



Pulmonary Hypertension

(High Blood Pressure in the Lungs)

Basics

OVERVIEW

- “Pulmonary hypertension” (high blood pressure in the arteries of the lungs) is defined as a peak systolic blood pressure in the arteries of the lungs (known as “pulmonary artery pressure”) greater than 30 mm Hg and/or a peak diastolic pulmonary arterial pressure greater than 15 mm Hg
- “Systolic” refers to “systole,” which is the period when the heart (especially the ventricles) contract to push blood into the lungs (right ventricle) or body (left ventricle)
- “Diastolic” refers to “diastole,” which is the period when the heart (especially the ventricles) relaxes to allow blood to fill the chambers
- The heart of the dog or cat is composed of four chambers; the top two chambers are the right and left atria and the bottom two chambers are the right and left ventricles; heart valves are located between the right atrium and the right ventricle (tricuspid valve); between the left atrium and the left ventricle (mitral valve); from the right ventricle to the main pulmonary (lung) artery (pulmonary valve); and from the left ventricle to the aorta (the main artery of the body; valve is the aortic valve)
- Several abnormalities can lead to elevations in blood pressure in the arteries of the lungs (pulmonary artery pressure)—narrowing or constriction of the arteries or capillaries of the lungs (known as “vasoconstriction”), blockage of the artery of the lung (pulmonary artery), high pressure within the left atrium (left-sided top chamber of the heart) with resultant increase in blood pressure in the capillaries of the lungs, or excessive blood flow in the arteries of the lungs
- Many of the causes for development of high blood pressure in the arteries of the lungs (pulmonary hypertension) involve the heart; the heart of the dog or cat is composed of four chambers; the top two chambers are the right and left atria and the bottom two chambers are the right and left ventricles; heart valves are located between the right atrium and the right ventricle (tricuspid valve); between the left atrium and the left ventricle (mitral valve); from the right ventricle to the main pulmonary (lung) artery (pulmonary valve); and from the left ventricle to the aorta (the main artery of the body; valve is the aortic valve)

GENETICS

- No specific genetic basis has been found
- High blood pressure in the arteries of the lungs (pulmonary hypertension) can be secondary to several congenital (present at birth) heart defects that may have a genetic basis
- Pets with genetic increased likelihood of developing left-sided heart disease probably have an increased likelihood of high blood pressure in the lungs (pulmonary hypertension)

SIGNALMENT/DESCRIPTION OF PET

Species

- Dogs
- Cats

Breed Predilections

- Possible breed predilections exist, based on the underlying cause of high blood pressure in the arteries of the lungs (pulmonary hypertension), such as congenital (present at birth) heart disease or pulmonary fibrosis (a condition characterized by excessive fibrous or scar-type tissue in the lungs)
- Terrier breeds have been suggested to have a higher likelihood of developing pulmonary hypertension than other breeds

Mean Age and Range

- Generally seen in elderly dogs

Predominant Sex

- An increased likelihood of developing high blood pressure in the arteries of the lungs (pulmonary hypertension) in females as compared to males has been reported

SIGNS/OBSERVED CHANGES IN THE PET

- Signs may be due to high blood pressure in the arteries of the lungs (pulmonary hypertension) and/or to the underlying primary disease
- Exercise intolerance; difficulty breathing with exertion (known as “exertional dyspnea”)
- Difficulty breathing (known as “dyspnea”)
- Rapid breathing (known as “tachypnea”)
- Coughing; spitting up of blood derived from the lungs due to pulmonary or bronchial hemorrhage (known as “hemoptysis”)
- Fainting (known as “syncope”)
- Abdominal distention
- Weight loss
- Sluggishness (lethargy)
- Heart murmur
- Abnormal heart and/or lung sounds heard when listening to the chest with a stethoscope
- Bluish discoloration of the skin and moist tissues (mucous membranes) of the body caused by inadequate oxygen levels in the red blood cells (known as “cyanosis”)
- Distension of the jugular veins in the neck
- Fluid buildup under the skin (known as “subcutaneous edema”)
- Sudden death

CAUSES

- Primary pulmonary hypertension
 - ♦ High blood pressure in the arteries of the lungs that occurs in the absence of underlying disease
 - ♦ Has not been identified in dogs and cats
 - ♦ Congenital (present at birth) disorder of the blood vessels of the lungs has been identified in people
 - ♦ Abnormalities in the chemicals of the blood vessels that normally cause the blood vessels to enlarge or dilate (known as “vasodilation”) or to constrict (known as “vasoconstriction”), resulting in blockage or narrowing of the blood vessels
 - ♦ Lung disease
 - ♦ Blockage of blood flow in the lungs
 - ♦ Pneumonia (bacterial, viral, fungal, or parasitic)
 - ♦ Long-term (chronic) inflammation of the bronchi (airways going from the windpipe [trachea] into the lungs; condition known as “bronchitis”)
 - ♦ Long-term (chronic) obstructive lung disease (known as “chronic obstructive pulmonary disease” or COPD)
 - ♦ Condition characterized by excessive fibrous or scar-type tissue in the lungs (pulmonary fibrosis)
 - ♦ Inflammation of the bronchi characterized by the presence of eosinophils, a type of white-blood cell involved in allergic responses by the body and active in fighting larvae of parasites (condition known as “eosinophilic bronchitis”)
 - ♦ Tumors or cancer in the lungs

