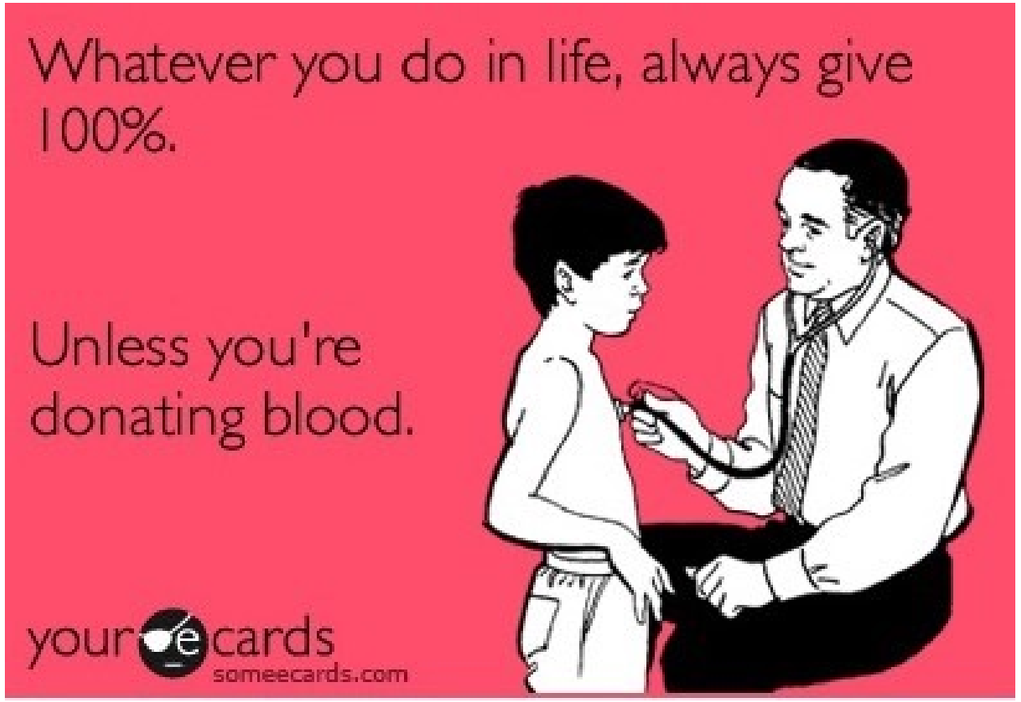
VCA Specialty Animal Hospitals

J. Michael Walters, DVM, MS, DACVECC.
Medical Director
VCA West Coast Specialty and Emergency Animal Hospital


SAN CLEMENTE

Personal Background


TOTALLY INAPPROPRIATE ANATOMY SNIFFER
SECURITY/SQUIRREL ALARM
DEAD BIRD SMELL COLLECTION AREA
COFFEE TABLE CLEARING MECHANISM
FACE MOISTURIZER/ BOTTOM CLEANER
UNCONDITIONAL ADORATION CHAMBER
SCRATCH-ACTIVATED FOOTWAG THROTTLE
LOW-OUTPUT WALK-INTERRUPTION DEVICE (MALE VARIANT)
PLASTIC BAG FULFILLMENT LINE
REVISED
CANINE ANATOMY


Whatever you do in life, always give 100%.
Unless you're donating blood.
someecards.com

Objectives

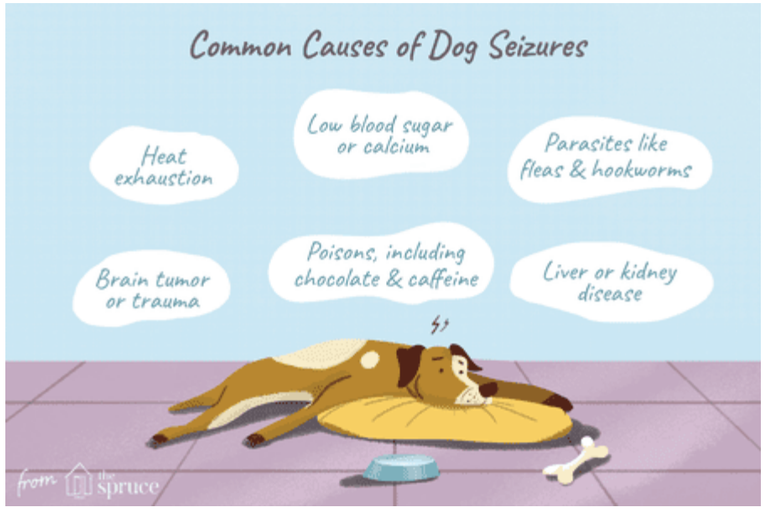
- Review the pathophysiology of syncope and the look-a-likes
- Review the causes of syncope
- Review the look-a-likes and how to differentiate from syncope
- Patient evaluation and the associated risks
- Treatment

Background

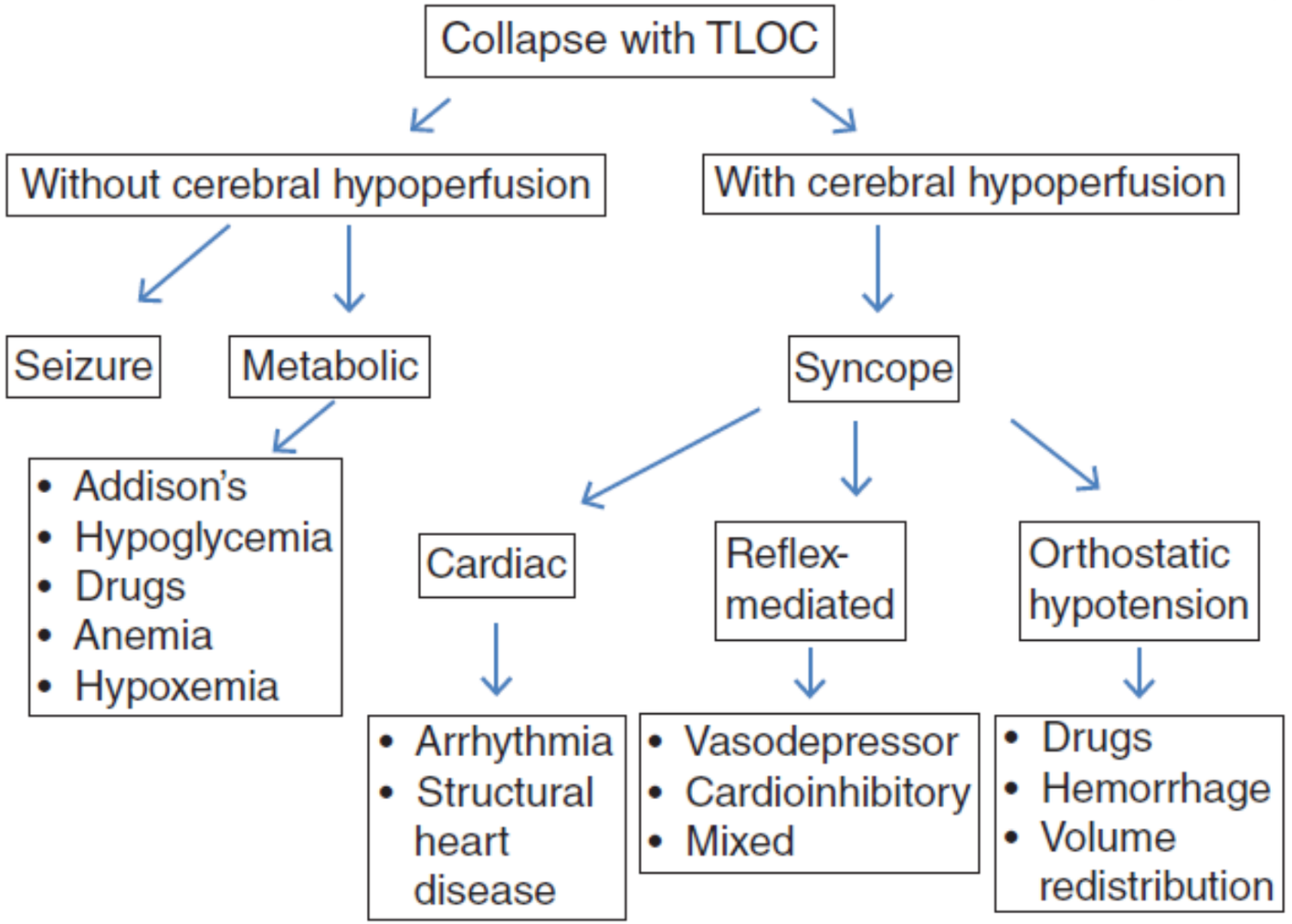
- Collapse, syncope, fainting
  - Somewhat interchangeable
- Collapse + loss of consciousness (LOC)
  - Syncope
  - Transient LOC (TLOC)
- Collapse
  - Sudden loss of postural tone
  - +/- LOC
- TLOC
  - Global cerebral hypoperfusion

Background

- Challenging cases
  - Benign?
  - Near death experience?
  - Intermittent
  - Rare
  - Normal afterwards
- Importance
  - Seizure vs syncope?



