

Hypertension Educational Toolkit



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Introduction

Systemic arterial hypertension (hypertension) is a well-recognized disorder in cats, although sometimes it is difficult to confirm. Early diagnosis is critical in avoiding damage to susceptible organs such as the heart, brain, eyes, and kidneys (target organs).

Instructions for Use

This educational toolkit is intended to be an implementation tool for veterinary professionals to access and gather information quickly. It is not intended to provide a complete review of the scientific data for feline hypertension. In order to gather a deeper understanding of feline hypertension, there are excellent resources for further reading linked in the left sidebar of the digital toolkit. We recommend that you familiarize yourself with these resources prior to using this toolkit.

To use the toolkit, click the tabs at the top in the blue navigation bar to access each page and read more information about each area including regulation, classification, clinical signs, treatment, measuring blood pressure, frequently asked questions (FAQs), and client resources. Each page also has an associated printable PDF that you can use in your practice. Additionally, a link to a printable version of the entire toolkit, which contains information from each page, is included in the left sidebar.

Acknowledgments



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Acronym Glossary

ACE Angiotensin Converting Enzyme

ARB Angiotensin Receptor Blocker

BCS Body Condition Score

BUN Blood Urea Nitrogen

BP Blood Pressure

CBC Complete Blood Count

CKD Chronic Kidney Disease

CNS Central Nervous System

CO Cardiac Output

GFR Glomerular Filtration Rate

HAC Hyperadrenocorticism

HDO High Definition Oscillometric

HR Heart Rate

MCS Muscle Condition Score

PD Polydipsia

PHA Primary Hyperaldosteronism

PU Polyuria

PVR Peripheral Vascular Resistance

SBP Systolic Blood Pressure

SDMA Symmetric Dimethylarginine

SV Stroke Volume

TOD Target Organ Damage

UPCR Urine Protein Creatinine Ratio

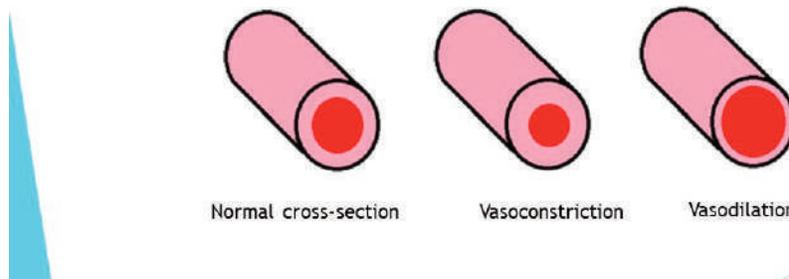
Regulation

Blood pressure (BP) is the product of cardiac output (CO) and total peripheral resistance (TPR).

- $BP = CO \times TPR$
- $CO = \text{heart rate (HR)} \times \text{stroke volume (SV)}$
 - Stroke volume is related to diastolic filling volume (preload), afterload, and contractility
 - The higher the ventricular filling volume, the higher the SV
 - The greater the strength of ventricular contraction, the greater the SV
- TPR, sometimes referred to as Peripheral Vascular Resistance, is determined by the diameter of blood vessels
 - Vasoconstriction leads to increased afterload resulting in high TPR
 - Vasodilation leads to decreased afterload resulting in low TPR

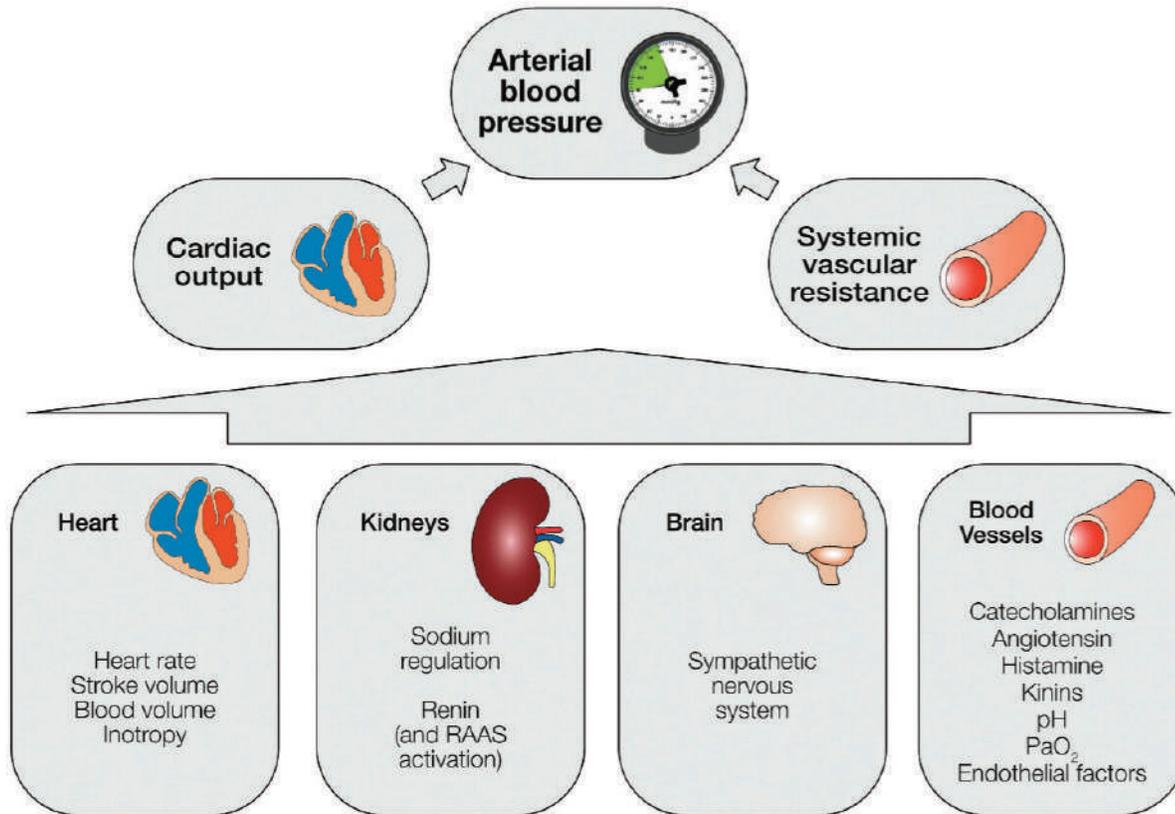
Determinants of Peripheral Vascular Resistance

- ▶ Diameter of blood vessels
- ▶ Vasoconstriction → increased afterload = high TPR
- ▶ Vasodilation → decreased afterload = low TPR



- Other determinants of blood pressure include:
 - Kidneys: sodium regulation via the kidneys and the renin-angiotensin-aldosterone system (RAAS)
 - Brain: sympathetic nervous system and central nervous system regulation
 - Blood vessels: vasculature tone regulation via release of catecholamines, angiotensin, histamine, kinins, pH, PaO₂, and endothelial factors

Regulation continued



Overview of some of the important mechanisms involved in the regulation of blood pressure.
RAAS = renin-angiotensin-aldosterone system.

