Feline Systemic Hypertension

Kathleen Dunbar, BA, RVT
Halifax, Nova Scotia, Canada

Over the past 2 decades, understanding of hypertension in companion animals has significantly improved. Greater availability of blood pressure (BP) measurement devices has enhanced the diagnostic process, and treatment has improved.

Veterinary technicians must have the knowledge and skills to help manage feline hypertension. Knowledge of its pathophysiology, the ability to recognize common clinical signs, and accurate BP measurement are key for veterinary technicians. Understanding the diagnostic complexities encountered by the veterinarian and the likely patient outcome are important for providing high-quality nursing care and case management. A successful outcome often depends on early recognition of clinical signs, proper BP measurement, proper treatment, conscientious follow-up, and regular patient monitoring.

Definition and Classification
Systemic hypertension is defined as persistently high BP. Systolic pressure, diastolic pressure, or both can be increased. In veterinary medicine, systolic pressure is mainly used for diagnosis because most devices only measure systolic pressure, and because the prevalence and significance of diastolic hypertension are undefined.

Ranges of normal BP values exist, so it can be difficult to identify a single value that represents a hypertensive state. A systolic BP >160 mm Hg and/or a diastolic BP >100 mm Hg are considered sufficiently elevated to warrant investigation by a veterinarian (TABLE 1).

Hypertension is classified by its risk of damaging organs, which is called target organ damage (TOD). TOD is divided into four risk categories, with category I representing minimal risk and category IV representing severe risk.

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Risk to Target Organ Damage</th>
<th>Systolic Blood Pressure (mm Hg)</th>
<th>Diastolic Blood Pressure (mm Hg)</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Minimal</td>
<td>&lt;150</td>
<td>&lt;95</td>
</tr>
<tr>
<td>II</td>
<td>Mild</td>
<td>150–159</td>
<td>95–99</td>
</tr>
<tr>
<td>III</td>
<td>Moderate</td>
<td>160–179</td>
<td>100–119</td>
</tr>
<tr>
<td>IV</td>
<td>Severe</td>
<td>≥180</td>
<td>≥120</td>
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Causes
Feline hypertension has three generally recognized causes: idiopathic, stress-induced or related, and underlying disease.

In humans, idiopathic (primary) hypertension accounts for at least 95% of cases. In animals, idiopathic hypertension may be less common or non-existent. Idiopathic hypertension is true primary high BP with no known cause, but it may be a type of secondary hypertension in a preclinical stage. In veterinary medicine, if a clinician cannot identify a cause after the patient workup, the term idiopathic is applied. Further studies are needed to determine whether primary hypertension exists in feline patients.

Stress-induced hypertension is also called the white-coat effect. This hypertension is not persistently high BP; rather, it is temporary because of a patient’s fear and/or excitement (e.g., at a veterinary hospital), resulting in stimulation of the autonomic nervous system and/or central nervous system (CNS). Cats are particularly affected by stress and anxiety at veterinary hospitals and, therefore, may be given a misdiagnosis of hypertension if the white-coat effect is not recognized and efforts are not made to reduce it. To help prevent the white-coat effect, see the section titled “Measuring Systemic Blood Pressure.”

Most, if not all, hypertension in cats is secondary to another disease. Renal, cardiac, and endocrine diseases most commonly cause hypertension in cats. Renal disease and hyperthyroidism are the most frequent causes in cats; diabetes mellitus and heart disease are less common causes. Rare diseases, such as pheochromocytoma, may also cause hypertension in cats.

Blood Pressure Control
BP is controlled by a complex feedback loop involving several mechanisms that are guided by (1) the amount of blood flow from the heart (i.e., cardiac output) and (2) the blood vessels’ resistance to the flow (i.e., systemic vascular resistance). Small changes in these two factors increase or decrease BP. The components of this feedback loop regulate BP within a narrow normal range by continuously reacting to information from various receptors in the body. Additionally, some tissues and organs (e.g., the kidneys) have their own mechanisms for regulating BP through a process called autoregulation. In general, the feedback control loop that balances BP can also create hypertension. In other words, the mechanisms that normally regulate systemic BP are also responsible for elevating BP when a disease process disrupts homeostasis.
Elevated Systemic Blood Pressure: Pathophysiology and Consequences

The pathophysiology of hypertension is largely unknown, and most of the available information on feline hypertension is garnered from human studies. Mechanisms that normally regulate BP are known to become pathogenic when a disease process disrupts the feedback loop. Cardiac output is affected by changes to heart rate and stroke volume; several pathogenic mechanisms associated with cardiac output can cause hypertension. Hyperthyroidism causes a pathogenic response when more sensitive cardiac β receptors or an increased number of these receptors increase heart rate. Kidney disease can cause sodium and water retention, which results in extracellular fluid volume expansion. The excess fluid results in hypervolemia, leading to increased stroke volume. Diabetes mellitus and pheochromocytoma intensify catecholamine secretion, which also increases stroke volume.