TLOC = Transient loss of consciousness



Textbook of Small Animal Emergency Medicine, First Edition. Edited by Kenneth J. Drobatz, Kate Hopper, Elizabeth Rozanski and Deborah C. Silverstein; 2019

Syncope with Cerebral Hypoperfusion

Pathophysiology - Cardiac

- Transient loss of consciousness (TLOC)
  - Acute drop in systemic blood pressure

BP = CO x SVR → LV afterload

CO = HR x SV
- Contractility
- Preload
- Afterload
- Arrhythmogenicity

  - Altered cerebral blood flow → syncope

Pathophysiology - Cardiac

Cardiac Syncope

- Bradycardia
  - SSS
  - High grade 2nd or 3rd deg AVB
  - Atrial standstill
- Tachycardia
  - VT
  - SVT
  - AT
  - AF
  - OAVRT
- Structural Heart Disease
  - PS
  - AS
  - PH with PTE
  - HWD
  - Advanced AV valve disease
  - DCM
  - HOCM

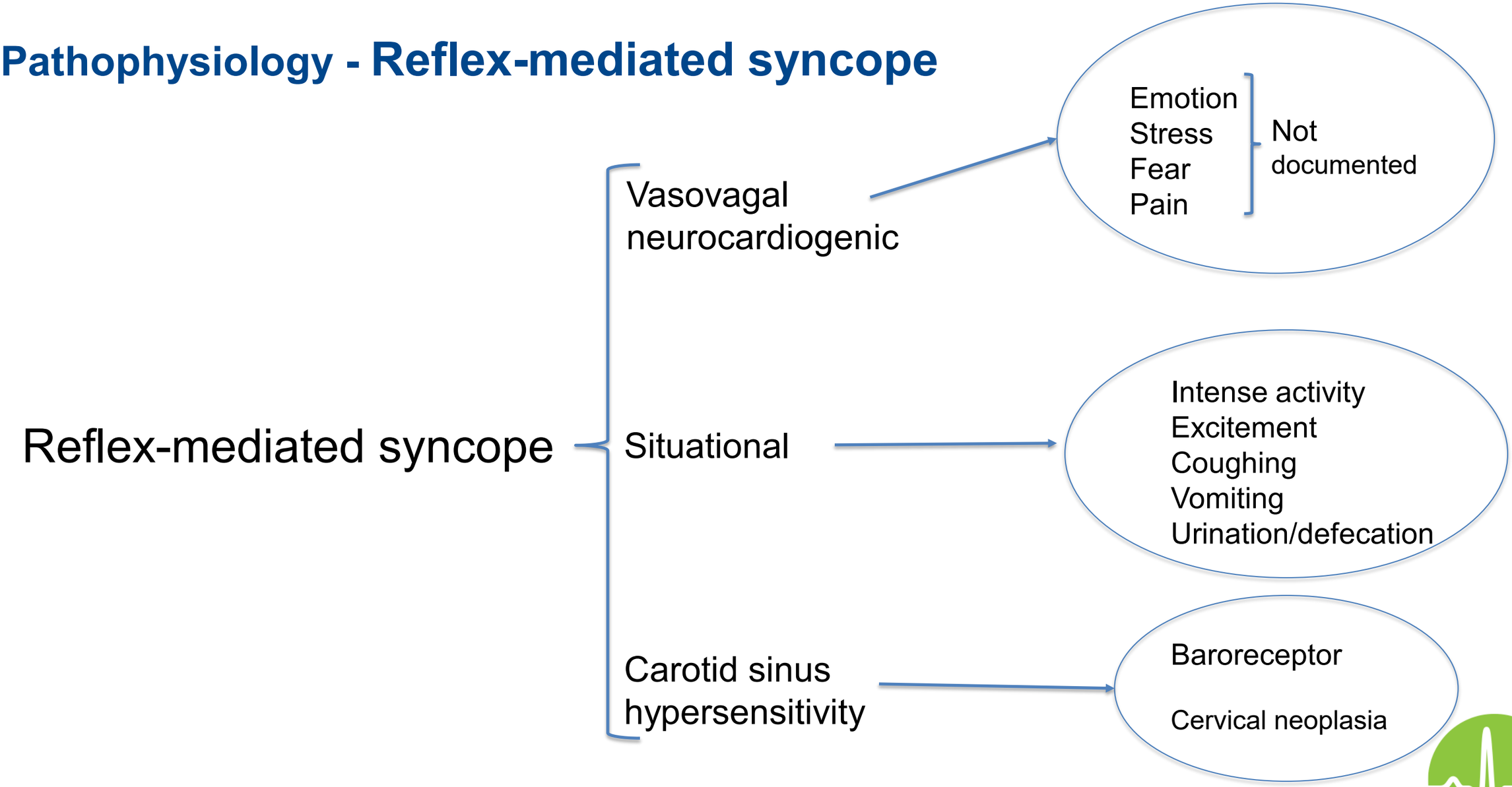
Pathophysiology - Cardiac

- Cats
  - Syncopal like syndrome with high grade AVB
    - Facial and whisker twitches
    - Salivation
    - Urination/defecation
    - Disorientation
    - Collapse + TLOC
  - Results in prolonged cerebral hypoperfusion
    - Hypoxic convulsive syncope

Pathophysiology - Cardiac

- Structural heart disease
  - Can result in syncope
    - Exertion
    - CO cannot meet demands
  - SAS, AS, PS
  - Primary pulmonary hypertension
    - With massive PE
      - Obstructs blood flow
      - Reduced CO
- Alternatively
  - Primary pulmonary hypertension
    - Increased intraventricular systolic pressure
    - Rise in mechanoreceptor stretch
    - Results in reflex-mediated syncope
    - With chronicity
      - Remodeling and scarring
        - » Result in severe outflow obstruction
        - » Arrhythmia >> syncope

Pathophysiology - Reflex-mediated syncope



Pathophysiology

Orthostatic syncope

(Postural hypotension)

- Drug induced hypotension
  - ACP, hydralazine, amlodipine nitrates, β blocker, diuretics
- Volume Depletion
  - Dehydration
  - Hemorrhage
  - Blood volume redistribution

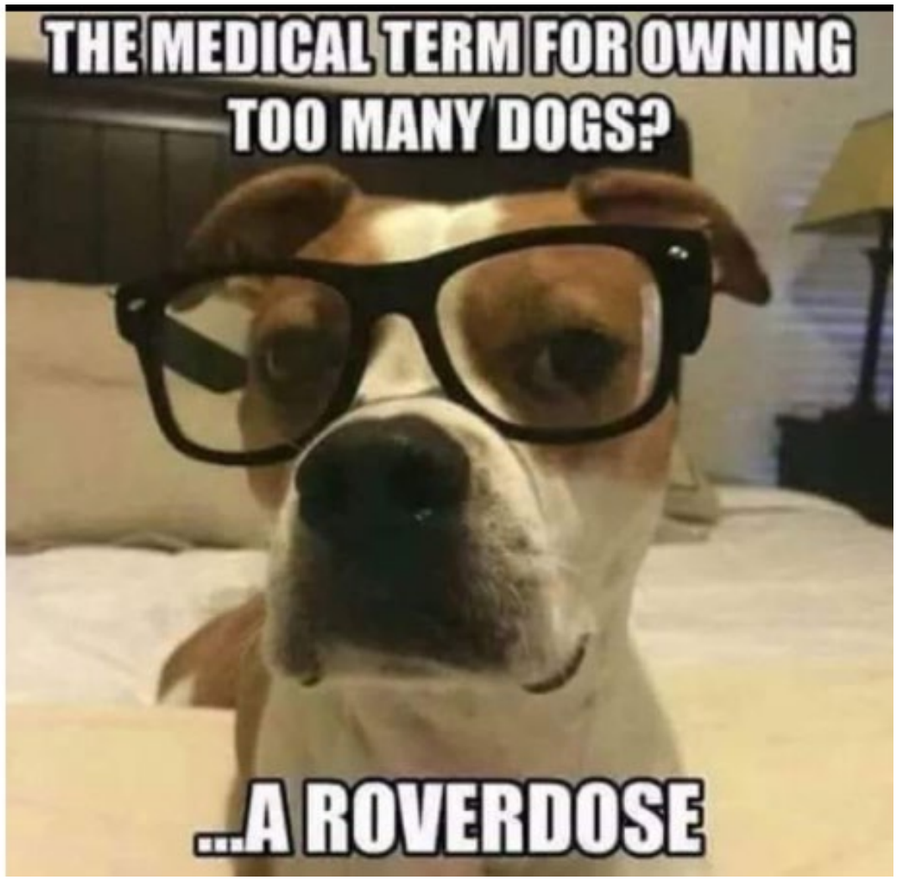
Patient evaluation

History and PE

- Careful history
  - What, when, how long, what else??
- PE
- Seizure vs syncope
  - Easier said than done
  - TLOC
  - Event includes
    - Disorientation – seizure??
    - Slower recovery to normal - seizure??
    - Hypersalivation - seizure??
- Event includes
  - Flaccid collapse, urination, defecation - Syncope?
    - Not always
      - Extensor rigidity associated with arrhythmia

Emergency

- Determine threat to life
  - Arrhythmia
  - Treat as needed
- Drug related
  - Treat as indicated
- Recognize lower risk cause and consider referral
  - Reflex mediated
  - Tussive syncope
- Repeat episode
  - Hospitalize
- Seizure?
  - Hospitalize

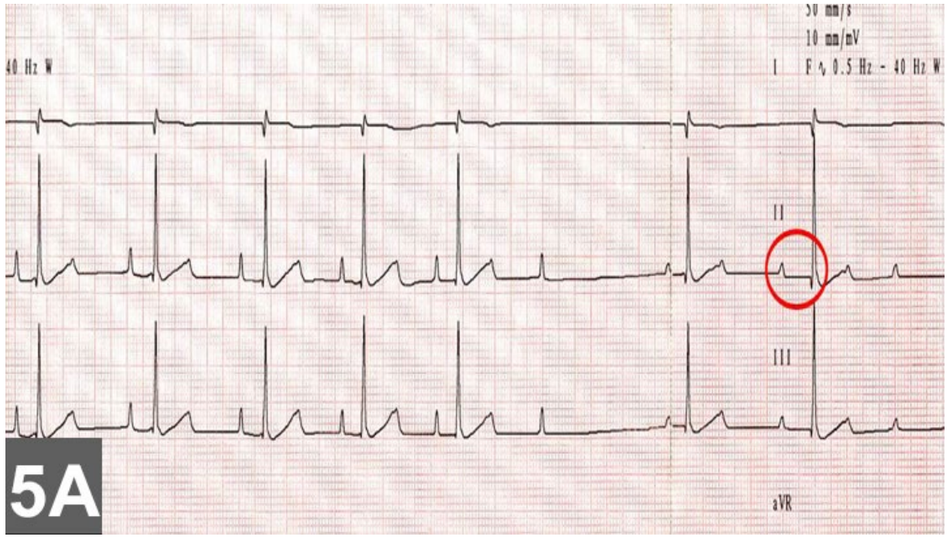


Emergency - Diagnostics

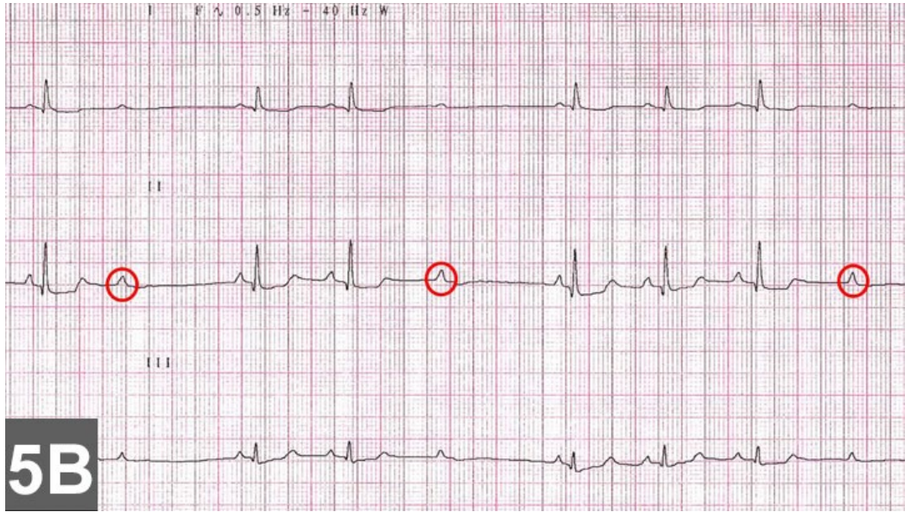
- Blood pressure
  - Hypotension
  - < 90 mmHg
    - Anesthesia induced
    - Cardiac failure
    - Drug induced
    - Hypovolemia
    - Shock
    - Neurogenic (noncardiogenic) pulmonary edema
- Hypertension
  - > 200 mmHg
    - Situational
    - Secondary
      - Kidney disease
      - Diabetes mellitus
      - HAC (dogs)
      - Hyperthyroidism (cats)
    - Pheochromocytoma, hyperaldosteronism
  - End organ injury

