

## Blood Pressure Monitoring from a Nursing Perspective

# PART 1: OVERVIEW OF BLOOD PRESSURE MONITORING

Lila K. Sierra, CVT, VTS (ECC), and Emily Savino, BA, CVT, VTS (ECC)  
University of Pennsylvania

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

Arterial blood pressure is essential for adequate perfusion of tissues, providing oxygen delivery 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.

Blood pressure monitoring has become a vital part of small animal practice, and is often the responsibility of the nursing staff. Veterinary nurses should:

- Have the technical skills to accurately assess blood pressure
- Understand the advantages and disadvantages of different monitoring techniques
- Recognize abnormal values and understand their implications
- Know when to alert the clinician who is managing the patient.

Part 1 of this article series discusses terms associated with blood pressure measurement, indications for measurement, and normal and abnormal blood pressure values. Part 2 will describe types of blood pressure monitors and provide step-by-step instructions on how to perform blood pressure measurement.

### BLOOD PRESSURE DEFINITIONS

#### Blood Pressure Values

When the left ventricle contracts, blood is pushed into the aorta creating **systolic arterial pressure (SAP)**; then the left ventricle empties, relaxes, and begins to fill again, and aortic pressure falls, creating **diastolic arterial pressure (DAP)**. **Mean**

**arterial pressure (MAP)** is calculated from the systolic and diastolic values:<sup>1</sup>

$$MAP = DAP + \frac{1}{3} (SAP - DAP)$$

#### Types of Monitoring

Arterial blood pressure can be monitored in 2 ways:

- **Direct arterial blood pressure monitoring**—considered the gold standard for monitoring—uses an arterial catheter and allows continuous monitoring of patient SAP, DAP, and MAP (**Figure 1**).<sup>2-4</sup>
- **Indirect arterial blood pressure monitoring** relies on detection of arterial blood flow or vessel wall movement in a peripheral artery, using Doppler or oscillometric methods (**Figures 2 and 3**, pages 54 and 55).



**FIGURE 1.** Direct arterial blood pressure being monitored in a dog with an arterial catheter in the dorsal pedal artery. The catheter is attached to a disposable pressure transducer system. An inflated pressure bag maintains the system under constant pressure that must be higher than SAP.<sup>2</sup>



FIGURE 2. Doppler blood pressure measurement.

### INDICATIONS FOR MEASUREMENT

Specific indications for blood pressure monitoring include:

- During anesthesia, when patients are anticipated to become cardiovascularly compromised due to the effects of anesthetic drugs, type of surgery performed, and nature of the patient's disease
- In an emergency/critical care setting, in which the condition of the patient changes from minute to minute
- In general practice, to obtain and help identify early markers of disease during baseline health checks
- In patients with known or suspected hypotension or hypertension due to underlying diseases.

### NORMAL ARTERIAL BLOOD PRESSURE VALUES

Blood pressure measurement provides important information about the cardiovascular status of a patient, and the importance of knowing normal values in different species cannot be overstated (**Table 1**).

### HYPOTENSION

Hypotension is defined as *lower than normal blood pressure*. Hypotension results in decreased tissue perfusion and can result in compromised

TABLE 1.

**Normal Arterial Blood Pressure Values in Adult Dogs & Cats<sup>5</sup>**

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

### Blood Pressure Monitoring: Looking at the “Big Picture”

Veterinary nurses should think *critically* about results obtained in their patients, never looking at 1 value independent of the rest of the patient.

In other words, think about your patient *globally* and consider the patient's blood pressure reading as part of the bigger picture. For example:

- If the patient is hypertensive, is it also

tachycardic?

- Is the patient in pain, anxious, or both?
- Is the patient's hypertension a result of being restrained to obtain a blood pressure reading?
- If the patient is hypotensive, is it also tachycardic or bradycardic?
- Is the patient hypothermic?

- How responsive is the patient? Is it dull or stuporous?

These are the types of questions that veterinary nurses should ask. By taking time to consider the “whole picture” rather than only looking at isolated pieces of information, veterinary nurses are better able to process what may be happening with their patients and pass significant concerns on to clinicians.



FIGURE 3. Feline patient connected to an oscillometric blood pressure monitor.

A hypotensive blood pressure reading should be followed by brief physical assessment of the patient, and the clinician should be notified of the patient's status.

**Monitoring**

Hypotensive patients should be monitored on a regular basis and their cardiovascular status should be re-evaluated, at minimum, every 30 minutes. Frequent reassessment is necessary to determine whether therapy is working or if more aggressive intervention is necessary.

It is important to remember that a patient's cardiovascular status can decline rapidly. Renal tissue perfusion diminishes when MAP declines below approximately 65 mm Hg.<sup>4</sup> In patients with sustained MAP < 65 mm Hg, the patient's urine output should be monitored closely because decreased urine output can signify impaired renal perfusion.

blood flow to vital organs. Common causes of hypotension are listed in **Table 2**.

**Diagnosis**

A diagnosis of hypotension is made based on the patient's presentation, physical examination, and blood pressure measurement.

