

Systemic arterial blood pressure (BP) monitoring is widely used during anesthesia in part because depth is difficult to establish simply using physical signs. Changes in BP and CO₂ level occur with Anesthetic depth, painful stimulation, cardiovascular dysfunction or changes in vasomotor tone such as occur with hypothermia. A mean BP > 60 mm Hg is required for adequate perfusion of the brain and to ensure production of glomerular filtrate by the kidneys. For these reasons frequent monitoring of BP is used in critical care. Routine clinical BP assessment has also led to better understanding and treatment of hypertension in dogs and cats.

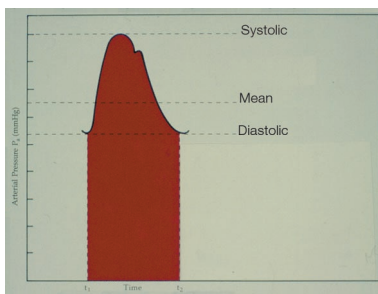
Steps to Better Understanding & Measurements

Physiology

The blood pressure waveform is like a sine wave, having an upstroke (systole or SAP = ejection phase) and a downstroke (diastole or DAP = filling phase). Mean arterial BP (MAP) is defined as the area under the BP curve. Because more time is spent in diastole, it has far greater than systole on MAP:

$$\text{MAP} = \text{DAP} + 1/3 (\text{SAP} - \text{DAP}) \text{ or}$$

$$\text{MAP} = (\text{SAP} + 2 \times \text{DAP}) / 3$$



Always assess mucous membrane colour when evaluating BP.

BP = Blood Flow x Resistance

Pink = good flow, BP may be low if vasodilated

Pale = lower flow, BP may be high if vasoconstricted

Clinical BP monitors:

- Invasive**, direct monitors that use an arterial catheter connected via a transducer to measure systolic, diastolic, + mean BP
- Non-invasive**, indirect blood pressure (NIBP) monitors that use a pneumatic cuff placed around a limb or the tail to estimate pulse rate, systolic and in some cases, diastolic and mean BP. In dogs NIBP monitors most accurately estimate systolic BP.



Common NIBP monitors

Doppler ultrasonic devices that use a blood flow transducer placed on a distal limb artery to indicate return of blood flow when a pneumatic cuff is deflated manually. Dopplers are the most consistent at detecting systolic BP in conscious cats.

Oscillometric devices (eg. CAS 740) that detect pulsations in the pneumatic cuff when blood flow returns to the limb as the cuff is

automatically deflated. In general, oscillometric devices must accurately detect the pulse rate in order to accurately determine BP.

Using Pneumatic Cuffs

Most errors of measurement are due to problems with cuffs.^{1,2}

- Cuff bladder width should usually be 40% of the circumference of the limb at the level of application



- Position
 - Thoracic limb - above the carpus approximately 1/3 distance towards the elbow
 - Pelvic limb - just above the hock (small dogs) or just below the hock (large dogs)
 - Tail - close to the base of the tail
- The occlusive bladder should be directly over the artery to be occluded, usually on the underside of the appendage.



- Clipping off some hair will help in animals with long or thick coats.
- Short, bent fore legs are a challenge (eg Dachshunds) - consider using a pelvic limb or tail
- Pneumatic cuffs and flow probes should be positioned at the level of the heart to avoid errors caused by gravity.
- Motion at the measuring site will generally affect any NIBP results.
- Deflate the cuff between readings or it will restrict blood flow to the limb causing catecholamine release which generally causes BP to rise.
- In anesthetized cats NIBP devices tend to under-estimate systolic BP (may more closely

estimate mean BP); therefore add 15 mm Hg to SBP readings.^{1,2}

- Doppler flow detectors are 'microphones' and are affected by external noise (eg clippers), electrical interference (eg electrocautery) and ultrasonic feedback noise.
- Occasionally polishing the connectors on the Doppler box will reduce static noise.
- Probe damage is the most common cause of Doppler problems.

Hypertension & Hypotension

- Cat NIBP measurement variations are in part due to small patient limbs.
- Treat hypotension during anesthesia by reducing Anesthetic depth, administering IV fluids or inotropes. Increasing HR with atropine may raise BP
- BP is dynamic and single measurements may not be representative. Consistent NIBP readings should be obtained over several hours or days to diagnose hypertension (average 3 sets of measurements).^{3,4} If readings are questionable consider comparing BP readings from different sites in the same animal. Vasodilator therapy can cause complications in normal, healthy animals!
- Treatment for hypertension should be considered in animals with clinical signs (eg retinal haemorrhage) even if BP values are not in the 'hypertensive' range.^{3,4}
- Stress ('white coat' disease) causes BP to rise in conscious animals so allow animals to rest, either with the owner or in a cage, prior to making BP measurements.



References:

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- Elliott J, Barber PJ, Syme HM et al. Feline Hypertension: clinical findings and response to antihypertensive treatment in 30 cases. *JSAP* 42:122-129; 2001
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Interpretation of blood pressure values

Systolic AP mm Hg	Dog	Cat
Normal conscious	135 +/- 10	155 +/- 10
Hypertension	180 +/- 10	190 +/- 10
Hypotension	85 +/- 5	70 +/- 5
Severe Hypotension	< 75	< 60