ECG

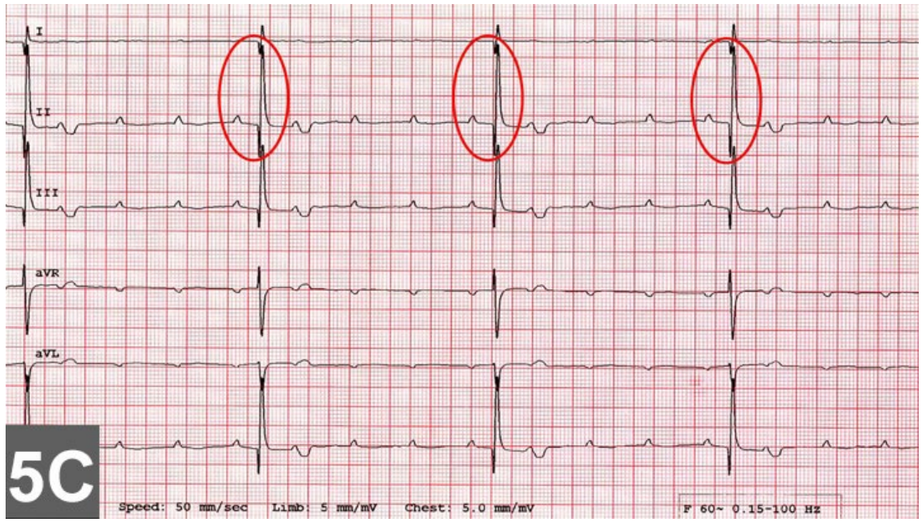
- Bradycardia



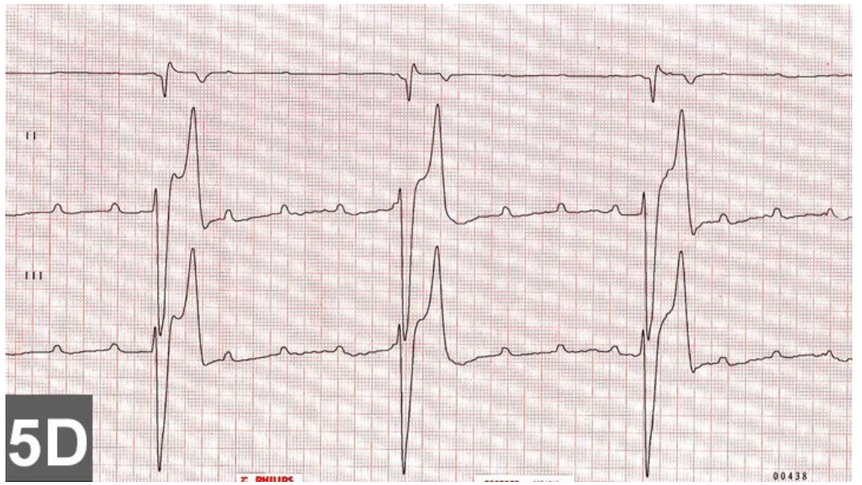
Mobitz Type I – prolonged PR then drop



Mobitz II – PR interval maintained then drop



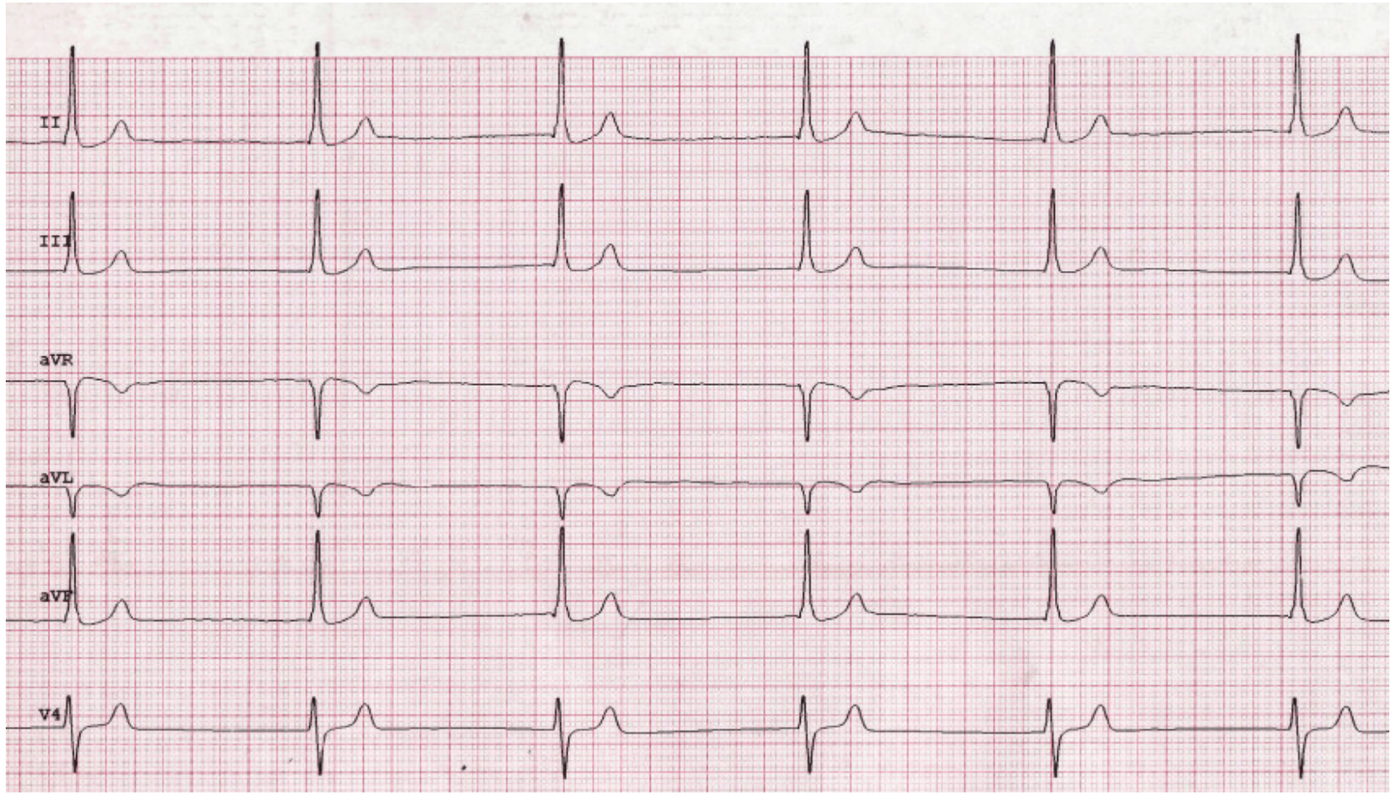
High grade AVB
- No 2 P's conducted
- Ex. 4:1



3rd degree (complete AVB)

ECG - Bradycardia

- Atrial standstill
- No identifiable P waves with normal QRS complexes consistent with atrial standstill and a junctional escape rhythm
- HR 73

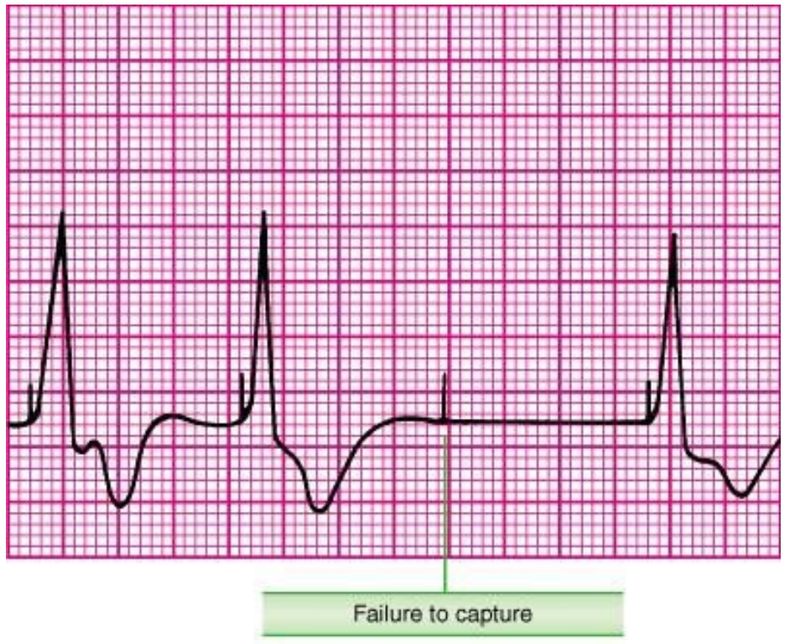


ECG - Bradycardia

- Sinus arrest
- Sudden absence of impulse from SA
- No impulse→ no depolarization→no contraction→drop in BP
- Longer the pause, worsening hypotension
- > 6 sec pause→medical emergency

