

Anesthesia-related hypotension in a small-animal practice

This retrospective study examines the occurrence of hypotension in dogs and cats undergoing elective procedures and should help you decide whether to routinely monitor arterial blood pressure in all anesthetized animals.

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HYPOTENSION, usually defined as mean arterial blood pressure less than 60 mm Hg or systolic arterial blood pressure less than 90 mm Hg, is reportedly one of the most common complications associated with general anesthesia in dogs and cats.^{1,2} Although most university veterinary teaching hospitals and some private practices routinely measure arterial blood pressure in anesthetized animals, many private veterinary practices unfortunately do not.³ Pulse strength or quality, which is commonly assessed by manual palpation, depends on the difference between systolic and diastolic arterial blood pressure and is not necessarily indicative of mean arterial blood pressure or perfusion pressure.⁴ So the incidence of anesthetic-related hypotension in healthy dogs and cats undergoing elective surgeries in the typical private practice setting is unknown since most anesthetists only assess pulse strength or quality.³ If blood pressure is not measured, hypotension cannot be recognized and corrected.

The purpose of this study was to document the occurrence of hypotension in

dogs and cats anesthetized in a private veterinary practice. Our hypothesis was that hypotension is a frequent complication during anesthesia, even in relatively healthy animals undergoing elective procedures.

Materials and methods

Patient selection

This study involved a retrospective review of anesthesia records of healthy animals anesthetized in a private veterinary practice for elective surgery. As such, owner consent for this retrospective study was not sought. Animals were cared for according to the practice's routine protocols. The records of all dogs and cats that were anesthetized for elective procedures during a three-month period by one of the authors (Andrea M. Gordon) or another technician colleague were reviewed. This patient group comprised 101 client-owned animals (42 cats, 59 dogs). The procedures for which anesthesia was indicated included ovariohysterectomy, castration, onychectomy, and dental prophylaxis. All the patients were considered to be physical status Class I (a normal patient with no organic disease) or Class II (a patient with mild systemic disease).⁵

Anesthetic protocols

Anesthetic drugs were selected based on the patient's species, physical status, and temperament and the attending veterinarian's preference. The dogs were either not premedicated or were premedicated with atropine (0.03 mg/kg) and morphine (0.2 mg/kg) administered in-

tramuscularly. Fifteen of the premedicated dogs also received acepromazine (0.01 mg/kg) intramuscularly to provide additional sedation. Some of the cats received no premedication or atropine (0.03 mg/kg). Others received acepromazine (0.01 mg/kg), and butorphanol (0.22 mg/kg) intramuscularly. Alternatively, six cats undergoing onychectomy were premedicated with ketamine (22 mg/kg) and acepromazine (0.2 mg/kg) intramuscularly.

Anesthetic induction was achieved in all the patients by administering ketamine (5.6 mg/kg) and diazepam (0.28 mg/kg) intravenously or with isoflurane or sevoflurane in 50% oxygen, with 50% nitrous oxide, delivered by mask. The patients were intubated with appropriately sized endotracheal tubes, at which time nitrous oxide administration was discontinued and either isoflurane or sevoflurane, delivered through a circle breathing system in 100% oxygen, was used to maintain anesthesia. Vaporizer settings during maintenance were 1.5% to 2% for isoflurane and 2% to 3% for sevoflurane. Oxygen flow rates were 800 ml/min for animals less than 20 lb (9.1 kg), 900 ml/min for animals 20 to 40 lb, and 1 L/min for animals greater than 40 lb (18.2 kg). All animals except for cats undergoing castration only had an intravenous catheter in place and were given lactated Ringer's solution at 5 ml/kg/hr intravenously.

