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Syncope

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DEFINITION AND DESCRIPTION

Syncope is a sudden, transient loss of consciousness associated with loss of postural tone (collapse). Syncope is a clinical sign, not a specific diagnosis or disease. Differentiating true syncope from seizures or transient weakness episodes as well as identifying the underlying cause of syncope in the individual patient can be challenging.

Syncope results from abruptly reduced perfusion or essential substrate delivery to the brain.^{1,2} Sudden collapse characterizes the syncopal event. The animal usually falls into lateral recumbency and may experience stiffening of the limbs and opisthotonic posture. Micturition and vocalization are common. However, facial fits, persistent tonic/clonic motion, defecation, a prodromal aura, (post ictal) dementia, and neurologic deficits are not generally associated with cardiovascular syncope. Yet, profound hypotension and prolonged asystole can result in hypoxic "convulsive syncope," with seizure-like activity or twitching.^{3,4} Electroencephalographic (EEG) monitoring in affected people has shown slow wave activity consistent with cerebral hypoperfusion.³ Careful observation should aid in differentiating convulsive syncope from seizures. Loss of muscle tone occurs before convulsive syncopal episodes. But, episodes caused by underlying neurologic disease usually are preceded by atypical limb or facial movement or staring spells before the loss of postural tone.³ Animals with pre-syncope, where reduced brain perfusion is not severe enough to cause unconsciousness, may transiently become "wobbly" or weak in the rear limbs.

CAUSES OF SYNCOPE

Many diseases can result in syncope (see Table 1). Mechanisms underlying syncope usually involve either:

- Abrupt reduction in cardiac output (often related to arrhythmias, decreased cardiac filling, or outflow obstruction)
- Hypoxia or hypoglycemia with normal cerebral blood flow
- Decreased vascular resistance (often related to neurocardiogenic reflexes)

Reduced cerebral blood flow can also result from cerebral vascular or other intracranial disease. Multiple mechanisms are likely involved in some cases of syncope. For example, syncope associated with subaortic stenosis, may involve left ventricular outflow obstruction, arrhythmias, and also neurocardiogenic reflex mechanisms.¹

A fall in cardiac output or vascular resistance reduces mean arterial pressure and consequently, cerebral perfusion. Syncope occurs when cerebral blood flow falls below 30–50% of normal. Symptoms of pre-syncope can occur with less severe hemodynamic changes.³

Syncope in dogs and cats, is often associated with excitement or exertion, when there is an increased demand for cardiac output and oxygenation.^{2,5-7} Cardiac arrhythmias as well as functional or structural abnormalities are commonly involved. Tachyarrhythmias (such as paroxysmal ventricular or supraventricular tachycardias and atrial fibrillation) can decrease cardiac output by compromising cardiac filling time and therefore, stroke volume (cardiac output = heart rate x stroke volume). Bradyarrhythmias (e.g., complete AV block, sinus arrest) can profoundly reduce heart rate. Underlying cardiac functional or structural abnormalities exacerbate the effects of arrhythmias. Even in the absence of arrhythmias, diseases causing poor myocardial contractility, impaired filling, or outflow obstruction may prevent adequate rise in cardiac output in response to increased demand.^{2,8-10} Inadequate cerebral oxygen delivery can occur with reduced blood oxygenation (e.g., right to left shunts, anemia, or severe pulmonary disease) even with normal cardiac output.² Hypoglycemia also



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can cause syncope, especially with exertion, although weakness and seizures are more common manifestations.^{2, 11}

Neurocardiogenic reflex mechanisms (e.g., vasovagal syncope) as well as cerebral vascular disease are more important causes of syncope in people than animals. Many abnormalities of orthostatic regulation have been identified in people.^{1, 12-14} Upright (rather than quadrupedal) posture renders people more susceptible to gravitational effects on the circulation. Peripheral venous blood pooling can lead to a sudden decrease in ventricular volume, which stimulates more forceful ventricular contractions. This activates ventricular mechanoreceptors (normally stimulated by stretch) and provokes a paradoxical reflex withdrawal of sympathetic tone, causing bradycardia and vasodilation. The ensuing fall in mean arterial pressure can cause syncope.^{12, 14} Autonomic hyperresponsiveness to various stressors is likely in affected individuals, who are otherwise normal between syncopal episodes. A number of primary (and secondary) autonomic failure syndromes are also described in people, and lead to autonomic dysfunction even under normal circumstances.¹² Reflex syncope in people is more likely to occur with hypovolemia, dehydration, use of certain drugs (vasodilators, diuretics), as well as psychiatric disturbances and other stressors.¹² Neurocardiogenic syncope is not well documented in animals.

