Special issue: Hypertension in cats

Volume 3 • Issue 3 • March 2017

feline focus

The International Society of Feline Medicine
Journal for Veterinary Nurses and Technicians

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Causes of hypertension

Closer look at...
Treatment of hypertension

How to...
Measure blood pressure

Case study
Hypertension treatment saves sight

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In the Journal of Feline Medicine and Surgery this month international guidelines on the diagnosis and management of hypertension are published, and here at Feline Focus we wanted to provide our readers with an overview of why blood pressure assessment is important in cats. These days most clinics have equipment to measure blood pressure in cats. This equipment is now comparatively inexpensive and should be well used! This issue of Feline Focus should certainly encourage you to dust off the Doppler or oscillometric machine and measure blood pressure in as many cats as possible. This month’s articles cover the causes of hypertension, then Martha Cannon tells us which cats should have their blood pressure measured and how to do it. Finally, Jenny Carter’s case of Pixie, the elderly cat, illustrates perfectly the importance of an early diagnosis of hypertension, which can save a cat’s sight, as well as improve its quality of life.

Nurses and technicians are often the best professional within a clinic to measure blood pressure, and I would encourage all readers to learn to do this simple, easy procedure that can make such a difference to a cat’s life.

Best wishes,

Sam Taylor, Veterinary Editor

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PROVEN RESULTS IN 9 OUT OF 10 CATS*
Causes of hypertension in cats

Hypertension is a common disease of older cats. Various neurohormonal factors affecting vascular resistance and cardiac output likely cause hypertension, but the mechanism is not fully understood. The majority of hypertensive cats have secondary hypertension, due to underlying diseases, commonly chronic kidney disease, hyperthyroidism or primary hyperaldosteronism. Falsely elevated blood pressure (‘white coat’ hypertension), can be minimised with various strategies to reduce causes of stress in the clinic environment.

Systemic arterial hypertension (usually simply termed hypertension) is a common condition of older cats, and causes severe clinical consequences to so-called ‘target organs’ (see pages 71–76, Consequences and treatment of hypertension). Early diagnosis of hypertension is desirable to reduce the risk of such organ damage. This article discusses the latest information on the causes of hypertension in cats, and therefore which groups of cats are most at risk of developing this treatable condition.

ISFM guidelines for hypertension management

The International Society of Feline Medicine (ISFM) has produced guidelines on the identification and management of hypertension in cats. These are published in the March 2017 issue of the Journal of Feline Medicine and Surgery.


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Samantha Taylor graduated as a veterinary surgeon in 2002 from the Royal Veterinary College, UK, and spent time in practice before becoming the International Cat Care Resident in Internal Medicine in 2006. She became a European Specialist in Internal Medicine in 2009 and a Royal College of Veterinary Surgeons Recognised Specialist in Feline Medicine in 2010.

How is blood pressure regulated?

In health, blood pressure (BP) is maintained within a narrow range by a complex process involving both local and systemic neural and
hormonal factors. The brain, heart and kidney respond to changes in BP by altering the key contributors to BP, which are cardiac output (CO) and systemic vascular resistance (SVR). CO is defined as the amount of blood pumped by the heart each minute (therefore affected by heart rate and cardiac contractility, for example). SVR is the resistance to blood flow caused by the body’s blood vessels, so will be increased as arterioles narrow. Circulating factors will result in narrowing or dilation of arterioles, for example the potent vasoconstrictor angiotensin II would increase blood pressure by increasing SVR. The renin-angiotensin-aldosterone system (RAAS) is important in the regulation of blood pressure, and is activated by various changes detected at the level of the kidney (for example, reduced renal blood flow or reduced sodium delivery). For further discussion of the RAAS the reader is referred to physiology textbooks. Figure 1 shows the important mechanisms involved in the regulation of blood pressure. Importantly, certain organs
such as the kidney and brain maintain their own BP to prevent organ damage. These protective mechanisms are overwhelmed when hypertension develops, and hence the clinical signs of hypertension include damage to these organs.

**Causes of hypertension in cats**
The true pathogenesis (mechanism) of hypertension is not fully understood in cats, and may be different to the pathogenesis in other species (e.g., humans and dogs). However, we know certain conditions are associated with hypertension and certain age groups of cats develop the condition. Hypertension is a disease of older cats, usually over 10 years of age, although it is occasionally reported in younger cats from 5–7 years.²,³

Hypertension can be classified as ‘primary’ (idiopathic), where no underlying disease is identified, or secondary, due to an underlying disease (see box). Secondary hypertension is more common in cats, due to chronic kidney disease (CKD), hyperthyroidism or hyperaldosteronism, for example. An additional cause of high blood pressure is ‘white coat’ hypertension, a name given to the elevated blood pressure measured in healthy cats when suffering from stress within a veterinary clinic.

