Blood Pressure

In Dogs and Cats

Articles curated by Dr Erik Johnson

High Blood Pressure in Dogs

Systemic Hypertension in Dogs

More commonly referred to as high *blood pressure*, *hypertension* occurs when the dog's arterial blood pressure is continually higher than normal. When it is caused by another disease, it is called secondary hypertension; primary hypertension, meanwhile, refers to when it actually is the disease. Hypertension may affect many of the dog's body systems, including heart, kidneys, eyes, and the nervous system.

Systemic hypertension can affect both dogs and cats. If you would like to learn more about how this condition affects cats, please visit this page in the PetMD health library.

Symptoms and Types

The following are just some of the more common symptoms displayed by dogs with high blood pressure:

- Seizures
- Circling
- Disorientation
- Blindness
- Dilated pupils
- Retinal detachment
- Hemorrhage of the eye
- Blood in the urine
- Protein in the urine
- Bleeding from the nose
- Swollen or shrunken kidneys
- Heart murmurs
- Weakness, either on one side of the body or in the legs
- Involuntary oscillation (rolling) of the eyeballs
- Palpable *thyroid gland* (when hyperthyroid)

Causes

The cause of primary hypertension in dogs is not known. However, there have been instances where breeding dogs with hypertension have produced *offspring* with hypertension, so it seems likely that there is a genetic component.

So how prevalent is this form of hypertension? Studies have varied, but one study found that between 0.5 percent and 10 percent of dogs suffer from high blood pressure. Ages of dogs with hypertension ranged 2 to 14 years old.

Secondary hypertension, which accounts for 80 percent of all hypertension cases, may be due to a variety of factors, including renal disease, hormonal fluctuation, and hyperthyroidism.

Diabetes may also be a cause for hypertension, although it is uncommon in dogs. If you suspect that your dog is suffering from hypertension, bring it in so that your veterinarian may provide a proper diagnosis.

Diagnosis

Blood pressure is often measured in pets in the same manner as in humans. An inflatable cuff will be placed on the dog's paw or tail, and standard blood pressure measuring instruments will check the pressure. It is important to keep the dog still long enough to get

The standards for dog blood pressure are:

- 150/95 – at this reading or below, there is minimal risk and tre
- 150/99 to 159/95 -- intervention is rotuinely not recommended
- 160/119 to 179/100 -- treatment should be sought to limit the
- 180/120 -- immediate treatment should be sought to limit the complications

Five to seven measurements are generally taken. The first measurement will be discarded, and the dog's excitement level during the procedure will be taken in account. If the results are in dispute, the procedure will need to be repeated.

Treatment

The underlying cause of the high blood pressure will be treated first. Otherwise, the dog will probably be on medication to control the blood pressure indefinitely. The medication of choice is either a calcium channel blocker or a beta-blocker. As to dog's diet, the veterinarian may recommend food that are lower in sodium.

Blood pressure should be checked regularly, and some lab tests may be ordered by your veterinarian to measure your dog’s reactions to the medication.

Source URL: https://www.petmd.com/dog/conditions/cardiovascular/c_multi_systemic_hypertension

clinician's brief®

Measuring Blood Pressure

Scott A. Brown, VMD, PhD, Diplomate ACVIM

CARDIOLOGY | NOVEMBER 2004 | PEER REVIEWED

Overview The principal function of the cardiovascular system is to generate the appropriate amount of intravascular pressure to ensure adequate tissue perfusion. In clinical practice, we can measure pressure within systemic arteries (commonly referred to as blood pressure, or BP) or within central systemic veins (central venous pressure). While central venous pressure has the strongest correlation with body fluid volume, arterial pressure is the driving force for tissue blood flow. As with most physiologic parameters, control systems normally regulate BP within an appropriate range, referred to as normal BP. If BP falls too low (i.e., systemic hypotension) organ perfusion may be inadequate; if it rises too high (i.e., systemic hypertension) organs may be overperfused or undergo barotrauma.

Hypotension is a frequent complication of anesthesia, some drugs or toxins, various forms of shock (e.g., hemorrhagic), and severe dehydration. On the other hand, systemic hypertension (i.e., high pressure within systemic arteries) is often observed in dogs or cats with kidney disease and hyperthyroidism as well as other metabolic conditions. To properly manage these conditions, it is becoming increasingly important for veterinarians to measure BP. Further, a diagnosis of systemic hypertension should always be based on determination of systemic arterial blood pressure. Antihypertensive agents should not be used unless reliable measurements of BP indicate the need.