- ◆ Adult respiratory distress syndrome, a group of lung abnormalities that develop secondary to various serious illnesses that cause sudden breathing difficulties
- ◆ Blood clots in the lungs (known as “pulmonary thromboembolism”)
- ◆ Excessive levels of steroids produced by the adrenal glands (known as “hyperadrenocorticism” or “Cushing’s syndrome”)
- ◆ Condition in which proteins are lost from the body through the kidneys (known as “protein-losing nephropathy”) or through the intestines (known as “protein-losing enteropathy”)
- ◆ Presence of pus-forming bacteria and their poisons in the blood or tissues (condition known as “sepsis”)
- ◆ Heartworm disease
- ◆ Immune-mediated hemolytic anemia—accelerated destruction or removal of red blood cells related to an immune response, in which the body produces antibodies against red blood cells
- ◆ Cancer
- ◆ Inflammation of the pancreas (known as “pancreatitis”)
- ◆ Inflammation/infection of the lining of the heart (known as “endocarditis”)
- ◆ Blood-clotting disorder (known as “disseminated intravascular coagulation” or DIC)
- ◆ Primary heart disease (typically right-sided heart disease)
- ◆ Heartworm disease
- ◆ Congenital (present at birth) heart disease
- ◆ Various heart defects (such as patent ductus arteriosus, ventricular septal defect, atrial septal defect)
- ◆ Left-sided heart disease
- ◆ Backward flow of blood through the mitral valve (known as “mitral regurgitation”)
- ◆ Heart muscle is flabby and weak (known as “dilated cardiomyopathy”)
- ◆ Heart muscle disease characterized by inappropriate enlargement or thickening of the heart muscle of the left ventricle (known as “hypertrophic cardiomyopathy”)
- ◆ Heart muscle disease in which the muscle is “stiff” and does not expand, such that blood cannot fill the ventricles normally (known as “restrictive cardiomyopathy”)
- ◆ Narrowing of the mitral valve (known as “mitral stenosis”)
- ◆ Tumors of the left atrium
- ◆ Causes of long-term (chronic) low levels of oxygen in the body (known as “hypoxia”)
- ◆ Decreased movement of air into and out of the lungs (known as “hypoventilation”)
- ◆ High-altitude disease

RISK FACTORS

- Heart and lung disease
- Heartworm disease
- Diseases associated with blood clots to the lungs (pulmonary thromboembolism)
- Obesity
- High altitude

Treatment

HEALTH CARE

- Hospitalize pets with severe breathing distress, until stable
- Administer oxygen therapy, medications to enlarge or dilate the bronchi (known as “bronchodilators”), medications to remove excess fluid from the body (known as “diuretics”), and antibiotics on an emergency basis in accordance with underlying disease
- Monitor hydration and body temperature closely
- Administer fluid therapy carefully; heart status and potential of congestive heart failure (condition in which the heart cannot pump an adequate volume of blood to meet the body’s needs) must be considered
- Maintain low-stress environment
- Treatment should be directed at the primary underlying disease process whenever possible
- Long-term oxygen therapy usually is not feasible; however, short-term or intermittent oxygen therapy may be beneficial

ACTIVITY

- Restricted

DIET

- Specific guidelines based on underlying disease
- If in congestive heart failure, restricted sodium diet may have benefit; congestive heart failure is a condition in which the heart cannot pump an adequate volume of blood to meet the body's needs

SURGERY

- Surgical heartworm extraction is a consideration in pets with severe infestation

Medications

Medications presented in this section are intended to provide general information about possible treatment. The treatment for a particular condition may evolve as medical advances are made; therefore, the medications should not be considered as all inclusive

- The ideal therapeutic agent should reduce blood pressure in the lungs without causing significant changes in the general (systemic) circulation; oxygen can accomplish this, but long-term oxygen administration is not feasible in these pets; short-term or intermittent use of oxygen may be beneficial

MEDICATIONS TO ENLARGE OR DILATE BLOOD VESSELS (KNOWN AS “VASODILATORS”)

