WEAKNESS, SYNCOPE AND SUDDEN DEATH

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OBJECTIVES

1. Become familiar with the differential diagnoses for diseases or etiologies associated with episodic weakness, syncope and sudden death.
2. Be able to design a diagnostic plan for an animal with syncope.
3. Understand the difference between continuous ECG monitoring, a Holter monitor recording, and an event monitor.
4. Be familiar with the cardiac rhythms that can be associated with sudden death.
5. Understand how a defibrillator works and know the indications for cardiac defibrillation.

EPISODIC WEAKNESS

Animals presented for episodic weakness can be challenging to diagnose and treat. The weakness may be due to a cardiac cause or a non-cardiac cause. Non-cardiac causes can include orthopedic disorders, hypoglycemia, seizure disorders, vestibular disorders, and blood loss, especially internal blood loss as might be seen in association with a bleeding mass in the spleen or liver.

Episodic weakness due to cardiac disease is a result of reduced cardiac output. Such a reduction in cardiac output can occur as a result of reduced cardiac filling, inability to pump blood forward due to reduced contractile function or obstructive lesions of the ventricular outflow tract, from cardiac restriction as might be seen in pericardial disease, or from cardiac arrhythmias.

The causes of episodic weakness are, for the most part, the same disease processes that can lead to syncope, however the reduction in cardiac output was not sufficiently long or severe enough to cause syncope.

SYNCOPE

Syncope can be defined as a sudden, transient loss of consciousness with spontaneous recovery. In some animals, syncope is a precursor to sudden death. Other animals experience repeated episodes of syncope and repeatedly recover without sudden death. Syncope is commonly seen in dogs with cardiac disease. Syncope occurs less frequently in cats and horses. In most animals, syncope is a sign of an underlying disease and the cause for syncope should be aggressively pursued.

Differential diagnosis*:*

Differential diagnoses for syncope include seizures, narcolepsy, catalepsy, and collapse due to muscular weakness. Syncope can be caused by hypoglycemia, hypoxia, severe anemia, and

hyperviscosity syndromes. Hypotension due to hypovolemia, inadequate vascular tone (e.g., vasodilators), and cardiac diseases that result in reduced cardiac output can all cause syncope. Finally, cardiac arrhythmias are a common cause of syncope. Both bradycardia and tachycardia can cause syncope. Many dogs with chronic valvular disease experience syncope, and in these dogs identification of the cause of syncope can be elusive. Uncontrolled congestive heart failure is often associated with syncope and treatment of CHF may eliminate syncope. Paroxysmal coughing can cause syncope through a variety or proposed mechanisms (tussive syncope, AKA "Cough-drop syndrome". Finally, syncope can result from a vagally-mediated bradycardia and hypotension (vasovagal or neurocardiogenic syncope).

History*:*

Most owners will identify that their animal has had a seizure rather than a syncopal episode. Differentiating a seizure from a syncopal event is essential, and the history is one of the most useful tools to make this differentiation. The classic seizure has a pre-ictal component or aura, the ictus or actual seizure, and a post-ictal period of disorientation. During the ictal event, most animals lose consciousness and have tonic/clonic limb motions, facial chomping, and hypersalivation.. Seizures usually do not have an identifiable precipitating event, whereas syncope is often precipitated by coughing, excitement or exercise. During the classic syncopal event, the animal will collapse and lose consciousness. Urination or defecation may occur with either syncope or seizure. Syncopal animals rarely have facial chomping or hypersalivation. Syncopal animal may struggle when recovering from the event, but they usually do not have classic tonic/clonic limb motions. When compared to animals with seizures, syncopal animals are more likely to extend their head back into a position of opisthotonus. During syncope the limbs may be either flaccid or extended rigidly. Seizure events often last 1 to 2 minutes, compared to syncopal events which often last less than 30 seconds. The post-ictal period after a seizure is variable but can last for minutes to hours. Many animals with syncope are awake and ready to return to normal activities within 30 seconds to 2 minutes of the event. Large and giant breed dogs with syncope often have a somewhat longer recovery period after syncope than cats and small breed dogs.

Key questions to ask:

How long did the event last?
How long after the event until your pet seemed to be normal again?
Did you see any hypersalivation or facial chomping?
Did you notice paddling or chaotic limb motions during the event?