**Idiopathic hypertension**
In humans ‘essential’ hypertension is the name given to hypertension with no underlying cause, and genetic predispositions may be involved in its pathogenesis. In cats, although 13–20% of hypertensive cats are reported to have idiopathic hypertension,²,⁴ some of these cats may have undiagnosed non-azotaemic renal disease. Cats diagnosed with idiopathic hypertension should be monitored closely for the development of other conditions such as CKD.

**Chronic kidney disease**
CKD is the most common condition associated with feline hypertension, with up to 74% of affected cats being azotaemic at diagnosis. To look at this another way, 19–65% of cats with CKD will be hypertensive.⁵,⁶ Activation of the RAAS may be involved in the cause of hypertension in cats with CKD; however, hypertensive cats often fail to respond adequately to treatment with angiotensin-converting enzyme (ACE) inhibitors, suggesting other mechanisms such as sodium and water retention and changes in arteriolar diameter may be responsible. The association between hypertension and CKD means all cats with CKD should have their blood pressure assessed, and conversely all hypertensive cats should be checked for CKD using blood and urine samples.
Hyperthyroidism

Hyperthyroidism is the most common endocrine condition of older cats (Figure 2), and 10–23% may also be hypertensive. Interestingly, nearly 25% of hyperthyroid cats that are normotensive at diagnosis will develop hypertension in the 6 months following diagnosis. This finding suggests that even successfully treated hyperthyroid cats should have their blood pressure assessed regularly. How hyperthyroidism causes hypertension is not clear, but thyroid hormones may directly affect cardiac muscle cells, and may have effects on the RAAS and cardiac sensitivity to other neurohormonal factors.

Primary hyperaldosteronism

Primary hyperaldosteronism (PHA) is an endocrine disease usually caused by an adrenal tumour which secretes aldosterone. Aldosterone is a hormone responsible for sodium and water retention, as well as potassium excretion. This excessive fluid retention may result in hypertension, although other mechanisms may be involved, again involving blood vessel diameter. Cats with PHA may present to the clinic with target organ damage, such as ocular changes, as around 40–60% of affected cats are hypertensive.

Other causes of secondary hypertension

Although CKD and hyperthyroidism are the most common conditions associated with hypertension, other conditions such as diabetes mellitus (DM), phaeochromocytomas and hyperadrenocorticism have been diagnosed in hypertensive cats. The prevalence of hypertension in diabetic cats is low, and as both DM

‘White coat’ hypertension

A barrier to more frequent assessment of blood pressure in cats is the effect of stress on the accuracy of the reading. All efforts should be made to reduce stress in the clinic environment to ensure readings are reflective of the cat’s true blood pressure. All readings should be within 20% of each other. If they do vary widely, or are increasing or decreasing the cat should be allowed to acclimatise further before continuing. See pages 77–81 for more information.

Key point

Around 25% of hyperthyroid cats develop hypertension in the 6 months following treatment, so should be monitored regularly even when euthyroid.
State of the art

and CKD affect older cats, some could have undiagnosed renal disease as a comorbidity. 1

Phaeochromocytomas are catecholamine secreting tumours of the adrenal glands that may cause hypertension, along with other clinical signs, but are rare in cats. A case report of hyperadrenocorticism and hypertension in a cat exists, 13 but this is again an uncommon diagnosis in cats.

References
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<table>
<thead>
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<th>Time</th>
<th>Session</th>
<th>Speaker(s)</th>
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<td>09.00–10.00</td>
<td>Registration</td>
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<tr>
<td>10.00–10.45</td>
<td>Contentment with confinement – coping with carriers and crates</td>
<td>Sarah Ellis, International Cat Care</td>
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<tr>
<td>10.45–11.30</td>
<td>Cats under stress – clinical significance and importance</td>
<td>Martha Cannon, Oxford Cat Clinic</td>
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<td>11.30–12.00</td>
<td>Coffee break</td>
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<td>12.00–12.45</td>
<td>Implementing Cat Friendly Clinic principles in practice</td>
<td>Martha Cannon, Oxford Cat Clinic</td>
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<tr>
<td>12.45–13.30</td>
<td>Pain scoring in cats - new tools and practical implications</td>
<td>Louise Clark, Davies Veterinary Specialists</td>
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<td>Lunch</td>
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<td>Analgesics and analgesic therapy – what you need to know</td>
<td>Louise Clark, Davies Veterinary Specialists</td>
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<td>15.15–16.00</td>
<td>Causes, management and monitoring of cats with seizures</td>
<td>Mark Lowrie, Dovecote Veterinary Hospital</td>
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<td>16.00–16.30</td>
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<td>16.30–17.00</td>
<td>Choices and management of long-term urinary and IV catheters</td>
<td>Sophie Adamantos, University of Bristol</td>
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<tr>
<td>17.00–17.30</td>
<td>The role of the nurse in managing the feline diabetic</td>
<td>Stijn Niessen, Royal Veterinary College</td>
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<tr>
<td>17.30</td>
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Hypertension in cats: consequences and treatment