In dogs and cats, MAP is the preferred value used for making a diagnosis of hypotension. A patient is considered hypotensive when:

- MAP is < 60 mm Hg.<sup>3,4</sup>
- SAP is < 90 to 100 mm Hg.<sup>2,4</sup>

**HYPERTENSION**

Hypertension is typically divided into 2 categories: primary and secondary.

**Primary Hypertension**

Primary hypertension is caused by an imbalance between cardiac output and systemic vascular resistance that has no known cause; therefore, it is

TABLE 2.

**Potential Causes of Hypotension<sup>3</sup>**

RESULTS IN HYPOTENSION	CAUSES
Reduction in preload	<ul style="list-style-type: none"> <li>• Hypovolemia</li> <li>• Obstructed venous return (eg, GDV, vena cava thrombosis)</li> </ul>
Decreased cardiac function	<p><b>Primary</b>, such as heart failure/cardiac disease due to:</p> <ul style="list-style-type: none"> <li>• Cardiomyopathy</li> <li>• Valvular dysfunction</li> <li>• Arrhythmia</li> </ul> <p><b>Secondary</b>, from decreased cardiac function due to:</p> <ul style="list-style-type: none"> <li>• Electrolyte abnormalities</li> <li>• SIRS/sepsis</li> <li>• Severe hypoxia, acidosis, or alkalosis</li> </ul>
Reduction of systemic vascular resistance	<ul style="list-style-type: none"> <li>• Drug or toxin (eg, anesthetic agent)</li> <li>• SIRS/sepsis</li> <li>• Electrolyte abnormalities</li> <li>• Severe acidosis or alkalosis</li> <li>• Severe hypoxia</li> </ul>

GDV = gastric dilatation volvulus; SIRS = systemic inflammatory response syndrome

sometimes referred to as *idiopathic hypertension*.<sup>6,7</sup> It is rare in small animals.

A diagnosis of primary hypertension is made when reliable blood pressure readings demonstrate a sustained increase in blood pressure, paired with a normal complete blood count, serum biochemical profile, and urinalysis.<sup>6</sup>

### Secondary Hypertension

Secondary hypertension is elevated blood pressure that occurs secondary to concurrent disease (**Table 3**), or due to administration of medications, including certain therapeutic agents, such as glucocorticoids, mineralocorticoids, erythropoietin, sodium chloride, phenylpropanolamine, and nonsteroidal anti-inflammatory drugs.<sup>6,7</sup>

### Diagnosis

The following blood pressure values—if measured on 3 separate occasions during the same visit—are consistent with hypertension:<sup>6,7</sup>

- Dogs: SAP/DAP > 150/95 mm Hg
- Cats: SAP > 150 mm Hg.

### Consequences

Persistent elevations in blood pressure can have serious consequences. Sustained hypertension is associated with damage to the eyes, ears, brain,

## When "Normal" Does Not Mean All is Well

It is important to note that even if blood pressure is normal, it does not necessarily mean that tissue perfusion is adequate.<sup>3</sup> In simple terms, the body attempts to maintain blood flow to the brain and myocardium at all costs:<sup>3</sup>

- As part of this homeostatic mechanism, the initial response of the body to compensate for decreased MAP is to bring it back up to normal by increasing systemic vascular resistance, by vasoconstriction.
- Vasoconstriction, in turn, can diminish blood flow to peripheral tissues, resulting in decreased tissue perfusion despite the patient remaining normotensive.
- Often, the patient does not become hypotensive until the compensatory mechanisms have failed.



### LILA K. SIERRA

Lila K. Sierra, CVT, VTS (Emergency and Critical Care) is the assistant nursing supervisor of the intensive care unit at Matthew J. Ryan Veterinary Hospital of University of Pennsylvania. She has lectured at state conferences and has published chapters in various veterinary manuals. Her passion lies in all aspects of advanced nursing care, including patient advocacy, innovative nursing development, and education of prospective veterinarians and nurses.



### EMILY SAVINO

Emily Savino, BA, CVT, VTS (Emergency and Critical Care) is the nursing supervisor of the intensive care unit at Matthew J. Ryan Veterinary Hospital of University of Pennsylvania. She has lectured on veterinary critical care nursing at conferences, and has published chapters in veterinary texts. She enjoys teaching new veterinary nurses the art of "critical thinking" and working in an environment where she is learning new things every day.

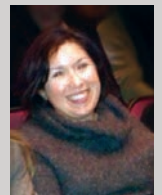


TABLE 3.

