Mitral Valve Disease in Dogs - Truly Epic
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Towson, MD

Chronic degenerative mitral valvular disease (DMVD) is the most common heart disease in dogs. In dogs with congestive heart failure, 75% have mitral regurgitation/degenerative valvular disease. Almost all have tricuspid regurgitations as well, but clinically the mitral regurgitation is the most significant. Degenerative valvular disease is most common in small breed dogs and more common in males than females. DMVD has been proven to be inherited in the Cavalier King Charles Spaniel and the Dachshund but several other breeds are predisposed, such as Bichons, poodles, Chihuahuas, Miniature Schnauzers, Boston Terriers.

The cause of degenerative valvular disease remains unknown. However, the valve changes occur due to a destruction of collagen, deposition of mucopolysaccharide in the spongiosa and fibrosa layer of mitral valve, which also affects chordae tendinea. These changes prevent effective coaptation of the valve leaflets leading to progressive mitral regurgitation.

Mitral regurgitation (MR) leads to decreasing forward output and increasing left atrial and left ventricular dilation and remodeling as well as activation of the neurohormonal systems. Typically, patients will have 2-3 years in asymptomatic phase (time between when heart murmur detected) until symptoms develop - congestive heart failure (CHF). We can detect progressive heart enlargement 6-12 months prior to the development of CHF. This means that we have a fairly long time period to intervene with therapy and alter the progression of the disease - we know what’s coming!

Eventually left atrial pressure increases sufficiently and pulmonary congestion develops leading to symptoms of CHF and can also lead to pulmonary hypertension. Approximately 30% of dogs with MR develop CHF - how can we detect which ones are going to go on to develop congestive heart failure?

Diagnosis
- Physical Examination - typical mitral murmur in typical breed/age
- Chest Radiographs - Left atrial +/- left ventricular enlargement +/- signs of CHF
- Echocardiogram - myxomatous degeneration + MR

ACVIM heart failure classification
- A - At risk for heart disease (such as CKCS)
- B1 - Heart disease present but no symptoms and no heart enlargement (murmur is present)
- B2 - Heart disease present, heart enlargement but no symptoms
- C - Congestive Heart Failure
- D - Refractory Heart Failure

A - routine yearly (or biannual) exams to evaluate carefully for development of heart disease
- B1 - Obtain chest radiographs and blood pressure
  - VHS > 10.5 - recommend echocardiogram
  - VHS = 8.7-10.5 - repeat chest radiographs in 6-12 months, +/- echocardiogram
- B2 - Chest radiographs - VHS > 10.5 - recommend echocardiogram
  - All Large breed dogs - recommend echocardiogram
- C - Chest radiographs, Echocardiogram, +/- ECG (if ausculted arrhythmia or breed at risk), sleeping respiratory rate

Goals of medical therapy
- Slow volume overload, progressive chamber dilation
- Blunt neurohormonal activation
- Improve quality of life
- Improve survival
- Decrease risk of sudden death

The medical management of asymptomatic DMVD has been controversial for years among veterinary cardiologists. Data from clinical trials has been conflicting until recently. The EPIC trial (Evaluation of Pimobendan In Cardiomegaly) was published in September 2016 in JVIM. In this study, small breed dogs were confirmed to have DMVD and cardiomegaly. So, had typical heart murmur, on chest radiographs had VHS > 10.5 and then had echocardiograms with board-certified cardiologist (Left atrial/aortic ratio > 1.6, LVEDDN > 1.7 (left ventricular dimension in diastole normalized to body weight). Most of the inclusion criteria for the study were echocardiographic measurements. Results of the study demonstrated that Pimobendan delayed the onset of CHF compared to placebo by ~ 15 months. The study demonstrates that Pimobendan has the greatest monotherapy benefit to delay the onset of heart failure in small dogs with stage B2 DMVD. There is always some risk to medications so we definitely want to choose the right...
patients to place on Pimobendan - so want to confirm that they are advanced enough to require medications via echocardiogram. However, now we know that early diagnosis can lead to better long-term outcomes. The data from this landmark study supports the use of Pimobendan once signs of significant left atrial and left ventricular dilation are present but not when the heart size is normal or even mildly enlarged. We do not yet know whether further improvement in survival is possible if Pimobendan is used in combination with other medications. The EPIC trial was a well-designed study and will change the way we treat patients with DMVD.

**Treatment for advanced stage B2 (based on chest radiographs + echocardiogram with cardiologist):**
- Pimobendan (0.25 mg/kg PO q. 12 hr) - off label use
- +/- ACE inhibitor (0.5 mg/kg PO q. 12 hr - adjust dose depending on renal/liver function/electrolytes)

**Treatment for stage C (based on chest radiographs + echocardiogram with cardiologist + chemistry profile + BP +/- ECG):**
- Furosemide (2 mg/kg PO q. 12 hr - usually starting dose depending on age/renal function/electrolytes - increase up to 3-4 mg/kg PO q. 8 hr)
- ACE-inhibitor (0.5 mg/kg PO q.12 hr - adjust dose depending on renal/liver function/electrolytes)
- Pimobendan (0.25 mg/kg PO q. 12 hr)
- +/- Spironolactone (1-2 mg/kg PO q.12 hr - adjust dose depending on renal/liver function/electrolytes)
Systemic Hypertension: How Low Can You Go?
Kristin Jacob, DVM, DACVIM
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- Normal Systolic: < 160-165 mm Hg
- Normal Diastolic: < 120 mm Hg
- Clinical signs are usually not present until systolic pressure > 180 mm Hg

Etiology
In the dog and cat, hypertension is almost always secondary to an underlying disease process and not primary or essential as seen in human beings.