What Is Normal BP? The definition of "normal" in the context of blood pressure is a difficult question. The Veterinary Blood Pressure Society has suggested interpretation of BP in light of clinical and laboratory findings. Species, gender, and age may also be considered in evaluating a patient's BP. The Society suggests that elevation (or depression) of BP causes a risk that is directly related to the severity of hypertension (or hypotension). Thus, BP that exceeds 150/95 mm Hg

poses some risk for hypertensive end-organ injury, and intervention should be considered; values above 180/120 mm Hg pose a high risk and intervention (e.g., administration of a pharmacologic antihypertensive agent) is clearly indicated. Similarly, BP below 100/60 poses some risk for reduced organ perfusion; values below 70/40 pose a high risk that mandates intervention (e.g., intravenous fluid therapy and/or reduction of dosage of anesthetic agent).

Patient Selection There is no sufficient rationale for routinely measuring BP in all patients. Hypotension may be present in anesthetized animals as well as those with suspected or confirmed cardiovascular diseases, such as heart failure, arrhythmias, shock, or excessive hemorrhage. Hypertension is often suspected in dogs and cats that present with clinical diseases associated with hypertension or with clinical findings compatible with end-organ injury from high BP (**Table**). Because of the high prevalence of certain occult diseases in elderly patients, routine screening of geriatric dogs and cats is an appropriate consideration. We will focus on the measurement of BP in conscious animals as would be done in screening for systemic hypertension. The same general principles apply to the diagnosis of hypotension in anesthetized or critical care patients.

How to Measure Blood Pressure

Blood pressure may be measured directly or indirectly. While direct measurement is the "gold standard," this technique has several drawbacks: It is technically difficult in unsedated dogs and cats; may be painful; and complications, such as hematoma formation, are more likely to occur. Indirect techniques are more easily applied to a clinical setting; such techniques require less restraint and are technically easier to do.

Indirect methods of blood pressure measurement include auscultatory, ultrasonic Doppler, oscillometric, and plethysmographic (**See Aids & Resources, page 80**). All of these indirect techniques use an inflatable cuff wrapped around an extremity. Pressure in the cuff is measured with manometer or pressure transducer. A squeeze bulb or automated device inflates the cuff to a pressure exceeding systolic blood pressure, thus occluding the underlying artery. Changes in arterial flow are detected by one of several means as the cuff is gradually deflated; the value for cuff pressure at various levels of deflation is then correlated with systolic, diastolic, and/or mean blood pressure. This detection method varies among the different indirect devices.[1]

Doppler Doppler flowmeters detect blood flow as a change in the frequency of reflected sound (Doppler shift) due to the motion of red blood cells. Blood pressure is read by the operator from an aneroid manometer connected to the occluding cuff, which is placed proximal to the Doppler transducer. These devices use a detection unit, cuff, ultrasonic probe transducer, and aneroid manometer (**Figure 1**). The probe must be separately positioned distal to the cuff on the same

limb (**Figure 2**). Doppler flowmeters are more reliable for measurement of systolic than diastolic BP.

Oscillometric Devices using the oscillometric technique (**Figure 3**) detect pressure fluctuations in the occluding cuff resulting from the pressure pulse. Machines using the oscillometric technique use a detection unit and cuff and generally determine systolic, diastolic, and sometimes mean BP as well as pulse rate.[1]

The Doppler devices are generally easier to use and less expensive. However, they normally provide a reliable value for only systolic BP, often require two technicians to measure BP, and do not cycle automatically (Automatic cycling is useful in anesthetized or immobile critical care patients.). The choice of unit ultimately depends on the needs and preferences of the individual practice; a device should be evaluated on a trial basis for 4 to 6 weeks before a purchase is made.

Site of Pressure Measurement The cuff may be placed around the brachial, median, cranial tibial, or medial coccygeal arteries. For the Doppler technique, the cuff is usually placed over the median artery and the transducer is placed ventrally between the carpal and metacarpal pad[1] (**Figure 4**). Clipping hair and applying acoustic gel at the site of transducer placement may enhance the signal. It is often easier to hold the transducer in place, if the animal tolerates this. Alternatively, the transducer may be taped in place with 1 inch of white adhesive tape. Since Doppler devices often make sounds that may alarm animals (especially cats), earphones should be used. For the oscillometric technique, the brachial (Figure 5) or coccygeal (**Figure 6**) arteries in cats and the median (**Figure 7**) or coccygeal artery in dogs seem to provide the most reliable readings.

The cuff should be placed at, or close to, the level of the aortic valve. If this cannot be done, an adjustment should be made for gravitational effect, with a 1.0-mm Hg change in blood pressure expected for each 1.3 cm of vertical distance between the level of the cuff and the level of the aortic valve (placing a cuff below heart level artificially raises the measurement). However, this adjustment is generally necessary for only large-breed dogs.

