Weakness, Syncope, and Sudden Death

John E. Rush, DVM, MS, DACVIM (Cardiology), DACVECC
Cummings School of Veterinary Medicine At Tufts University
Episodic Weakness

Diagnostic challenge
Many Differential diagnoses

- Non-cardiac
  - Muscular weakness
  - Orthopedic
  - Neurological
  - Metabolic
  - Hypovolemia (blood loss, esp. internal)
  - Thromboembolic disease

- Cardiac – reduced cardiac output due to
  - Arrhythmia (bradycardia or tachycardia)
  - Obstructive lesions (PS or SAS or HOCM)
  - Poor contractile function
  - Pericardial disease
Episodic Weakness

Key historical details
• Back limbs or all 4 limbs?
• Altered consciousness?
• Duration of weakness?
• Recurrence or frequency?
• Exercise related?
• Rate of onset?
• Is there metabolic or systemic disease?
• Shortness of breath?
Episodic Weakness

- PE findings are key!
  - Neurologic, orthopedic, cardiac, respiratory
- Diagnostic testing
  - CBC, chemistry profile, urinalysis
  - Thoracic radiographs
  - Limb or spine radiographs, MRI, CT
  - Blood pressure, ECG +/- Echo
  - Abdominal ultrasound
    - Abdominocentesis if fluid
Syncope

- Sudden, transient loss of consciousness with spontaneous recovery
- Syncope can be a precursor to sudden death
- Pre-syncope is akin to episodic weakness
Syncope

- Common in dogs with cardiac disease, +/- systemic diseases
- Less common in cats
- Uncommon in horses
Syncope

• Syncope is a clinical event, not a diagnosis
• The cause of syncope should be sought aggressively
• Some animals have single episode of syncope before sudden death
• Others have single (or repeated) syncope and no progression
Collapse or Syncope in Dogs
Diagnoses and Outcome

• 42% - Resolved without intervention
• 11% - A firm diagnosis was established
• Cause of syncope was the cause for death in 16% of cases
• Of the dogs that died (37), 49% of them succumbed to the disease causing collapse

Barnett L JSAP 2011
Syncope

Causes of syncope
- Hypoglycemia
- Hypoxemia
- Mild to severe anemia
- Hyperviscosity syndromes
- Hypotension
  - Hypovolemia
  - Inadequate vascular tone (e.g., vasodilating drugs)
  - Cardiovascular causes
Cardiovascular Causes of Syncope

- Bradycardia
- Tachycardia
- Low cardiac output (PS, SAS, myocardial failure)
- Cardiac restriction (pericardial tamponade or tension pneumothorax)
- Vasovagal or neurocardiogenic syncope
- Cough (tussive) syncope
Neurocardiogenic Syncope
AKA Vasovagal Syncope

• Common cause for syncope in people
  • Occurs in dogs but more difficult to prove
• Cardiac mechanoreceptors and aortic baroreceptors sense “overstimulation”
• Messages to brain: “Too much cardiovascular tone and CV stress”
• CNS output:
  • Less sympathetic tone
  • Increased parasympathetic tone
  • Result is reduced heart rate, low cardiac output, and loss of vasomotor tone
• CV effect:
  • Profound bradycardia and plummeting blood pressure
  • Reduced CNS perfusion causes syncope
• Triggers of vasovagal syncope: Anemia, hypovolemia, CHF (dogs), being a Boxer, not enough sleep, too much alcohol, emotional stimulation
Syncope

Differential diagnoses:

• Seizure
• Narcolepsy
• Catalepsy
• Collapse from muscular or orthopedic weakness
Findings from the History:
Syncope vs. Seizure

<table>
<thead>
<tr>
<th>Syncope</th>
<th>Seizure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner Hx is typically seizure</td>
<td>Owner Hx is typically seizure</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>Loss of consciousness</td>
</tr>
<tr>
<td>Collapse and on side</td>
<td>Collapse and on side</td>
</tr>
<tr>
<td>May urinate or defecate</td>
<td>May urinate or defecate</td>
</tr>
<tr>
<td>• Less often than seizure</td>
<td>• +/- Head/neck may extend back or tonic and flexed</td>
</tr>
<tr>
<td>• +/- Head/neck may extend back or flaccid</td>
<td></td>
</tr>
</tbody>
</table>

