

Stressors, Pressors and Heartache Disasters
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Appropriate blood pressure is vital for sustaining a healthy cardiovascular, cerebral and internal organ system. Without healthy blood pressure these systems can suffer, leading to chronic disease processes and death. In veterinary medicine monitoring blood pressure is still relatively new when compared to the human medical field and refining the best techniques in accurate measurement and treatment is under constant research. Nearly every species we deal with has physiologic differences and tolerances when it comes to their blood pressure and how effective various modalities work in each species. The following is a very broad overview of common medications used to treat abnormal blood pressure under anesthesia, with a focus on hypotensive correction.

Treating hypertension or hypotension (MAP <60mmHg for many species) while under anesthesia should never first start with pharmacological agents unless the patient has a pre-diagnosed cardiovascular condition. Treatment for either hyper or hypotension should first start with a careful patient assessment. These are some questions that should run through your head before moving to pharmaceutical intervention. Is the patient too light or painful? Is the gas inhalant or total IV anesthesia rate too high? Is the fluid therapy adequate? Are my monitoring devices (i.e. Doppler or mechanical blood pressure monitors) appropriately placed and do the numbers appear to match with how the animal looks clinically? Does my patient have an underlying cardiac issue? Does my patient have an arrhythmia?

Atropine- Although not typically considered a blood pressure medication, atropine plays an important role in treating certain arrhythmias under anesthesia. Neonates and immature animals are more reliant on heart rate for appropriate cardiac output and thus blood pressure. While atropine has fallen out of favor in the pre-medication plan it is a drug that warrants shelf space in all operating rooms.

Ephedrine- Ephedrine is a safe, yet somewhat expensive option in the first line of pharmaceutical intervention of hypotension. Ephedrine increases cardiac output, heart rate, blood pressure, coronary blood flow, and myocardial oxygen consumption. It reduces the need and time for CRI's of other vasopressors and inotropes with its longer duration of action. Ephedrine is used in human medicine second to phenylephrine for hypotension during pregnancy and fetal surgery. One study found in dogs a bolus only lasted 5 minutes and the increases of cardiac output and increased BP were merely transient. Ephedrine also causes stimulation of the respiratory centers and bronchodilation.

Dopamine- This is a highly dose dependent drug. For effective increases in MAP in dogs and cats research suggests rates starting at 7µg/kg/min to increase the A1-adrenergic agonist effects take the lead. The effect will increase systemic and pulmonary vascular resistance, venous return, and possibly PVC's due to splenic contraction. Tachycardia can occur at higher dose rates. When using dopamine it is recommended to decrease the CRI in a stepwise manner. The receptor effects of dopamine are dose dependent. Dopamine stimulates the release of endogenous norepinephrine from presynaptic storage sites at adrenergic receptors causing an endogenous sympathomimetic effect. There is some debate on the use of dopamine in felines as they lack the typical distribution of dopamine receptors found in canines.

Dobutamine- Dobutamine is another commonplace inotrope used to treat hypotension related to poor cardiac output. Current thought regarding the medication for treatment of hypotension

during inhalation anesthesia is that it lacks good predictable effects, especially in cats. Higher doses ~10mcg/kg/min were needed to produce vascular resistance in dogs and an increase in cardiac output, but caused vasodilation in cats. In both studies minimal to no increase in blood pressure was noted.

Phenylephrine- Phenylephrine is a direct-acting sympathomimetic amine with strong Alpha1-adrenergic receptor agonist effects. It is used intravenously during anesthesia to increase systemic vascular resistance therefore increasing blood pressure. Phenylephrine is the first line medication for hypotension during fetal surgery.

Norepinephrine- This medication has largely B-adrenergic receptor mediated effects. At sufficient doses we see an increase in cardiac output, increased SYS, DIA and MAP, along with systemic and pulmonary vascular resistance. Coronary arterial flow is also increased via vasodilation. Tachycardia is less pronounced compared to epinephrine.

Epinephrine 0.01–1 µg/kg/min

Norepinephrine 0.01–0.2 µg/kg/min

Dobutamine 1–20 µg/kg/min

Phenylephrine 0.2–2 µg/kg/min

Dopamine 1–10 µg/kg/min, >10 µg/kg/min Primarily α effects

Ephedrine 0.05–0.5 mg/kg

Drug	Drug Class	Dose	Time to Effects	Effects on BP	Effects on HR	Efficacy in Species	Fetal Safety	Mechanism of action	Notes
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Dopamine (\$0.70 per ml)	Adrenergic / Dopaminergic inotrope	10-12 mcg/kg/min (Alpha effects)	2-5 minutes, last 5-10 minutes post cessation	++	+++	C, F, NHP, O, S, B	Most likely safe, but use with caution	Precursor to norepi and indirectly releases norepi causing vasoconstriction	2-10 mcg/kg/min, organ and GFR are increase sans vascular resistance
Dobutamine (\$0.40 per ml)	Beta adrenergic inotrope	1-20 mcg/kg/min	2-5 minutes, Peaks at 10 minutes lasts 5-10 minutes post cessation	++ Dose dependent	++ Dose dependent	C, F, NHP, O, S, B, R(High dose)	Most likely safe	Increase myocardial contractility (can increase cardiac O2 demands)	Good for alveolar fluid buildup, patient must be hydrated, Liver is primary metabolizer. Can produce ectopic HB's, chest pain, palpitations, nausea and headaches.
Phenylephrine (\$7.72 per ml)	Alpha adrenergic agonist Vasopressor	0.5-3 mcg/kg/min in NaCl or D5W	Immediate, lasts 5-10 minutes post cessation	+++	0+ (report of reflex bradycardia, correct with atropine)	C, F, NHP, O, S, B, R, L	Safe and preferred in humans. Can cause uterine contraction.	Vasoconstriction, slight decrease in cardiac output with increase in coronary flow.	Use in hydrated patients
Ephedrine (\$26.50 per ml)	Sym. Bronchodilator/ Vasopressor	0.03-0.25 mg/kg bolus, q 5 min	immediate	+++	+++	C, F, NHP, O, S, B, R, L	Safe for healthy fetus (excreted in milk)	releases norepi causing vasoconstriction (Can deplete norepi)	Do not use in cardiac patients
Norepinephrine (\$39.00 per ml)	Alpha & Beta Adrenergic Vasopressor Cardiac inotrope	0.01-0.2 mcg/kg/min, max dose of 2 mcg/kg/min. Add 4mg to 1L 5% Dextrose sol. run at 0.75-1.5 mls/kg/hr	immediate	+++	0+ (report of reflex bradycardia, correct with atropine)	C, F, NHP, O, S, B, R, L	Do no use for viable pregnancy	Vasoconstriction, coronary artery dilator, slight increase in cardiac contractility	Use in hydrated patients. Good for Septic patients, high doses can lead to poor perfusion
Epinephrine (\$6.00 per ml)	Alpha & Beta Adrenergic agonist	0.01-1 mcg/kg/min, START LOW	immediate, lasts 5-10 minutes post cessation	+++	+++	C, F, NHP, O, S, B, R, L	Do no use for viable pregnancy	Vasoconstriction, Increased cardiac contractility, increase in coronary and pulmonary flow	Better for increasing systolic BP, can Decrease Diastolic. Use in hydrated patients only. Can cause poor tissue perfusion at high doses.
Vasopressin (\$69.50 per ml)	Hormone	20 pressor U/ml, 1-4mU/kg/min	Immediate	+++	0+	C, F, NHP, O, S, B, R, L	Do no use for viable pregnancy	vasoconstriction	Hepatic flow increase