Hypertension is a common problem in older cats that causes significant damage to kidneys, eyes, brain and myocardium. Early diagnosis and appropriate treatment minimises long-term target organ damage so routine blood pressure measurement is recommended for all ‘at risk’ cats. Obtaining reliable blood pressure measurements in conscious cats in a veterinary practice environment can be challenging but is achievable if appropriate cat-friendly approaches are applied.

Hypertension is a common problem in older cats and is closely associated with chronic kidney disease (CKD) and hyperthyroidism. Hypertension may be a contributing cause of CKD as well as a complication of it, and is also a cause of vascular damage in the eye, heart and central nervous system.

Current guidelines¹ recommend regular screening of all ‘at risk’ cats (see Table 1) with the aim of identifying those with hypertension, so that treatment can be initiated. Accurate assessment of blood pressure in the conscious cat poses significant challenges and in a busy practice it can be difficult to introduce widespread blood pressure screening for cats in a way that is affordable to clients. Nevertheless, recognition and management of feline hypertension is a critical component in the care of older cats and blood pressure measurement should become a routine part of their preventive healthcare.

Key point
Blood pressure measurement should form a routine part of preventive healthcare for older cats.

Martha Cannon
BA VetMB DSAM(fel), RCVS Recognised Specialist in Feline Medicine

Graduating as a vet from Cambridge University, UK, in 1992, Martha Cannon was appointed to work in small animal practice in Canterbury and was instrumental in establishing the radio-iodine treatment centre for hyperthyroid cats, before taking the position of International Cat Care Resident in Feline Medicine at Bristol Veterinary School, UK. In 2004 Martha was awarded the Diploma in Small Animal Medicine (feline). She is a recognised Royal College of Veterinary Surgeons Specialist in Feline Medicine and co-director at the Oxford Cat Clinic, UK.

The causes of hypertension are discussed in detail in the article on pages 65–69 of this issue.

Consequences of systemic hypertension
Chronic systemic hypertension damages organs that have a rich arterial and arteriolar supply, most notably the eye, kidney, brain and heart, and hence these have been termed ‘target organs’. It is important to note that these more advanced changes are not reversible, so ongoing signs of
A closer look at...

target organ damage (TOD) may be seen even after control of hypertension.

Common clinical signs of target organ damage include:

- **ocular effects:** hypertension causes hyphaema (Figure 1), retinal haemorrhage, retinal detachment (Figure 2) and blindness. More subtle changes in the retina, including focal retinal exudates, focal retinal haemorrhage and tortuosity of the retinal vessels (Figure 2), will be recognised in the early stages of disease.

- **CNS effects:** altered cerebral perfusion can cause behaviour changes that may mimic or exacerbate senile cognitive dysfunction. Altered behaviour, nocturnal vocalisation, disorientation and ‘insecurity’ are common. In humans, headaches are a common sign of hypertension; while we cannot identify this in our feline patients, some do exhibit lethargy and/or short temper which may be a consequence of pain. Focal haemorrhages in the brain or spinal cord can also occur, causing focal or multi-focal neurological deficits such as vestibular signs, ataxia, paresis or seizures.

- **myocardial and vascular effects:** chronic hypertension leads to left ventricular hypertrophy which may easily be misinterpreted as hypertrophic cardiomyopathy. Coronary artery vascular wall changes also lead to reduced myocardial perfusion and myocardial hypoxia which in turn may result in myocardial ischaemia, infarcts and conduction abnormalities. Congestive heart failure may occur, but this is unusual if there is no concurrent primary heart disease.

- **renal effects:** CKD is a major cause of hypertension in cats. It is likely that sustained systemic hypertension also contributes to progression of renal disease. Systemic hypertension is associated with proteinuria, which is in turn associated with more rapidly progressive kidney disease.1

![Figure 1: Hyphaema (blood in the anterior chamber) due to hypertension in an elderly domestic shorthair cat](image1)

![Figure 2: Hypertension can cause retinal haemorrhage (white arrows), retinal detachment (circled) and retinal vessel tortuosity (black arrow)](image2)
**Diagnosis**

Certain groups of cats are at higher risk of hypertension than others. Table 1 shows the groups of cats that should have blood pressure measured. Additionally, the ISFM Guidelines\(^1\) suggest that healthy adult cats (3–6 years) should also have their blood pressure assessed yearly to obtain a baseline measurement for the individual cat. Measurement of systolic blood pressure is an essential element in the diagnosis of feline hypertension (see *Blood pressure measurement in cats: Doppler and oscillometry* on pages 77–81 of this issue). However, stress-induced ‘white coat’ hypertension can be a very significant confounding factor when

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**Table 1:** Which cats are candidates for blood pressure measurement?