CardioRush
Findings from the History:
Syncope vs. Seizure

- Often precipitated by exercise or cough
- No (or brief) pre-ictal period
- Duration shorter (30 sec)
- Limbs flaccid or extended
- Limb motion when trying to recover
- Recovery fast (30 sec to 2 min)
- No hypersalivation or facial chomping

- No relationship to activity
- Often pre-ictal period
- Duration of ictus is often 1-2 min
- Tonic/clonic limb motion during ictus
- Post-ictal phase - minutes to hours
- Hypersalivation or facial chomping are common
Syncope- Diagnostics

- History critically important!
- PE is often normal
  - CV signs such as arrhythmia, gallop, murmurs, signs of CHF, etc.
  - Membrane pallor
  - Abdominal distension
  - Lack of neurological deficits
Syncope- Diagnostics

- ECG – Sometimes misses transient arrhythmias
- Echo – Identify underlying cardiac disease
- Thoracic radiographs
- CBC, Chemistry profile, urinalysis
- Arterial blood gas or pulse oximetry
- Event monitor recording
- Holter monitor recording
- ECG recording during hospitalization
- Blood pressure
- Abdominal ultrasound
Continuous ECG Monitoring in an ICU Environment

- No report, no quantification
- Watching for ECG abnormalities
Holter Recorder
24 hour Continuous Ambulatory ECG Recording

• Records multiple ECG channels for 24 to 48 hours
• Gives accurate count of:
  • Number of QRS complexes in 24 hours
  • Number of VPCs in 24 hours
  • Frequency/length of repetitive ventricular or supraventricular arrhythmia
  • Minimum HR, maximum HR, length of pauses, etc.
• Useful for frequent syncope
• Often suggestive of arrhythmic cause even if syncope does not occur during recording
<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>QRS complexes</td>
<td>95706</td>
<td>Represent 4% of total QRS complexes</td>
<td></td>
</tr>
<tr>
<td>Ventricular ectopics</td>
<td>4433</td>
<td>Represent &lt;1% of total QRS complexes</td>
<td></td>
</tr>
<tr>
<td>Supraventricular ectopics</td>
<td>382</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paced QRS complexes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Ventricular Ectopy

| Type            | Count | Description          | Duration   | Date       |
|-----------------|-------|----------------------|------------|
| Isolated        | 4075  | Bigeminal Cycles     | 240 BPM at 12:38:53 | 14-AUG-87  |
| Couplets        | 1268  | Runs                 | 251 BPM at 00:20:37 | 14-AUG-87  |
| Beats in Runs   | 194   | Beats LONGEST        | 240 BPM at 12:38:53 | 14-AUG-87  |
| Beats FASTEST   | 97    | Beats FASTEST        | 251 BPM at 00:20:37 | 14-AUG-87  |

### Heart Rates

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
<th>Description</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>MIN</td>
<td>76</td>
<td>11:45:47</td>
<td>14-AUG-87</td>
</tr>
<tr>
<td>AVG</td>
<td>126</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td>163</td>
<td>07:22:31</td>
<td>14-AUG-87</td>
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### S-T Levels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>mm</td>
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</table>
Event Recorder

- Continuous loop recording
- Saves approximately 30 sec to 30 min of ECG
  - 20 sec before and 10 sec after button is depressed
- Implantable devices also available
- Some studies suggest better diagnostic yield than Holter recorder
  (48% positive diagnosis rate in 1 study)
Management of Syncope

- Depends upon underlying cause
- High grade AV block and sinus arrest (SSS)
  - Rx with pacemaker or drug therapy
- Tachyarrhythmias treated with antiarrhythmic drugs
- CHF and baroreceptor dysfunction – digoxin, theophylline, Rx CHF, etc.
- Cough syncope – cough suppressants
- Vasovagal syncope – Beta-blockers? Digoxin?
- No therapy if cause uncertain……..
Sudden Death
(Sudden Cardiac Death)

• Defined as an unexpected death (from cardiac cause) generally occurring within 1 hour of the onset of signs
Sudden Death