Clinical findings*:*

Many animals presented for syncope will have a normal physical examination. In other animals, evidence of cardiac disease will be present such as a cardiac murmur or gallop, dyspnea, tachypnea, pulmonary crackles, ascites, jugular vein distention, or other signs of heart failure or cardiac dysfunction. When cardiac arrhythmia is the cause of collapse then an irregular heart rhythm and/or pulse deficits may be present. When syncope occurs due to a systemic disease, the physical examination may reflect the primary disease (e.g., pale mucous membranes and brisk arterial pulses with anemia). The neurologic examination is usually normal in animals with syncope.

Tests*:*

1. Electrocardiography

   Electrocardiography should be performed in all animals with syncope. Although syncope will rarely occur at the time an ECG is obtained, the ECG may document a cardiac arrhythmia that likely account for syncope (e.g., third degree AV block, sick sinus syndrome). Unfortunately, in the majority of cases a standard 2 minute Lead II ECG will not provide a definitive diagnosis.

2. Echocardiography

   Echocardiography is indicated in animals with syncope. Diseases causing syncope that might be diagnosed by echocardiography include pulmonic stenosis, sub-aortic stenosis, pericardial effusion with tamponade, dilated or hypertrophic cardiomyopathy, congenital cardiac defects associated with cyanosis, and cardiac mass lesions or thrombi that are partially or intermittently obstructing blood flow through valves. Dogs with chronic valvular disease and mitral and/or tricuspid regurgitation often have syncope, esp. at the onset of CHF. Echocardiography can also assist in diagnosis of diseases that limit blood flow through the lungs (e.g., heartworm disease, pulmonary thromboembolism) as they result in marked right heart enlargement and a small left ventricular cavity size.

3. Thoracic radiographs

   Thoracic radiographs are indicated to search for cardiac enlargement, congestive heart failure, and other underlying diseases.

4. Laboratory testing

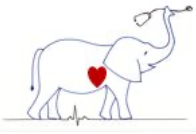
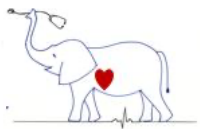
   Abnormalities on laboratory testing that might cause or contribute to syncope include hypoglycemia, anemia or polycythemia, and elevated globulins. Hypoxemia may be evident from a blood gas or pulse oximetry.

5. Event monitor recording

   An event monitor or cardiac event recorder can be attached to the animal for several days to a week. The event recorder continuously records a loop of ECG (for example, 30 seconds of ECG is saved) and the loop is saved when a button is depressed on the recorder. Subsequent analysis of the recording can provide a determination as to whether a cardiac arrhythmia was temporally related and therefore responsible for the syncopal event. A recent study identified a high diagnostic yield for cardiac event recording, however this tool has not been as reliably useful in our clinical experience.

6. Holter monitor recording (Continuous ambulatory ECG recording)

   During a Holter monitor recording, the animal is fitted with an ECG recording device for 24 hours (or 48 hours) and the entire ECG is saved during the recording time. Subsequent analysis of the tape may provide a definitive cause for syncope, however the animal may not experience a syncopal event during the 24-hour recording period. In a recent study, Holter recordings were useful in establishing a diagnosis in 42% of cases.

7. ECG recording during hospitalization

   Animals can be admitted to the hospital for continuous ECG monitoring. For animals with infrequent syncope, this approach is less desirable than either Holter monitor recording or an event monitor. A syncopal event often does not occur during hospitalization. Most clinics cannot record the entire ECG tracing and cannot devote an individual to monitor the ECG 24 hours a day, so valuable diagnostic information may be missed.

8. Other specialized testing

   The cause of syncope is often difficult to define, and in up to 40% of people with syncope a cause cannot be determined. Other tests that can be used to search for a cause of syncope include abdominal ultrasound, ECG recording during a vagal maneuver, signal-averaged ECG, upright tilt testing, and invasive electrophysiologic testing via cardiac catheterization.