Feline
- Chronic renal disease (with or without proteinuria)
- Hyperthyroidism
- Diabetes mellitus
- Occasionally hyperaldosteronism, pheochromocytoma or other endocrine

Canine
- Chronic renal disease (especially glomerular disease with concurrent proteinuria)
- Cushing’s disease
- Diabetes mellitus
- Hyperaldosteronism
- Pheochromocytoma
- Metabolic abnormalities, obesity, hypercholesterolemia
- Resolution of the underlying endocrinopathy or treatment of chronic renal failure may not restore the blood pressure to normal.

Note: Secondary cardiac changes are common with hypertension but hypertension does not result from cardiac disease.

Clinical signs or laboratory findings
1. Ocular: Hypertensive retinopathy is the primary lesion noted especially in cats
   a. Blindness, hemorrhage in anterior chamber, retinal vessel tortuosity, papillary dilation
2. Neurologic: Associated with cerebrovascular hemorrhage
   a. Depression, ataxia, disorientation, seizures, circling
3. Renal: Proteinuria is best marker of hypertensive effects on kidneys
   a. Microalbuminuria or elevated UP:UC ratio (> 0.5 in dog, > 0.4 in cat)
4. Cardiac
   a. Left ventricular hypertrophy, mitral regurgitation, diastolic dysfunction, CHF (rare in dogs & cats)

Diagnosis
Indirect blood pressure measurement (serial monitoring is best)
- Doppler devices are best in conscious animals
- Oscillometric devices underestimate BP but by disparate amounts as BP increases
- Fundic Examination – subjective
- Tortuous vessels, hemorrhage
- Labwork – Chemistry profile, Serum T4, ACTH stimulation, UA
- Echocardiogram – especially in cats
- Left ventricular hypertrophy can be present without heart murmur
- Degree of hypertrophy does not correlate with severity of hypertension

When to treat?
- Asymptomatic - Systolic BP consistently > 200 mm Hg in cats or > 180 mm Hg in dog (especially > 20 kg)
- Symptomatic (clinical signs as above) - Systolic BP > 180 mm Hg in cat and > 160 mm Hg in dog
- Retinal detachment often seen when BP > 180 mm Hg

Goal of treatment is to achieve repeatable systolic BP < 160 mm Hg
Treatment options

- Diet – lower sodium diet (< 0.25% sodium on dry matter basis) can help with BP control need to consider renal disease as well (most prescription renal diets are sodium restricted as well)
- Obesity – weight loss is essential as it is in human medicine – discuss this and implement a diet plan with your client

Medical

- Amlodipine (Norvasc)
- Vascular calcium channel blocker
- Usually first choice in veterinary medicine (+/- with ACE inhibitor)
- Cats: 0.625 mg-0.125 mg once or twice daily per cat
- Dogs: 0.05-0.5 mg/kg PO q. 12-24 hr.
- Enalapril (Enacard) or Benazepril
- ACE Inhibitor
- Used with other agents to control BP
- Used to treat protein-losing nephropathy
- Cats: 0.25-0.5 mg/kg PO q. 24 hr
- Dogs: 0.5 mg/kg PO q. 12 hr

Atenolol

- Beta-blocker
- 3rd choice (added on) treatment for controlling BP
- Used in cats with hyperthyroidism if persistently tachycardic – caution because negative inotrope and risk for CHF in patients with significant cardiomyopathy
- Cats: 6.25 -12.5 mg PO q. 24 hr/cat
- Dogs: 0.25-1.0 mg/kg PO q. 12-24 hr

Other therapies

- Hydralazine, Phenoxybenzamine, Diuretics (more common in human medicine)

Who should have a blood pressure checked?

Cats

- Renal disease – 20-30% have concurrent systemic hypertension
- Hyperthyroidism – 10-30% have concurrent systemic hypertension - Diabetes mellitus
- Ocular signs (hemorrhage, retinal detachment)
- Neurologic signs
- Cardiac murmur, gallop or cardiomegaly
- Any cat > 8 years of age – yearly BP screening

Dogs

- Renal disease – especially if concurrent proteinuria
- Cushing’s Disease, Diabetes Mellitus, Hypothyroidism
- Ocular signs (hemorrhage, retinal detachment)
- Neurologic signs
- Any dog > 8 years of age

Technique

- Cuff Size – Dogs (40%) and Cats (30-40%) of the limb used
  - If cuff is too large, it will underestimate BP, if too small, it will overestimate BP
- Cuff Placement – where cuff is placed on limb should be at level of heart
  - Cuff position, cuff size and operator name should be recorded for consistency between visits
- Ideally record 5 BP measurements – discard 1st and any obviously spurious measurements, average rest
- Avoid placing cuff too tight
- Only measure systolic pressure
- Decrease “White Coat Effect”
  - Obtain BP prior to PE, vaccines, blood draw, etc.
  - Allow 5-minute acclimatization to exam room and keep room quiet
  - Have owner remain with pet to keep pet calm
General points