Cough syncope is a form of situational syncope (Table 1) that does occur fairly often in dogs, especially those with brachycephalic conformation, underlying airway disease or collapse, or chronic mitral regurgitation with left atrial enlargement. Coughing transiently increases intrathoracic pressure (which reduces venous return to the heart) as well as intracranial pressure. Inadequate cerebral perfusion can result from the reductions in cardiac output and cerebral perfusion pressure (see below). In addition, coughing may reflexly stimulate a vagally-mediated bradycardia and vasodilation that can contribute to hypotension and syncope.^{2, 15}

Central nervous system diseases that increase intracranial pressure can impair blood flow to the brain by reducing cerebral perfusion pressure and compressing intracranial vessels (blood flow = perfusion pressure / vascular resistance; perfusion pressure = mean arterial pressure - intracranial pressure).²

SYNCOPE: COMPARATIVE ASPECTS

Syncope is quite common in people, with an estimated incidence as high as 30–50%.^{1, 16, 17} Syncope in people is often benign, although it causes injury in about 15% of cases.¹⁷ But, serious heart or other disease may be the cause especially when syncope is associated with exercise.^{3, 17} Transient orthostatic hypotension resulting from inadequate or uncoordinated neurohumoral circulatory reflex responses is a major cause of syncope in people. Up to 50% of children have had a syncopal episode by the end of adolescence. Most episodes are related to neurally mediated hypotension and/or bradycardia (neurocardiogenic; vasovagal). Seizures, migraine, and cardiac disease are less common causes.^{3, 17} The elderly are more likely to have arrhythmias, underlying heart disease, and abnormal reflex responses to situational and orthostatic stresses.^{1, 13, 18} Cardiac arrhythmias are thought to account for approximately 14%–30% of human syncope cases.¹⁶ The etiology remains unknown in 30–50% of affected people after standard diagnostic evaluation.^{1, 16} Carotid sinus syncope, also more common in the elderly, involves hypersensitivity of the carotid sinus reflex mechanism. Carotid sinus pressure induces transient asystole or bradycardia or a sudden decrease in blood pressure. A compatible history includes loss of consciousness with head turning, tight collars, or a neck mass.¹³

Psychiatric disorders (e.g., panic disorder, generalized anxiety disorders, and major depression) are noted in about 20% of people with syncope of unknown cause.¹ Affected patients tend to be younger and therapy of the primary disorder reportedly leads to resolution of syncope in most.¹

Several population based studies indicate that people with cardiac causes of syncope have higher one-year mortality (18–33%) than those with non-cardiac causes (0–12%) or those with unknown cause (6%).^{1, 4, 14} It appears that the presence of underlying cardiac disease is more important in determining prognosis than the presence or



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cause of syncope.^{1, 14} Similar data are not available in animals; but, it is likely that advanced age and the presence of cardiac disease (especially heart failure) are associated with worse prognosis in animals also.

SYNCOPE IN DOGS AND CATS

The true incidence of syncope in dogs and cats is unknown. A survey of the Veterinary Medical Database (VMDB) over the period from Jan. 1, 1990 through Dec. 31, 1999, identified 647 dogs with a diagnostic code of 'syncope,' 'syncope due to unknown,' or 'carotid sinus syncope' out of a total 444,410 individuals in the database (0.15%)^a. During the same time period 43 out of a total 132,862 cats in the VMDB (0.03%) were given a diagnostic code for syncope^a. While syncope may be underreported, the low prevalence in dogs and cats compared to people supports the contention that neurocardiogenic syncope (especially orthostatic hypotension) is rare in quadrupeds. Furthermore, only 3 dogs were identified as having carotid sinus syncope. The greater frequency of syncope in older animals and its common association with cardiac (and other) disease also suggests that syncope is a much less benign sign than in people.