Blood pressure measurement

Baseline blood pressure measurements were not obtained in awake ani-

mals. During anesthesia, systolic arterial blood pressure was measured with an oscillometric blood pressure monitor (Pulse Ox/NIBP 6004—SurgiVet) in about 75% of the animals and a Doppler ultrasonic flow detector with sphygmomanometer (Hadeco Mini Dop ES-100 VX—Jorgensen Laboratories) in about 25% of the animals. In each case, the blood pressure monitor was applied as described in the literature, using a cuff width as close to 40% of the limb circumference as possible.⁴ Measurements were performed at least every 10 minutes or more often if low readings were obtained. A systolic blood pressure measurement less than 90 mm Hg was considered to indicate hypotension. For this study, the occurrence of hypotension was calculated as the percentage of the 101 anesthetized animals that had at least one systolic arterial blood pressure measurement of less than 90 mm Hg.

When hypotension was detected, the treatment depended on which anesthetist was in charge of the case: one anesthetist always attempted to correct hypotension, while the other anesthetist did not have the experience to do so. At the time of the study, the practice lacked a standard protocol for responding to a hypotensive incident. When attempted, treatment for hypotension included decreasing the isoflurane or sevoflurane vaporizer setting by 0.5% to 1% and administering an intravenous fluid bolus of 5 to 10 ml/kg. If blood pressure did not improve within five to 10 minutes, a second fluid bolus of 5 ml/kg was administered. Inotropic and pressor drugs were not available in the practice at the time these animals were anesthetized.

Statistical analysis was not performed on the blood pressure measurements.

Results

Of the 59 dogs anesthetized during the study period, 13 (22%) met the criteria for hypotension. Of the 42 anesthetized cats, 14 (33%) met the criteria for hypotension. The overall occurrence of hypotension in

this study population was 26.7%.

Of the 27 animals that were hypotensive, 13 received no treatment and 14 were treated by reducing anesthetic delivery and administering intravenous fluids. Six of the treated animals responded with an increased systolic arterial blood pressure measurement of 90 mm Hg or above within five to 15 minutes after treatment was initiated; eight treated animals showed no improvement.

Discussion

The results of this retrospective clinical survey indicate that hypotension may occur during anesthesia in relatively healthy dogs and cats anesthetized for elective procedures. Hypotension was detected in at least one animal in every anesthetic group, indicating that hypotension can occur in any anesthetized animal, no matter what drugs are used. Because of the large variation in sample size among anesthetic regimens and our desire not to overinterpret the data, no statistical analysis was performed on the blood pressure measurements reported in this study.

The noninvasive methods used to measure systolic arterial blood pressure in this study are convenient and expeditious, although not as accurate as direct blood pressure measurement.⁴ In particular, the Doppler method tends to underestimate systolic blood pressure in cats by about 10 to 14 mm Hg.⁶ So it is possible that some of the animals counted as hypotensive in the current survey were not truly hypotensive. Nevertheless, it seems more prudent to treat animals whose measured blood pressures may be falsely low than to ignore the possibility of hypotension in all anesthetized animals. The risk of complications from an unnecessary bolus of intravenous fluid in an otherwise healthy animal is probably low, as it has been reported that administering intravenous fluids at rates of up to 90 ml/kg/hr does not cause pulmonary edema in normal dogs and cats.⁷

As the goal of this retrospective re-

view was to document whether hypotension occurred during anesthesia, no attempt was made to define specific causes of hypotension. Because no baseline blood pressure measurements were obtained in awake animals, it is uncertain whether these dogs and cats had normal blood pressure before anesthesia. However, as they were considered to be otherwise healthy, and intraoperative hemorrhage was minimal, the most likely reason for hypotension during anesthesia was the anesthetic drugs.⁸

Vital organs such as the brain and kidneys have the ability to adjust blood supply for their metabolic needs through autoregulation of their vascular beds. This autoregulation is effective only if the mean arterial blood pressure is between 60 and 160 mm Hg.⁹ Mean arterial pressure is generally 20 to 30 mm Hg less than systolic arterial blood pressure, suggesting that ade-

quate perfusion could be maintained at systolic arterial blood pressure between 80 to 90 mm Hg and 180 to 190 mm Hg.