ECG - Bradycardia

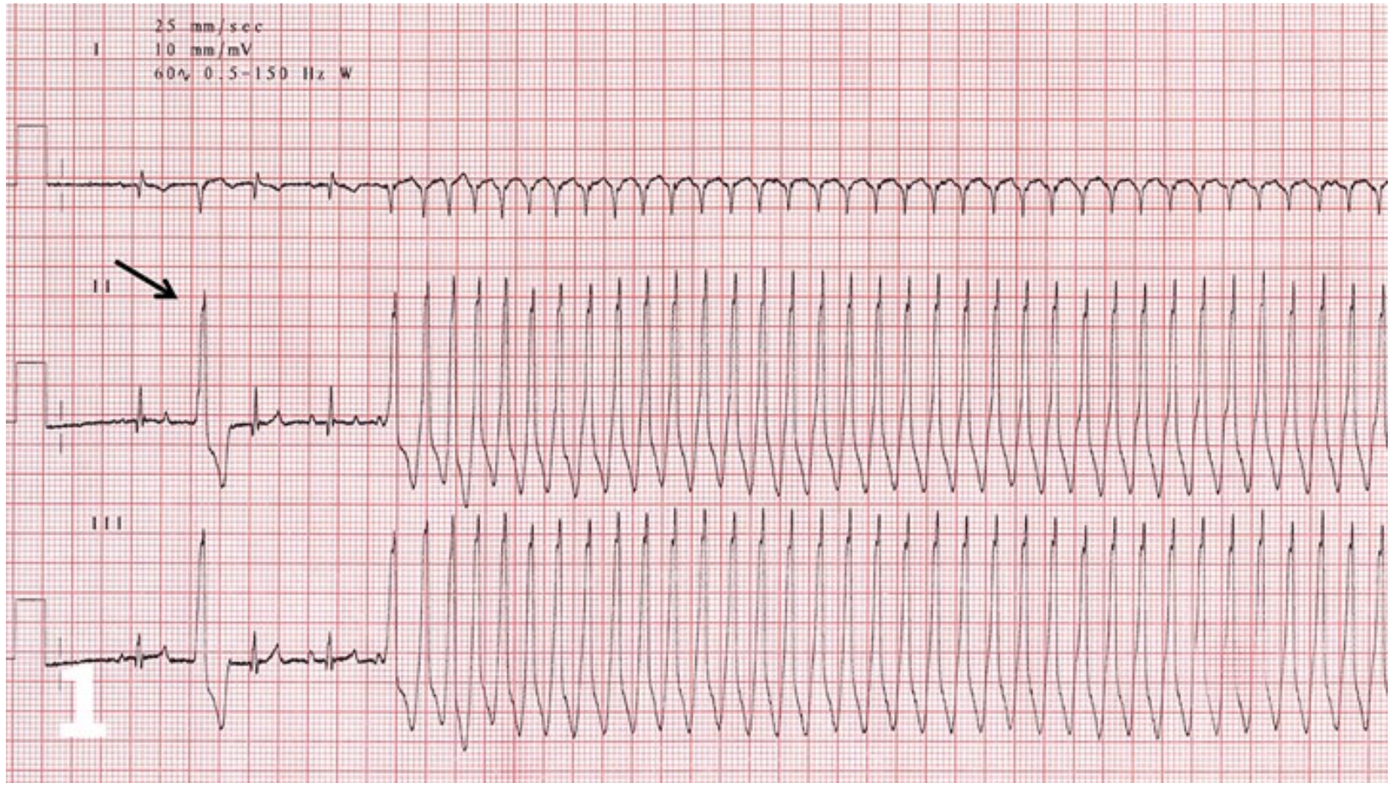
Pacemaker malfunction



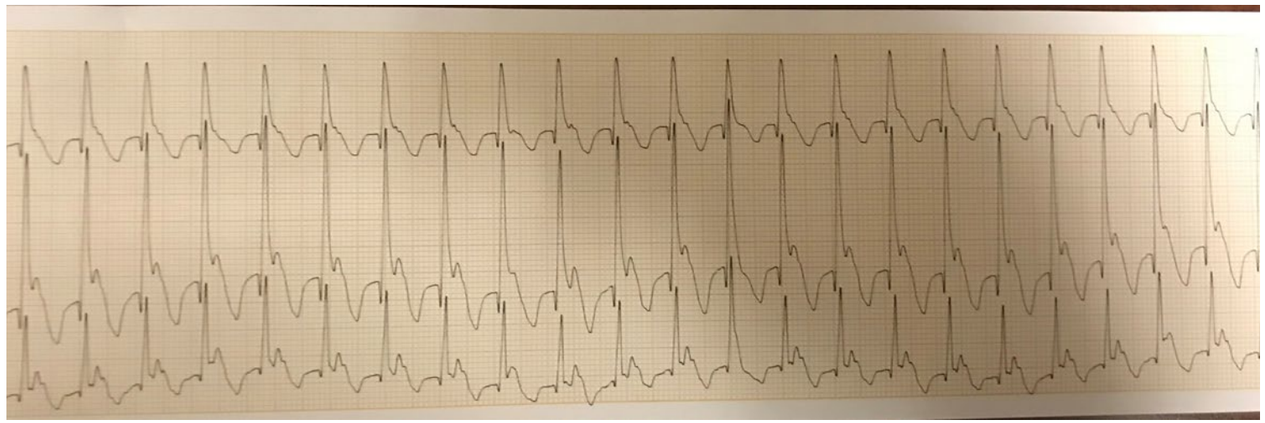
ECG - Tachycardia

Monomorphic ventricular tachycardia

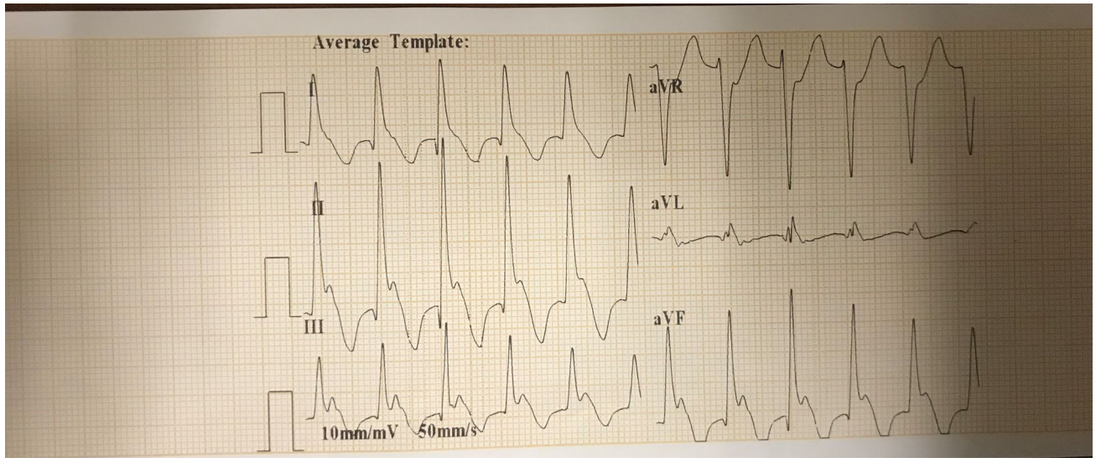
ARVC in Boxer

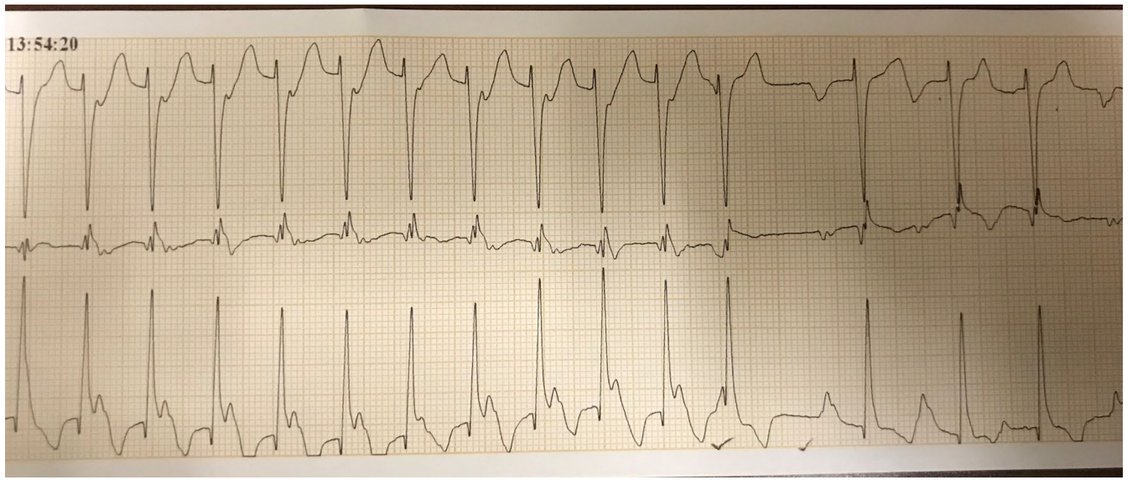


ECG - Tachycardia



Narrow complex tachycardia
with suspected re-entrant

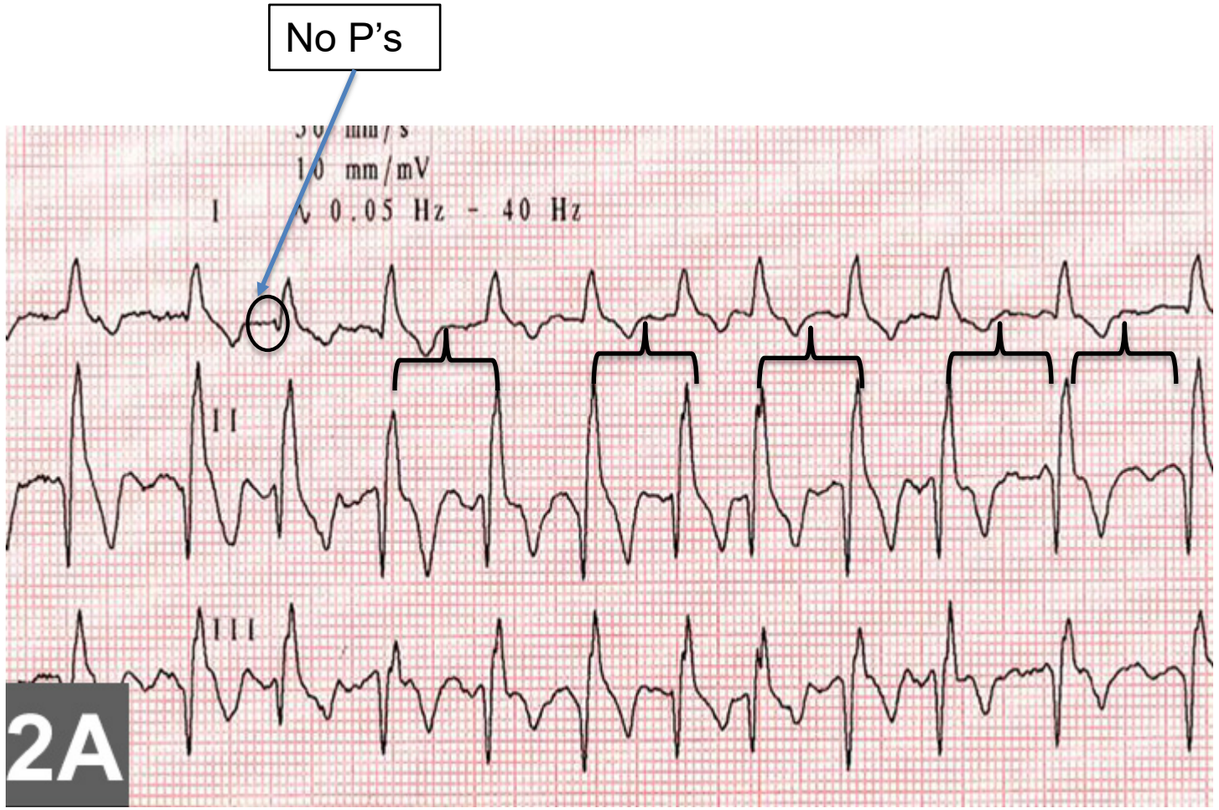




Pause with conversion to NSR

ECG – Tachycardia

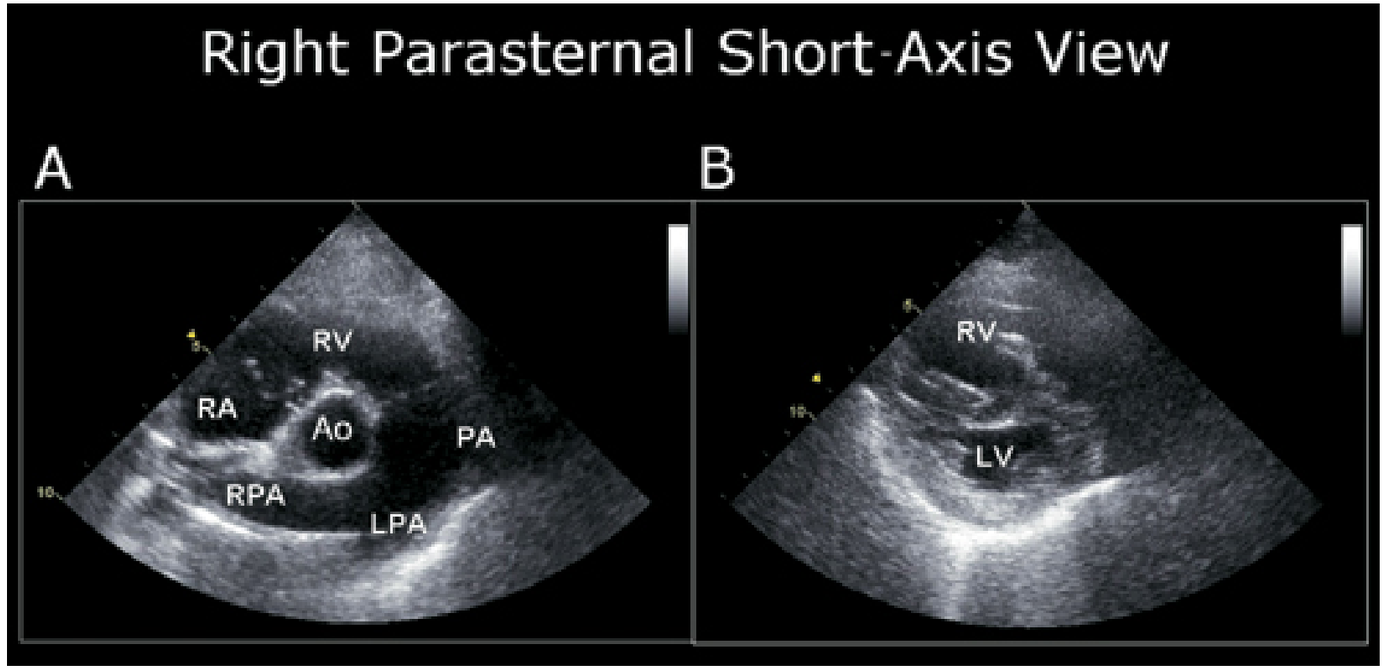
- Atrial fibrillation
  - Multiple re-entrant circuits
  - AV acts as a gate keeper
  - Lone AF vs dogs with structural heart disease
    - Giant breeds = lone AF
  - Structural heart disease more common
    - Cats and dogs



https://www.cliniciansbrief.com/article/top-5-arrhythmias-dogs-cats

Pulmonary Hypertension

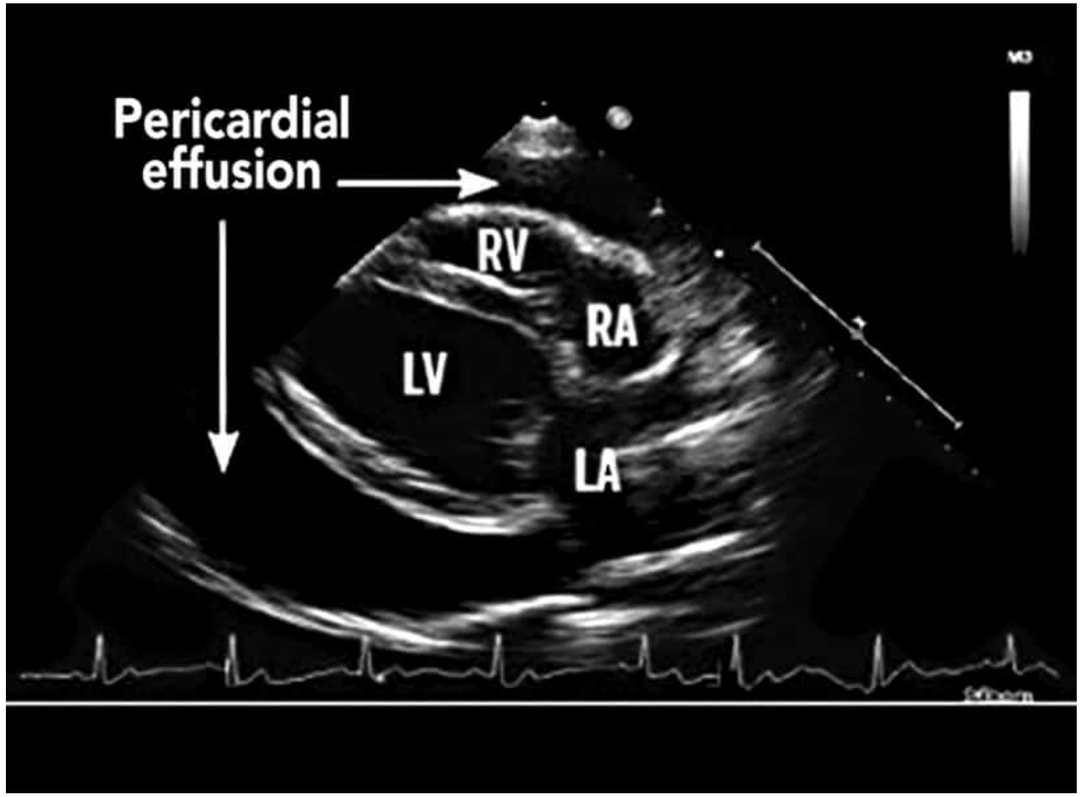
- ECG – nonspecific
- Thoracic radiography - nonspecific
- Echo – Gold standard, noninvasive
  - Subjective
    - RV changes associated with increased RV afterload
    - RVH
    - Septal wall flattening
    - Paradoxical septal wall motion
    - PA dilation
  - Objective
    - PA velocity profiles
    - Systolic PA pressure assessment
    - Doppler diastolic PA pressure assessment



Pericardial effusion – Syncope look alike

- Neoplasia
- Inflammatory/infectious
- Trauma
- Idiopathic
- Hypooncotic state→low albumin; uncommon
- PPDH

- Treatment→Pericardiocentesis



Diagnostics – Bloodwork

- Serum chemistry
  - Electrolytes
    - Hyperkalemia
  - Hypoglycemia
- T4/fT4
  - Hyperthyroidism
- Cardiac biomarkers
  - NTproBNP
- CBC
  - Anemia
  - Thrombocytopenia
- Neuro exam

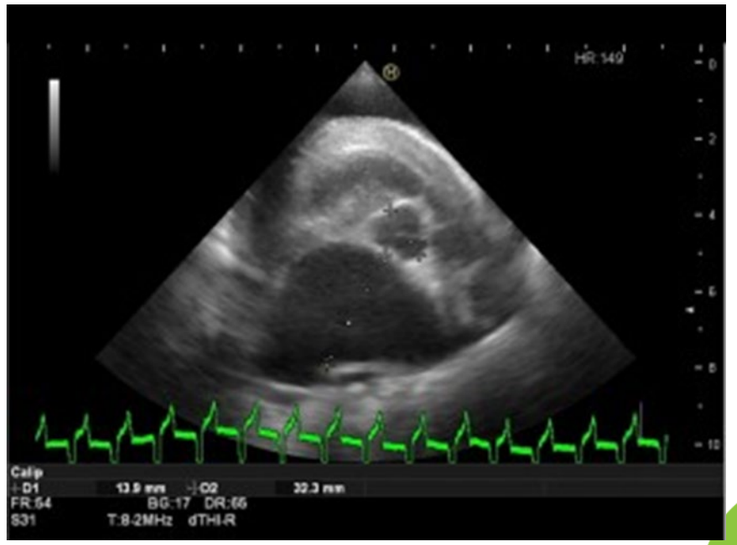
Positive NTproBNP→ likely cardiac related. Needs ECG and echocardiogram