Systemic vascular resistance is affected by pathogenic mechanisms that change vascular tone. Hyperthyroidism, cardiac disease, and renal disease fuel resistance by increasing the number of calcium ions in intracellular fluid, increasing sensitivity to circulating catecholamine, and activating the renin-angiotensin-aldosterone system. Vascular resistance is triggered when angiotensin II causes blood vessels to constrict, increasing vascular resistance. Renal disease reduces synthesis and release of prostaglandins and bradykinin, lowering vasodilator concentration.

When regulation fails, BP can become dangerously elevated, damaging the microvasculature. As a result, capillaries distend and endothelial junctions rupture, resulting in leakage of plasma into interstitial tissue. Furthermore, increased vascular resistance leads to edema, ischemia, hemorrhage, necrosis, and fibrosis of tissues. This tissue damage causes TOD, specifically to the eyes, kidneys, heart, and brain.

Clinical Signs
Detecting evidence of TOD requires recognition of overt and subtle clinical signs of hypertension. Knowledge of these signs is important for veterinary technicians because they monitor hospitalized patients for extended periods of time, triage patients, and are responsible for alerting the veterinarian to concerns. Technicians must be observant and learn to recognize clinical signs of a wide variety of underlying diseases and of TOD. Nonspecific signs may appear as behavioral changes, such as lethargy, depression, restlessness, unusual vocalization, a change in sleep pattern, and increased or decreased appetite.

Ocular signs are frequently the most obvious and common signs of TOD; therefore, a full ocularexamination is essential. A gross examination may detect overt signs, such as buphthalmos, acute blindness, pupillary dilation, laxed lens, and hyphema. Retinal changes, papilledema, and conditions related to increased intraocular pressure (glaucoma) require investigation using a direct and/or an indirect ophthalmoscope and a tonometer.

Overt cardiac signs of TOD include acute heart failure after administration of fluids, a new heart murmur, and recent development of a gallop rhythm. Subtle diagnostic findings may include electrocardiographic abnormalities and left ventricular hypertrophy; a subtle clinical sign is injected mucous membranes. Overt kidney-related signs of TOD (e.g., weight loss, inappetence, polydipsia/polyuria) are typically related to acute or chronic renal failure; overt diagnostic findings may include azotemia, uremia, an increased urine albumin level, an increased urine protein:creatinine ratio, and palpation of renal abnormalities during the physical assessment. Subtle laboratory findings may include normal creatinine and blood urea nitrogen levels, but an increased urine protein:creatinine ratio and decreased urine concentration. Overt CNS signs include seizures, changes in mentation, obtundation, and coma. Subtle signs may include focal facial seizures and photophobia.

Diagnosis
A veterinarian’s diagnosis of systemic hypertension is based on evidence of causative disease, evidence of TOD, and a BP reading indicative of hypertension. Which diagnostic tests to order depends on the patient history, the physical examination findings,
and the suspected primary disease. For example, if hyperthyroidism is the suspected cause of hypertension, the technician may be asked to draw blood to submit for thyroid function testing.

Cats with overt or subtle clinical signs should have their BP assessed as part of a standard workup. Because false readings are common, the American College of Veterinary Internal Medicine (ACVIM) Hypertension Consensus Panel does not recommend annual screening of healthy cats and dogs younger than 10 years (Box 1). Furthermore, hypertension should not be diagnosed based on a series of readings alone. Ideally, the cat should return for another evaluation on a different day, with the veterinary staff taking great care to reduce patient stress, fear, and anxiety, all of which may result in spurious values.

Measuring Systemic Blood Pressure

BP can be measured using the direct method or an indirect method. The direct method is the most accurate but is invasive, involving placement of a direct line in an artery. This method requires greater skill than indirect methods, but its exactness and immediate results make it indispensable in critical care and major surgery cases.

Hospitalizing a cat for long-term management of hypertension is neither appropriate nor practical in clinical situations. Therefore, indirect (noninvasive) methods using Doppler sphygmomanometry or oscillometry are used more often. A new method of noninvasive monitoring, called high-definition oscillometry, is also available. Except for this new method, all other noninvasive methods are highly subject to user error, and no existing devices meet the guidelines of the Association for the Advancement of Medical Instrumentation (AAMI) (Box 2). Therefore, technicians must be sure to use proper technique and be aware of possible mistakes.

To help ensure consistent results, only one or two technicians should be designated to obtain measurements. Additionally, all BP devices need to be calibrated semiannually to maintain accuracy. The following guidelines can help reduce user errors.