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Classification

Systemic hypertension is defined as a sustained increase in systolic blood pressure (SBP) and is categorized as idiopathic, secondary, or situational.

Idiopathic Hypertension

- Persistent pathological hypertension in the absence of any identifiable underlying causes
- Accounts for approximately 13%-20% of cases in cats
- Need to rule out underlying conditions
 - Increased BP may induce polyuria (pressure diuresis), producing a low urine specific gravity (USG) <1.030, making it difficult to rule out kidney disease as an underlying cause
 - Approximately 12% of nonazotemic, nonhyperthyroid cats were hypertensive in one study
 - In another study, 7% of 133 apparently healthy, initially normotensive cats >9 years developed idiopathic hypertension

Secondary Hypertension

- Persistent pathological hypertension concurrent with a disease or condition known to cause hypertension OR hypertension associated with the administration of a therapeutic agent or ingestion of a toxic substance known to cause increased BP
- **Hypertension may persist even after effective treatment of the primary condition is initiated**
- If primary condition is resolved by therapeutic intervention, institute serial follow-up evaluations
- **Cats often have more than one condition, so complete evaluation for other causes is necessary**
- **Chronic Kidney Disease (CKD)**
 - Most common condition associated with hypertension
 - **Azotemia has been reported in up to 75% of hypertensive cats**
 - Between 19%-65% of cats with CKD have been found to be hypertensive
 - **Prevalence and severity of hypertension does not appear to be related to severity of CKD**
 - Cats with congenital kidney insufficiency may have normal serum creatinine and BUN levels but decreased USG
 - Exact pathogenesis is not completely understood
- **Hyperthyroidism**
 - Hypertension has been documented in 10%-23% of cats with hyperthyroidism at the time of diagnosis
 - Not uncommon for hyperthyroid cats to have concurrent CKD
 - **Approximately 25% of hyperthyroid cats normotensive at diagnosis become hypertensive after treatment of their condition**
 - Pathophysiology of hyperthyroid induced hypertension is poorly understood
 - Hyperthyroid cats should have their BP closely monitored before, during, and after treatment
- **Diabetes Mellitus (DM)**
 - **Severe hypertension in cats with DM is uncommon:**
 - Prevalence rate of 0%-15%
 - Often confounded by concurrent conditions, such as CKD
 - **Important to look for comorbidities in cats with DM if hypertension is identified**





Classification continued

Secondary Hypertension continued

- **Primary Hyperaldosteronism (PHA)**

- **Uncommon condition in cats**
- PHA is an excess production of aldosterone independent of its regulator, angiotensin II
- Typically due to an adrenal tumor
- Hypertension is present in 50%-100% of cats with PHA
- PHA may be underdiagnosed, mistaken for CKD
- **Low serum potassium levels, weakness, polyuria (PU)/polydipsia (PD), and hypertension unresponsive to therapy should prompt further investigation**
- Clinical findings serving as clues: low potassium levels, PU/PD, ocular changes
- Blood pressure, potassium levels difficult to regulate with conventional therapy

- **Pheochromocytoma**

- **Rare tumor in cats**
- Excessive circulating catecholamine levels
- Sustained or paroxysmal bouts of hypertension

- **Hyperadrenocorticism (HAC)**

- **Uncommon condition in cats**
- Prevalence of hypertension reported to be 19%

- **Medications Associated with Hypertension**

- Erythropoiesis-stimulating agents
- Phenylpropanolamine
- Ephedrine
- Chronic high-dose sodium chloride
- **Albuterol intoxication**

Situational Hypertension

- BP increase that occurs during in-practice measurement in an otherwise normotensive individual
- Caused by autonomic nervous system alterations resulting from excitement or anxiety on higher centers of the central nervous system (CNS)
- Resolves under conditions that decrease or eliminate the physiologic stimulus
- Can lead to an erroneous diagnosis of pathologic systemic hypertension – there is no justification to treat situational hypertension in cats
- There are many situations that may induce situational hypertension resulting in falsely elevated BP readings, including:
 - Acute situational (iatrogenic hypertension)
 - Anxious cats more prone
 - Trip to practice
 - Pain
 - Hospitalization
 - Intravenous fluid therapy
 - Hospitalization in same ward as dogs, ward with lights on all the time
 - Handling by staff who wear heavy scents, scrubs smelling of dogs
 - Prolonged hospital stays
 - Too frequent handling, disturbing unnecessarily when resting
 - Chronic situational
 - Generally stressed cats – behavioral
 - Pain – osteoarthritis (OA), periodontal disease, systemic disease

Confirm hypertension with repeat BP measurements at a separate visit prior to starting medical therapy except in emergent situations where there is clear evidence of ocular or neurological target organ damage (TOD). Use minimal, gentle Feline-Friendly handling (visit catvets.com/handling) in a calm, quiet environment to reduce situational hypertension.



Classification continued

Categorization

Categorization of hypertension ideally includes:

- Complete and thorough history including diet, medication, and supplements
- Complete physical examination including ophthalmic exam
- Repeatable BP levels (note type of BP device, cuff size, limb used – see BP Assessment Form in the digital toolkit)
- Complete blood count (CBC), chemistry profile, Symmetric Dimethylarginine (SDMA), Total T4, Free T4
- Urinalysis, urine culture, urine protein creatinine ratio (UPCR)

Additional diagnostic tests may be considered:

- Thoracic radiographs
- Abdominal radiographs
- Echocardiogram
- Electrocardiogram
- Abdominal ultrasound
- Potentially ACTH stimulation test, aldosterone level

Clinical Signs

Sustained high blood pressures target the arterial and arteriolar systems of the eyes, brain, heart, and kidney (target organs). The changes are referred to as target organ damage (TOD). The observation of TOD can help raise the suspicion of, and increase the opportunity to, diagnose hypertension in the cat.