<table>
<thead>
<tr>
<th>Category</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kidneys</strong></td>
<td>Progressive CKD, proteinuric CKD</td>
</tr>
<tr>
<td><strong>Eyes</strong></td>
<td>Acute-onset blindness, retinal detachment, bleeding in the eye (retina, posterior chamber, anterior chamber), retinal vessel tortuosity, perivascular oedema, retinal degeneration</td>
</tr>
<tr>
<td><strong>Central nervous system</strong></td>
<td>Lethargy, nocturnal vocalisation, altered behaviour, altered awareness, disorientation, vestibular signs, seizures, ataxia, paresis</td>
</tr>
<tr>
<td><strong>Cardiovascular</strong></td>
<td>Systolic heart murmur, gallop rhythm, reduced ability to tolerate intravenous fluids, left ventricular hypertrophy</td>
</tr>
</tbody>
</table>

1. Blood pressure should be measured in **ALL** cats that present with clinical abnormalities that could indicate hypertensive target organ damage (TOD). (See main text for more detailed description of TOD)

2. Blood pressure should be measured in **ALL** cats that have a disease that is associated with hypertension

   **Chronic kidney disease**
   - **Note:** Cats with low urine specific gravity (<1.030) but normal serum creatinine may have pre-azotaemic CKD (IRIS stage 1 and early stage 2 CKD). Blood pressure measurement is indicated if there is no other evident cause of polyuria

   **Hyperthyroidism**
   - **Note:** Cats that are normotensive at the time of diagnosis commonly become hypertensive once their hyperthyroidism has been controlled. Ongoing monitoring of blood pressure is recommended in all hyperthyroid cats

   **Hyperaldosteronism**
   - An uncommon endocrinopathy in cats, most commonly manifesting as refractory hypokalaemia \(\mp\) hypertension

3. **Routine blood pressure measurement is recommended**\(^1\) in all older cats as part of their regular preventive healthcare plan

   **Cats aged 7–10 years**
   - Measure blood pressure at least every 12 months

   **Cats aged >11 years**
   - Measure blood pressure at least every 6–12 months

CKD = chronic kidney disease; IRIS = International Renal Interest Society
A closer look at...

**Definition of hypertension**
- **normotensive**: systolic pressure consistently <150 mmHg
- **borderline hypertension**: systolic pressure consistently 150-159 mmHg
- **hypertension**: systolic pressure consistently 160-179 mmHg
- **severe hypertension**: systolic pressure consistently >180 mmHg

The definition and classification of systemic hypertension in cats has recently been reviewed and refined by the International Renal Interest Society (IRIS). For more information visit www.iris-kidney.com.

Measurement of systolic blood pressure (SBP) in cats is considered adequate for clinical assessment, as isolated diastolic hypertension appears to be rare.

**Key point**
Cats with systemic hypertension have reduced vascular compliance and consequently may have compromised ability to tolerate intravenous fluids when required for treatment of other concurrent disease (eg, CKD) or during anaesthesia.

(measuring blood pressure in conscious cats, so all efforts must be made to ensure that an apparently high reading is a genuine finding. This involves minimising stress, but also taking account of the clinical history, the presence or absence of evidence of TOD and if the elevated BP is repeatable, before making a decision of whether or not to start treatment for hypertension.

When hypertension is identified, potential underlying diseases must be explored. Investigations should always include measurement of blood urea, creatinine and total thyroxine (T4), as well as urinalysis (including specific gravity and screening for proteinuria). Additional cardiac investigations may also be indicated depending on clinical examination findings.

**Treatment of hypertension**
Treatment should be decided on individual circumstances and taking into account concurrent disease. Care should be taken before initiating lifelong anti-hypertensive treatment if there is no evidence of TOD.

Treatment is with amlodipine besylate (Amodip; Ceva Animal Health) at an initial dose of 0.625 mg once daily, rising to 1.25 mg

**Key point**
Cats with suspected hypertension should be assessed for 'target organ damage' to organs including the kidneys, brain, heart and eyes.
A closer look at...

When is anti-hypertensive treatment justified?