Technicians must reduce the white-coat effect as much as possible by controlling potential patient stressors. Each feline patient should be allowed to settle in a quiet room without other animals for 5 to 10 minutes before the assessment, which should be performed before the physical examination if possible. If this is not feasible, the cat should be given time to relax before the measurement. The owners can remain in the room if they help calm the cat and remain relatively quiet. The cat should be allowed to position itself as it chooses if the position is not conducive to harming staff. Acceptable positions include sternal or lateral recumbency on the examination table or someone's lap. The cat should be allowed to relax between steps of the procedure and soothed during the measurement. The veterinarian should be informed of the cat's demeanor before and during the measurements so that this can be considered when the assessment is reviewed.

For cats, the width of the cuff should be 30% to 35% of the circumference of the appendage used. A measuring tape is useful for calculating the exact circumference. If the cuff is too large, the reading will be too low; if the cuff is too small, the reading will be falsely high.

The cuff site should be level to the left atrium of the heart, ±10 cm (maximum). If the cuff site is lower than the heart by too much, the reading will be falsely high. If the cuff site is higher than the heart by too much, the reading will be falsely low.

Technicians should use gentle, proper restraint so that the patient moves as little as possible during the reading. The patient's appendage for the reading should be chosen on a case-by-case basis. If the cat seems agreeable, any appendage can be used; if the cat is fractious, shaking, or purring, the base of the tail is the best choice.

The cuff should be tight enough that a person's little finger does not fit between the extremity and the fastened cuff. If the cuff is movable, the device will not detect arterial oscillations.

No fewer than three, but preferably five to seven, readings should be taken, with at least 1 minute between each reading. The first measurement and any obvious invalid readings should be discarded. Systolic values should not vary by more than 20%.

Treatment

Technicians must be familiar with standard treatment so that they can knowledgeably answer client questions and can help monitor treatment progress and evaluate patients for adverse drug effects.

The treatment plan is complex and depends on the cause and severity of the disease. Antihypertensive therapy aims to reduce (1) the risk and progression of end-organ damage and (2) systolic
Key Points

- Most secondary systemic hypertension is caused by renal, cardiac, and endocrine diseases.
- Systemic hypertension is classified by risk of target organ damage (TOD); reducing risk of TOD is considered the main goal of treatment.
- Indirect methods of blood pressure measurement are the most practical but are subject to user error, so competency and following a standard protocol are very important.

BP to <160 mm Hg and diastolic BP to <100 mm Hg.

The treatment strategy should consider whether the risk of TOD is minimal, mild, moderate, or severe. If TOD such as acute blindness has occurred and the BP indicates hypertension, immediate treatment is needed. Once the cat is stable, the cause of hypertension should be investigated and treated.

When hypertension is secondary, treatment is directed at the underlying disease. If arteriolar damage has not worsened vascular resistance, treatment of the primary disease may be enough to resolve hypertension. In certain cases, such as hyperthyroidism, antihypertensive medication will be initiated but decreased or discontinued once the primary disease has stabilized. When BP is elevated only mildly or moderately, specific antihypertensive therapy may not be necessary. Conversely, cats with hypertension caused by chronic renal failure may require lifetime antihypertensive medication.

In many cases, pharmaceutical treatment does not appear to increase feline life expectancy (see discussion of proteinuria below), but it does improve quality of life. Many pharmaceutical treatments are available, but the preferred drug is amlodipine besylate, a calcium-channel blocker. This drug inhibits the influx of calcium into cardiac and vascular smooth muscle, reducing systemic peripheral resistance and increasing vasodilatation.

Amlodipine has improved the treatment of feline hypertension. The drug decreases BP by as much as 30 to 50 mm Hg and has several other advantages. It is long acting and allows once-daily dosing. It works gradually, so a swift decrease in BP is less likely. The drug also conveniently reduces proteinuria, which has been shown to increase survival.

Despite the efficacy of amlodipine, the use of angiotensin-converting enzyme inhibitors (ACEIs) may be necessary when hypertension and proteinuria do not respond to amlodipine. Specifically, if the urine protein:creatinine ratio is >0.4 mg/dL on two tests at least 2 weeks apart, with inactive sediment and negative culture results, ACEIs must be considered. By inhibiting the angiotensin-converting enzyme, ACEIs reduce systemic peripheral resistance, thereby reducing vasoconstriction. When ACEIs lower filtration in the glomerulus, proteinuria is reduced. These benefits make ACEIs an ideal choice for cats with mild to moderate renal impairment, but not for cats with severe renal disease because azotemia can occur secondary to vasodilatation. Feline patients should be scheduled to return for BP measurement 7 days after starting or changing medication, then monthly, and every 3 to 6 months thereafter. When counseling owners, technicians must indicate that medication may be a lifelong commitment and that BP will be monitored regularly. Technicians must also make owners aware of the potential adverse effects of medication, including anorexia, vomiting, weakness, syncope, and organ failure.