Of the 647 dogs with syncope, 167 (26%) had no other diagnostic code listed. The remaining 480 (74%) were given at least one other diagnostic code. Common associated conditions are categorized in Table 2. Overall, there were 440 cardiac abnormalities noted (some animals had more than one abnormality). When more than one code for an abnormality was listed for each individual, only the more specific one was tallied (e.g., in a dog with codes for 'acquired mitral insufficiency' and 'murmur,' only 'acquired mitral insufficiency' was recorded for this survey). Atrioventricular (AV) valve disease and arrhythmias were very common in dogs with syncope. Pulmonary signs of various types were also frequent. Although the specific causes for syncope in these cases cannot be determined from these data, the frequency and types of associated diagnoses provide some insight. Figures 1 and 2 summarize the age and weight distribution of dogs with syncope. There were 347 females (53.6%) and 295 males (45.6 %) affected. The animals' status at discharge was also noted: 616 (95%) were alive, 19 (3%) had died, and 12 (2%) were euthanized. Breeds with ≥ 5 affected dogs are listed in Table 3 along with the prevalence in that breed within the database.

Of 43 cats with syncope, 15 (34.9%) had no other diagnostic code listed. For the remaining 28 cats, there were 18 occurrences of structural or functional cardiac abnormalities (Table 4). Arrhythmias and respiratory signs were among the more frequent diagnoses. Figure 3 summarizes the age distribution of affected cats. There were 19 female (44.2%) and 24 male (55.8%) cats identified with syncope. Breeds affected were: mixed (17 cats), American domestic shorthair (16 cats), Persian (6 cats), and 1 cat each for Burmese, Himalayan, Rex, and Siamese breeds. Discharge status indicated 39 (90.7%) were alive and 4 (9.3%) died or were euthanized.

DIAGNOSTIC APPROACH

The clinical history and physical examination always are of central importance in the diagnosis of syncope in both animals and people.^{1, 2, 14} Identification of the cause of syncope is possible using the history, physical exam, and ECG in about 50% of people.^{1, 4} Other diagnostic tests are done to confirm a suspected cause or to seek other potential causes.^{14, 16} Key historical information relates to the situation in which syncope occurred (e.g., preceding events and prodromal signs), a description of the event itself, and the animal's mentation and activity after the event. Other important information includes the number and frequency of previous events; a history of cardiopulmonary disease, signs of other systemic disease, collapse or sudden death in related animals, and the patient's current medications. The physical examination should be thorough and evaluate all body systems as well as the cardiovascular system. This includes assessment of heart rate and rhythm, respiratory rate and character, and mucous membrane color/capillary refill time, as well as jugular vein evaluation (for distension and/or abnormal pulsations), precordial and arterial pulse palpation, careful cardiac and pulmonary auscultation, abdominal palpation, and neurologic exam.



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A routine medical database consisting of CBC, biochemical profile, urinalysis, heartworm test, and arterial blood pressure measurement should be done. Although these tests are often normal, a contributory underlying disease may be revealed. Endocrine tests may be useful in some cases.

A baseline electrocardiogram (ECG) is recommended, although the resting ECG may be non-diagnostic. ECG abnormalities are reportedly found in about one-half of people with syncope, but this test is diagnostic in only about 5%.¹⁻⁴ Nevertheless the ECG may suggest underlying cardiac enlargement, conduction abnormalities, or arrhythmia that could contribute to syncope.

Thoracic radiographs are recommended to evaluate the lungs, pleural space, mediastinum and pulmonary vasculature, as well as cardiac size and shape. Suspicion for an underlying cardiac cause for syncope is usually generated by the combination of history, physical examination, the ECG and chest radiographs.

Echocardiography is useful to confirm the presence and severity of structural or functional cardiac abnormalities that could lead to syncope or be risk factors for ventricular tachycardia or other arrhythmias. But the diagnostic yield of echocardiography is low in the absence of suggestive historical, physical or ECG findings.⁴

¹⁴

Ambulatory ECG (Holter) monitoring has been useful for identifying or excluding cardiac arrhythmias as a cause for syncope in some animals and people.^{1, 4, 6, 14, 19} In a study of 44 dogs with syncope, Holter monitoring had a diagnostic yield (both positive and negative results) of 42%. In 30 % of cases, arrhythmias were implicated as the cause (20% with ventricular tachyarrhythmias, 10% with bradyarrhythmias); in 12% arrhythmias did not occur during syncope.⁶ A syncopal episode must occur during monitoring to make a definite diagnosis. Although arrhythmias without clinical signs often occur in both animals and people, not all arrhythmias cause enough hemodynamic compromise to induce syncope.^{5, 6, 14, 20-23} Holter studies reportedly have greater utility in older people (and presumably also dogs and cats) because of the increased occurrence of arrhythmias in this population. Holter monitoring is of most benefit in patients with multiple or frequent syncope over a short period of time.¹⁴ But, as was shown in dogs, the frequency of syncope does not predict the likelihood of an event during Holter monitoring.⁶ Holter monitoring is useful for quantifying type and severity of arrhythmias, for identifying arrhythmias in asymptomatic patients, and for assessing antiarrhythmic drug efficacy.