The new ISFM Guidelines\(^1\) state that, if SBP has been carefully measured, anti-hypertensive treatment is justified when:

- **Indirect SBP is >=150 mmHg on a single occasion and there is clear evidence of ocular or neurological TOD.** If clinical signs do not respond appropriately to adequate anti-hypertensive therapy, the diagnosis should be reassessed and other potential causes of the signs investigated.

- **Indirect SBP is >=160 mmHg on at least two separate occasions and there is evidence of TOD including ocular, neurological, cardiac or kidney damage.**

- **Indirect SBP is >=170 mmHg on at least two separate occasions and the clinician does not consider ‘white coat’ hypertension is likely to be the cause.**

- **Indirect SBP is <150 mmHg but where there is clear evidence of active ocular TOD.**

Cats should be monitored carefully and other potential causes of clinical signs treated.

Some drugs mentioned are not licensed for the treatment of hypertension in cats.

Monitoring

Response to anti-hypertensive treatment should be assessed closely in the first 2 weeks of treatment by measuring SBP and monitoring clinical signs of TOD (cats with severe hypertension or TOD should be reassessed during the first 24-72 h of treatment). In successfully treated cases, the blood pressure should drop into the target range (ideally <150 mmHg) within 1-2 weeks of initiating therapy.

Monitor urea and creatinine in all cats before and during the initial treatment period. If anti-hypertensive treatment is too aggressive and induces hypotension, the glomerular filtration rate may drop and azotaemia may increase. Nevertheless, appropriate anti-hypertensive treatment is important for cats with CKD because hypertension may contribute to further renal damage.

Once blood pressure is stable, SBP should be reassessed at least every 3 months, and the cat monitored for clinical signs of TOD.

Prognosis

The long-term prognosis for hypertensive cats will depend on the degree to which hypertension can be controlled and the level of pre-existing TOD. Early diagnosis and treatment will limit the extent of pre-existing damage. so screening ‘at risk’ cats (see Table 1) is important. The prognosis for any underlying disease which is causing or contributing to the hypertension must also be considered.

daily if blood pressure remains above 160 mmHg after 1-3 weeks of treatment.

If blood pressure remains high despite using the higher dose of amlodipine, adjunctive treatment may be indicated; eg, adding an ACE inhibitor or angiotensin receptor blocker.* Underlying diseases should
Conclusions
Hypertension is a common problem in older cats, especially those with CKD or hypertension. Measurement of systolic blood pressure in conscious cats is to some extent an art as well as a science, and it should be considered an important part of the preventive healthcare plan for older cats.

Management of hypertension is usually straightforward, successful and highly rewarding for owners and veterinary staff.

References
How to...

Blood pressure measurement in cats: Doppler and oscillometry

Blood pressure can be measured using Doppler or oscillometric techniques. For either technique the cat must be kept calm and allowed to acclimatise to the environment. The forelimb or tail can be used, and for the Doppler technique the cuff should be 40% that of the limb (or tail) circumference. High definition oscillometric machines should be connected to a computer so the blood pressure trace can be examined to exclude artefacts. Five to seven readings should be taken and the first, and any inconsistent readings, discarded.

Blood pressure machines suitable for use in conscious cats use either the Doppler or oscillometric methods. The Doppler method (eg, systems marketed by Parks Medical and Thames Medical) has traditionally been regarded as more accurate in conscious cats (see Box 1) because traditional oscillometric units were found to be unreliable and these units are not recommended. However, newer high-definition oscillometric (HDO) equipment (eg, VetHDO, S+B medVet) have overcome many of the problems associated with traditional oscillometry and, when used appropriately (see Box 2), can produce reliable information with the potential advantage that HDO will provide a measure of diastolic (DBP) and mean arterial pressure (MAP) in addition to SBP. In the future this may prove helpful, but currently isolated diastolic hypertension is regarded as rare in veterinary patients and measurement of SBP is considered sufficient.

Online help for blood pressure measurement

The International Society of Feline medicine (ISFM), in association with Ceva Animal Health, has recently published a set of ‘Practical recommendations on the indirect measurement of blood pressure in conscious cats’ with full text free to access at:
http://icatcare.org/vets/guidelines/hypertension-cats

This is supported by four illustrative videos available at:
www.youtube.com/user/iCatCare

These recommendations provide a wealth of practical information aimed at making blood pressure measurement in cats achievable and reliable.

Martha Cannon graduated as a vet from Cambridge University, UK, in 1992. She was an International Cat Care Resident in Feline Medicine at Bristol Veterinary School, UK, and is a recognised Royal College of Veterinary Surgeons Specialist in Feline Medicine. She is co-director at the Oxford Cat Clinic, UK.

Martha Cannon
BA VetMB DSAM(fel), RCVS Recognised Specialist in Feline Medicine
How to...