TOD: Eyes

- Chronic, sustained increases in systolic blood pressure (SBP) can overwhelm any autoregulatory mechanisms or blood-retinal barriers, resulting in hypertensive retinopathy, choroidopathy, and optic neuropathy
 - Hypertensive retinopathy: tortuosity of retinal vessels, retinal hemorrhages, intraretinal edema
 - Hypertensive choroidopathy: severe bullous retinal detachment, choroidal hemorrhages
 - Hypertensive optic neuropathy: papilledema and secondary optic nerve atrophy



- **Presenting complaints:** blindness, mydriasis, vitreous hemorrhage, hyphema, none
- **Potential clinical findings:** blindness, mydriasis, retinal hemorrhage, multifocal retinal edema, retinal vessel tortuosity, retinal perivascular edema, papilledema, vitreous hemorrhage, hyphema, secondary glaucoma, retinal degeneration
- **Changes can occur as early as 168 mmHg SBP and risks increase substantially >180 mmHg SBP**
- The benefit of routine fundic examinations:
 - Become familiar with normal
 - Become comfortable with examination techniques
 - Detect changes early before retinal detachment
 - Detect hypertension early as ocular changes may prompt blood pressure testing

Clinical Signs continued

TOD: Eyes continued



Direct Retinal Exam



Indirect Retinal Exam

- **The one-minute retinal exam**

- Pupillary dilation is essential for a good retinal examination. Ensure the cat does not have glaucoma, then dilate the pupils with 1-2 drops of tropicamide. Dilation takes 5-10 minutes
- Darken the room
- **Direct**
 - Equipment: ophthalmoscope
 - Provides small field of view at higher magnification
 - Images are upright
- **Indirect: monocular and binocular**
 - Equipment: handheld lens and bright focal light source or indirect headset
 - Preferred method for small cats
 - Larger field of view
 - Images are inverted and reversed

TOD: Brain

- Neurologic signs may occur in as many as 29%-46% of hypertensive cats
- Anatomic changes in hypertensive encephalopathy include:
 - White matter edema and vascular lesions described in humans with hypertension
 - Vasogenic edema in the occipital and parietal lobes of the brain
 - Hemorrhage and infarction in the CNS
- A response to anti-hypertensive medications can be observed early in the disease process
- Hypertensive encephalopathy is more likely to occur in cats with a sudden increase in blood pressure (BP), an SBP above 180 mmHg, or both
- **Presenting complaints: nighttime howling, acting lost, disorientation, balance disturbances, vision loss, hearing loss, altered mentation, seizures, other changes in behavior**



Clinical Signs continued

TOD: Brain continued

- **Potential clinical findings:** signs consistent with intracranial disease including lethargy, ataxia (subtle), vestibular signs, head tilt, nystagmus, evidence of seizure activity, evidence of stroke, and/or paralysis
 - Behavioral changes may not be observed during exam
 - **Signs of hypertension may be misattributed to cognitive dysfunction syndrome**
 - Other hypertension-related risks in the CNS include **ischemic myelopathy** of the cranial cervical spinal cord, potentially leading to ambulatory tetraparesis or tetraplegia. These cats may present with SBP readings below normal

TOD: Heart and Vasculature

- Sustained hypertension is associated with increased systemic vascular resistance, which can lead to increased left ventricular wall stress resulting in concentric left ventricular hypertrophy
- Left-sided congestive heart failure is an uncommon complication
- Aortic aneurysm/dissection is a rare complication and requires a high index of suspicion prompting advanced imaging for diagnosis
- **Presenting complaints: signs consistent with heart disease (lethargy, weakness, collapse, lameness, inability to use limbs, pain), none**
- **Potential clinical findings:** systolic murmur, gallop murmur, arrhythmias as an indication of hypertrophic disease, saddle thrombus (absence of pulse, cold extremity, look for cyanosis at nail beds, pain), increased heart rate, increased respiratory rate, jugular vein distension (congestive heart failure), epistaxis
- Changes can occur with sustained hypertension, with risks increasing when >180 mmHg SBP
- **Diagnostic tests:** auscultation, palpation of peripheral pulses, assessing for jugular vein distension, thoracic radiographs, electrocardiogram, echocardiogram
- Degree of hypertrophy does not correlate with magnitude of hypertension
- Check and compare pulses in all limbs

TOD: Kidneys

- Sustained hypertension is associated with progression of kidney disease, but a direct cause remains uncertain. Many cats with hypertension have concurrent CKD and which came first is often difficult to determine
- A controlled study of over 200 cats demonstrated increased glomerulosclerosis and arteriosclerosis in cats with elevated BP
- Hypertension has been associated with proteinuria and histological kidney injury in both experimental models and naturally occurring disease
- Proteinuria has been associated with more rapid progression of kidney disease
- **Presenting complaints: signs consistent with kidney disease (PU, PD, weight loss, decreased appetite, vomiting, lethargy), ocular lesions, uremic breath, decreased body condition score (BCS) or muscle condition score (MCS), none**
- **Potential clinical findings:** weight loss, fundic changes, uremic breath, oral ulcerations, small irregular kidneys or big kidney/little kidney upon abdominal palpation, none
- Clinical pathology findings: serial increases in serum creatinine, SDMA, persistent proteinuria or microalbuminuria, decreased glomerular filtration rate (GFR)
- Changes can occur with sustained hypertension with a moderate risk increasing when >160 mmHg SBP
- **Diagnostic tests:** serum creatinine, blood urea nitrogen (BUN), SDMA, urinalysis and quantitative assessment of proteinuria or albuminuria, GFR measurement, survey abdominal radiographs, abdominal ultrasonography
- Hypertensive cats may be nonazotemic but proteinuric
- Establishing baseline kidney biomarker values is important for monitoring progression of disease and response to therapy. Watch for trends in values!
- Recognize onset of kidney dysfunction early



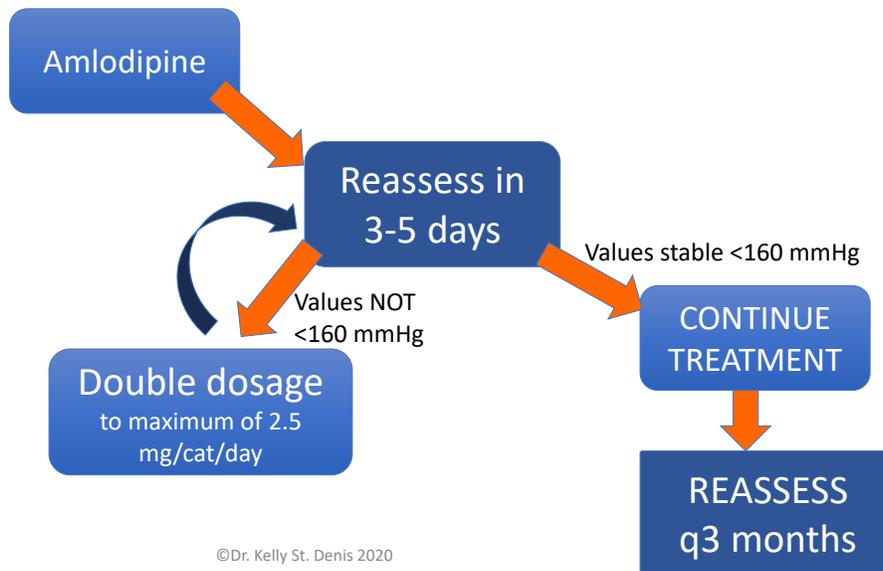
Treatment

Goals of Treatment

1. TOD: decrease risk, reverse damage (if possible)
2. Improve or maintain health of cat
3. In cases of secondary hypertension, treat primary disease
4. Target ≤ 150 -160 mmHg SBP
 1. Investigate other potential causes of TOD
 2. Monitor BP and clinical response to antihypertensive therapy carefully
 3. Perform medication withdrawal trial once stable if there is any uncertainty about hypertension diagnosis