Cuff Choice There are many cuff choices (**Figure 10**), with cuff width being the most important characteristic. The site of cuff placement should be carefully measured, and cuff width should be 30% to 40% of limb circumference. An oversized cuff may give erroneously low recordings; an undersized cuff yields falsely high readings. Many cuffs indicate which side should face the patient, cuff size (a number), cuff width (in mm), portion of the cuff to place over the artery, and/or the range of limb circumferences for which the cuff should be used (**Figure 11**).

Anxiety-Induced Artifact The visit to the veterinary clinic, restraint, noises, odors, and other unusual stimuli may induce anxiety and falsely elevate the BP measurement. Anxiety may be

minimized by obtaining BP measurements before a physical examination or other manipulations to which the animal may object; taking all measurements in a quiet room in a calm, reassuring manner; and allowing the animal to acclimate to its surroundings for at least 5 (and preferably 15) minutes before obtaining measurements. If possible, the owner should be present.

Blood Pressure Measurement Technique The same individual (preferably a technician with a calm demeanor) should perform all BP measurements following a standard, written protocol. Measurements should be obtained only in a calm, minimally restrained, and motionless patient. Regarding choice of equipment, it is perhaps most important to use an indirect device with which the operator has experience and confidence (often developed by practice on healthy animals presented for vaccination).

Use a cuff of appropriate width; choice of site depends on operator preference and patient comfort. The operator should obtain at least 5 to 7 consistent measurements (< 20% variation in systolic readings) from the first cuff placement. The cuff should be removed and replaced. An additional five to seven consistent measurements should be taken from the second placement. Repositioning should be repeated as often as necessary until results agree.

The first value from each cuff position is discarded; then an average of all other values is calculated. Alternatively, all values can be averaged after the first, highest, and lowest readings are discarded. The overall average is considered the final value. If in doubt, the entire process should be repeated on another day or later the same day. A diagnosis of systemic hypertension should never be based solely on a single BP measurement session. Measuring BP is a complex process and requires at least 15 minutes under ideal circumstances and perhaps 45 minutes or more in difficult cases.

Records All pertinent data-measurements, the method of determining averages, cuff size and site, position of animal, device used, name of individual taking the measurements, and attitude of patient during measurement-should be recorded for future reference. It is generally best to create a special form to assure completeness of records. For comparative purposes, the same device and site for cuff placement should be used each time the patient is evaluated.

Indications for Screening Dogs or Cats for Systemic Hypertension

Acute or chronic kidney disease Hyperthyroidism (especially cats) Hyperadrenocorticism Diabetes mellitus (especially dogs) Hyperaldosteronism Pheochromocytoma Marked obesity Advanced age (dogs and cats > 10 years) Clinical findings compatible with hypertensive end-organ injury, such as • Blindness, retinal vascular tortuosity or hemorrhage, retinal detachment,

hyphema • Seizures, ataxia, sudden collapse • Dyspnea, unexplained left ventricular hypertrophy or gallop rhythm • Proteinuria or low urine-specific gravity

Patient Positioning The best position is the one in which the animal is most comfortable. Lying immobile in a relaxed position is preferred. However, some animals prefer to lie (**Figure 8**) or sit (**Figure 9**) on the examination table or in their owner's lap. The keys to patient positioning are that the patient should be in a sustainable, comfortable position; the extremity being cuffed must be readily accessible, relaxed in a natural position, and immobile; and stress should be minimized to the extent possible.

Procedure Pearl BPs above 180/120 mm Hg or below 70/40 pose a high risk, and intervention is clearly indicated.

Procedure Pearl Important considerations for patient positioning include making sure the animal is in a sustainable, comfortable position, with the extremity being cuffed readily accessible, relaxed in a natural position, and immobile. Stress should be reduced to the extent possible.

Procedure Pearl Width is the most important consideration in choosing a cuff.

MEASURING BLOOD PRESSURE • Scott A. Brown

Reference 1. **Diagnosis and treatment of systemic hypertension.** Brown SA, Henik RA. *Vet Clin North Am Small Anim Pract* 28:1481-1494, 1998.