Unlike in human medicine, no studies have supported sodium-restricted diets as an effective treatment for hypertension in cats. Rather, low-sodium diets have been implicated in reducing the glomerular filtration rate, activating the renin-angiotensin-aldosterone system, and inducing unsuitable kaliuresis. In addition, no studies support weight loss as an effective treatment. However, obesity has been proven to increase the risk of hypertension in dogs and humans, so technicians should encourage weight loss in cats, if it is necessary. Technicians should also encourage exercise if the patient does not have a disease or condition for which exercise is contraindicated. Further studies on lifestyle factors may find benefits of specific diets, weight loss, and exercise for cats.

Conclusion

Technicians must understand the causes, diagnosis, and treatment of feline hypertension and be able to measure BP correctly. Technicians are ideally placed to monitor for clinical signs, educate owners on causes and treatment, and help monitor patient outcome. Hypertension can have serious consequences if left untreated, but early intervention can produce positive results.

References

1. Clinical signs of TOD include
   a. bleeding in the eyes and problems with mentation.
   b. fundus changes and polyuria/polydipsia.
   c. a new heart murmur and hypothyroidism.
   d. a and b

2. An initial BP measurement in a feline patient is 180/90. The cuff site is level with the heart, and the circumference of the cuff is 30% of the circumference of the tail. The cat appears relaxed and has not moved. Your next step is to
   a. wait a minute and obtain two more readings because diagnosis should not be based on one reading only.
   b. stop to inform the veterinarian of the result.
   c. wait a minute and obtain at least four more readings because five to seven readings is ideal.
   d. allow the patient to walk around the room for 5 to 10 minutes to relax until the next reading.

3. Which of the following statements is incorrect?
   a. Cats with ocular TOD may have an aversion to light.
   b. If the patient is moving or purring, the base of the tail is a good site for BP measurement.
   c. Amlodipine blocks the influx of calcium into cardiac and smooth muscle, causing vasoconstriction and decreasing BP.
   d. Subtle renal diagnostic signs may include an increased urine protein:creatinine ratio and decreased urine concentration with normal creatinine and blood urea nitrogen levels.

4. Hypertension is/may be caused by
   a. a problem with regulation of cardiac output and systemic vascular resistance.
   b. renal, cardiac, and endocrine diseases.
   c. stimulation of the autonomic nervous system and the CNS.
   d. all of the above

5. After a cat receives a diagnosis of hypertension, the owner may need to
   a. initiate a weight loss plan, increase the cat’s exercise, and begin feeding a reduced-sodium diet.
   b. consider adjusting the cat’s diet to encourage weight loss if the cat is overweight.
   c. administer medication until the cat no longer shows overt clinical signs.
   d. b and c

6. BP measurement devices are subject to inaccurate readings because
   a. cats are especially vulnerable to stress caused by the clinic environment.
   b. a standard protocol for use has not been developed, allowing user variation.
   c. long-term monitoring of BP is not practical with these devices.
   d. a and b

7. A cat in renal failure had several BP readings around 198/110 and suddenly became blind. The cat was a bit anxious during the BP readings. The veterinarian should
   a. ask the owner to return with the cat the following day for another BP measurement because the cat was experiencing the white-coat effect.
   b. immediately prescribe amlodipine.
   c. prescribe amlodipine and recommend a diet that might induce kaliuresis because studies have shown that it changes the glomerular filtration rate.
   d. immediately prescribe an ACEI because the cat’s urine protein:creatinine ratio is likely >0.4 mg/dL.

8. Past developments in diagnosing and treating companion animal hypertension include
   a. better treatments, such as amlodipine.
   b. BP measurement devices that are common in general practice.
   c. successful validation of BP measurement devices.
   d. a and b

9. Which of the following statements is false?
   a. If a primary disease increases vascular resistance or cardiac output, hemodynamic changes occur.
   b. Direct and indirect BP measurements are both prone to inaccuracy.
   c. Clinical signs of feline hypertension include ocular changes.
   d. If the BP cuff site is lower than the heart by too much, the reading will be falsely high.

10. When you review your clinic’s feline BP measurement protocol with a new technician, which of the following should you mention?
    a. BP should be measured in a quiet room with no other patients.
    b. The cat should always be placed in sternal recumbency because it produces the most accurate readings.
    c. Systolic values should not vary by more than 30%.
    d. all of the above