- Dogs (especially with renal disease) require combination therapy for adequate BP control
- Recheck BP q. 2 weeks until < 160 mm Hg, then recheck in 1 month and then every 3-4 months to be sure remains < 160 mm Hg.
- Recheck labwork (CBC, Chem profile, UA, serum T4) at least every 6 months – but tailored to each patient depending on underlying cause of hypertension and medications required to control hypertension.
Why is Evaluating Chest Radiographs so Difficult?  
Cardiac Case-Based Interpretation Tips to Make Your Life Easier

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Thoracic radiographs can be key in differentiating cardiac disease from respiratory disease. It is crucial that they are interpreted in conjunction with history, signalment and physical examination. Thoracic radiographs are important for initial treatment decisions as well as determining whether further imaging, such as echocardiography, is necessary.  

Spend time developing a technique chart for your thoracic radiographs - optimal technique is essential.

Obtain 2 views, (if not 3-views) for best assessment

- Best to always use the same views (always DV or VD, always right or left lateral)
- There are subtle differences between the views – train your eye so you are used to looking at the same views (VD difficult in dyspneic patient – patient care always comes first!)
- Radiograph evaluation is pattern recognition so looking at a lot of radiographs is key.

Develop a systematic strategy for evaluating thoracic radiographs - do the same thing every time!

- Go from the outside in, or the inside out
- Examine all structures - chest wall, bones, abdomen, mediastinum, heart, hilar region, lungs, trachea, larynx
- If abnormalities are present, check to see if present on both/multiple views - confirm what you are seeing
- Compare to previous films of the same patient, if available – Gold standard
- Be critical of your technique: with regards to positioning, phase of inspiration, exposure
  - Obliquity distorts cardiac silhouette, changes relationship between bronchi and pulmonary vessels
  - Inspiratory radiographs can mimic lung pathology
- Consider the body condition and breed of the patient
  - Obesity can mimic cardiomegaly - can sometimes differentiate fat from cardiac silhouette on second view
  - VHS (Vertebral Heart Score) can help decrease effect of breed conformation on heart size

Learn and use the vertebral heart score for evaluating heart size

- Measure the long and short cardiac axes - combine the lengths and scale against the length of the vertebrae beginning with T4
- Various tutorials online to learn method
  - 11 = enlarged in dog, > 8 = enlarged in cat
- Excellent way to record heart size in medical record
- Excellent for serial evaluation of cardiac size and to standardize heart size measurements between clinicians

Evaluate the pulmonary parenchyma

- Normal or abnormal?
- NT-proBNP can help improve confidence and accuracy in interpreting radiographs and differentiating pulmonary infiltrates due to congestive heart failure vs. respiratory disease.
- Pulmonary patterns
  1) Interstitial
  - Early pulmonary edema - blurring of pulmonary vessels as fluid leaks into interstitium
    - Evaluate location of infiltrate - dogs pulmonary edema generally begins in caudodorsal lung fields
  2) Alveolar
  - More advanced pulmonary edema - air has been replaced by edema fluid, can see air bronchograms, may obscure pulmonary vessels if severe enough
  - Also caused by pneumonia, hemorrhage (trauma, rodenticide) - evaluate location/distribution
  3) Bronchial
  - Bronchial walls thickened due to inflammation of airways - donuts and tram lines
  - Can be subtle and can be confused with interstitial pattern
  - Can also see bronchiectasis - dilation of bronchi
  4) Pleural space disease
  - Pleural effusion - VD radiograph is preferred (fluid moves away from heart (doesn’t obscure heart as much))
  - Pleural masses
- Pleural thickening
- Pneumothorax

**Feline thoracic radiographs**
- Cardiomegaly is difficult to evaluate since hypertrophy is often concentric
- Not a good screening test for heart disease in cats, VHS helps - NT-proBNP is best!
- Look for left atrial/left auricular appendage enlargement on the VD/DV view – rare to observe on the lateral view
- Pulmonary edema can be cranioventral in the cat - can have any pattern
- Tips for diagnosing CHF: evaluate for pulmonary vessel enlargement, look for left atrial enlargement, is there a heart murmur, gallop or arrhythmia? is the NT-proBNP elevated/abnormal?

**Canine thoracic radiographs**
- Know where to evaluate for left atrial enlargement
- Use your VHS! Helps to negate some of the effects of breed variation
- Tips for diagnosing CHF: look for left atrial and left ventricular enlargement, is there a heart murmur? Evaluate for pulmonary venous enlargement/distension, is the NT-proBNP elevated/abnormal?
- Commonly see concurrent mitral valve disease and respiratory disease - challenging cases and not a radiographic diagnosis alone (need an echocardiogram, consult your friendly, local cardiologist!)