Negative NTproBNP + no auscultable arrhythmia→likely not cardiac related BUT may have intermittent arrhythmia; consider Holter or implantable monitor (cardio consult)

Treatment

- Treat the underlying disease
  - Arrhythmia→antiarrhythmics or pacemaker
  - Reflex-mediated without structural heart disease
    - Difficult to manage
    - Possible pacemaker if bradycardia during event
      - If hypotensive + bradycardia – pacing may not help
  - Avoid pre-treatment with β-blocker to treat the tachycardia trigger
    - Can exacerbate the bradycardia related syncope

- Reflex-mediated syncope with high preload
  - Impending failure
  - 'Cardiac unloading'
    - Diuretic, pimobenden, ACEi



Long Term Monitoring

Implantable loop recorders (ILR)

AliveCor

Holter monitor

In House telemetry

- Differentiating syncope vs seizure vs neuromuscular collapse

Clinical features	Syncope	Seizure	Neuromuscular collapse*
Mentation	Normal	May be abnormal	Normal
Gait	Normal	Normal	Often abnormal
Alteration of consciousness	Yes	Frequent†	No
Tonic-clonic muscle activity	Rare	Usually	Variable depending on specific disease
Trigger events (excitement, activity, cough, gag, etc.)	Possible	Usually none	Variable depending on specific disease
Duration of episode	Seconds to few minutes	Minutes to hours	Varies
Prodromal phase	Very rare	Rare to common	Rare
Abnormal mentation after the event	Uncommon	Frequent	No
Urination/defecation during the event	Uncommon	Frequent	No
Response to antiseizure medication	No	Usually	No

* Neuromuscular causes include polmyositis, polyneuropathy, myasthenia gravis, narcolepsy, botulism, tick paralysis, hepatic encephalopathy, paraneoplastic syndromes, and central nervous system lesions

† Some seizures (e.g. simple focal/partial seizures) are not associated with alteration of consciousness.