Management*:*

Permanent pacemaker implantation is indicated for most animals with syncope due to third degree AV block, sinus arrest, sick sinus syndrome, and atrial standstill due primary cardiac disease. Drug therapy can be attempted for these arrhythmias, especially when pacemaker implantation is not an option based on financial limitations or owner wishes. Anticholinergic drugs (e.g., propantheline bromide), sympathomimetic drugs (e.g., terbutaline), and theophylline or aminophylline can be used in an attempt to increase the heart rate and/or improve conduction across the AV node. Tachyarrhythmias that result in syncope are usually treated medically (see arrhythmias). When syncope occurs in dogs being treated for heart failure both cardiac arrhythmias and drug-induced hypotension should be considered as possible causes. Blood pressure measurement and/or adjustment of cardiac medications likely to cause hypotension (vasodilators, beta-blockers, and calcium channel blockers) may alleviate syncope. Many dogs with chronic valvular disease have concurrent respiratory disease, and syncope in these dogs may respond to theophylline or sometimes to digoxin (which may restore baroreceptor function). Vasovagal syncope, sometimes diagnosed in young Boxers, may respond to metoprolol. When syncope is associated with an underlying disease process that results in hypovolemia, anemia, or hypoglycemia then treatment of the underlying disease will often eliminate syncope.

SUDDEN DEATH

The causes of sudden death can differ for the various veterinary species. In racing horses that die suddenly, a cardiac cause is often suspected. Lesions such as cardiomyopathy, pulmonary hemorrhage, intracranial hemorrhage, and anomalous coronary artery anatomy might be discovered.

In cats that die suddenly a cardiac cause is often found. Cardiomyopathy is a common cause for sudden death, and this is also true for cats that die unexpectedly during or shortly after anesthesia. These deaths can result from cardiac arrhythmias, CHF or thromboembolic disease. Arterial thromboembolism to a coronary artery can cause death, and in some cases a large thrombus can cross the mitral valve orifice but become lodged in and obstruct the left ventricular outflow tract.

In dogs, sudden death can be seen in response to acute cardiac failure, pulmonary failure, or a critical CNS disturbance. Pulmonary thromboembolism is a common cause of death in dogs with systemic illness that die after a short course of worsening respiratory distress. Coronary thromboembolic disease can also result in sudden death in this hospitalized population. In dogs with advanced chronic valvular heart disease, a tear of the left atrial wall can lead to acute

cardiac tamponade and sudden death. Dogs with a right atrial hemangiosarcoma can also have death occur after a very short clinical course when acute cardiac tamponade develops. Finally, for large breed dogs that are found dead at home, acutely developing severe illnesses such as gastric dilatation and volvulus must be considered as prime differential diagnoses. Sudden death is perhaps most common in two breeds of dogs, the Doberman pinscher and the Boxer dog with their respective forms of cardiomyopathy. In these cases, sudden death is usually a result of cardiac arrhythmia (ventricular fibrillation in most cases), rather than acute worsening of congestive heart failure which led to hypoxemia and respiratory failure.

Arrhythmic death can occur in response to bradycardias or tachyarrhythmias. Ventricular fibrillation is the most common arrhythmic cause of sudden death in people, although a variety of other arrhythmias are noted in dogs and cats at the time of cardiopulmonary arrest. Bradyarrhythmias such as sinus bradycardias or asystole can account for death in up to 50% of hospitalized ICU dogs and cats. Another arrhythmia seen at arrest is pulseless electrical activity, or PEA (AKA electromechanical dissociation), which is identified as QRS-T complexes on the ECG and no palpable pulses on exam. This can occur is cases of severe myocardial depression or electrolyte abnormalities, however it can also be seen in animals with severe hypovolemia, cardiac tamponade or tension pneumothorax.

Prevention of sudden death usually requires prior identification of certain cardiac risk factors. Ventricular tachycardia can be associated with the development of sudden death, especially due to ventricular fibrillation. Unfortunately, no ventricular antiarrhythmic drug studied to date in people with ventricular arrhythmias has been shown to prevent sudden death; indeed most of the antiarrhythmic drugs are associated with a reduced survival in people. Implantable cardioverters with defibrillators have been shown in many human clinical trials to prevent sudden death and prolong survival. Unfortunately, these devices require care programming in order to prevent inappropriate shocks in dogs, and only isolated reports exist regarding use of these devices in dogs. Finally, the portable automatic external defibrillators might be useful in dogs with severe arrhythmias, although they have not been studied well in this clinical setting.

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