We will look at a lot of radiographs together and put these tips into action.
A Practical Approach to Arrhythmias
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Objectives
• Electrocardiogram (ECG) Interpretation Review
  – Normal Pathway and ECG configuration
  – Evaluation Technique
• Tachyarrhythmias
  – Primary vs. Secondary
  – Approach to Treatment
• Bradyarrhythmias
  – Primary vs. Secondary
  – Approach to Treatment

What is an ECG?
• Peripheral detection and recording of internal cardiac electrical activity
  – Lead II – Most common orientation
    • R arm to L leg
  – Take the time to get a diagnostic ECG
    • Right lateral recumbency
    • 50mm/s; 10mm=1mV
  – Pattern of tracing based on lead observed
    • Varies based on point of perception/observation

Normal electrophysiologic pathway
• Sinoatrial (SA) Node
  – Spontaneous activity of the atrial pacemaker
• Atrioventricular (AV) Node
  – Only normal pathway of electrical conduction between atria and ventricles
  – Provides normal atrioventricular delay (PR interval)
• Normal Ventricular Conduction
  – Bundle of His > Purkinje fibers
    • Rapid conduction via Purkinje fibers results in narrow QRS complex

Evaluation technique
• Find Your Normal
• Questions to Ask…
  – What is the overall heart rate?
  – Is the rhythm regular or irregular?
  – Is there a P for every QRS?
    • No? > Then there is ventricular ectopy
  – Is there a QRS for every P?
    • No? > Then there is AV block
  – For each QRS complex
    • Is it expected, delayed, or premature?
    • Is it similar or different in morphology?
      • Abnormal?
        • Aberrancy vs. Ventricular in origin

Arrhythmias – Why do we care?
• Four main determinants of Cardiac Output
  – Preload
  – Afterload
  – Contractility
  – Heart Rate and Rhythm

Abnormal QRS complex?
• Abnormal QRS Complex – “Wide and Bizarre”
  • Ventricular origin
    • High velocity conduction of Purkinje fibers not utilized
• Width of complex due to slow conduction
  • Positive in Lead II – Right ventricular origin
  • Negative in Lead II – Left ventricular origin
  • No relationship between P wave and QRS

  • Supraventricular origin
    • Consistent PR interval between P waves and QRS complex
    • High velocity conduction of Purkinje fibers damaged or depressed
      • Positive in Lead II – Left bundle branch block
      • Negative in Lead II – Right bundle branch block

Tachyarrhythmias – Differentials
• Primary Cardiac Disease
• Secondary
  • Hypoxia/hypovolemia
  • Peri-anesthetic
  • Drug induced
  • Intra-abdominal disease/Post-operative >Splenic disease/manipulation
  • Trauma/myocarditis
  • Pancreatitis/SIRS/Systemic inflammatory state
  • Pain/Catecholamine
  • Electrolyte Derangements
    • Hypokalemia, hypercalcemia, other

Tachyarrhythmias – Ventricular (VT) vs supraventricular (SVT)
• Wide complex tachycardia
  • Ventricular tachycardia >95% of the time
  • Rarely SVT with aberrancy
• Narrow complex tachycardia
  • SVT
• Physiologic differences
  • SVT utilize the normal conduction pathway
    • Organized and effective ventricular contraction
      • Decreased preload due to reduced diastolic filling period
  • Ventricular ectopy occur outside of the Purkinje system
    • Ineffective/disorganized ventricular contraction
      • Decreased preload and effective contraction
        • Significant drop in cardiac output

Ventricular tachycardia
• Emergent Assessment
  • Level of complexity
    • Aggressive couplets/triplets
      • R on T morphology
    • Multifocal – greater electrical instability
    • Sustained V-tach
  • Evidence of hemodynamic compromise
    • Lethargy, depression, weakness
    • History of syncope
    • Pallor/poor pulse quality
    • Hypotension
  • Underlying etiology
    • Primary cardiac – Typically considered more life threatening
    • Secondary
      • Often can address underlying etiology
      • Typically do not need long term therapy
• Emergent Management
  • Treat any underlying abnormalities if identified
    • Address hypokalemia, hypoxia, and/or pain
      • Magnesium 0.1-0.3mEq/kg over 20min
  • Anti-arrhythmics
    • First line – Lidocaine
      • 2mg/kg IV slow bolus – Up to 4x; Followed by 30-75mcg/kg/min IV CRI

55
• Feline 0.2mg/kg IV slow bolus
  • Decreased efficacy with hypokalemia
  • Signs of toxicity: Seizures, lethargy, nausea, vomiting.
  • Minimal hemodynamic effects
• Procainamide
  • 6-8mg/kg IV over 10min – Up to 3x; Followed by 25-40mcg/kg/min IV CRI
• Sotalol PO – Ideally know IV systolic function
  • 1-2mg/kg PO > Allow 1-2 hours to assess efficacy
• Amiodarone
  • Only recommended if you have Nexterone available
  • Other formulations contain Polysorbate 80
    • Consistently results in anaphylactic reactions even with pretreatment with Benadryl/Dexamethasone
  • 2.5mg/kg slow IV over 10 min – Can repeat; Followed by 13mcg/kg/min CRI or 10mg/kg PO BID
  
• Ventricular Arrhythmia Work-up
  • CBC/Chem/T4/UA
  • NT-proBNP?
  • Echocardiogram
  • Blood pressure
  • Holter monitor
  • Case dependent diagnostics > Abdominal US, Tick Titors, Troponin I, other