Many anesthetic drugs, particularly the inhaled anesthetics halothane, isoflurane,

contributing factor. At least one expert on renal disease in animals has suggested that measuring arterial blood pressure during anesthesia (and, presumably, treating hypotension) would help reduce the likeli-

Hypotension was detected in at least one animal in every anesthetic group.

and sevoflurane, tend to reduce arterial blood pressure as a result of decreased cardiac contractility and vasodilation.⁸ So anesthetizing animals incurs the potential risk of hypotension, which could damage the kidneys or other vital organs. Kidney disease is often cited as a leading cause of death in dogs,^{10,11} and we think that hypotension during anesthesia could be a

hood of renal ischemia.¹² Moreover, a recent study of anesthetic management in people concluded that intraoperative hypotension was a significant predictor of increased mortality during the year after an anesthetic episode, suggesting that "intraoperative anesthetic management may affect outcomes over longer time periods than previously appreciated."¹³

A survey of anesthetic records at the Colorado State University Veterinary Teaching Hospital indicated that 32% of dogs were hypotensive at some point

during anesthesia.¹⁴ Previously, two other published studies have reported the incidence of hypotension during anesthesia in dogs: 7% in one study¹ and 17.9% in the other.² The report with the lowest incidence of hypotension was a retrospective review of anesthesia records that relied on the anesthetists' checking a box to indicate that hypotension had occurred.¹ It is possible that the true incidence of hypotension was actually higher, as not all anesthetists may have remembered to check the box when completing the record at the end of a case. In the latter report, the criteria for defining hypotension were different (the hypotension had to be more severe) than in the study reported here: systolic arterial blood pressure less than or equal to 70 mm Hg or mean arterial blood pressure less than or equal to 50 mm Hg.² Thus, animals with systolic arterial blood pressures less than 90 mm Hg but greater than 70 mm Hg were not counted as hypotensive.

Veterinarians should consider monitoring arterial blood pressure in all anesthetized animals.

In all of these reports, data were gathered from dogs anesthetized in a university veterinary teaching hospital setting, which might imply an older or more critically ill patient population and, thus, one that is more susceptible to anesthetic-induced hypotension than is encountered in many private veterinary practices. However, a separate survey of one month's anesthesia records from dogs anesthetized for ovariohysterectomy at the Colorado State University Veterinary Teaching Hospital indicated an incidence of hypotension of 28% even in those routine cases.¹⁴ Because relatively few private veteri-

nary practitioners have traditionally measured blood pressure in anesthetized animals, the incidence of hypotension in dogs or cats undergoing elective surgery such as ovariohysterectomy or castration in private practices was previously unknown. In a survey of 20 veterinary practitioners in Colorado published in 2002, the only veterinarian who considered hypotension to be a problem during anesthesia was also the only veterinarian who regularly measured blood pressure in all her patients.³ This is unlikely to be simple coincidence.

Anesthetic-related hypotension can usually be corrected. Fewer than half (six of 14) of the hypotensive dogs and cats in the current study responded (exhibited increased blood pressure) when anesthetic delivery was reduced and additional intravenous fluids were administered. For anesthetized dogs undergoing ovariohysterectomy or castration at the Colorado State University Veterinary Teaching Hospital, decreasing the anesthetic vaporizer setting and administering additional intravenous fluids resulted in improved blood pressure in 57% of hypotensive animals (Colorado State University Teaching Hospital, Fort Collins, Colo: Unpublished data). For the remaining 43% of hypotensive dogs, administering inotropic drugs, generally ephedrine or dobutamine, was required to increase blood pressure to a satisfactory level. It could be concluded that inotropic drugs should be available for use in any veterinary practice that anesthetizes animals. Recommendations for the appropriate use of inotropic drugs have been previously published.^{4,15}

While treatments for anesthetic-related hypotension in the above-mentioned surveys were not difficult to implement, it is unlikely that the anesthetists would have

used them if blood pressure had not been measured and hypotension had not been detected. It appears that the reason many veterinarians do not worry about hypotension is that they do not recognize that it is occurring since they do not measure blood pressure during anesthesia.³ The results of this retrospective clinical study, indicating a 26.7% occurrence of anesthetic-related hypotension in this population of dogs and cats, should encourage veterinarians to consider monitoring arterial blood pressure in all anesthetized animals.

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