Suggested Reading **Association between initial systolic blood pressure and risk of developing a uremic crisis or of dying in dogs with chronic renal failure.** Jacob F, Polzin DJ, Osborne CA, et al. *JAVMA* 222:322-329, 2003. **Blood pressure assessment in healthy cats and cats with hypertensive retinopathy.** Sansom J, Rogers K, Wood JL. *Am J Vet Res* 65:245-252, 2004. **Comparative diagnostic test characteristics of oscillometric and Doppler ultrasonographic methods in the detection of systolic hypertension in dogs.** Stepien RL, Rapoport GS, Henik RA, et al. *J Vet Intern Med* 17:65-72, 2003. **Epidemiological study of blood pressure in domestic dogs.** Bodey AR, Michell AR. *J Small Anim Pract* 37:116-125, 1996. **Essential Facts of Blood Pressure in Dogs and Cats.** Egner B, Carr A, Brown S-Babenhausen, Germany: *Vet Verlag*, 2003. **Spontaneous systemic hypertension in 24 cats.** Littman MP. *J Vet Intern Med* 8:79-86, 1994.

Indirect Blood Pressure Measurement Devices for Use in Dogs and Cats Oscillometry Cardell Model 9401,2,3-Sharn Veterinary Inc., 800-325-3671, www.sharnvet.com Dinamap Model 8300-No longer available Memoprint, Memodiagnostic, S+B medVET- www.submedvet.de Doppler ultrasonography Jorgensen Model J5373-Jorgensen Labs, 800-525-5614, www.jorvet.com Parks Model 811-B-Parks Medical Electronics, 800-547-6427, www.parksmed.com Vet-Dop-Vmed Technology Inc, 800-926-9622, www.vmedtech.com Pressure plethysmography VetSpecs Model BP2,3-VetSpecs Medical Systems, 800-599-2566, www.vetspecs.com

For global readers, a calculator to convert laboratory values, dosages, and other measurements to SI units can be found here.

Non-Invasive Blood Pressure (Doppler)

Last Updated: November 27, 2018 by Dr. Truchetti Geoffrey, DMV, MSc, DES, DACVAA — Leave a Comment

Why use a Doppler?

One of the objectives of anesthesia is to provide adequate blood flow to tissue. **One way to assess blood flow is to measure blood pressure (ideally mean blood pressure) and heart rate**.

Most of the time, in small animal anesthesia, blood pressure is measured non-invasively. It is, however, possible to measure blood pressure invasively to obtain a more precise value. Only non-invasive blood pressure monitoring techniques are explained below. Non-invasive blood pressure can either be monitored with oscillometric devices (PetMap for example) or with a Doppler flow monitor (later call Doppler).

A Doppler only detects flow and makes sounds when the arterial flow changes during each heartbeat. **When measuring blood pressure with a Doppler, the principle is to occlude arterial blood flow by inflating a cuff** and then deflating it until the flow goes back to normal. When the pressure in the cuff is just below the systolic blood pressure, blood flow can pass the cuff and is detected by the Doppler probe. **Heart rate can be calculated with the sounds of the Doppler**.

Advantages

- Continuous monitoring of hemodynamic changes

Disadvantages

Manual, intermittent measurement of blood pressure

- Only systolic blood pressure measurement
- Data may be false for small patients and cats
- Data may be false in case of arrhythmia

When to use a Doppler?

Hypotension is one of the common risks of anesthesia. Non-invasive blood pressure monitoring is easy and quick to install and **should be used for every patient. Blood pressure monitoring can be placed before induction if the level of sedation allows it**.

With the Doppler, the sound is heard continuously, and this provides **continuous monitoring** of the heart rate and the velocity of the blood. **Blood pressure, however, can only be measured when inflating the cuff. Ideally, it should be done at least every five minutes**.

Systolic blood pressure below 100 mmHg should be a concern. Systolic blood pressure below 80 mmHg is a major concern.

Related Products we Have for You!

Blood Pressure Cuffs

Doppler Medical Electronics 811-B

Post #4 of 6 of the series What data is provided by monitoring devices? What are those devices used for?

Blood Pressure Monitoring from a Nursing Perspective

PART 2: BLOOD PRESSURE MONITORING TECHNIQUES

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University of Pennsylvania

Systemic arterial blood pressure is created by the pumping action of the heart, circulating arterial blood volume, and the smooth muscle tone of blood vessel walls.

Arterial blood pressure is essential for adequate perfusion of tissues, delivering oxygen for energy demands. The ability to measure and monitor blood pressure trends provides important data about patient cardiovascular status and may help define approach to treatment.

Part 1 of this article series—**Overview of Blood Pressure Monitoring** (January/February 2015 issue)—discussed terms associated with blood pressure measurement, indications for measurement, and normal and abnormal blood pressure values. This second article describes types of blood pressure monitors and provides step-by-step instructions on performing blood pressure measurement.