Supraventricular tachycardia
• Regular narrow complex tachycardia
  • Focal atrial tachycardia
  • Re-entrant activity
    • Atrial flutter
      • “Sawtooth” pattern of baseline
      • Can be irregular if AV node dysfunction of pharmacologic inhibition of AV node
  • Wolf-Parkinson-White (WPW) Syndrome
    • Accessory pathway mediated
• Irregularly irregular narrow complex tachycardia
  • Atrial fibrillation
    • Most common SVT in veterinary medicine
    • No mechanical contraction of atria
    • Usually secondary to underlying structural cardiac diseases
      • Enlarged atria support the development of A-fib
        • Common cause for sudden clinical deterioration of chronic CHF patient
      • Primary arrhythmia in some giant breed dogs
• Emergent Management of SVT
  • Vagal maneuver first
  • Ideally need to know cardiac contractility
  • IV therapy only if hemodynamically compromised
    • Rarely needed – Generally can be managed with oral therapy
      • Extreme heart rates >300bpm and/or underlying systolic dysfunction can result in hemodynamic instability
• Anti-arrhythmics for SVTs
  • Diltiazem
    • 1mg/kg PO TID
    • 0.2-0.5mg/kg IV over 5 minutes; Followed by 1-5mcg/kg/min IV CRI or above PO therapy
  • Digoxin
    • 0.003-0.06mg/kg PO BID
    • Mild positive inotrope
    • Target therapeutic level of 0.8-1.2
    • Side Effects: GI- some individuals intolerant, complex arrhythmias with toxic levels
    • Relative contraindication with WPW syndrome – can worsen tachycardia
  • Sotalol PO – Ideally know IV systolic function
    • 1-2mg/kg PO BID
      • Allow 1-2 hours to assess efficacy
    • Esmolol
      • Ultra-short acting beta blocker (10min half-life)
0.1-0.5mg/kg IV; Followed by 50-200mcg/kg/min IV CRI

**Bradyarrhythmias**
- **Atrioventricular Block (AVB)**
  - 1st degree AVB
    - Prolongation of PR interval
      - Not an issue as a sole finding
      - Typically due to high vagal tone
        - Respiratory disease
        - Upper airway obstruction/brachycephalics
        - Severe GI disease, Ophthalmic disease, other
      - Digoxin toxicity
  - 2nd degree AVB
    - Intermittent loss of atrioventricular conduction
    - Mobitz Type I – typically vagal mediated
      - >Better prognosis and response to medical management
    - Mobitz Type II – typically associated with AV nodal disease
  - 3rd degree (Complete) AVB
    - Complete loss of atrioventricular conduction
    - Heartbeat maintained by ventricular subsidiary pacemaker (“back-up generator”)
    - Regular rhythm but slow > Loss of atrial-ventricular synchrony
    - Cats tolerate complete AV block much better than dogs due to higher subsidiary pacemaker rate
      - Cats HR 100-120bpm
      - Dogs HR 30-60bpm

- **Sick Sinus Syndrome**
  - Bradycardia-Tachycardia Syndrome
  - Typified by periods of sinus arrest +/- atrial tachycardia
  - Symptoms almost always associated with bradycardia component of disease
    - Miniature Schnauzers, Cocker Spaniels, Westies most common

- **Non-cardiac/Vagal**
  - Hyperkalemia (blocked cats)
  - Excessive Vagal Tone (Respiratory/GI disease)
  - CNS Disease (Brain-heart syndrome)
    - Cushing’s reflex > Systemic hypertension results in baroreceptor mediated bradycardia
    - Similar mechanism of Dexdomitor induced bradycardia
  - Hypothyroid crisis
  - Hypothermia
  - Adverse effects of medications
    - Opioids, dexdomitor, beta-blockers, calcium channel blockers, digoxin toxicity

- **Bradyarrhythmia Work-up**
  - CBC/Chem/T4/UA
  - Atropine Response Test (0.04mg/kg IV)
  - Echocardiogram
  - Blood pressure
  - Holter monitor

- **Bradyarrhythmia Treatment**
  - If positive atropine response test, then potentially responsive to oral therapy
    - Theophylline 5-10mg/kg BID
    - Hyoscyamine (Levsin) – 0.003-0.006mg/kg BID
    - Terbutaline 0.2mg/kg BID to TID
    - Propantheline – 0.25-0.5mg/kg BID to TID (Difficult to obtain)
  - Generally, if a patient is symptomatic for a bradyarrhythmia, then a permanent transvenous pacemaker is the only viable and definitive therapy
Syncope: Diagnosis and Management
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Objectives
• Define syncope and differentiate from seizures
• Review pathophysiology
• Review different types of syncope and targeted approach to treatment

Syncope definition
• Transient loss of consciousness secondary to cerebral hypoperfusion and hypoxemia
  – Rapid onset
  – Rapid spontaneous recovery
• Presyncope - Transient weakness/ataxia with altered level of consciousness

Syncope differentials
• **Seizures**
  – Petit mal/partial
  – Grand mal
• Exercise induced collapse (EIC)
  – Labradors, Spaniels, and others (University of Minnesota Genetic Tests)
• Narcolepsy
• Transient ischemic attacks (TIA)
• Hypoglycemia - Insulinoma