- Classification of syncope

Category of syncope	Cause of syncope	Examples
Cardiac syncope	Bradyarrhythmia	Sick sinus syndrome, AVB: high grade 2nd or 3rd degree, atrial standstill
	Tachyarrhythmia	Ventricular tachycardia, atrial tachycardia, atrial fibrillation, OAVRT
	Structural heart disease	Aortic and pulmonic stenosis, pericardial effusion, pulmonary hypertension due to pulmonary thrombosis/embolism, heartworm disease, advanced degenerative AV valve disease, DCM, hypertrophic obstructive cardiomyopathy
Reflex-mediated syncope	Vasovagal neurocardiogenic	Mediated by emotion: stress, fear, pain (not documented in veterinary patients)
	Situational	Intense activity, excitement, coughing, urination/defecation, gagging/vomiting
	Carotid sinus hypersensitivity	Primary dysfunction of baroreceptors in carotid arteries, neoplasia in cervical region
Orthostatic syncope	Drug-induced hypotension	Acepromazine, hydralazine, amlodipine, nitrates, beta-blockers, diuretics
	Volume depletion	Dehydration, hemorrhage, redistribution

AVB, atrio-entricular block; DCM, dilated cardiomyopathy; OAVRT, orthodromic atrioventricular reciprocating tachycardia.

- Breed/species associated with syncope

Breed or species-related cause of syncope	Associated conditions	ECG findings
Miniature schnauzer, American cocker spaniel, West Highland white terrier	Bradyarrhythmia +/– tachyarrhythmia	Sick sinus syndrome: brady tachy arrhythmia, junctional or ventricular escape rhythm, sinus arrest
Boxer/Doberman*	Tachyarrhythmia	Ventricular tachycardia
Advanced cardiomyopathy in large breed dogs	Arrhythmia	Atrial fibrillation, ventricular tachycardia
Any dog with slow heart rate	Bradyarrhythmia	Advanced second or third degree atrioventricular block
English springer spaniel	KCNQ1 gene mutation	Long QT in sinus rhythm, biphasic T waves, presumed tachyarrhythmia as cause for collapse
Exercise-induced collapse syndrome (reported in Labrador retriever, Chesapeake Bay retriever, border collie, curly-coated retriever, Boykin spaniel and Pembroke Welsh corgi)	Dynamin-1 mutation, associated with acute hyperthermia	Presumed tachycardia
Cats with exertional syncope	Cardiomyopathy, left ventricular outflow tract obstruction, anemia	Normal to ventricular tachycardia
Cats or dogs with hypoglycemia	Hypoglycemia (insulin overdose), insulinoma, neonate	Normal
Older cats	Hyperthyroidism	Tachyarrhythmias to atrioventricular blocks

*Presumed to be ventricular tachycardia, but Boxers and Dobermans can collapse from reflex-mediated bradycardia and vasodilation as well.
ECG, electrocardiogram; KCNQ1, potassium voltage-gated channel subfamily Q member 1.

- Drugs used for cardiac syncope associated with arrhythmias

Drug	Indication	Maintenance dosage	Frequency
Lidocaine	Acute, life-threatening ventricular arrhythmias	2 mg/kg bolus IV, over 1–2 min followed by CRI at 40–80 µg/kg/min	Repeat up to 4 times, if no effect or the arrhythmia recurs
Atropine	Sinus bradycardia, high-grade AV block, atropine response test	0.02–0.044 mg/kg IV, IM, SQ	
Procainamide HCl	Life-threatening ventricular and supraventricular arrhythmias	2-4 mg/kg (up to 20 mg/kg) IV SLOWLY over 10 min followed by CRI at 20–50 µg/kg/min	Repeat bolus 2 times (but negative inotrope and may cause hypotension)
Esmolol	Ventricular and supraventricular arrhythmias	25–100 µg/kg IV bolus followed by CRI at 10–200 µg/kg/min	Repeat 2 times PRN
Sotalol	Ventricular and supraventricular arrhythmias	Dog: 0.5–2.5 mg/kg PO Cat: 10–20 mg	q12–24h q12h
Diltiazem HCl	Supraventricular arrhythmias	0.05–0.25 mg/kg IV bolus, followed by CRI at 2–6 µg/kg/min	Repeat up to 3 times
Diltiazem XR (Dilacor)	Supraventricular tachycardia, atrial fibrillation	Dog: 3–4 mg/kg PO Cat: 30–60 mg total dose	q12h q12–24h (start with 30 mg q24h)
Cardizem	Supraventricular tachycardia	Dog: 0.5–1.5 mg/kg PO, increase PRN Cat: 7.5 mg/cat, increase PRN	q8h q8–12h
Cardizem CD	Supraventricular tachycardia	Cat: 6–10 mg/kg PO	SID q24h
Amiodarone HCl	Ventricular and supraventricular arrhythmias	2 mg/kg IV bolus slowly over 10 min followed by CRI at 0.8 mg/kg/h for 6 h	
Amiodarone	Ventricular and supraventricular arrhythmias	Dog: 10 mg/kg PO Dog: 5 mg/kg PO	q12h for 1 week (loading)* q24h* (maintenance)
Mexiletine	Ventricular arrhythmias	5–8 mg/kg PO	q8h
Hyoscyamine sulfate	Sick sinus syndrome Advanced heart block	0.003–0.005*** mg/kg PO	q8–12h
Propantheline bromide	Sick sinus syndrome	0.2–0.5 mg/kg PO, increase PRN	q8–12h q12h BID
Digoxin	Atrial fibrillation	Dog: 0.005–0.01 mg/kg PO**	q12h BID

Look-a-likes

Seizure

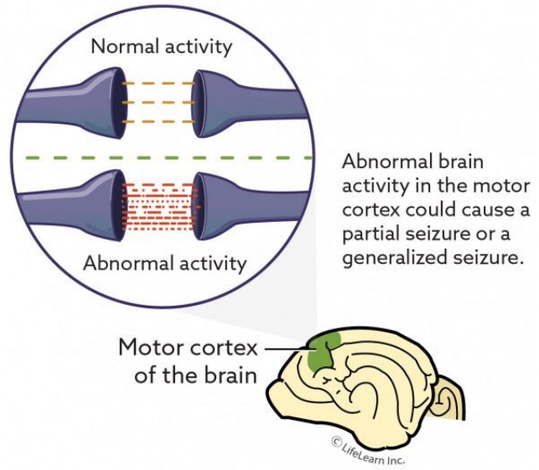
VCA Specialty Animal Hospitals

Syncope Look-a-likes

- Seizure
  - Cerebral event
  - Hypoglycemia
- Narcolepsy
  - No cerebral hypoperfusion
  - Easily awakened
- Exercise intolerance
- Exercise induced collapse
- Border Collie collapse (BCC)
- Episodic falling syndrome
  - CKCS

Seizure

- Abnormal and excessive excitation and synchronization of cortical neuron population
- Epilepsy
  - Recurrent seizures
- Status Epilepticus (SE)
  - Seizure > 5 min
  - > 30 mins
    - Permeant brain injury
- Cluster
  - ≥ 2 in 24 hour period



- Focal (Partial) Seizure
  - With or without loss of consciousness
  - Non convulsive (sensory)
  - Altered mentation
    - Hypersalivation
    - Jaw chomping (chewing gum)
    - Fly biting
    - Symmetric/asymmetric facial twitching
    - Rhythmic limb movement

Seizure

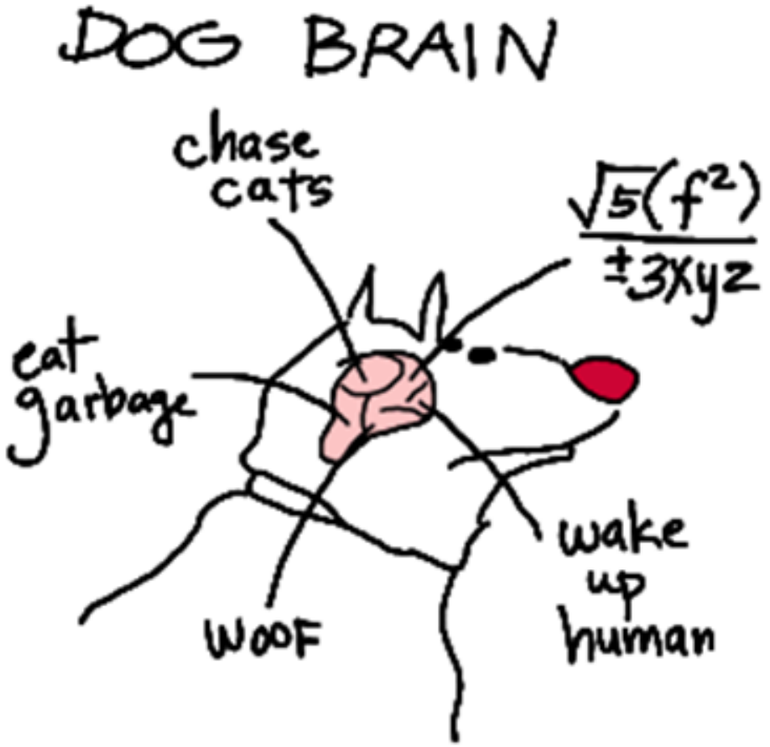
- Generalized seizure
  - Convulsive or non-convulsive
  - Tonic-clonic
    - Bilateral, symmetrical, violent muscle contractions
    - LOC
    - Autonomic phenomena
      - Hypersalivation
      - Urination
      - Defecation
- Post ictal
  - Rhythmic movement noted
    - Eyelids
    - Face