Box 1: Blood pressure measurement using the Doppler technique

When using a Doppler blood pressure machine, the forelimb is generally well tolerated but the tail can be used if the cat is unsettled by handling of the forelimb.

- **forelimb**: place the cuff mid-way between elbow and carpus and use the Doppler probe to detect the median digital artery running straight down the middle of the caudal aspect of the limb between the carpal and metacarpal pads (see Figure 1).
- **tail**: place the cuff around the tail base. Blood flow is detected in the caudal artery running straight down the middle of the ventral aspect of the tail.

It is important to use a cuff of an appropriate size —the width of the cuff should be approx 40% of the circumference of the limb (or tail) at the site where the cuff will be placed (see Table 1). Fit the inflatable cuff snugly in place and inflate and deflate it a few times. This settles the cuff into the fur and also allows the cat to get used to the feel of the pressurised cuff.

The Doppler probe requires good contact to detect blood flow in the artery. This can be achieved by wetting the fur with water or surgical spirit and then working a liberal volume of ultrasound coupling gel into the area so that the fur is completely saturated. Apply a small amount of gel to the Doppler probe too. Clipping the fur is not necessary and will be stressful for most cats.

The audible signal produced by Doppler machines can disturb cats, so if headphones are available they should be used. In the absence of headphones, keep the volume turned down as the probe is applied to the skin, and then slowly increase the volume to an appropriate volume.

Apply the probe to the site of the artery. Don’t press too hard with the probe as this will occlude the artery and abolish pulsatile flow. Carefully adjust the position of the probe, keeping it on the midline until pulsatile blood flow is heard.

If it is difficult to detect the pulse, apply more ultrasound gel, ensure that battery-operated machines have fresh batteries in, check that the probe is appropriately aligned and move the probe slightly cranially (on the midline) where the artery will be slightly wider and its position may be more reliable.

Once a signal is detected, inflate to approx 40 mmHg above the point at which the signal is lost. Slowly deflate the cuff. The systolic blood pressure is the pressure at which return of blood flow is first heard.

The first reading is discarded as the cat needs to become accustomed to the procedure. SBP is then measured until 5–7 consistent readings (less than 20% variance) have been acquired. Ensure that the cuff deflates completely between each reading to allow the artery to refill and recover.

Record all readings and calculate the average SBP, which is taken as the mean of the 5–7 consistent readings. Sometimes several initial readings may have to be discarded if there is a consistent drop in SBP (eg, due to initial stress).
How to achieve reliable results

Whichever method is used it is important to use standardised protocols to reduce external variables and make measurements as reproducible and clinically reliable as possible. Consideration must be given to:

- **environment**: choose a calm, quiet, environment, away from dogs, and where there will be no interruptions. Place a sign on the outside of the door requesting that no-one enters while blood pressure measurement is taking place. While it is generally recommended that blood pressure is measured away from other animals, in some cases keeping the cat in its cage in a cat-only ward while it rests in familiar bedding may be a good option (Figure 2). Alternatively allowing the cat to rest in the bottom half of its carrying basket provides some sense of familiarity and security (Figure 3).

- **acclimatisation**: the cat must be allowed at least 10 mins acclimatisation time in the room, with the people who will be present during blood pressure measurement. During acclimatisation the cat should not be restrained, but allowed to explore and to interact with the people in the room if it chooses to. Other interventions (eg, physical examination, administering medications, taking blood and urine samples) must not be undertaken during this time.

- **personnel**: blood pressure should be measured by a trained individual. Veterinary nurses and technicians should be familiar with the techniques and routinely measure BP in nurse clinics. For out-patients it is often helpful to have the owner present to reassure the cat in a quiet, gentle way.

<table>
<thead>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
<td>6.1–8 cm</td>
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<tr>
<td>3</td>
<td>8.1–11 cm</td>
</tr>
<tr>
<td>4</td>
<td>11.1–13 cm</td>
</tr>
<tr>
<td>5</td>
<td>&gt;13 cm</td>
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How to...

Box 2: Blood pressure measurement using high-definition oscillometry

When using an HDO machine it is essential that it is connected to a computer to view the trace of the recording (see Figure 4). Movement or other artefacts can lead to false blood pressure readings (see Figure 5), and using HDO without viewing the tracing on a screen can give spurious results without the operator being aware that this is the case.

HDO equipment comes with a single size cuff for cats. So long as it is well tolerated it should be used on the tail as this is easier and less likely to result in false readings from movement artefact.

The cuff is snugly positioned so that the insertion point of the inflation tube lies over the artery (see Figure 6). Once the cuff has been placed many cats will settle in a basket or bed without requiring further restraint. When a blood pressure reading is taken the cuff automatically inflates and deflates. In the absence of too much movement the heart rate blood pressure (SBP, MAP and DBP) will then be shown on the display. This information will also be shown on the computer screen along with a visual trace.