Syncope vs. Seizure

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Seizure</th>
<th>Syncope</th>
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<tbody>
<tr>
<td>Prodrome</td>
<td>Common</td>
<td>Rare/Not seen</td>
</tr>
<tr>
<td>Timing</td>
<td>Often at rest or asleep</td>
<td>Typically with exertion/excitement or preceding trigger</td>
</tr>
<tr>
<td>Precipitating event</td>
<td>Uncommon</td>
<td>Common</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;Exercise, startle/excitement, cough, micturition/defecation</td>
</tr>
<tr>
<td>Presentation/Signs</td>
<td>Generalized/Grand Mal &gt;Extensor rigidity, progressing to tonic-clonic paddling Partial seizure &gt; Abnormal behavior with rhythmic motor activity &gt;&quot;Fly biting&quot;, facial twitching, etc</td>
<td>&gt;Rapid loss of consciousness and collapse &gt;Frequent extensor rigidity followed by flaccid paralysis &gt;&quot;Paddling&quot; associated with trying to right themselves</td>
</tr>
<tr>
<td>Involuntary Urination</td>
<td>Common</td>
<td>Common</td>
</tr>
<tr>
<td>Involuntary Defecation</td>
<td>Common</td>
<td>Uncommon to Rare</td>
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<tr>
<td>Hypersalivation</td>
<td>Common</td>
<td>Uncommon</td>
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<tr>
<td>Vocalization</td>
<td>Common</td>
<td>Common</td>
</tr>
<tr>
<td>Post-ictal Dementia Period or Prolonged Recovery</td>
<td>Common</td>
<td>Uncommon</td>
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<tr>
<td></td>
<td></td>
<td>&gt; If present then associated with prolonged cerebral hypoxia/sustained arrhythmia</td>
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Syncope pathophysiology

- Determinants of oxygen delivery
  - Hemoglobin content
  - Blood oxygen saturation
  - Cardiac output
    - Preload
    - Afterload
    - Contractility
  - Blood pressure/vascular tone

Syncope etiologies

- Neurocardiogenic/Reflex Mediated
  - Situational
    - Excitement
    - Tussive - “Cough drop dog”
    - Defecation, vomiting, micturition, other
  - Cardiogenic
    - Arrhythmia
      - Bradycardia
        - High second degree and complete AV block
        - Sick Sinus Syndrome
      - Tachycardia
        - Ventricular tachycardia
        - Paroxysmal SVT, onset of atrial fibrillation
    - Pericardial effusion
    - Outflow obstruction
    - Pulmonary hypertension
- Hemorrhagic (Prolonged recovery – atypical syncope)
  - Acute hemoabdomen, pericardial effusion, other
- Metabolic (Uncommon to Rare)
  - Anemia (Acute)
  - Hypoglycemia (Typically prolonged/vague signs)
  - Hypoadrenocorticism
  - “Thyroid Storm”

The work-up

- Thorough History and Physical Exam
- CBC/Chem/UA/T4
- ECG
- TFAST (Older patients or prolonged recovery)
- Echocardiogram
- Holter
- +/- Event monitor

Neurocardiogenic/Reflex mediated syncope

- Neurocardiogenic/Reflex Mediated
  - Excitement induced
    - Most commonly seen in dogs with significant valve disease
      - “Empty ventricle” syndrome
        - Sympathetic surge and increased contractility with increased regurgitant volume
        - Afferent C-fiber activation of the ventricles leads to stimulus of the central vagal nucleus and abrupt withdrawal of sympathetic tone and increased vagal tone
      - If cardiomegaly is present, then off-loading the ventricle is frequently effective even in the absence of CHF
        - ACE-I – 0.5mg/kg BID
        - +/- Low dose Furosemide
        - +/- Pimobendan if significant cardiomegaly
• (LA:Ao >1.6, LVEDDN >1.7)
  • Also seen in young Boxers and Golden Retrievers
  • Sympathetic surge and excessive reflex bradycardia/vasodilation
  • Can be difficult to manage and diagnose
    • Diagnosis based on normal Echo/Holter and Hx
    • Event monitor?
    • Avoid trigger

• Situational
  – Tussive – “Cough-Drop” Dog
    • Bradycardia/vasovagal etiopathogenesis
      • Manage the cough dependent on etiology (Cardiogenic? – See above)
        • Theophylline 5-10mg/kg BID
        • Lower airway work-up/management
  – Defecation/tenesmus, micturition/stranguria, other
    • Vasovagal
      • Uncommonly requires primary treatment > Manage the trigger