Amlodipine Besylate

- Calcium channel blocker
- Potent peripheral arterial dilator
- Dosage: 0.625-1.25 mg/cat PO q24h
- Dosage: 0.125-0.25 mg/kg PO q24h
- **Rapid mode of action: reassess in 3-5 days**



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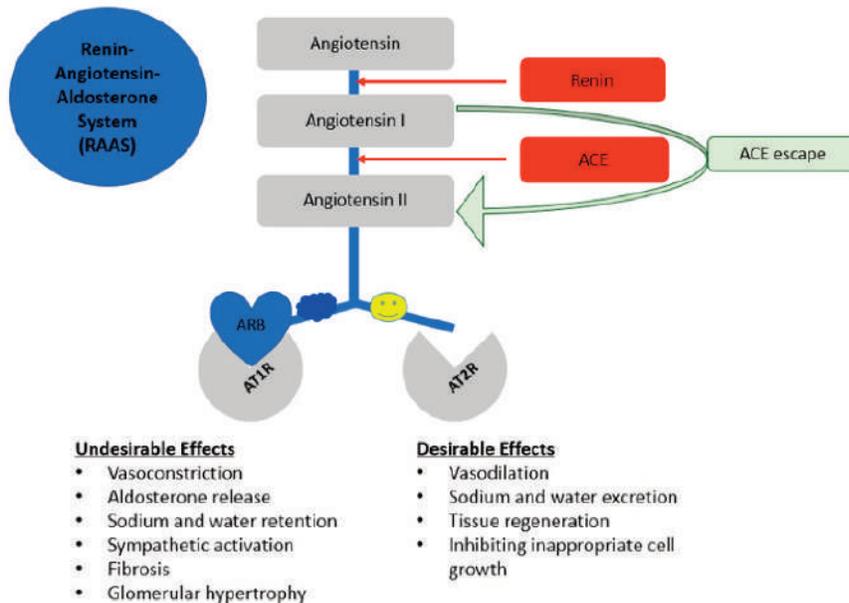
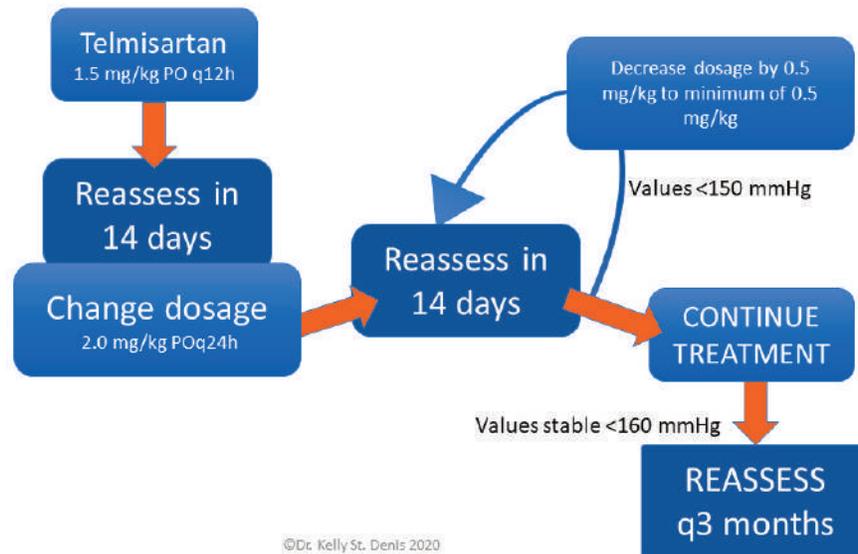
• Troubleshooting partially or uncontrollable hypertension with amlodipine:

- Assess compliance
- Review dosage - maximum 2.5 mg/cat q24h
- May require additional medications (0%-40% patients):
 - Telmisartan – Dosage: 1.0 mg/kg PO q24h
 - Benazepril – Dosage: 0.5-1.0 mg/kg PO q24h
 - Atenolol
- Consider possible PHA

Treatment continued

Telmisartan

- ARB
- In Canada: licensed for the reduction of proteinuria associated with CKD in cats
- In the USA: licensed for the treatment of feline hypertension
- Dosage: 1.5 mg/kg PO q12h 14d then 2.0 mg/kg PO q24h long term
- Reduce dosage in 0.5 mg/kg dose increments to a minimum of 0.5 mg/kg
- **Timing for rechecks will vary with the individual patient**
- **Administered directly into the mouth, or next to or on top of a small amount of food. Do not mix into a full meal in case the patient does not finish the meal**





Treatment continued

ACE Inhibitors: Benazepril, Enalapril, Ramipril

- Insignificant impact on hypertension and therefore **should not be used as primary drug or alone as a treatment for systemic hypertension**
- May be beneficial as an adjunct to refractory treatment with amlodipine
- Do not add if patient is dehydrated
- Benazepril – Dosage: 0.5-1.0 mg/kg PO q24h

β -Blocker: Atenolol

- Indicated in some cases with tachycardia or hyperthyroidism
- Dosage: 1.0-2.0 mg/kg PO q12h

Spirolactone

- Indicated in refractory hypertension secondary to hyperaldosteronism
- Mode of action: Aldosterone antagonist
- Dosage: 1.0-2.0 mg/kg PO q12h