### Diseases Associated with Secondary Hypertension in Dogs & Cats

DOGS	CATS
<ul style="list-style-type: none"> <li>• Acute kidney disease</li> <li>• Chronic kidney disease</li> <li>• Diabetes mellitus</li> <li>• Hyperadrenocorticism</li> <li>• Hypothyroidism</li> <li>• Obesity</li> <li>• Pheochromocytoma</li> <li>• Primary hyperaldosteronism</li> </ul>	<ul style="list-style-type: none"> <li>• Chronic kidney disease</li> <li>• Diabetes mellitus</li> <li>• Hyperthyroidism</li> <li>• Obesity</li> <li>• Pheochromocytoma</li> <li>• Primary hyperaldosteronism</li> </ul>

Adapted from Brown S, Atkins C, Bagley R, et al. Guidelines for the identification, evaluation, and management of systemic hypertension in dogs and cats. *J Vet Intern Med* 2007; 21:542.

and kidneys.<sup>6,7</sup> A *hypertensive emergency* occurs when the patient has a marked elevation of blood pressure and is at risk for development of end-organ damage or vascular incidents, such as cerebral hemorrhage causing neurologic signs or intraocular hemorrhage causing blindness.<sup>7</sup>

### Monitoring

It is imperative that severely hypertensive patients are treated at a facility that can provide 24-hour critical care monitoring.

## ACCURATE BLOOD PRESSURE MEASUREMENT

Stress and anxiety in the clinic setting, coupled with stress during handling to obtain a blood pressure measurement, can cause elevated readings, resulting in a false diagnosis of hypertension. The following steps should be taken to ensure an accurate measurement:

1. Prior to blood pressure measurement, patients should be allowed to remain calm in a quiet examination room for 5 to 10 minutes.<sup>6</sup>
2. Blood pressure measurements should be taken



### White Coat Syndrome

Some patients may fall into the category of *white coat syndrome*, which should not be confused with true hypertension. Unfamiliar faces, scents, and sounds, followed by a close encounter with a stranger in a white coat can inadvertently cause stress, anxiety, and fear, hindering our ability to obtain accurate blood pressure readings.

In human medicine, this is a well-recognized phenomenon. Blood pressure surges occur in patients with this condition, making it difficult to ascertain valid blood pressure measurements, and potentially resulting in an inaccurate diagnosis of hypertension.<sup>8</sup>

only after the patient has had time to acclimate to the clinic setting.<sup>6</sup>

- Heart rate should always be recorded at the time of blood pressure measurement; presence of tachycardia in association with hypertension should prompt consideration of *white coat hypertension*.

Minimizing the risk of an incorrect diagnosis of hypertension in the fearful or painful patient relies on interpretation of a pet's body language during the examination, use of a little creativity, and a lot of patience:

- Provide a safe, quiet, comfortable environment and slowly introduce yourself, allowing the pet to feel at ease and build a sense of trust.
- Consider taking the pet into a quiet room, attempting to make the cage/carrier more comfortable, using a box as a retreat sanctuary for a cat, or engaging in gentle play using a dog's favorite toy.
- If you are successful and can measure blood pressure, take 3 readings to obtain an average; then consider repeating the process later when the pet is more relaxed.

### IN SUMMARY

Veterinary nurses play a fundamental role in patient care. We are often on the front lines, assessing patients as they are initially presented and then assessing them repeatedly after the clinician leaves. This gives us unique insight to detect subtle variations that may otherwise go unnoticed. Documenting that information, interpreting it, and communicating changes to the clinician provides the veterinary team an opportunity to proactively manage potential problems.

DAP = diastolic arterial pressure; MAP = mean arterial pressure; SAP = systolic arterial pressure

### References

- Grimm KA, Tranquilli WJ, Lamont LA. *Essentials of Small Animal Anesthesia and Analgesia*, 2nd ed. Ames, IA: John Wiley and Sons, Inc, 2011, p 208.
- Waddell LS, Brown J. Hemodynamic monitoring. In Silverstein DC, Hopper K (eds): *Small Animal Critical Care Medicine*, 2nd ed. St. Louis: Elsevier, 2015, pp 957-962.
- Cooper E, Cooper S. Direct systemic arterial blood pressure monitoring. In Burkitt Creedon JM, Davis H (eds): *Advanced Monitoring and Procedures for Small Animal Emergency and Critical Care*. Ames, IA: Wiley-Blackwell, 2012, pp 122-133.
- Cooper E. Hypotension. In Silverstein DC, Hopper K (eds): *Small Animal Critical Care Medicine*, 2nd ed. St. Louis: Elsevier, 2015, pp 46-50.
- Williamson JA, Leone S. Noninvasive arterial blood pressure monitoring. In Burkitt Creedon JM, Davis H (eds): *Advanced Monitoring and Procedures for Small Animal Emergency and Critical Care*. Ames, IA: Wiley-Blackwell, 2012, pp 134-144.
- Brown S, Atkins C, Bagley R, et al. Guideline for the identification, evaluation, and management of systemic hypertension in dogs and cats. *J Vet Intern Med* 2007; 21:542.
- Labato MA. Antihypertensives. In Silverstein DC, Hopper K (eds): *Small Animal Critical Care Medicine*, 2nd ed. St. Louis: Elsevier, 2015, pp 840-845.
- Oaklander M. Do you have high blood pressure or are you a victim of white coat syndrome? *Prevention* 2014; available at [prevention.com/health/healthy-living/your-doctors-raising-your-blood-pressure](http://prevention.com/health/healthy-living/your-doctors-raising-your-blood-pressure).