**Cardiogenic syncope**

• Bradyarrhythmias
  – Almost always evidence of bradycardia on exam > **Need an ECG**
    • SSS (Brady-Tachycardia syndrome)
      • Schnauzers, Cockers, and Westies
    • High second degree or complete AV block
    • Anecdotally most common cause of syncope in cats
      • Perform Atropine response test (0.04mg/kg IV)
        • Typically partial or no response
    • Treatment:
      • Ultimately, all canine patients symptomatic for a bradyarrhythmia need a pacemaker
        • Cats tend to do well clinically once they develop complete AV block
      • If evidence of positive response to IV atropine, then can try medical management
        • Theophylline 5-10mg/kg BID
        • Hyoscyamine (Levsin) – 0.003-0.006mg/kg BID
        • Terbutaline - 0.2mg/kg BID to TID
        • Propantheline – 0.25-0.5mg/kg BID to TID (Difficult to obtain)
  – SVT’s
    • By far the most common is the onset of atrial fibrillation
      • Small breed dog with longstanding murmur
    • Treatment
      • Digoxin (0.004 mg/kg BID) – Contraindicated with WPW
        • Target Digoxin level of 0.8-1.2
      • Diltiazem (1-3mg/kg BID-TID)
      • Sotalol (1-3mg/kg BID)
  – Ventricular arrhythmia (Out-patient management)
    • Need an echocardiogram to determine etiology of ventricular arrhythmia and extent of underlying myocardial disease
    • Lack of cardiomegaly on thoracic radiographs gives some confidence that severe myocardial disease and impending heart failure is unlikely
      • Treatment:
        • Mexiletine (5-8mg/kg TID) – safer with systolic dysfunction
        • Sotalol (1-3mg/kg BID)
        • Atenolol (0.5mg/kg up to 1mg/kg)
          • Typically adjunct to mexiletine)
        • Amiodarone (10mg/kg BID for 7 days, then 5mg/kg BID)
          • Need to monitor hepatic enzymes and thyroid
  – Tachyarrhythmias
    • Frequently auscultable abnormalities on exam
      • If you hear premature beats on exam > **Need an ECG**
    • Consider the signalment
      • Typically present BAR
        • (Emergent management of tachyarrhythmias beyond the scope of this lecture)
    – Emergent management of tachyarrhythmias beyond the scope of this lecture
      • Need an echocardiogram to determine etiology of ventricular arrhythmia and extent of underlying myocardial disease
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        • Amiodarone (10mg/kg BID for 7 days, then 5mg/kg BID)
          • Need to monitor hepatic enzymes and thyroid

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Pericardial effusion (acute)
- Typically large breed older dogs
  - Non-situational collapse with prolonged recovery
    - Pale mucous membranes noted by some owners
    - Will frequently present weak with pale mm and weak pulses
  - Acute pericardial effusion/hemorrhage results in collapse/syncope
    - Chronic (idiopathic) effusion more often results in lethargy/malaise/ascites

Outflow obstruction (SAS, PS, AS, Fe1SAMMV)
- Patients with significant outflow obstructions almost all have loud systolic murmurs
  - Location of murmur PMI is almost always left basilar
  - Syncope in young animals with a loud murmur frequently are due to outflow obstructions
    - Presence of a loud systolic murmur = diagnostic echocardiogram
  - Typically managed with beta-blockade
  - PS is many times amenable to balloon valvuloplasty

Pulmonary hypertension
- Typically small breed dogs +/- chronic cough
  - Increased index of suspicion if...
    - Loud predominantly right sided murmur
    - Right heart enlargement pattern and pulmonary artery distension on radiographs
      - Variable degree of pulmonary interstitial changes/distribution
    - Frequently clinical signs of dyspnea and exercise intolerance between events
    - Ultimately an echocardiographic diagnosis
  - Treatment:
    - Sildenafil ~2mg/kg TID
    - Identify and treat the underlying cause!
      - Thromboembolic – Why?
        - Look for etiology for hypercoagulable state
          - PLN!, Cushing’s, occult neoplasia, other
        - Empirically treat if index of suspicion
          - Clopidogrel (Plavix) 2-3mg/kg QD
        - Acute peracute onset? > Increased suspicion of PTE
          - Heparin CRI (Kirk’s Current XIV Nomogram)
            - Or…Lovenox 1mg/kg SQ BID
            - …and Clopidogrel (Plavix) 2-3 mg/kg QD
        - Chronic lower airway disease
        - Heartworm disease
        - L to R shunting congenital defects
The Clinical Utility of NT-ProBNP in Veterinary Cardiology
Neal Peckens, DVM, DACVIM
DVCA Cardiac Care for Pets
Leesburg, VA

Objectives
- Diagnosis of Occult Feline Cardiac Disease
  - Limitations and shortfalls of historical screening methods
  - Clinical use of available NT-proBNP Assays
- Determination of Cause of Feline Dyspnea
- Screening for Canine Cardiac Disease with NT-proBNP
- Determination of Etiology of Canine Dyspnea