MONITORING TECHNIQUES

Arterial blood pressure can be measured in 2 ways:

1. **Direct arterial blood pressure** (DABP) monitoring—considered the gold standard—uses an arterial catheter connected to a pressure transducer. This system allows continuous monitoring of patient systolic, diastolic, and mean arterial pressure (SAP, DAP, and MAP, respectively)[1-3] and also simplifies collection of samples for arterial blood gas analysis. However, DABP monitoring is not used as frequently as other methods because an arterial catheter must be placed.
2. **Indirect arterial blood pressure** (IABP) monitoring relies on noninvasive detection of arterial blood flow or vessel wall movement in a peripheral artery and provides intermittent measurements of arterial blood pressure.

   IABP monitoring is the most frequently used technique in clinical practice; the most commonly used indirect methods are Doppler ultrasonography and oscillometric blood pressure monitoring. To obtain an IABP reading, a cuff is inflated over an artery until arterial blood flow is occluded.[1]

Normal arterial blood pressure values for adult dogs and cats are listed in **Table 1**.

INDIRECT BLOOD PRESSURE MONITORING: Doppler Ultrasonography

Doppler technology uses 10 MHz ultrasound waves to detect blood flow in a peripheral artery (**Figure 1**), which is then made audible via the probe/crystal and a speaker.[1]

The Doppler technique does not provide a measurement of MAP or DAP in small animals.[1,4,5] While some studies have reported that Doppler readings may more closely reflect MAP than SAP in cats,[1,3] the most recent study

FIGURE 1. Doppler ultrasonographic blood pressure measurement.

TABLE 1.
Normal Arterial Blood Pressure Values in Adult Dogs & Cats[4]

BLOOD PRESSURE VALUES	DOGS	CATS
Systolic arterial pressure	90 to 140 mm Hg	80 to 140 mm Hg
Diastolic arterial pressure	50 to 80 mm Hg	55 to 75 mm Hg
Mean arterial pressure	60 to 100 mm Hg	60 to 100 mm Hg

FIGURE 2. The Doppler crystal, shown in this image, should be placed parallel to the artery's blood flow.

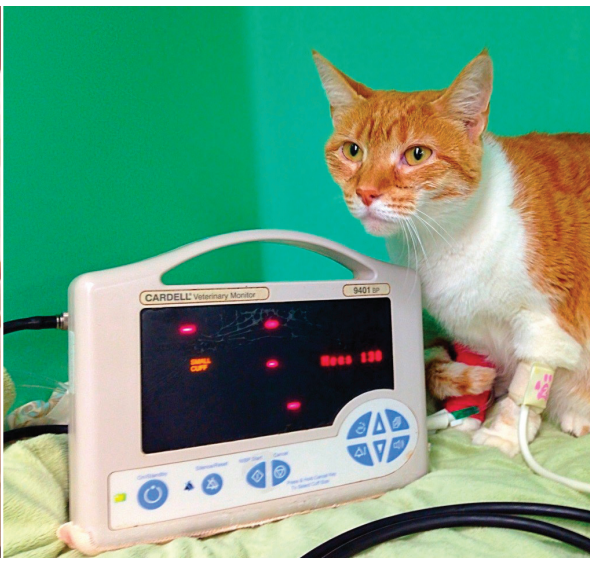

FIGURE 3. Oscillometric blood pressure monitor (Cardell 9401 Veterinary Monitor, midmark.com).

was performed on healthy anesthetized cats.[1] Therefore, most clinicians consider that Doppler readings in awake animals estimate SAP.

Advantages

Doppler ultrasonography has several advantages when compared with other blood pressure monitoring techniques; the technology is:

- Relatively easy to use, not requiring a great deal of expertise
- Affordable and readily available in most clinical settings
- Appropriate to use in patients with significant hypotension and cardiac arrhythmias[1]
- Commonly used in small animals (cats, small dogs, rabbits, ferrets, other exotic species).

Blood Pressure Measurement: Step by Step

Table 2 lists the supplies needed for Doppler ultrasonographic blood pressure measurement.

1. Select a peripheral artery for Doppler probe placement; common locations include the dorsal pedal artery, digital artery, and coccygeal artery.
2. Clip the hair coat over the chosen artery, or wet it with alcohol, and apply ultrasound coupling gel to the Doppler probe.
3. Place the Doppler probe over the artery, oriented parallel to blood flow (**Figure 2**); the probe is considered correctly placed when pulsatile blood flow is audible.
4. Connect a pressure cuff to a sphygmomanometer and place the cuff proximal to the Doppler probe.
5. Inflate the cuff until the artery is occluded and Doppler sounds are no longer audible; then slowly deflate the cuff, while observing the sphygmomanometer.
6. Record the pressure at which the first audible arterial pulse is heard as the SAP.
7. Obtain several consecutive measurements; average the middle 3 readings, and record the average as the SAP. Make sure to use the same limb and same size cuff for serial blood pressure measurements.