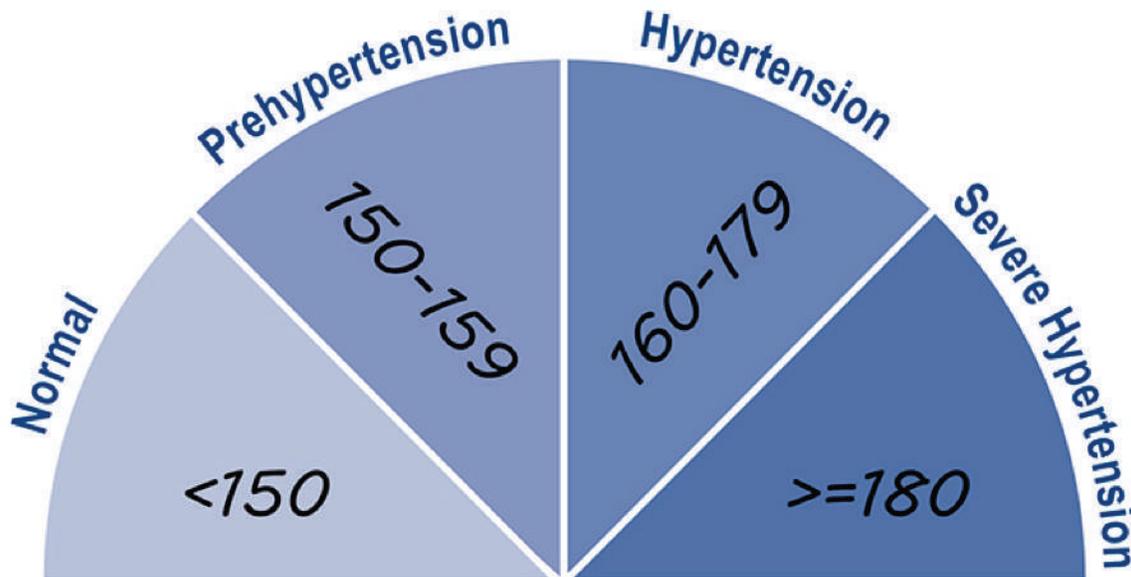


Measuring Blood Pressure

Routinely checking blood pressure at all ages establishes baseline measurements for the individual cat that can be used to track trends and aid in early detection of hypertension. This is especially important in cats 10 years of age and older, and cats at risk for secondary hypertension. Routine blood pressure measurement may also help the cat get used to the procedure and reduce false elevations from situational hypertension. Sustained high blood pressures put cats at risk for TOD.

SBP(mmHg)	Category	Risk of TOD
<150	Normal	Minimal
150-159	Borderline (Prehypertension)	Low
160-179	High (Hypertension)	Moderate
>=180	Severe Hypertension	High

**This table was created based on the ISFM Hypertension Guidelines. To view guidelines, please visit <https://journals.sagepub.com/doi/pdf/10.1177/1098612X17693500>.*

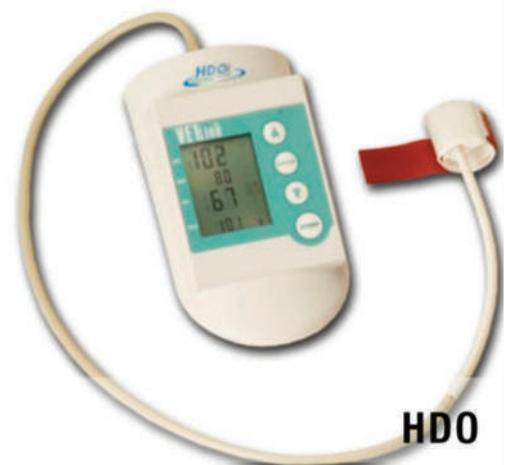
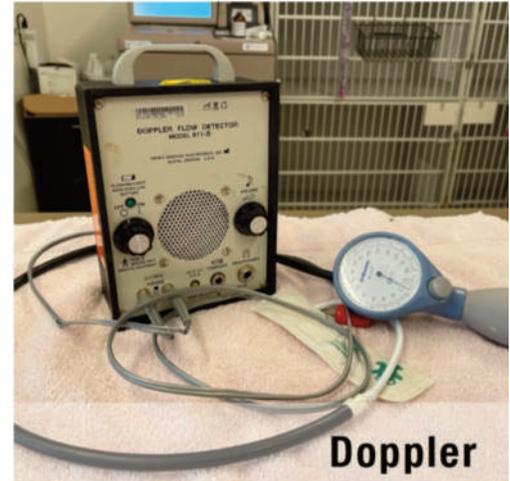


Measuring Blood Pressure *continued*

Equipment

- Direct
 - Central catheter-arterial cannulation
 - Radio-telemetric implant
- Indirect
 - Doppler
 - Oscillometric
 - HDO
- Doppler sphygmomanometry
 - Good correlation and accuracy compared with direct
 - Requires alcohol or shaved area over artery of interest
 - Requires fixation of the Doppler over the artery with hook and loop self-fasteners
 - Noise may disturb cat – use headphones
- Traditional Oscillometric
 - Less accurate than Doppler in conscious cats
 - Often underestimates BP at higher values
 - Requires cuff placed on limb or tail
 - No noise!
- High Definition Oscillometric (HDO)
 - Shown to produce accurate results compared with direct BP in conscious cats
 - Requires cuff placed on limb or tail
 - Moderate noise
- Check BP equipment calibration weekly if possible, semiannually at a minimum

Try to obtain BP at the beginning of the examination before handling or any diagnostic tests. Assign and train specific technicians to measure BP. Cat Friendly Veterinary Professionals (CFVPs) are ideally suited for this role. Please visit catvets.com/certificate to learn more about the Cat Friendly Certificate Program.



Measuring Blood Pressure *continued*

Environment

- Conduct in a calm, quiet room away from other animals
- Allow the cat to adjust to the room and explore if desired (ideally 5-10 minutes)
- Having the owner present may be helpful
- Allow the cat to rest on its own bedding or a warm towel in a comfortable position
- If carrier has a removable top, allow the cat to stay in the bottom of the carrier if preferred (some cats prefer to be partially or fully covered with a blanket)
- Consider using a synthetic facial pheromone to reduce stress
- Use quiet clippers if shaving fur is needed to detect blood flow (Doppler), and allow cat time to resettle before measuring SBP
- Use minimal, gentle Feline-Friendly handling (visit catvets.com/handling). Some cats will sit still with ZERO restraint, and ZERO restraint is ideal
- If the cat becomes stressed, take a break and allow the cat to resettle or reschedule if necessary



Cuff Selection and Placement

- Measure cuff for every patient each time BP is checked
- Cuff width should be 30%-40% the circumference of the limb or tail which it is applied
- Some cuffs show "optimum zones" to help determine the 30%-40% circumference
- Use a flexible metric ruler to measure circumference
- A cuff that is too large falsely decreases readings
- A cuff that is too small falsely elevates readings
- Doppler: cuff may be placed mid-radius on forelimb, **proximal to hock on hindlimb**, or tail base
- Oscillometric: cuff may be placed mid-radius on forelimb, **mid-tarsus on hindlimb**, or tail base
- **Select a limb positioned at heart level whenever possible**
 - Cuff placement above the plane of the heart falsely decreases readings
 - Cuff placement below the plain of the heart falsely increases readings
 - If in lateral recumbency, use the nondependent leg
- Tail is preferable for HDO and cats with osteoarthritis (seniors) or cats with sensitive paws
- Ensure the inflation tube is positioned over the artery to be occluded
- Ideally, direct transducer tubing should be away from the cat and towards the monitoring device
- Secure the cuff with hook and loop self-fasteners. Only use a very loose piece of tape if absolutely necessary, as tightly wrapped tape will restrict airflow to the cuff's bladder and cause inaccurate readings
- Do not place cuff on a compromised limb or a limb with an arterial catheter, IV catheter, or pulse Ox probe
- Review the Cuff Do's and Don'ts for additional information and examples of best practices
- See next page for full size print version of the Blood Pressure Cuff DO's and DON'Ts form.