Continuous loop event monitors allow a longer monitoring period than Holter monitoring and are better suited for patients with infrequent symptoms.^{5, 14, 19, 24} These digital loop recorders continuously monitor heart rhythm; when activated, the ECG is saved into memory for a brief period prior to and following activation. The ECG data are then transmitted by telephone for printing and interpretation. Event monitors have a higher diagnostic yield than Holter.^{1, 5, 14} In a study of dogs and cats that were monitored from 3 to 14 days, the overall diagnostic yield was 85%.⁵ It was higher for animals with structural heart disease. A cardiac arrhythmia was ruled out (negative diagnostic study) as a cause for syncope in 33 of 60 animals; an arrhythmia was identified during syncope in 18 cases. The most common arrhythmia associated with syncope in this study was sinus arrest with an inadequate escape rhythm.⁵ A previous study¹⁹ found a diagnostic yield of 56%. Disadvantages of event monitors are that they do not record potentially significant arrhythmias unless activated, and they do not quantify the frequency of arrhythmias.

Insertable loop recorders (Reveal, Medtronic) have been used rarely in veterinary patients. These subcutaneously implanted devices must be activated at the onset of symptoms in order to save ECG data. They can be worn about 18 months, but cannot be downloaded transtelephonically. Currently they are recommended in people with recurrent, but infrequent and unexplained syncope who have a negative cardiac evaluation and non-diagnostic tilt test and psychiatric exam.

When suggestive neurologic signs are present an EEG, computed tomography of the head, or other more specific test may be helpful. But without a history typical for seizures (e.g., tonic/clonic movement, post ictal confusion) and without abnormalities in the neurologic exam, the diagnostic yield of these tests is very low.^{1, 14}



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Diagnosis of neurocardiogenic syncope in people may include tilt table testing, a provocative test of orthostatic stress.^{1,4,13} In cases of suspected carotid sinus hypersensitivity, carotid sinus massage can uncover abnormal cardioinhibitory and vasodepressor responses.¹ Signal averaged ECG and electrophysiologic studies are other techniques sometimes used in people with syncope. The potential utility of these techniques in veterinary medicine is unknown.

TREATMENT

Therapy is aimed at managing underlying abnormalities, as well as avoiding precipitating factors such as exertion or environmental stressors, when possible. This may include instituting or adjusting medications for heart failure, correcting anemia, or treating respiratory or metabolic diseases. When an arrhythmia appears to be the cause of syncope, appropriate antiarrhythmic drug therapy or pacing is indicated. The reader is referred to other articles in this symposium for treatment recommendations for specific cardiac disorders.

Table 1. Potential Causes of Syncope

- Cardiovascular
 - Arrhythmias
 - Tachyarrhythmias
 - Ventricular tachyarrhythmias
 - Supraventricular (atrial or AV junctional) tachyarrhythmias
 - Atrial fibrillation
 - Bradyarrhythmias
 - Sinus node dysfunction—Sick sinus syndrome
 - Atrial standstill
 - High grade AV blocks (2nd degree, 3rd degree)
 - Impaired forward cardiac output
 - Myocardial failure
 - Dilated cardiomyopathy
 - Myocardial infarction or inflammation
 - Severe valvular insufficiency
 - Impaired cardiac filling
 - Hypertrophic cardiomyopathy
 - Restrictive cardiomyopathy
 - Cardiac tamponade
 - Constrictive pericarditis
 - Intracardiac tumor
 - Cardiac outflow obstruction
 - (Sub)aortic stenosis
 - Hypertrophic obstructive cardiomyopathy
 - Intracardiac tumor or thrombus
 - Pulmonic stenosis
 - Pulmonary hypertension (including heartworm disease)
 - Pulmonary thromboembolism
 - Cyanotic heart disease (Right to left shunts)
 - Tetralogy of Fallot
 - Eisenmengers physiology ("reversed" ASD, VSD, or PDA)



