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## Measurement of Systemic Blood Pressure in Cats & Dogs

Measurement of systemic blood pressure (BP) is indicated in dogs and cats at risk for systemic hypertension, evidence of target organ injury, concurrent disease affected by hypertension, animals with suspicion of low BP, or for monitoring during sedation or anesthesia. This article will outline how to measure BP in small animal patients; please see the Recommendations article on the [\*Diagnosis and Management of Systemic Hypertension in Cats and Dogs\*](#) for further information on underlying conditions and therapeutic recommendations for animals with systemic hypertension.

### Methods of Blood Pressure Measurement

There are three methods to measure and monitor arterial blood pressure in small animals – direct invasive measurement, non-invasive Doppler sphygmomanometry, and non-invasive oscillometric techniques. Direct arterial monitoring is performed by placement of an over-the-needle catheter into the dorsal pedal, superficial palmar arch, brachial, or femoral artery. Direct measurement allows for continuous assessment of systolic, diastolic, and mean pressure, and continuous invasive monitoring of arterial BP can detect changes in BP rapidly. Direct arterial monitoring is feasible in most dogs, though the small size of feline arteries makes placement of an arterial line challenging even in the anesthetized cat and is impractical in the awake cat. For both dogs and cats in the awake clinical setting, non-invasive techniques are most commonly employed for measurement of BP.



FIGURE 1

The two primary methods for non-invasive estimation of BP are Doppler sphygmomanometry and oscillometry, available as a standard or high-definition device. Importantly, no non-invasive device in veterinary medicine meets suggested guidelines for validation<sup>1</sup> and studies suggest that measurements made by different noninvasive devices are not interchangeable.<sup>2</sup> Indirect measurements of BP deviate further from invasive measurements at extremes of hypo or hypertension and care should be taken in the interpretation of indirect BP in critical patients. However, careful and repeated measurements in a controlled environment can frequently detect significant variations in BP from normal and are advised for animals at risk for hyper- or hypotension. Doppler sphygmomanometry in the cat has been shown to be more accurate than oscillometric measurements when direct measurement is used as the gold standard.<sup>3,4</sup> However, studies in dogs often favor the accuracy of oscillometric techniques to Doppler.<sup>5,6</sup>

Blood pressure measurement is performed with the animal lightly restrained in sternal or lateral recumbency (Figure 1). Lateral recumbency has been shown to have better correlation between direct and oscillometric measurements in dogs.<sup>7</sup> At times, it is easier to perform the measurement in cats in a sitting position or sternal recumbency, but care should be taken to keep the measurement site at the same horizontal plane as the animal's heart. With respect to the limb chosen, the forelimb for the Doppler measurement of BP works well and prior studies in the cat found a stronger correlation between Doppler and directly measured BP from the forelimb as compared to the hindlimb.<sup>3</sup>

A study in anesthetized dogs also found greater accuracy and precision for oscillometric measurements on the forelimb, compared to the hindlimb.<sup>8</sup> For oscillometric measurement of BP in cats, one study found better tolerance of oscillometric BP measurement from the tail as compared to the forelimb of conscious cats.<sup>9</sup> Notably, studies have also shown disparate results within the same animal and using the same method when different anatomic sites of measurement were compared.<sup>10,11</sup> The optimal anatomic site for measurement of BP in an animal varies by the experience of the operator, the tolerance of the patient, and the characteristics of the measurement device. No matter which site is chosen for measurement, values should be compared to reference intervals derived from that location and the same site should be used for any future measurements.

It is preferable to have 1 or 2 dedicated technicians perform all BP measurements in a given practice, with a recent study showing much greater variability in BP measurements performed by less experienced operators.<sup>12</sup> The variability that is inherent in the technique can likely be reduced by practice and consistency between measurements. Whichever method and site are chosen, it is important to note both in the medical record and to use the same methodology for future measurements when monitoring an animal over time.