Seizure

- Signalment
- Past pertinent HX
  - 1st time vs pre-existing?
  - What, where, when, how long, how many?
  - Conscious, unconscious or hard to say?
  - Otherwise healthy?
  - Travel, vaccination, trauma, toxin
  - Medications
  - Indoor vs outdoor
    - Cats

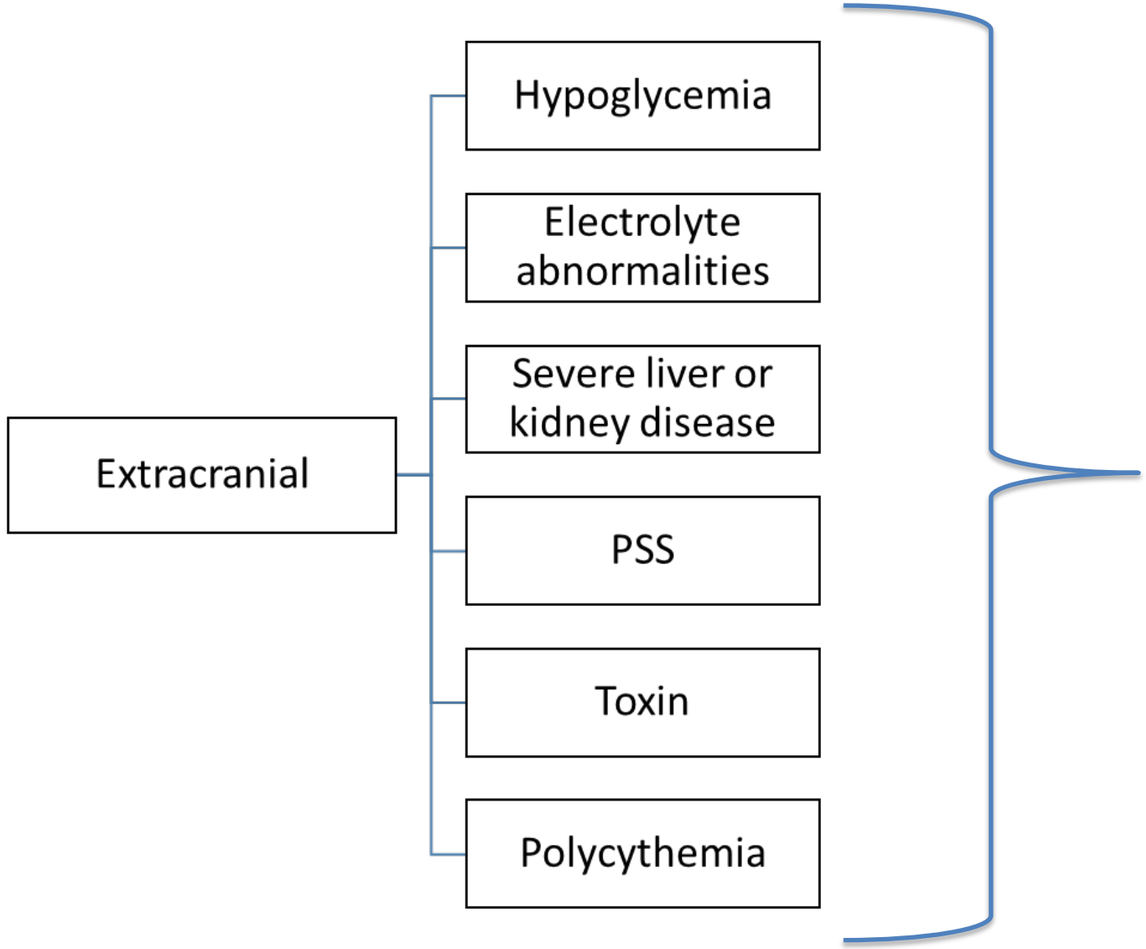
Seizure

- PE
  - Ideally before medications
- Preictal
  - Agitation
  - Clingy
  - Hiding
- Postictal
  - Impaired vision
  - Disoriented
  - Hyperactive
  - Aggression