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- Non-Cardiac
 - Neurologic
 - Cerebrovascular disease or thromboembolism
 - Brain tumor
 - Seizures
 - Narcolepsy/cataplexy
 - Metabolic and hematologic
 - Acute hemorrhage
 - Anemia
 - Diseases causing hypoxemia
 - Hypoglycemia
- Reflex
 - Neurocardiogenic (vasovagal)
 - Situational
 - Cough
 - Micturition, defecation, etc.
 - Carotid sinus hypersensitivity
- Primary & Secondary Autonomic Failure Syndromes (reported in people)



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Table 2. Most Frequent Associated Conditions in Dogs with Syncope

- Cardiac Diseases and Abnormalities (440)*
 - AV Valvular diseases (128)
 - "Murmur"/other heart valve disease (54)
 - (Sub)aortic or pulmonic valve stenosis (21)
 - Cardiomyopathy/myocardial disease (28)
 - Other (digoxin toxicity, pericardial effusion, cardiac tumor, etc.) (37)
 - Heart failure/pulmonary edema/"congestion heart" (47)
 - Cardiac arrhythmias (125)
 - Ventricular tachyarrhythmias (26)
 - Atrial fibrillation & other supraventricular tachyarrhythmias (18)
 - "Sinus arrhythmia due to unknown (sick sinus syndrome)" (21)
 - Sinus bradycardia (28)
 - Conduction blocks (32)
- Respiratory Diseases/Signs (106)
 - Cough (19)
 - Tracheobronchial diseases (24)
 - Pulmonary diseases (14)
 - Pulmonary vascular disease & heartworm disease (18)
 - Upper airway diseases/malformations (15)
 - Other respiratory abnormalities (16)
- Hematologic and Metabolic Diseases
 - Anemia (30)
 - Various tumors (except cardiac) (36)
 - Renal disease & failure (16)
 - Liver disease & failure (14)
 - Vomiting/gastroesophageal diseases (11)
 - Hyperadrenocorticism (11)
- Neurologic Conditions
 - Seizures/epilepsy (40)
 - "Brain syndrome" (15)

* Number of animals with the abnormality noted in parentheses. Some animals had more than one associated condition.
Data from VMDB, 1/1/90-12/31/99.



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Table 3. Breed Associations of Dogs with Syncope*

| Breed | # Dogs with Syncope | % of Total Dogs in Breed |
|---------------------------|---------------------|--------------------------|
| American Cocker Spaniel | 30 | 0.154 |
| Beagle | 7 | 0.126 |
| Boston Terrier | 14 | 0.415 |
| Boxer | 59 | 0.954 |
| Brittany Spaniel | 5 | 0.173 |
| Bulldog | 10 | 0.265 |
| Chihuahua | 8 | 0.236 |
| Dachshund | 7 | 0.084 |
| Doberman Pinscher | 14 | 0.152 |
| German Shepherd | 9 | 0.046 |
| Golden Retriever | 24 | 0.099 |
| Great Dane | 5 | 0.136 |
| Labrador Retriever | 39 | 0.104 |
| Lhasa Apso | 12 | 0.309 |
| Maltese | 14 | 0.554 |
| Miniature Pinscher | 7 | 0.618 |
| Miniature Poodle | 24 | 0.311 |
| Miniature Schnauzer | 35 | 0.451 |
| Mixed breed | 124 | 0.129 |
| Pekingese | 8 | 0.273 |
| Pomeranian | 15 | 0.421 |
| Pug | 5 | 0.219 |
| Shetland Sheepdog | 6 | 0.078 |
| Shih Tzu | 20 | 0.298 |
| Standard Schnauzer | 9 | 0.602 |
| Toy Poodle | 10 | 0.169 |
| Rottweiler | 6 | 0.045 |
| West Highland White Terr. | 11 | 0.384 |
| Yorkshire Terrier | 10 | 0.149 |
| All Breeds in Database | 647 | 0.146 |

* Only breeds with 5 or more affected individuals included.