• Cardiac causes
  • Arrhythmias, cardiomyopathy, myocardial infarction, pericardial hemorrhage
  • Thromboembolism
  • Pulmonary hemorrhage
  • CNS event (stroke or hemorrhage)
  • Aortic rupture or anomalous coronary artery
  • “Found dead at home” – GDV, splenic mass, usually not a toxn
Sudden Death

- Ventricular fibrillation
- Bradycardia – AV block
Cardiac Rhythm Diagnosis at Time of Arrest for Hospitalized Cases

- Ventricular fibrillation
- Sinus bradycardia or sinus tachycardia
- Pulseless electrical activity, (AKA electromechanical dissociation)
- Asystole
- Ventricular tachycardia, atrial fibrillation, AV block, etc.
Cardiac Rhythms associated with Syncope or Sudden Death

- Asystole
- Pulseless electrical activity
- Advanced AV block
- Ventricular tachycardia
- Ventricular fibrillation
- Supraventricular tachycardia (syncope only)

How would you treat each of the above rhythms?
Asystole
Pulseless Electrical Activity (Electromechanical Dissociation)
Advanced AV Block
Dogs

• Preferred treatment:
  • Cardiac pacing

• Possible drug therapies (usually will not prevent sudden death):
  • Propantheline
  • Terbutaline
  • Theophylline
Atropine Response Test

Pre-atropine

Lead II 25 mm/sec, 1 cm/mv

Post-atropine

25 mm/sec
Ventricular Tachycardia
Management of Ventricular Arrhythmias

• Underlying cardiac disease?
  • Thoracic radiographs
  • Echocardiography
  • Troponin I concentration

• Systemic disease?
  • Acid-base status
  • Electrolytes
  • Hypoxemia
  • Anemia
  • Coagulopathy
  • Blood volume
  • Pain
  • Drug toxicity
Lidocaine Bolus
Prevention of Sudden Death in Dogs with Serious Ventricular Arrhythmias

Longterm treatment appropriate?
- Sotalol – 1-3.5 mg/kg BID
- Mexiletine – 5-8 mg/kg TID
- Beta-blockers
- Amiodarone
Sudden Death Prevention Trials
(People with Coronary Disease or DCM)

• Beta-blockers – Improved survival
• Class I drugs – Worse survival than placebo
• Sotalol – +/- Worse survival than placebo
• Amiodarone – Survival equal to or no better than placebo for chronic Rx
• Implantable cardioverter-defibrillator – Survival improved (people)
Ventricular Fibrillation
Defibrillation

- Definition: Termination of ventricular (or atrial) fibrillation, usually by electroshock
- Also called DC countershock
- Time to defibrillation is the most important factor in human survival from cardiac arrest
Defibrillation Statistics:

Defibrillation’s chances of restoring a pulse decrease rapidly with time.

- **60% chance of success** at 2 minutes elapsed.
- **20% chance of success** at 8 minutes elapsed.
- **80% chance of success** at 1 minute elapsed.
- **Virtually 0% chance of success** at 13 minutes elapsed.
Ventricular Fibrillation

• Electrical DC countershock (defibrillation)
• Current must traverse the heart
• Many cells depolarized at once (>28%)
• “New” rhythm is hopefully a pulse generating rhythm
• Repeated shocks (2-3 in a row)
• Continue CPR, epinephrine, amiodarone (?), magnesium
Indications for Defibrillation

- Ventricular fibrillation
- Ventricular flutter
- Torsades de pointes
- Pulseless ventricular tachycardia

- Most sources do not recommend defibrillation for asystole or for pulseless electrical activity (electromechanical dissociation)
Energy for Defibrillation

- Dose 2-4 Joules/kg
- 2 J/kg (under 7 kg)
- 5 J/kg (8 to 40 kg)
- 5-10 J/kg (above 40 kg)
Intrathoracic Defibrillation

- Lower energy requirements so lower energy selection
- 0.2 J/kg initial energy selection
- Saline used on paddles
- “Squeeze” the heart between the paddles
Ventricular Waveforms During VF

- Coarser waveforms easier to defibrillate
- Higher frequency waveforms are easier to defibrillate than lower frequency
- Epinephrine and vasopressin can coarsen and increase the frequency of waveforms