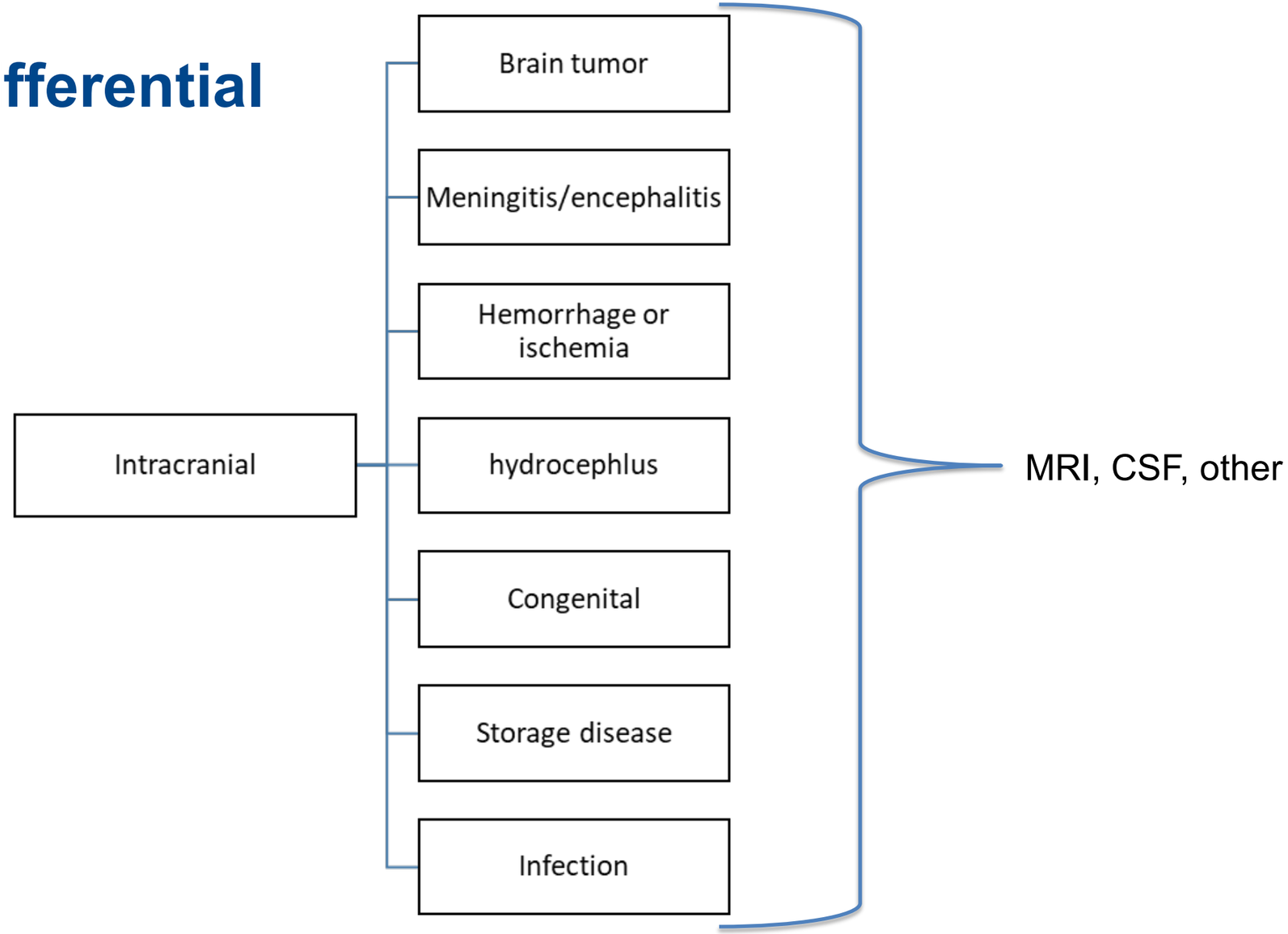
Seizure – Differential

Seizure - Differential

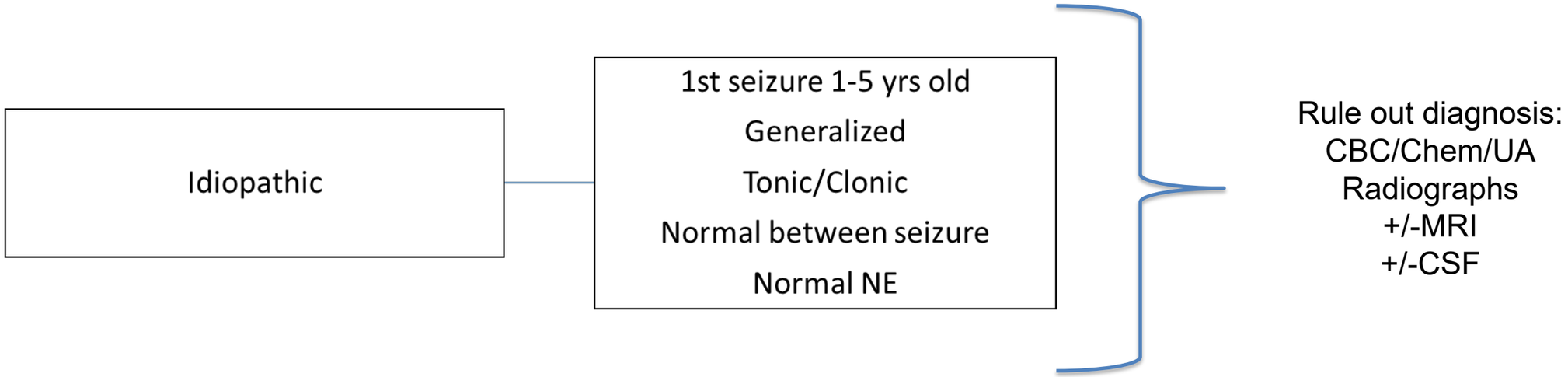


Requires diagnostics: blood, urine, imaging

Seizure - Differential



Seizure - Differential



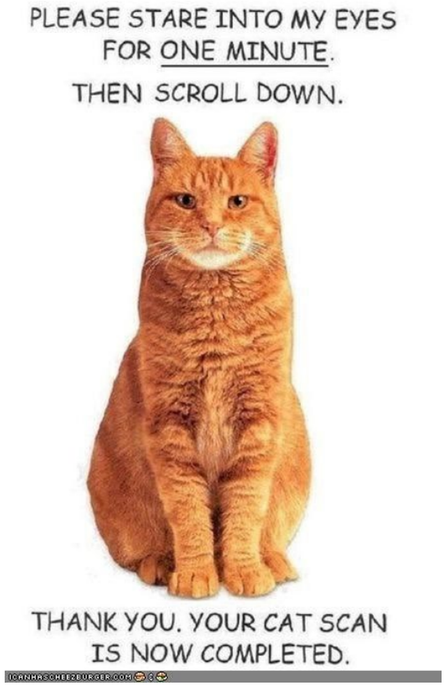
Seizure – minimum data base

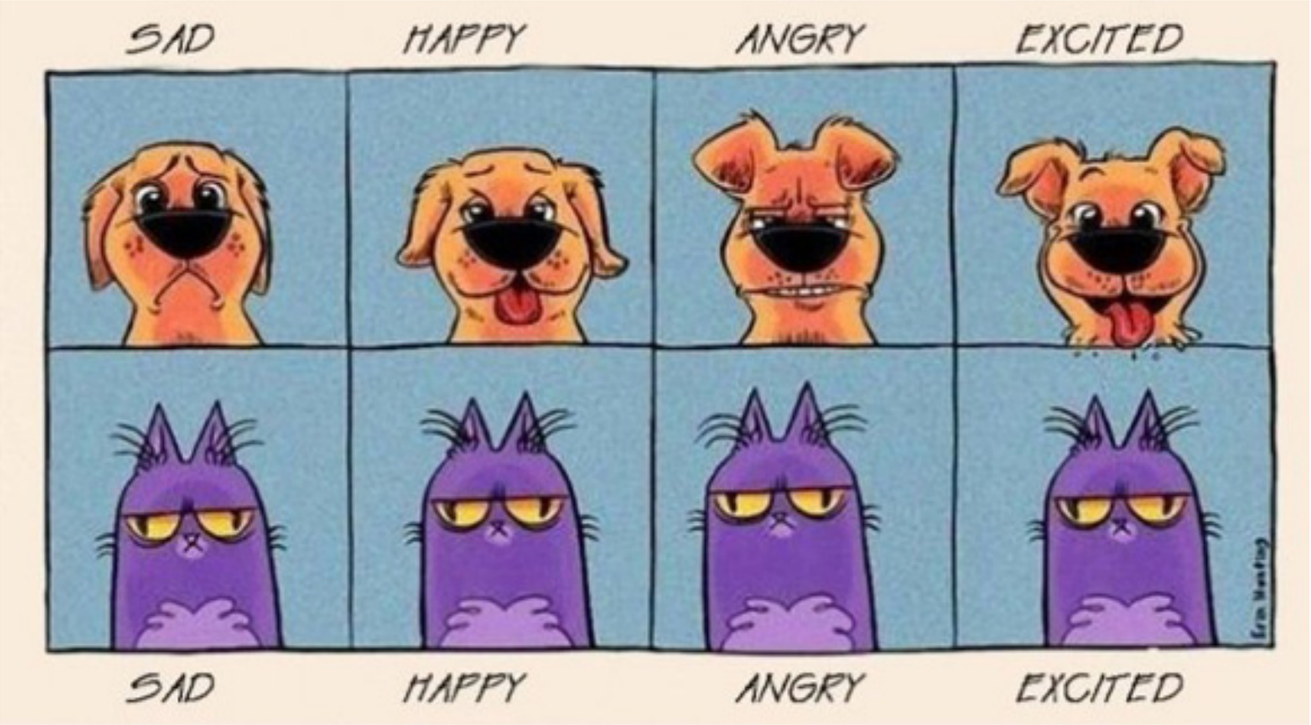
- PCV
- BG
- BUN
- Metabolic profile
  - NOVA
  - ISTAT
- ECG

Seizure – extended diagnostics

- CBC/Chem/UA
- Tick/vector borne disease profile
- FeLV/FIV
- Thoracic radiographs
- CT
  - Head trauma and unstable patients
- MRI
  - Post ictal
- CSF

- Lead
  - Once stable
  - If suspected
- Cholinesterase levels
  - Once stable
  - If suspected




SAD
HAPPY
ANGRY
EXCITED
SAD
HAPPY
ANGRY
EXCITED

Seizure - Anticonvulsants

- Benzodiazepines
  - Fast acting
  - IV, PR, IN
    - Not the compounded suppositories
  - Diazepam
    - IV 0.5-1 mg/kg
    - PR 0.5-2 mg/kg
    - IN 0.5 mg/kg
    - CRI 0.5-2 mg/mg/h
- Midazolam
  - IV 0.07-0.22 mg/kg
  - IM 0.07-0.22 mg/kg
    - Not ideal in acute setting
  - IN gel [50 mg/mL, dogs]; 0.2 mg/kg

Am J Vet Res. 2012 Apr;73(4):539-45. doi: 10.2460/ajvr.73.4.539.

Bioavailability of a novel midazolam gel after intranasal administration in dogs.

Eagleson JS[1], Platt SR, Strong DL, Kent M, Freeman AC, Nghiem PP, Zheng B, White CA.

Am J Vet Res. 2018 Jan;79(1):73-82. doi: 10.2460/ajvr.79.1.73.

Pharmacokinetic evaluation of novel midazolam gel formulations following buccal administration to healthy dogs.

Aldawsari MF, Lau VW, Babu RJ, Arnold RD, Platt SR.

Seizure - Anticonvulsants

- Phenobarbital
- SE, clusters
- PO, IV, IM
- Loading dose
  - 4-6 mg/kg IV
    - q 30 min up to 4-6 hr
    - Patient directed
    - Max 24 mg/kg over 24 hr

- Refractory seizures
  - After 24 hrs of combined BZD/PB
  - Likely a structural lesion
  - More aggressive therapy needed
    - Levetiracetum
    - Propofol CRI
    - BZD CRI

Seizure - Anticonvulsants

- Levetiracetum
  - PO, IV
  - Minimal metabolism, renal excretion
  - Limited drug interactions
  - Short half-life
    - 3-4 hrs in dogs
  - IV 20 mg/kg q8h
  - Loading dose: 60 mg/kg IV once
- In cats
  - Therapeutic range after 10 mins; maintained for 9 hrs
- Can be combined with other drugs
  - Good safety margin
  - Minimal side-effects

Seizure - Anticonvulsants

Case Series

Journal of Veterinary Emergency and Critical Care 20(3) 2010, pp 346–351
doi: 10.1111/j.1476-4431.2010.00537.x

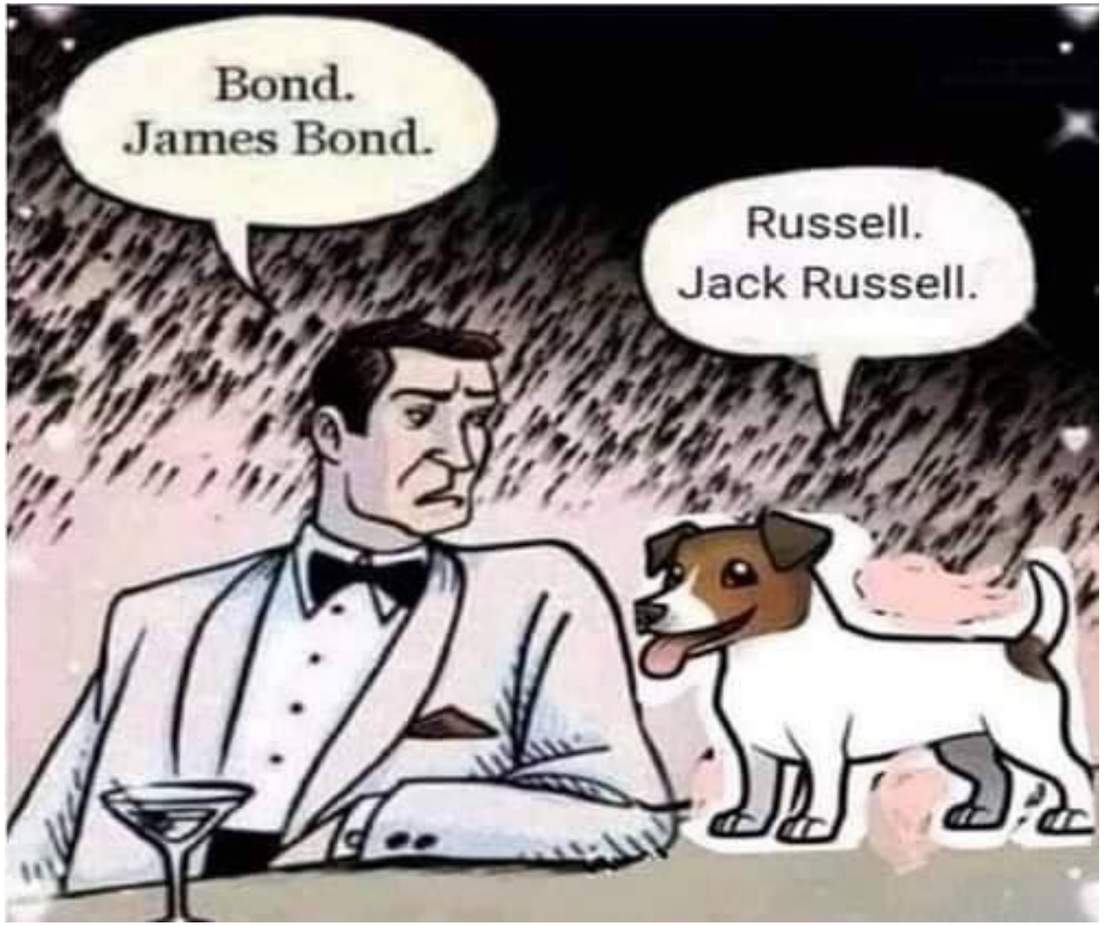
Outcome from status epilepticus after portosystemic shunt attenuation in 3 dogs treated with propofol and phenobarbital

- Propofol
  - GA
  - Hypnotic/amnestic
  - Similar to PB and BZD
  - Apnea, vasodilation, myocardial depression common
  - Suppresses gag reflex
    - Aspiration pneumonia
    - Be prepared to intubate and ventilate

- Efficacy is controversial
  - Anticonvulsant and proconvulsant qualities
  - Antiepileptogenic qualities are dose dependent and high
- Epileptic dogs under Propofol
  - Exhibit epileptiform activity on EEG
- Study in PSS dogs
  - Showed promise of seizure control using PB and Propofol for refractory seizure

Seizure - Anticonvulsants

- Ketamine
  - NMDA receptor antagonist
  - Experimental
    - Management of refractory seizure in humans and rodents
    - NMDA activation results in a loss of GABAergic inhibition
    - May be beneficial


Bond.
James Bond.
Russell.
Jack Russell.

Thank You!

Questions?

jmichael.walters@vca.com