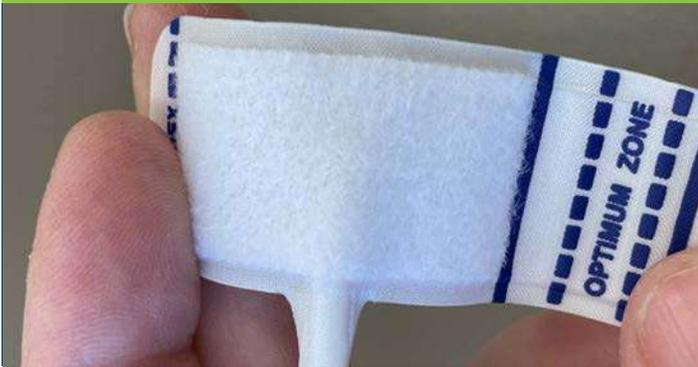


Top: Cuffs showing optimal zones

Bottom: Proper cuff placement

Blood Pressure Cuff DO's and DON'Ts

DO



✓ CLEAN CUFF IN GOOD CONDITION

DON'T



✗ CUFF WITH FUR COVERING THE HOOK AND LOOP SELF-FASTENER



✓ CUFF PLACED WITH TRANSDUCER TUBING DIRECTED AWAY FROM THE CAT



✗ CUFF PLACED WITH TRANSDUCER TUBING DIRECTED TOWARD THE CAT



✓

- CUFF POSITIONED AT HEART LEVEL
- CUFF PLACED ON NONDEPENDENT LEG IN LATERAL RECUMBENCY
- TRANSDUCER TUBING AWAY FROM THE CAT



✗

- CUFF POSITIONED BELOW HEART LEVEL
- CUFF PLACED ON DEPENDENT LEG IN LATERAL RECUMBENCY
- TRANSDUCER TUBING TOWARD THE CAT

For more information, visit catvets.com/hypertension-toolkit.

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Measuring Blood Pressure *continued*

Taking BP Measurements

- Use the minimum number of people necessary (no more than two if possible)
- The cat can be positioned in ventral or lateral recumbency. The cuff needs to be in plane with the level of the heart whenever possible. Above (false decrease) or below (false increase) changes the readings
- The cat must be still and relaxed during readings. Movement and stress will cause false readings
- Doppler
 - Sound may disturb cats. Use headphones. If not available, use lowest volume needed to hear pulsatile blood flow
 - Blood flow detection requires good contact between the Doppler probe and the skin. This is best achieved with alcohol to dampen the hair and skin, and plenty of ultrasound gel
 - Position probe with gentle pressure to avoid restricting blood flow, and adjust the position slowly until pulsatile blood flow is heard
 - Inflate and deflate the cuff a few times before taking recordings to help the cat to get used to the sensation
 - Slowly inflate the cuff to 20-40 mmHg above the point where blood flow is no longer heard
 - Allow air to bleed from the cuff slowly. SBP is the point at which pulsatile blood flow is first detected
- A minimum of six readings should be taken, with the first reading discarded and the remainder averaged
- Use the same patient position, limb, cuff, and machine when rechecking a patient to document trends accurately
- Document details, including cuff site, cuff size, staff, and if the owner was present. The BP Assessment Form in the digital toolkit can be used to record data from initial and recheck readings
- See next page for full size print version of the Blood Pressure Assessment Form.



Blood Pressure Assessment Form

CAT'S NAME

OWNER'S NAME

CAT'S AGE

WEIGHT

WHO'S IN THE ROOM

DATE

TIME

ROOM

PERFORMED BY

MEDICATION(S) GIVEN & TIME

CAT'S POSITION

Ventral

Lateral

Other (specify): _____

CAT'S LOCATION

Carrier

Exam Table

Other (specify): _____

CAT'S Demeanor (Subjective)

Calm

Slightly Anxious

Anxious

Stressed

EQUIPMENT USED

Doppler

Oscillometric

HDO

CUFF SIZE _____

CUFF SITE

Tail

Front limb (L/R)

Hind limb (L/R)

POSITION OF CUFF (e.g. below elbow) _____

SBP READINGS (mmHg) 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____

AVERAGE (discard first reading) _____

TREATS PROVIDED _____

FACIAL PHEROMONES USED

Diffuser

Spray

Wipe

CAT'S PREFERENCES NOTED (describe experience in detail for future readings) _____

*This form can be printed, saved on a desktop, or scanned into the patient's medical record.
Recheck blood pressure measurements can be added on subsequent visits.*

For more information, visit catvets.com/hypertension-toolkit.



Measuring Blood Pressure *continued*



Tips for Successful Blood Pressure Management

- Avoid measuring BP while the cat is moving
- Attempt to schedule BP appointments at times when the practice is less busy
- Consider technician appointments for BP readings
- If errors, check for:
 - Expired tubing/cuffs
 - Broken Doppler crystals
 - Not cleaning/covering crystal after each use
 - Kinked/cracked tubing
 - Poor hook and loop self-fastener closure due to fur/fuzz
 - Degradation of inflation bulb and pressure-release valve
 - Degradation of cuff bladder
- If false elevations occur, check for:
 - Correct size of cuff (too small increases BP)
 - Cuff is not deflating or has stretched areas
 - Cuff is being overly inflated
 - Cuff is not vertical to the heart
- Use minimal Feline-Friendly handling (visit catvets.com/handling) whenever possible



FAQs

Which machine is best for measuring blood pressure in cats?

Both Doppler and HDO provide accurate readings when used correctly. Staff training with consistent protocols for the equipment used is key. When using Doppler, headphones are recommended to reduce the sound that may disturb the cat and contribute to acute situational hypertension. Additional information can be found on the Measuring Blood Pressure page of the Toolkit.

What is the ideal patient position for obtaining an accurate BP measurement?

The cat can be positioned in ventral or lateral recumbency. The cuff needs to be at the level of the heart whenever possible. Cuff placement above the plane of the heart falsely decreases readings. Cuff placement below the plane of the heart falsely increases readings. In order to obtain accurate BP readings, it is essential to allow the cat to settle into a comfortable position where the cat will remain still. Ultimately, the cat will determine their most comfortable position.

Can I use a sedative prior to measuring BP?

Many sedatives will impact blood pressure, depending on their impact on the cardiovascular system.

Does the use of gabapentin prevent accurate measurements of blood pressure?

Using reasonable doses of gabapentin pre-appointment should not be avoided if it eases the cat's anxiety and improves the patient experience. Document the dose given and the time the gabapentin was administered. Any evidence of TOD must be taken into consideration when interpreting readings. If hypertension is suspected, reevaluation on a lower dose of gabapentin can be helpful in making a determination. The impact of gabapentin on BP is not clear at this time.

Does the use of trazadone prevent accurate measurements of blood pressure before the veterinary visit?