Preventing Inaccurate Results

Several factors can result in erroneous readings:

- Cuff size is critically important to obtain accurate Doppler readings.[1,4,6]
  - » A cuff that is *too large* falsely decreases the reading

TABLE 2.
Required Supplies for Doppler Measurement

- Clippers or alcohol for either clipping or wetting hair
- Doppler unit and sphygmomanometer
- Ultrasound coupling gel
- Inflatable cuff, the width of which should be:
  - » In dogs, 40% of the limb circumference
  - » In cats, 30% of the limb circumference
- Rubber tubing, which connects inflatable cuff and sphygmomanometer
- Earphones, if it is difficult to hear the Doppler signal

» A cuff that is *too small* falsely elevates the reading.

- Patients must be held/restrained during Doppler measurements; however, this handling may increase the animal's blood pressure.
- Patient position during Doppler measurement can contribute to inaccurate readings; ideally, patients should lie in lateral recumbency, with the cuff positioned on the limb at the level of the right atrium.[1,4]
- Obtaining Doppler measurements in patients with severe peripheral vasoconstriction (hypovolemia, shock, significant hypothermia) can be difficult; therefore, accuracy of readings in these patients can be affected by degree of vasoconstriction.[3,4]

INDIRECT BLOOD PRESSURE MONITORING: Oscillometric Measurement

Oscillometric measurement (**Figure 3**) provides values for SAP, MAP, DAP, and pulse rate; therefore, this type of blood pressure monitoring provides more information than Doppler measurement.[1,3,4] Most oscillometric devices measure the MAP; then calculate the SAP and DAP via programmed algorithms; therefore, the MAP is the most reliable reading.[4]

Advantages

Oscillometric blood pressure measurement has several advantages over Doppler methodology; the:

- Process is more automated, requiring less technical skill; the operator simply chooses the appropriate cuff size, places it on the patient, and hits the start button
- Monitors can be programmed to measure blood pressure at timed intervals (eg, Q 15 min)
- Automated nature of measurement helps ensure that elevated values are less likely a result of stressful patient handling.[1,4]

Disadvantages

However, oscillometric techniques tend to be *less accurate* in patients:[3,4]

- Under 5 kg
- With cardiac arrhythmias, significant tachycardia or bradycardia, vasoconstriction, or hypothermia
- That are moving or shivering.

Blood Pressure Measurement: Step by Step

1. Place the cuff—attached to an oscillometric monitor—on a distal artery; common locations for oscillometric cuff placement are similar to those used for Doppler blood pressure measurement.
2. Once the device is started, the cuff automatically inflates to a pressure that occludes arterial blood flow.
3. As the cuff is deflated, the arterial wall oscillations *increase at SAP, maximize at MAP,* and *decrease at DAP*.[4]
4. The oscillometric monitor display will show numeric values for SAP, MAP, and DAP as well as pulse rate.
5. Compare the oscillometric pulse rate with a manually obtained pulse rate to determine accuracy: if the rates do NOT match, it is likely that the blood pressure readings on the monitor are *inaccurate*.

Preventing Inaccurate Results

As discussed in the **Indirect Blood Pressure Monitoring: Doppler Ultrasonography** section:

- Selection of an appropriately sized cuff is crucial to obtaining accurate values; cuff selection is outlined in **Table 2**.
- To ensure accuracy, it is important to take several consecutive readings; then compare the readings to ensure that the values are reproducible.
- Ideally, the same size cuff and same limb should be used for all consecutive blood pressure measurements.

DIRECT BLOOD PRESSURE MONITORING

In general, DABP monitoring (**Figure 4** and **Figure 5**, page 96) is indicated for any critical patient, but specific indications in the clinical setting include patients:

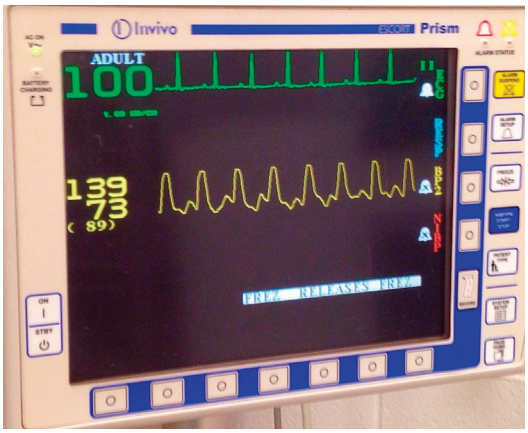

FIGURE 4. Simultaneous electrocardiography and direct arterial blood pressure readings (Escort Prism Patient Monitor, invivocorp.com)

