

# Blood Pressure Monitors

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**B**lood pressure monitoring is essential for many veterinary patients. It allows for detection of both hypertension and hypotension and guides us in choosing and monitoring appropriate therapy for these conditions. Normal values for dogs have been reported to be 110 to 190 mm Hg for systolic and 55 to 110 mm Hg for diastolic blood pressures. For cats, normal ranges have been reported to be 120 to 170 mm Hg systolic and 70 to 120 mm Hg diastolic. However, systolic pressures consistently above 160 mm Hg and diastolic pressures above 100 mm Hg should be considered hypertensive in both dogs and cats. Hypotension is defined as systolic pressures below 80 mm Hg and/or mean arterial pressures below 60 mm Hg in either species.

Blood pressure monitoring can be divided into two main categories, invasive and noninvasive. Invasive blood pressure monitoring directly measures arterial pressure; this method is the gold standard but is not done in most veterinary practices. The noninvasive methods are most commonly used, and either oscillometric or Doppler technology is available for use in veterinary patients. Noninvasive blood pressure monitoring is based on inflation of a cuff to occlude arterial flow followed by measurement of the pressure at which flow returns.

## Indications

There are two categories of patients that benefit from blood pressure monitoring—those suspected of being hypertensive or hypotensive. The following presentations are indica-

tions for blood pressure monitoring as they may be associated with hypertension:

- Sudden blindness
- Acute neurologic signs
- Acute or chronic renal failure
- Hyperthyroidism
- Diabetes mellitus
- Hyperadrenocorticism
- Pheochromocytoma
- Poor pulse quality
- Decreased tissue perfusion

Hypotension can be caused by decreased circulating volume, peripheral vasodilatation, and/or myocardial dysfunction. Patients under sedation and general anesthesia can develop hypotension secondary to a combination of these factors.

## Noninvasive Blood Pressure Monitors

### Advantages

All noninvasive blood pressure monitors are technically easy to use; the equipment is not cost-prohibitive and is readily available. With frequent use, blood pressure measurements can be done quickly, relatively easily, and fairly accurately.

### Disadvantages

Noninvasive methods can give erroneous results, usually due to inexperience of the operator and selection of an inappropriate cuff size. If the cuff is too small, a falsely high



Blood pressure measurement in a cat with acute renal failure using the Doppler. The front leg is used, with the cuff on the antecubital region and the Doppler probe over the metacarpal artery.

reading will be obtained; if the cuff is too large, a falsely low pressure will be given. The appropriate cuff width should be approximately 40% of the circumference of the limb. All of the noninvasive methods tend to give systolic readings that are lower than those measured by direct, or invasive, methods. The degree of error is dependent on the noninvasive method used as well as the patient's blood pressure. Patients with hypertension will have the greatest difference in systolic pressures reported by noninvasive methods compared with direct measurements.

## Doppler

Doppler methods use a 10-MHz ultrasound probe to detect blood flow in an artery. The probe is placed over an artery distal to the cuff. Doppler sounds become audible when pressure in the cuff is less than that in the artery.

### Advantages

These methods are useful in patients with hypotension or those who have arrhythmias. The audible signal is particularly useful during procedures in which the patient is anesthetized, as it allows the clinician to hear the heart rate and rhythm and to detect changes in blood pressure.

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Dinamap blood pressure monitor. This is an oscillometric system. The display gives diastolic, systolic, and mean pressures and heart rate.

### Disadvantages

The Doppler method only measures systolic pressure. It also takes a higher level of technical skill than do oscillometric methods because the artery has to be located with the probe.

A study published a few years ago compared Doppler readings to systolic and mean arterial blood pressure measured via direct method in anesthetized cats.<sup>1</sup> This study used healthy cats and induced hypotension with isoflurane. The investigators found that the Doppler consistently underestimated systolic pressures, but correlated well to mean arterial blood pressure. This has been a point of great discussion, but the limitations of the study should be remembered. These were otherwise healthy cats under anesthesia. How well this can be extrapolated to critically ill, hypotensive cats is unknown.

### Dinamap

The Dinamap (Device for Indirect Noninvasive Automatic Mean Arterial Pressure) is an oscillometric method of blood pressure determination. The cuff is alternately inflated and deflated. During deflation, oscillations (i.e., alterations) in cuff pressure are sensed by the transducer. These oscillations are caused by pulses in the limb. The peak amplitude of oscillations equals the mean arterial pressure.

Systolic pressure equals the pressure at which oscillations are first detected, and diastolic pressure equals the pressure at which oscillations decrease rapidly. The heart rate is measured as the number of oscillations per minute and should always be compared with the patient's heart rate as determined by palpation or auscultation by stethoscope.

### Advantages

The Dinamap is technically easier to use than the Doppler, since the exact location of the artery does not need to be found. It can be set to repeatedly measure the blood pressure at a defined interval (for example, every 30 minutes) and will retain several readings until the machine is turned off.

### Disadvantages

Errors can result if the patient moves or if significant arrhythmias are present. Another disadvantage is that readings are not given instantaneously, so although it can be set for repeated measurements, readings can only be made every few minutes.

### Cardell

The Cardell system also uses the oscillometric method. These systems can measure systolic, diastolic, and mean arterial pressures and heart rate.

### Advantages

The Cardell system has been shown to be effective in measuring pressure in cats and dogs of all sizes. Advantages over the Dinamap system include less time to obtain measurements and smaller size and thus easier portability.

### Disadvantages

Because this is a newer system, it is more expensive than some of the others, and refurbished units are not yet available to reduce the cost. Significant arrhythmias and movement by the patient can cause difficulty in obtaining readings.

### Economic Impact

The initial purchase of the equipment can be relatively expensive—most systems range between \$750 and \$2500. However, the equipment does not require much maintenance or supplies, so ongoing costs are minimal. The potential use for these machines in a practice is unlimited, as they can benefit many geriatric patients, patients under anesthesia, animals with chronic disease, and emergency and critical care patients. The cost of the equipment can easily be regained by charging a fee for blood pressure measurement. ■

See Aids & Resources, back page, for references, contacts, and appendices.



Cardell blood pressure monitor being used on a dog after surgery for traumatic diaphragmatic hernia repair. The cuff is on the left antebrachium.