The first reading is discarded and the mean of 5–7 consistent (<20% variance) readings is taken. Note that the automatically calculated average may not discard the first reading or subsequent spurious readings, so should not be used.

If the cat becomes restless, agitated or starts moving, take a break, allow the cat to settle, and then start again.
• **restraint and positioning:** If restraint is needed (ie, the cat is not in its hospital cage or carrier) it must be minimal and gentle. Having comfortable and familiar bedding for the cat to rest on and allowing the cat to choose where in the room it settles will help to reduce the amount of restraint required. While the cat can be in a sitting or standing position, bear in mind that movement during measurement needs to be avoided so having the cat sitting or lying comfortably in sternal recumbency is usually most productive.

• **cuff site:** blood pressure can be measured on any limb or on the tail — the forelimb may be easier to use for Doppler, and the tail may work better for HDO. When using the forelimb care is needed in older cats as elbow arthritis may make it uncomfortable — in these cases the tail may be a better choice. Where possible, the site of blood pressure measurement should be roughly on the same level as the heart (Figure 3).

• **written records:** records should be kept of all aspects of the blood pressure measurement, including date, environment, position of the cat, size of the cuff, site of cuff placement, equipment used, individual SBP measurements, and calculated mean SBP. Pre-printed record sheets (Figure 7) can be used to ensure that all relevant information is recorded. ISFM blood pressure assessment forms can be downloaded from: https://icatcare.org/sites/default/files/PDF/CEVA-BP-Booklets/SBP-Form.pdf

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**How to...**

**FREE WEBINARS**

The ISFM has a library of online webinars at: [www.icatcare.org/nurses](http://www.icatcare.org/nurses)

All nurse members are emailed details of how to register for upcoming webinars.

**RACE approved**

ISFM is the International Society of Feline Medicine, the veterinary division of International Cat Care.
Lethal lilies

Eating any part of the lily – flowers, leaves, stem or pollen – is EXTREMELY DANGEROUS TO CATS and can cause kidney damage and even death.

IF YOU THINK YOUR CAT HAS EATEN ANY PART OF A LILY, CONTACT YOUR VET IMMEDIATELY.

Lilies (Lilium species) and day lilies (Hemerocallis species) are highly toxic to cats.

Download free practice posters at http://icatcare.org/advice/keeping-cats-safe

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INTERNATIONAL CAT CARE – KEEPING CATS SAFE CAMPAIGN

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Case study

Pixie: hypertension treatment saves sight

This case describes an elderly cat that had normal blood pressure at her annual check-up. Five months later her owners brought her back to the veterinary clinic and at this visit she had hypertension diagnosed. There was evidence of deterioration of the fundus, which is a target area for damage from uncontrolled hypertension. As the changes in her eyes were at an early stage, her ocular lesions improved when oral medication was given to reduce her blood pressure.

Pixie, a 20-year-old, female neutered, domestic shorthair weighing 4.1 kg, initially presented for her annual health check. Four years previously she had been given radioactive iodine (\(^{131}\text{I}\)) therapy for hyperthyroidism. She had been diagnosed with chronic kidney disease (CKD) 18 months earlier, and was predominantly being fed a renal diet. She was not receiving any medication. During her check-up her systolic blood pressure (SBP) was measured, which was considered normal at 152 mmHg. She also had fundic pictures taken (Figure 1) which were unremarkable. She had blood and urine tests performed. She was azotaemic with blood urea nitrogen measuring 17.4 mmol/l (reference interval [RI] 5.7-12.9) and creatinine measuring 206 mmol/l (RI 49-165). Her urine was inappropriately dilute at 1.013.

Key point

Measure blood pressure prior to physical examination to avoid artefactual increases due to stress.

Jenny Carter graduated as a vet from Massey University, New Zealand, in 2000. She spent the next 6 years working in various small animal practices in Australia and the UK before moving back to New Zealand. In 2013 she completed her Masters in Veterinary Medicine through Massey University where her research was focused on geriatric cats with ocular disease secondary to hypertension.
**Case study**

**Hypertension diagnosis**

Five months later the owner brought her to the veterinary clinic as she was concerned that Pixie looked like she had lost some weight and was a bit quieter than usual. At this visit she weighed 3.85 kg. Her blood pressure was taken before examination; she had an SBP of 191 mmHg. Her vision was assessed at this stage. Her pupillary light reflex and menace reflex were present and brisk in both eyes and she could navigate around obstacles put on the floor of the consultation room, which suggested she had reasonable vision.