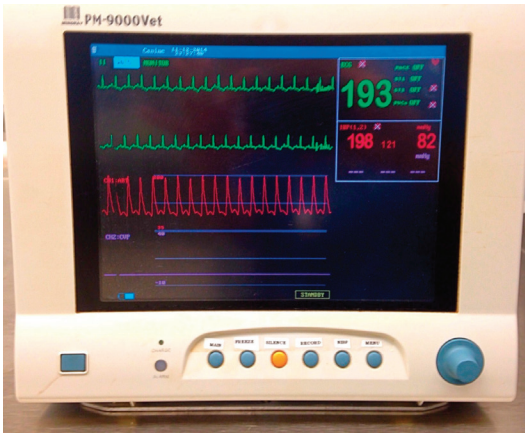

FIGURE 5. Simultaneous electrocardiography and direct arterial blood pressure readings demonstrated on a different monitor (PM-9000 Vet Monitor, mindray.com).

- Presenting in hypovolemic or septic shock
- In congestive heart failure, especially when receiving powerful vasodilator medication for purpose of afterload reduction
- Requiring vasopressors or mechanical ventilation
- Receiving medication for severe hypertension
- Demonstrating a high anesthetic risk.

DABP monitoring is NOT indicated in healthy, ambulatory patients because these patients are more likely to disconnect an arterial line, or remove the arterial catheter, increasing the risk for arterial hemorrhage.

Advantages

DABP has many advantages over other methods of blood pressure monitoring. Two of the most important advantages include:

- "Real-time" monitoring of blood pressure and blood pressure trends, even in extremely hypotensive patients; this up-to-the-minute information about a patient's hemodynamic status enables clinicians to gauge whether a specific therapy is working or if additional, immediate intervention is necessary.
- Handling and restraint of the patient is usually limited to the initial arterial catheter placement; therefore, DABP values are less prone to falsely elevated readings related to stress of restraint and handling.

Disadvantages

However, DABP monitoring is not used extensively because it has several drawbacks:

- The equipment necessary to monitor DABP (eg, pressure transducers, hemodynamic monitors) can be cost prohibitive, especially when not used frequently.
- Arterial catheters are invasive, and arterial access can be technically difficult to obtain and maintain.
- Complications that can result from arterial catheterization include bleeding from the catheter insertion site, hematoma formation, significant hemorrhage if the system becomes disconnected, infection, and arterial thrombosis with possibility of necrosis of the tissues distal to the catheter.

Blood Pressure Measurement: Step by Step

Table 3 lists the supplies needed for DABP measurement (**Figure 6**).

1. Place and secure an arterial catheter; common sites for arterial catheterization include the dorsal pedal artery, coccygeal artery (**Figures 7 and 8**), and medial auricular artery.[1,2]
2. Once the arterial catheter is placed and secured, connect it to the DABP monitoring system.
3. At one end of the system—the end farthest away from the patient—a fluid administration set is connected to a heparinized bag of 0.9% sodium chloride (**Table 3**).
4. Pressurize the fluid bag to a range between 250 and 300 mm Hg: the goal is to achieve a pressure

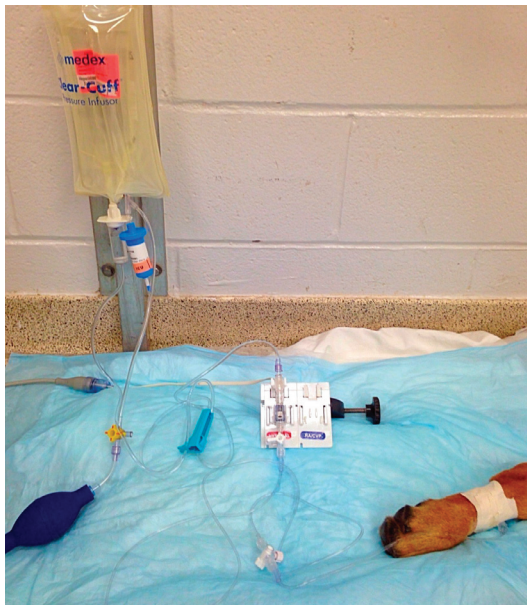

FIGURE 6. DABP supplies: Transpac disposable pressure transducer (icumed.com), heparinized saline bag inside pressurized air bag, electronic cable to connect Transpac to monitor, transducer board (white), arterial catheter (dorsal metatarsal).