Screening for feline cardiac disease
- Auscultation
  - Identification of a murmur
    - Most studies have found that the presence of a murmur increases the likelihood of cardiac disease by ~2 fold. (JVIM 2011, JAVMA 2004)
    - >15-43% prevalence in apparently healthy cats
    - >30-85% prevalence in cats with occult cardiomyopathy
  - Well designed study performed at Virginia Tech (JAVMA 2009)
    - Blinded auscultation and echocardiographic exam of 103 healthy cats
    - Heart murmur detected in 16 cats; of these 5 had HCM
    - HCM diagnosed in 16 cats; heart murmur detected in only 5
      - **HCM prevalence is ~15%** in the population of apparently healthy felines in our region
      - -Abnormal auscultation – **Sens 33%** and Spec 87.4% for Dx of HCM
      - -Abnormal auscultation- PPV 31% (probability of disease w/ murmur)
      - -Normal auscultation – NPV- 89% (probability of no disease)
  - Identification of a Gallop
    - Associated with higher intra-cardiac pressures and significant cardiac disease
    - In a study of 227 cats:
      - 17% of affected cats and 0% of normal individuals had a gallop (JVIM 2011)
      - -Insensitive but much more specific for cardiac disease
      - -HR of 1.8 for risk of cardiac death (JVIM 2013)
  - Identification of an Arrhythmia
    - Presence of an arrhythmia is indicative of underlying myocardial disease
    - Further evaluation is warranted
    - -HR 3.2 for risk of cardiac death (JVIM 2013)
- Thoracic Radiographs
  - Hypertrophic cardiomyopathy is the most common myocardial disease of the cat and is defined by concentric hypertrophy in which the cardiac silhouette is not expected to increase
  - Low sensitivity to detect hypertrophic disease
  - Even in the presence of left atrial enlargement (LA:Ao >1.6) the sensitivity of thoracic radiographs to detect these changes are relatively low (up to 70%)
- Evidence of Ineffective Screening Practices
  - Borgeat et al. Arterial Thromboembolism in 250 Cats in General Practice
    - Only 29 cats previously diagnosed with cardiac disease
      - -59 additional cats had previously had an auscultable abnormality
    - Only 35% of cats had diagnosis or suspicion of heart disease
  - Smith et al. Arterial Thromboembolism in Cats: Acute Crisis in 127 Cases
    - Only 9 cats previously diagnosed with cardiac disease
      - -16 additional cats had previously had an auscultable abnormality
    - -24% of cats had diagnosis or even suspicion of heart disease
    - 97/127 (76%) had no clinical suspicion of cardiac disease prior to presentation
  - Laste et al. Retrospective of 100 cases of FATE
    - Only 7% of cats diagnosed with heart disease prior to FATE event
      - -Only additional 4 cats had previously had a murmur detected
      - -39% of cats with auscultable abnormality on presentation
  - Schoeman et al. FATE in 44 cases
    - Only 23% of cases had evidence of pre-existing heart disease
    - **SUMMARY: <35% of cats determined to be at risk…**
• NT-proBNP – A blood chemistry for the heart
  • Established as the best current biomarker for the screening of feline myocardial disease
    • Quantitative NT-proBNP
      – Superior in assessing severity of disease/risk for clinical signs
      – Recommended for serial monitoring of patients with mild disease (alternative to serial echos) or at-risk breeds
      – NT-proBNP elevations can also be caused by hyperthyroidism, systemic hypertension, or significant azotemia (IRIS Grade III or IV)
    • NT-proBNP SNAP test
      – Visual positive around ~130-140pmol/L
      – Not as sensitive as the quantitative
      – Given prevalence of cardiac disease it does provide a good negative predictive value
        • Will miss some mild to moderately affected individuals
    • So we have diagnosed a cat with cardiac disease…what next?
      – Good question…
      – Given the diversity of feline myocardial disease, an echocardiogram is needed to determine a treatment plan.
        • Atenolol is not indicated in many cats as it can cause decompensation and heart failure

Differentiating dyspnea in the cat
  – Quantitative NT-proBNP >265 (270) optimal cut-off; 90% Sens; 88% Spec
  – What about the SNAP test?
    – Positive result ~130-140 pmol/L
    – Sensitive, but lower Specificity
      – Qualitatively darker with higher level
      – Strong negative predictive value
        – Negative, then it is not CHF

Differentiating “white coat” vs actual systemic hypertension in cats
  – Normal BNP = Normotensive

Screening for canine cardiac disease
  • The most common heart disease in dogs is degenerative mitral valve disease
    – About 10% of the population of dogs has mitral valve disease
    – Estimates that over 60% of older small breeds of dogs are affected
    – Physical examination finding of a murmur makes screening relatively easy
      • Typically long asymptomatic phase

Current Interpretation Guidelines for NT-proBNP

Asymptomatic Patients with New Heart Murmur Consistent with Degenerative Valve Disease
  • <900 pmol/L
    – Clinically significant cardiac disease is unlikely;
    – Monitor NT-proBNP every 6 months
  • 900-1500 pmol/L
    – Clinically significant cardiac disease is likely; Further diagnostics are warranted
  • >1500pmol/L
    – Patient is at increased risk for congestive heart failure within the next 12 months. Further cardiac workup or cardiac consultation is recommended

• Benefits of Collaborative Care
  – Unpublished Data
    • 75% increase in survival of canine patients co-managed with primary care veterinarian and cardiologist
    • Positive correlation with patient survival time and primary veterinarian revenue (In-press with JAVMA)

Screening for canine cardiac disease - Dilated cardiomyopathy
  • Current recommended screening practices are an annual Holter and screening echocardiogram beginning at 3-4 years of age.
  • NT-proBNP is insensitive for Doberman’s with ventricular arrhythmias before left ventricular dilation
  • Best use of NT-proBNP in Dobermans is in combination with Holter
    >NT-proBNP >437 and/or100 VPC’s/24 hr highly predictive for DCM
    >>Sens 94% and Spec 88%
  • Note lower cut-offs for DCM screening
    • Cut-offs recommended here are lower than published IDEXX cut-off
Differentiating etiology of canine dyspnea

- Quantitative NT-proBNP >2450pmol/L provides 81% Sens and 73%
  - Not a point of care test so problem with turnaround times and necessity of prompt treatment
  - Major *Asterisks*
    - Significant pulmonary hypertension results in marked elevations in NT-proBNP
    - Major limitation in canine veterinary cardiology