- Some vasodilators (such as sildenafil or tadalafil) primarily cause enlargement or dilation of the blood vessels of the lungs (known as “pulmonary vasodilation”), with mild enlargement or dilation of the generalized (systemic) blood vessels
- Sildenafil (Viagra)—known to cause enlargement of lung blood vessels with minimal enlargement of generalized (systemic) blood vessels; numerous studies have shown clinical improvement in dogs
- Tadalafil (Cialis)—one study suggested benefit in enlarging or dilating the blood vessels of the lungs (pulmonary vasodilation)
- Vardenafil (Levitra)—not yet evaluated in veterinary medicine; studies in people do not show the benefit of enlarging or dilating the blood vessels of the lungs (pulmonary vasodilation) as seen with similar drugs
- Other vasodilators have limited benefit due to development of generalized (systemic) low blood pressure (known as “hypotension”); however, these medications are very important in treatment of pulmonary hypertension resulting from left-sided heart disease; choices include angiotensin converting enzyme (ACE) inhibitors (such as enalapril, benazepril), hydralazine, calcium channel blockers (such as diltiazem or amlodipine), and pimobendan

MEDICATIONS TO ENLARGE OR DILATE BRONCHI (BRONCHODILATORS)

- May be of benefit in pets with lung disease
- Methylxanthines (such as theophylline or aminophylline) may have a mild effect on enlarging or dilating the arteries of the lungs (pulmonary arterial vasodilation)
- Choices include sympathomimetics (such as terbutaline) and methylxanthines (such as theophylline, aminophylline)
- Bronchodilators may have additional positive effects on contraction of heart muscle (known as “positive inotropes”)

MEDICATIONS TO INCREASE CONTRACTION OF HEART MUSCLE (POSITIVE INOTROPES)—DIGOXIN, DOBUTAMINE

- Not a primary treatment for high blood pressure in the arteries of the lungs (pulmonary hypertension)
- May be of benefit in the treatment of right-sided or left-sided congestive heart failure; congestive heart failure is a condition in which the heart cannot pump an adequate volume of blood to meet the body's needs
- Monitor closely for irregular heartbeats (known as “arrhythmias”) that may occur with treatment

MEDICATIONS TO PREVENT BLOOD CLOTS (KNOWN AS “ANTICOAGULANT THERAPY”)

- Indicated if blood clots in the lungs (pulmonary thromboembolism) are diagnosed
- Choices include heparin, warfarin, and aspirin
- Clopidogrel (Plavix) and low molecular-weight heparin (enoxaparin)—currently being investigated for use in pets
- Aspirin and clopidogrel (Plavix) can be administered simultaneously, as directed by your pet’s veterinarian

MEDICATIONS TO BREAK UP EXISTING CLOTS (KNOWN AS “THROMBOLYTIC DRUGS”)

- Veterinarians debate whether medications to break up existing clots (thombolytic drugs) are indicated or effective
- Choices include streptokinase and tissue plasminogen activator (t-PA)

ANTIBIOTICS AND MEDICATIONS TO DECREASE INFLAMMATION (KNOWN AS “ANTI-INFLAMMATORY DRUGS”)

- Antibiotics—used in treating bacterial pneumonia, if present
- Steroids—used to decrease inflammation in the lungs, where the underlying cause of the high blood pressure in the arteries of the lungs (pulmonary hypertension) has an inflammatory component (such as in heartworm disease and some lung diseases)

Follow-Up Care

PATIENT MONITORING

- Physical examination with careful listening of the heart and lungs with a stethoscope (known as “auscultation”)
- Monitor for worsening of clinical signs
- Serial echocardiograms (use of ultrasound to evaluate the heart and major blood vessels) to assess improvement or worsening of the high blood pressure in the arteries of the lungs (pulmonary hypertension)
- Serial blood pressure monitoring, if the pet is on medications to enlarge or dilate blood vessels (vasodilators)
- Possible repeat chest x-rays (radiographs)
- Possible repeat arterial blood gases (measurements of oxygen and carbon dioxide levels in arterial blood)

PREVENTIONS AND AVOIDANCE

- Early evaluation and prevention of conditions that increase likelihood of development of high blood pressure in the arteries of the lungs (pulmonary hypertension)

POSSIBLE COMPLICATIONS

- Right-sided heart failure
- Fainting (syncope)
- Progressive debilitating signs (such as difficulty breathing with exertion [exertional dyspnea], sluggishness [lethargy], weakness, and lack of appetite [anorexia])
- Irregular heartbeats (arrhythmias)
- Extreme weight loss with muscle wasting due to heart disease (known as “cardiac cachexia”)
- Sudden death

EXPECTED COURSE AND PROGNOSIS

- Based on ability to reverse underlying disease
- When changes are irreversible, treatment is designed to improve the pet’s condition rather than to cure the disease
- In general, prognosis is very guarded

Key Points

- Diagnosis of pulmonary hypertension often is presumptive (that is, based on clinical signs); for definitive diagnosis, need heart catheterization and/or Doppler echocardiography (use of ultrasound to evaluate the heart and major blood vessels)
- Prognosis varies with reversibility of the underlying disease, but is very guarded in most cases

- Avoid environments that may increase likelihood of breathing distress—excessively cold or dry air, excessive heat, second-hand smoke, high altitudes

Notes

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