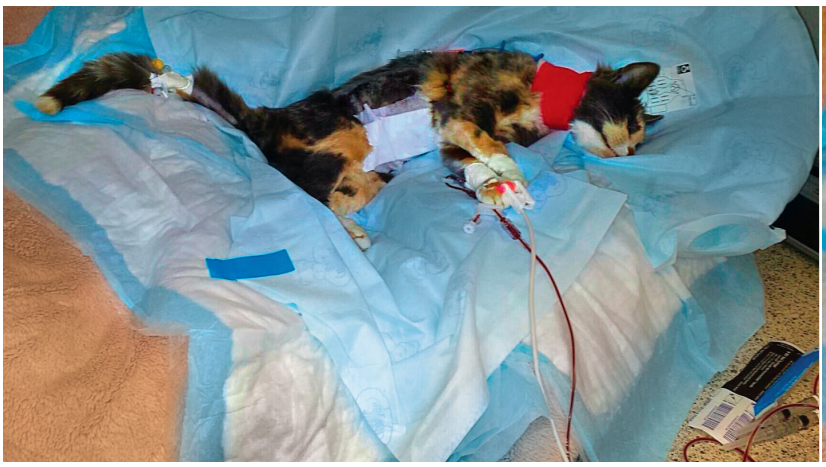

FIGURE 7. Patient with coccygeal arterial catheter; note that arterial catheters should not be maintained in cats for longer than 6 to 12 hours owing to risk for arterial thrombosis.

FIGURE 8. Close-up image of coccygeal arterial catheter in a cat.

in the fluid bag greater than the patient's systolic pressure, which prevents back flow of arterial blood into the monitoring system.[1,2]

5. The fluid bag tubing connects to a pressure transducer, which is connected by a cable to the physiologic monitor, mounted on a board placed at the level of the patient's heart. At the other end of the transducer, semi-rigid tubing connects to the arterial catheter's T-set.
6. Once the pressure transducer is connected to the monitor, zero it at the level of the patient's right atrium. Once zeroed, the pressure transducer converts the pressure changes in the artery to an electrical signal that is displayed on the monitor as a pressure wave form; numeric values for SAP, MAP, and DAP are also displayed.[1]
7. Flush the DABP monitoring system with heparinized saline before connecting it to the patient.
8. Supervise patients with arterial catheters at all times and carefully care for the catheter:
   - Clearly label the catheter, allowing easy identification as arterial rather than venous and, thereby, alerting personnel NOT to administer medications through the catheter.
   - Rewrap the catheter, at a minimum, once daily; rewrap soiled catheters promptly.
   - While the catheter is unwrapped, evaluate the insertion site for redness, warmth, swelling, pain, or discharge; remove catheters that are painful or oozing from the insertion site.
   - Document when the catheter is rewrapped and note the appearance of the insertion site in the medical record.
   - Consider putting an E-collar on patients to prevent access to arterial catheters.
   - Do NOT maintain arterial catheters in cats for longer than 6 to 12 hours[1] owing to increased risk for arterial thrombosis.

TABLE 3.
Required Supplies for DABP Measurement

- Arterial catheter
- T-set primed with heparinized saline
- DABP transducer system primed with heparinized saline
- Transducer cable
- Physiologic monitor that displays DABP wave form and numeric values for SAP, DAP, and MAP
- 250-mL bag of heparinized saline (1 U heparin/1 mL 0.9% sodium chloride)
- Pressure bag
- Board for stabilization of the transducer

Preventing Inaccurate Results

Although DABP is considered the gold standard in blood pressure monitoring, a number of situations can cause erroneous readings, which can be prevented by:

- Using only semi-rigid tubing to connect the pressure transducer to the patient—the use of compliant tubing results in excessive damping of the pressure wave, causing inaccurate readings
- Ensuring air bubbles are not present in the system
- Checking the semi-rigid tubing for kinks
- Making sure the pressure bag is inflated to at least 250 mm Hg
- Reassessing the transducer level; if the transducer is displaced, replace it to approximately the level of the right atrium and zero to the patient
- Ensuring that the arterial catheter is patent; flush the arterial catheter if needed.

Learn More

Visit **TVPjournal.com** and select Resources to read **Blood Pressure Monitoring: The Nursing Thought Process**, which outlines the 5 steps of the nursing process and how they help the veterinary team prioritize, troubleshoot, and solve issues related to blood pressure measurement and monitoring before they become an emergency.

IN SUMMARY

Veterinary nurses play a fundamental role in patient care. Appropriately monitoring patient blood pressure, documenting results, interpreting them, and communicating changes and concerns to the clinician provides all members of the veterinary team with an opportunity to proactively manage potential problems.

DABP = direct arterial blood pressure; DAP = diastolic arterial pressure; IABP = indirect arterial blood pressure; MAP = mean arterial pressure; SAP = systolic arterial pressure

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