At this visit one drop of tropicamide was put in each eye to dilate the pupil so that fundic pictures could be obtained. On examination her heart rate was 168 beats per min, respiratory rate was 24 and temperature was normal at 38.4°C. The fundic pictures (Figure 2) showed evidence of target organ damage from the systemic hypertension. Both eyes had generalised and focal areas of retinal oedema, and the left eye had a region of serous retinal detachment. The fundic lesions were subclinical at this stage and her vision seemed unaffected. Pixie was prescribed amlodipine besylate and a revisit was booked for 7 days’ time.

We did not see Pixie again for 4 weeks, unfortunately, and over this time the owner had not been giving Pixie the antihypertensive medication. As a result the hypertensive fundic lesions had progressed (Figure 3).

**Outcome**

The owner reported that her demeanour had improved, she seemed happier and a little more active. Two months later the fundic

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**Figure 2:** SBP 191 mmHg, 5 months later. There are focal areas of retinal oedema and an area that has coalesced to form a region of serous retinal detachment (arrow).

**Figure 3:** SBP 180 mmHg. Left eye, 4 weeks after antihypertensive medication had been recommended. The owner had not given the cat amlodipine besylate at this point. There is now a bullous retinal detachment medial to the optic nerve head (arrow). The area of serous retinal detachment had enlarged. The owner now started medicating the cat with amlodipine besylate every 24 h.
pictures were repeated (Figure 4) and improvement was apparent. The bullous lesion had resolved and the generalised retinal oedema had improved. Pixie’s SBP measurement at this time was 148 mm Hg.

Discussion
Hypertension in cats is often diagnosed when a cat presents to the veterinary clinic blind from ocular lesions that have developed secondarily to hypertension (Figure 5). Unfortunately, cats that are already blind secondarily to hypertension have only a limited chance of regaining any vision, even if they start on appropriate treatment immediately. This case highlights the benefit of detecting the presence of hypertension early in a cat, at a time when the patient is not displaying clinical signs associated with the disease. Many cats with hypertension are actually asymptomatic, and if the hypertension is diagnosed at an early stage, before serious complications such as blindness develop, then this provides the best chance of long-term wellbeing.

Hypertension is usually diagnosed in cats that are 8 years of age and older. The majority of cats diagnosed with hypertension have an underlying disease present such as chronic kidney disease or hyperthyroidism. Primary hypertension is not common in cats. Older cats should have their blood pressure checked every 6-12 months. Cats with disease known to be associated with hypertension such as chronic kidney disease, should have their blood pressure measured every 3-6 months.

Key point
Owners should be well informed that follow-up appointments are vital to assess the effectiveness of medication and check compliance with anti-hypertensive medication.

Figure 4: SBP 148 mmHg. Pixie’s left eye following 10 weeks on amlodipine besylate treatment at 1.25 mg every 24 h. The area of serous retinal detachment appears now as a hypo-reflective, thickened, area of retina

Figure 5: Blind cat with an SBP of 195 mmHg. He has bilaterally dilated pupils and in the right eye vitreal haemorrhages are present
Case study

Key point
Diagnosing hypertension at an early stage can avoid devastating consequences and is why routine BP measurement is so important.

Nursing priorities
Veterinary nurses play an integral role in obtaining reliable blood pressure readings from patients. Fear and stress from visiting the veterinary clinic and having procedures performed can transiently elevate the blood pressure in a patient which can lead to an incorrect diagnosis of hypertension.

There are steps veterinary nurses can take to maximise the chances of obtaining trustworthy blood pressure measurements:

- As soon as the cat is brought into the veterinary clinic it should be moved to a quiet room where it cannot see other animals.
- Give the cat 10 mins in the quiet room to acclim atise. This will help reduce anxiety.
- Use minimal restraint and preferably have the owner present to help keep the cat calm and happy.
- Blood pressure measurement should be carried out with well-established procedures for picking the correct size of the cuff, positioning of the cuff on the patient and evaluating blood pressure with the equipment available.

Measuring the blood pressure of cats in a veterinary clinic situation can be problematic, as the visit to the clinic and the procedures undertaken to get a blood pressure reading, can cause anxiety which may artificially raise the blood pressure. It is important that veterinary nurses and technicians become proficient in calm and careful techniques for getting an accurate blood pressure reading in their patients.

Conclusions
Older cats need to be monitored for hypertension to enable the disease to be detected early. Once detected, hypertension can often be effectively managed by giving the daily oral medication amiodipine.

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The Cat Friendly Clinic (CFC) programme is run by the ISFM in collaboration with several different partners across the world. It is designed to help create more cat friendly veterinary clinics, reducing stress for the cat as well as both the owner and veterinary staff treating the cat.

Find out more at: www.catfriendlyclinic.org