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Table 4. Most Frequent Associated Conditions in Cats with Syncope*

- Cardiac Diseases and Abnormalities (30)
 - Cardiomyopathy/myocardial disease (11)
 - "Murmur" & other cardiac diseases (9)
 - Cardiac arrhythmias (10)
 - Ventricular tachyarrhythmias (3)
 - Supraventricular tachyarrhythmias (2)
 - Sinus arrest (2)
 - AV Conduction blocks (3)
- Respiratory Diseases/Signs (5)
 - Pleural effusion or pulmonary edema (3)
- Other Systemic Diseases
 - Hyperthyroidism (3)
 - Diabetes mellitus (2)
 - GI Diseases (4)
 - Renal insufficiency (2)
- Neurologic Conditions (2)

* Number of animals with the abnormality noted in parentheses. Some animals had more than one associated condition.
Data from VMDB, 1/1/90-12/31/99.

Figure 1. Age Distribution of Dogs with Syncope

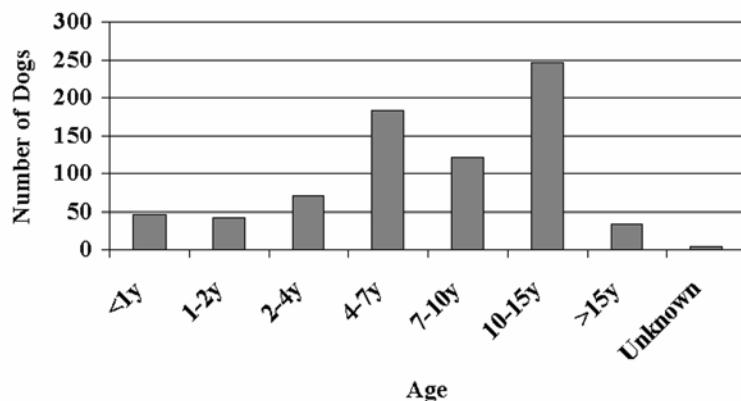


Figure 2. Weight Distribution of Dogs with Syncope

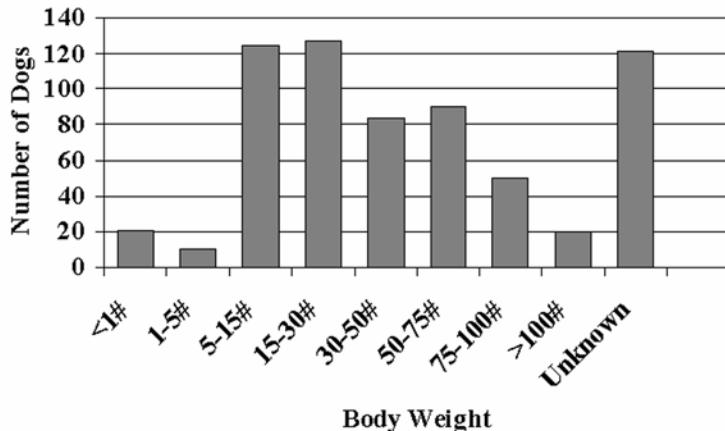
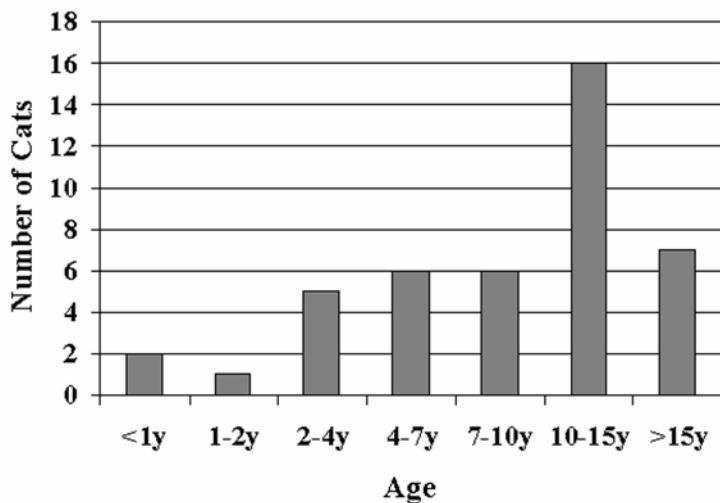


Figure 3. Age Distribution of Cats with Syncope



ENDNOTES

- a. Ware, WA, unpublished data searches from VMDB, Purdue University



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KEYWORDS

Syncope, collapse, dogs, cats, transient loss of consciousness, cardiac arrhythmias, cardiac output, neurocardiogenic, ECG