### Measurement Technique – Doppler Sphygmomanometry

An appropriately-sized Velcro cuff is determined by the cuff width equal to ~40% of the limb circumference; 30-40% of the circumference has been suggested for cats (Figure 2).<sup>13,14</sup> The cuff is then placed snugly around the site of measurement, i.e. antebrachium of the non-recumbent forelimb or base of the tail, with the center of the cuff's inflatable bladder centered over the artery, and tape or adhesive wrap gently applied to hold the cuff from separating during inflation. The pulse is found by detecting an audible Doppler signal, placing the Doppler crystal either on the ventral aspect of the distal forelimb or hindlimb used, typically just proximal to the metacarpal/metatarsal pad, or at the ventral base of the tail for tail cuffs (Figure 2). Improvement in picking up the audible pulse signal is achieved by wetting the measurement site with alcohol and using gel to maximize coupling between the skin and the Doppler crystal. Occasionally, clipping the fur at the site of Doppler crystal placement may be needed in addition to application of coupling gel. Additionally, headphones attached to the Doppler unit are useful to block out extraneous noise to the operator and to minimize the effect of movement artifact and loud Doppler signals from stressing the animal. The cuff is gently inflated with a sphygmomanometer until the audible pulse signal is lost and then pressure in the cuff is gradually released until the pulse is again audible; this pressure indicates the animal's systolic BP. This measurement should be repeated ~5 times until consistent values are achieved (varying by <10%) and the average of these measurements used; often, the first measurement is rejected as the animal is not yet used to having the cuff inflated and the BP may be falsely elevated. If repeat measurements continue to drop as the animal becomes accustomed to the procedure, the measurement is repeated until consistent values are obtained. Reevaluation in 1-2 hours during which the animal is kept in a calm environment should be considered if spurious results are obtained; particularly if there is no evidence of target organ injury. All conditions and values of measurement should be recorded in the medical record, see template on the last page of this article.



FIGURE 2

### Measurement Technique - Oscillometric

Oscillometric devices are often most useful in very compliant or sedated patients. Such devices are more sensitive to patient movement and can provide false readings in the animal that cannot lie perfectly still. The benefit of an oscillometric device is that it provides diastolic and mean BP estimates in addition to the systolic measurement; however, isolated diastolic hypertension has not been described in animals and the systolic BP is therefore likely

sufficient to screen animals for hypertension. Values of mean arterial pressure are more useful in hypotensive or anesthetized animals.

Oscillometric devices are automated; activation of the device initiates a sequence of cuff inflation and gradual deflation. As with the Doppler technique, the mean of 5 consecutive and consistent measurements should be obtained with the first measurement and any clear outlying values discarded. For the high-definition oscillometric technique, the traces of cuff inflation and pulse waves should be viewed on a computer to verify that the traces are acceptable for assessment. The rate of cuff deflation should be linear and the pulse wave curve should have a bell-shaped distribution for the measurement to be reliable.<sup>15</sup>

## Record keeping

A record of the BP measurement event should be kept in the patient's medical record. Meticulous attention to the technique used, cuff site and size, heart rate, and demeanor of the animal allows comparison over time for animals receiving therapy for systemic hypertension, and allows the clinician to evaluate the results in light of the conditions under which the measurement occurred. A sample BP recording form can be found at the end of this article; the form can be adapted for the needs of the practice. If the patient's BP is elevated and the patient was noted to be other than relaxed during measurement, or in the case of dogs, was panting during measurement, a second measurement occasion several hours later can be scheduled to confirm the elevated BP results. Though if target organ injury is apparent, an elevated BP result is likely accurate.

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# Blood Pressure Measurement Record

Date/Time:	Age:	Sex:	Clinician:
Patient:	Med Rec #:	BP Performed by:	
Current Medications:			Time Since Last Dose:

<b>Equipment:</b>			<b>Cuff Size:</b>						
Doppler	Oscillometric	Other:	#1	#2	#3	#4	#5	#6	#7
Direct	High-Def Oscillometric								

<b>Site of Measurement:</b>				<b>Patient Position:</b>	
Rt. Forelimb	Lt. Forelimb	Right Lateral	Left Lateral		
Rt. Hindlimb	Lt. Hindlimb	Sternal	Sitting		
Tail		Standing (tail cuff only)			

<b>Stress Level of Patient:</b>				
Relaxed	Tense	Nervous	Panting/Vocalizing	Agitated
Heart Rate:				

<b>Measurements (mmHg):</b>			
	<b>Systolic</b>	<b>Diastolic</b>	<b>Mean</b>
1.			
2.			
3.			
4.			
5.			
6.			
7.			
Avg.			

Notes:

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