Yes. In one study, trazadone was shown to significantly lower SBP in healthy cats.

We have a cat that does not respond to gabapentin and requires full sedation. Do sedatives such as butorphanol, ketamine, or dexmedetomidine affect blood pressure?

Yes. The patient should be monitored throughout the sedated procedure and trends monitored. If the patient remains at borderline high or high, the patient may actually be hypertensive, but this determination must be made carefully. It is important to discuss any clinical signs observed at home that can help determine if the cat is showing the signs of hypertension. Evidence of TOD is essential in assessing these cases in addition to signs at home.

continued on next page



FAQs continued

What other measures can be used to help calm the feline patient?

There are many Cat Friendly ways to reduce stress. Refer to the AAFP's [Handling Guidelines](http://catvets.com/handling) (catvets.com/handling) and [Nursing Care Guidelines](http://catvets.com/nursing-care) (catvets.com/nursing-care) for more in-depth information. Additionally, the Cat Friendly Practice Program® and Cat Friendly Certificate Program provide an abundance of tips and ideas that can help calm each individual patient. Some ideas include:

- Use feline facial pheromones (diffuser and spray on scrubs/towels/blankets 15-20 minutes beforehand)
- Utilize a quiet environment and private room
- Allow the cat time to acclimate to the room and explore (if cat desires) prior to obtaining blood pressure
- Utilize feline friendly staff who have knowledge about reading feline behavior/facial cues and body language, utilizing feline-friendly handling, and understanding ways to reduce stress and to assess for each patient (sign up staff to learn about this through the Cat Friendly Certificate Program at catvets.com/certificate)
- Ensure the cat is not near loud noises (i.e., barking dogs, high traffic areas with a lot of talking, washing machine, etc.)
- Ensure the cat is not in a visual line of sight with other animals before and during the readings
- Determine the preferred location for each cat (i.e., under a warm fluffy towel partially or completely covered, in a cat bed, in the bottom half of their carrier with or without being covered by a blanket, ventral or lateral recumbency, etc.)
- Document what the cat prefers so it can be utilized during future visits
- Speak in a low voice and avoid sounds that mimic hissing, such as “shhh”
- Cats should feel safe and be given the opportunity to hide if needed
- Remove “distressing” scents beforehand (i.e., cleaning/disinfecting tables/equipment, scent from another animal on scrubs, etc.)
- Take a break if the cat’s fear or anxiety is escalating
- Provide [recommendations](http://catfriendly.com/getting-cat-veterinarian) (visit catfriendly.com/getting-cat-veterinarian) to reduce the stress prior to the cat arriving at the practice because the visit starts at home (i.e., carrier and vehicle acclimation, etc.)

How many readings should be obtained for accurate results?

A minimum of six readings should be taken, with the first reading discarded and the remainder averaged. The cuff should be inflated slowly to allow the cat to acclimate to the feeling of pressure on the limb and not over-inflated past the end number of the gauge used. It is important to avoid rushing when obtaining blood pressure as false elevations can occur. The Blood Pressure Assessment Form can be used to record results.

How long do I have to wait between readings?

Allow the cuff to deflate fully before proceeding to the next reading. The blood vessels do not require any ‘resting’ period between readings. If the cat is becoming stressed, anxious, or frustrated, consider taking a break.

How can you tell when blood pressure cuffs need to be replaced?

Discoloration, incomplete cuff closure, over-stretched areas on the cuff balloon, or needing to use tape or other methods to keep the cuff closed indicate a cuff should be disposed of. The cuff should stay closed by its own hook and loop self-fastener closure at all times and not peel away from itself when inflated. With regular use, a blood pressure cuff tends to have a shelf life of six months.

continued on next page





FAQs continued

During general anesthesia, which limb should be used to monitor blood pressure?

The limb with no intravenous/arterial catheter should be used. If the limb with a catheter is used, pressure measurements may be affected, and backflow of fluids into the line can occur. The area farthest away from the incision/surgery site is ideal.

When should blood pressure be evaluated after starting medication?

While recheck frequency needs to be tailored for each individual patient, there are treatment templates that can be referred to for general guidance.

Can blood pressure be taken on pediatric patients?

Yes! Any critically ill kitten should have its blood pressure monitored just like an adult cat. Veterinary cuffs size 1-2.5 are available for pediatric patients.



Client Resources

Catfriendly.com Client Resources

- Feline Hypertension - catfriendly.com/feline-hypertension
- Giving Your Cat Medication - catfriendly.com/giving-cat-medication
- Getting Your Cat to The Veterinarian - catfriendly.com/getting-cat-veterinarian

Responses to Common Cat Caregiver Questions

This flyer includes common questions you might receive from cat caregivers. You can print the document and hand it out to your clients. See next two pages for full size print version.

Feline Hypertension Flyer for Cat Caregivers

This flyer is a handout to cat caregivers whose cat has been diagnosed with feline hypertension. See next two pages for full size print version.

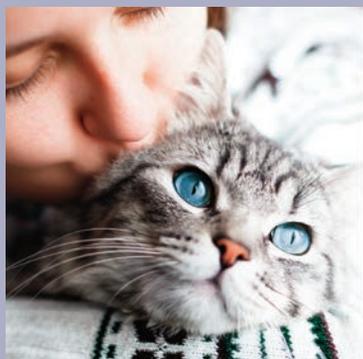
Feline Hypertension

COMMON CAT CAREGIVER QUESTIONS



What causes high blood pressure in cats?

There are a number of diseases that can cause high blood pressure in cats, such as kidney disease, hyperthyroidism, and heart disease. There are some uncommon diseases and medications that can cause high blood pressure in cats as well. There is also a term called “idiopathic hypertension” which is used to describe cases where no underlying cause has been identified. Additionally,



some cats will experience temporary elevations in blood pressure when they are stressed, but their blood pressure is normal the rest of the time. These cats are said to have “situational hypertension.”

What are some of the signs of feline hypertension I can look out for?

Noticeable signs of high blood pressure often relate to damage in the kidneys, eyes, brain, and heart. A few common signs of feline hypertension include:

- Trouble breathing
- Unexplained changes in behavior
- Increased drinking
- Evidence of blindness (e.g., bumping into furniture, missing jumps)

The Cat Friendly Homes *Feline Hypertension* webpage (catfriendly.com/hypertension) describes these signs. Some cats will not show any signs. Routine veterinary visits are critical because having your cat’s blood pressure checked as part of their routine wellness checkup will help establish your cat’s baseline blood pressure, monitor trends, and detect high blood pressure even if your cat is not showing signs.

What is involved with screening a cat for feline hypertension?

Blood pressure is determined using a device that either measures the sound of blood flow through the blood vessels (Doppler) or the motion of the blood through the blood vessels (Oscillometry). Blood pressure is measured in cats very much like it is measured in humans. However, smaller blood pressure cuffs are used as well as different sites for cuff placement, including the tail.

My cat was diagnosed with high blood pressure. How can I help my cat?

A diagnosis of feline hypertension means your cat may need to be given medication to lower their blood pressure for the rest of their life. Blood pressure medications for cats are administered once to twice a day. The Cat Friendly Homes *Giving Your Cat Medication* webpage (catfriendly.com/giving-cat-medication) has tips for administering oral medications with links to videos demonstrating how to give a cat medication in both pill and liquid form. Be sure to schedule the follow-up visits that your veterinarian recommends. When first diagnosed, your veterinarian will want to see your cat more often to make sure he is responding to treatment and his blood pressure is coming under control. Afterwards you can expect to have your cat’s blood pressure checked about every 3-6 months.

How can I help keep my cat calm when his blood pressure is checked in order to help reduce false elevated readings from stress?

Your cat’s veterinary visit begins at home. The best way to reduce stress prior to the visit is to help your cat become comfortable and familiar with the carrier. This can help keep your cat calm prior to arriving in the veterinary practice. The Cat Friendly Homes *Getting Your Cat to The Veterinarian* website (catfriendly.com/getting-cat-veterinarian) provides helpful tips and a video about helping your cat learn to associate the carrier with a positive experience, and getting an unwilling cat into the carrier.

For more information, visit
catfriendly.com/hypertension.



Feline Hypertension (High Blood Pressure)

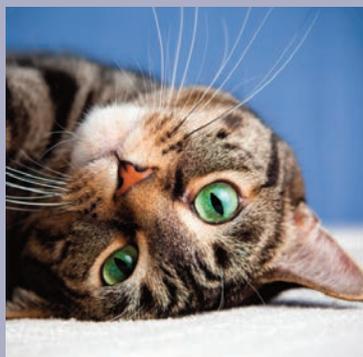
INFORMATION FOR CAT CAREGIVERS



Feline Hypertension, or high blood pressure, is a condition in which a cat's blood pressure is elevated above normal, safe levels. As cats age their risk of developing high blood pressure increases.

Signs and Symptoms of Hypertension

In both humans and cats, high blood pressure often has no signs or symptoms. This makes the condition very dangerous since it can go unnoticed. High blood pressure has harmful effects on the following four main body systems. When blood pressure is too high, damage to these systems occurs, but signs of damage are not always observed right away:



- **Heart:** trouble breathing, signs of stroke including dragging a limb or both hindlimbs, collapse
- **Brain:** unexplained changes in behavior including increased meowing and howling
- **Kidneys:** increased drinking, large urine clumps in the litter box, vomiting
- **Eyes (retinas):** Sudden blindness including bumping into furniture, missing jumps, walking along walls to help with direction

What Causes Hypertension in Cats

High blood pressure in cats can be related to a number of factors. Some cats with kidney disease will develop high blood pressure. This can occur because the kidneys play a role in controlling blood pressure. When the kidneys are damaged, the cat's blood pressure may increase. A number of other conditions, including heart disease and hyperthyroidism, can also contribute to high blood pressure in cats. In some cases, the cause cannot be identified and this is termed 'idiopathic hypertension.'

Testing for Feline Hypertension

It is extremely important to bring your cat for regular veterinary checkups because there are so many factors that can cause high blood pressure and your cat may not ever show any symptoms. At the check-up, the veterinary team will measure your cat's blood pressure which will help establish your cat's baseline blood pressure, monitor trends, and detect high blood pressure even if your cat is not showing signs. High blood pressure is diagnosed in cats much the same as it is in humans. A blood pressure cuff is placed on the cat's limb or tail, and the cuff is inflated and deflated. Blood pressure is determined using machines that measure the sound of blood flow through the blood vessels (Doppler) or the motion of the blood through the blood vessels (Oscillometry).

Treating Hypertension in Cats

There are effective treatments for controlling high blood pressure in cats. Medication to regulate your cat's blood pressure will need to be given each day. Your veterinarian will want to recheck your cat shortly after starting medication to ensure the right dose is being used. Your cat will most likely need to be given daily medication for the rest of his life. Once your cat's blood pressure is under control, your veterinarian will recommend checking blood pressure every three to six months to make sure it stays stable.



For more information, visit catfriendly.com/hypertension.





Further Reading

Guidelines

ISFM Consensus Guidelines on the Diagnosis and Management of Hypertension in Cats.
journals.sagepub.com/doi/pdf/10.1177/1098612X17693500.

AAFP/ISFM Feline-Friendly Handling Guidelines. journals.sagepub.com/doi/pdf/10.1016/j.jfms.2011.03.012.

Other Resources

AAFP Webinar: Feline Hypertension: Essentials in Diagnosis and Management.
catvets.com/education/online/webinars/feline-hypertension.

ACVIM Guidelines for the Identification, Evaluation, and Management of Systemic Hypertension in Dogs and Cats Table 5: Evidence of Target Organ Damage (TOD). ncbi.nlm.nih.gov/pmc/articles/PMC6271319/table/jvim15331-tbl-0005/?report=objectonly.

ACVIM Guidelines for the Identification, Evaluation, and Management of Systemic Hypertension in Dogs and Cats Table 1: Protocol for Accurate Blood Pressure (BP) Measurement.
ncbi.nlm.nih.gov/pmc/articles/PMC6271319/table/jvim15331-tbl-0001/?report=objectonly.

International Renal Interest Society (IRIS) Education: Systemic Hypertension.
iris-kidney.com/education/hypertension.html.

ISFM Practical Recommendations on the Measurement of Indirect Blood Pressure in Cats.
icatcare.org/app/uploads/2020/05/ISFM-BP-recommendations.pdf.

ISFM video: Doppler Blood Pressure Measurement in the Cat: Use of the Leg. youtube.com/watch?v=rGTLoUUXUrl.

ISFM video: Blood Pressure Measurement in the Cat: use of HDO (High-Definition Oscillometry) Equipment.
youtube.com/watch?v=FLKJm2ZefCo.

The Veterinary Nurse: Demeanor and Assessment Score Chart for Feline Blood Pressure Measurements.
theveterinarynurse.com/review/article/feline-systemic-hypertension-the-how-and-why-of-blood-pressure.



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Lila K. Sierra CV (ECC), and ESBCV (ECC). Blood Pressure Monitoring from a Nursing Perspective, Part 2: Overview of Blood Pressure Monitoring. <https://todaysveterinarypractice.com/todays-technician-blood-pressure-monitoring-from-a-nursing-perspective-part-2-blood-pressure-monitoring-techniques/>.

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Martel E, Egnor B, Brown SA, et al. Comparison of high- definition oscillometry – a non-invasive technology for arterial blood pressure measurement – with a direct invasive method using radio-telemetry in awake healthy cats. *J Feline Med Surg* 2013; 15: 1104–1113.

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