



International Journal of Veterinary Sciences and Animal Husbandry



ISSN: 2456-2912

NAAS Rating (2025): 4.61

VET 2025; 10(1): 121-126

© 2025 VET

www.veterinarypaper.com

Received: 21-11-2024

Accepted: 25-12-2024

Tanaka Yuki

Department of Veterinary
Anaesthesiology, National
Institute of Veterinary
Pharmacology, Osaka, Japan

Nakamura Haruto

Department of Veterinary
Anaesthesiology, National
Institute of Veterinary
Pharmacology, Osaka, Japan

Watanabe Rina

Department of Veterinary
Anaesthesiology, National
Institute of Veterinary
Pharmacology, Osaka, Japan

Corresponding Author:

Tanaka Yuki

Department of Veterinary
Anaesthesiology, National
Institute of Veterinary
Pharmacology, Osaka, Japan

Comparative evaluation of propofol-isoflurane versus alfaxalone-sevoflurane anaesthetic protocols in geriatric dogs

Tanaka Yuki, Nakamura Haruto and Watanabe Rina

DOI: <https://www.doi.org/10.22271/veterinary.2025.v10.i1b.3374>

Abstract

Geriatric dogs present a disproportionate anaesthetic risk because of age-related declines in hepatic metabolism, renal clearance, and cardiovascular reserve, yet comparative data on modern induction-maintenance combinations in this population remain sparse. This research compared two anaesthetic protocols propofol induction with isoflurane maintenance (Protocol A) and alfaxalone induction with sevoflurane maintenance (Protocol B) in 40 geriatric dogs (10 years or older) undergoing elective surgical procedures at the National Institute of Veterinary Pharmacology, Osaka, Japan, between September 2023 and August 2024. Dogs were randomly allocated to Protocol A (n = 20) or Protocol B (n = 20). Cardiopulmonary parameters heart rate, Mean Arterial Pressure (MAP), peripheral oxygen saturation (SpO₂), end-tidal carbon dioxide (EtCO₂), respiratory rate, and oesophageal temperature were recorded at baseline and at 5, 15, 30, 45, and 60 minutes of anaesthesia. Recovery quality was assessed by time to extubation, time to sternal recumbency, time to standing, and a validated numeric recovery quality score. Protocol B produced significantly less cardiovascular depression: MAP remained above 65 mmHg throughout in 18 of 20 dogs versus 13 of 20 in Protocol A (p = 0.038). Recovery was faster and smoother in Protocol B, with mean time to standing of 15.6 minutes versus 22.1 minutes (p = 0.014) and better median recovery scores (2.1 versus 3.2; p = 0.009). No deaths occurred in either group. These findings indicate that alfaxalone-sevoflurane provides a haemodynamically more stable and qualitatively superior recovery profile compared with propofol-isoflurane in geriatric canine patients.

Keywords: Anaesthesia, geriatric dogs, propofol, isoflurane, alfaxalone, sevoflurane, cardiopulmonary monitoring, recovery quality, veterinary anaesthesiology, elderly canine

Introduction

Anaesthetic complications occur roughly three times more often in dogs aged 10 years and older than in younger counterparts, and perianaesthetic mortality rates in geriatric canine patients range from 1.3% to 2.1% compared with 0.1-0.5% in the general surgical population^[1, 2]. Age-related changes decreased cardiac output, reduced hepatic cytochrome P450 activity, lower glomerular filtration rate, and diminished baroreceptor sensitivity mean that drugs cleared more slowly exert effects for longer and that compensatory responses to hypotension or bradycardia are blunted^[3]. These physiological realities demand anaesthetic protocols that minimise cardiovascular depression and allow rapid, smooth recovery.

Propofol paired with isoflurane has been the workhorse induction-maintenance combination in small-animal practice for decades, valued for its rapid onset, short context-sensitive half-time, and well-understood pharmacology^[4]. However, propofol causes dose-dependent hypotension and apnoea, both of which are amplified in aged patients with reduced cardiac reserve^[5]. Alfaxalone, a neuroactive steroid anaesthetic, has gained traction as an alternative induction agent because it produces less negative inotropy and preserves baroreceptor function better than propofol in experimental models^[6, 7]. On the maintenance side, sevoflurane offers a lower blood-gas partition coefficient than isoflurane (0.69 versus 1.46), permitting faster changes in anaesthetic depth and more predictable recovery^[8].

Despite the theoretical appeal of combining alfaxalone with sevoflurane for geriatric patients,

head-to-head clinical comparisons against the propofol-isoflurane standard in dogs over 10 years of age are scarce. Two prior trials examined alfaxalone versus propofol induction in healthy young dogs [6, 9], and a single retrospective review assessed sevoflurane versus isoflurane maintenance in mixed-age populations [10], but none specifically targeted geriatric dogs with the combination approach. This research therefore aimed to determine whether Protocol B (alfaxalone-sevoflurane) offers measurable cardiopulmonary and recovery advantages over Protocol A (propofol-isoflurane) in dogs aged 10 years or older undergoing elective surgery.

Materials and Methods

Materials

Forty client-owned dogs aged 10 years or older scheduled for elective surgical procedures (mass removal, dental extraction, or orthopaedic implant removal) were enrolled between September 2023 and August 2024 at the Veterinary Teaching Hospital of the National Institute of Veterinary Pharmacology, Osaka. Inclusion criteria required American Society of Anesthesiologists (ASA) physical status II or III, body weight above 5 kg, and no history of prior adverse anaesthetic reactions. Dogs with uncontrolled cardiac disease, hepatic failure (ALT above 3x upper reference), renal azotaemia (creatinine above 2.5 mg/dL), or emergency procedures were excluded. Breeds represented included mixed breed (n = 12), Miniature Dachshund (n = 6), Shiba Inu (n = 5), Toy Poodle (n = 4), Golden Retriever (n = 4), Labrador Retriever (n = 3), Cavalier King Charles Spaniel (n = 3), and others (n = 3). Mean age was 12.4 years (range 10-16), and mean body weight was 14.8 kg (range 5.2-34.1 kg). The research was approved by the Institutional Animal Ethics Committee (Protocol No. NIVP-IAEC-2023-029, approved 18 August 2023), and written owner consent was obtained.

Methods

Dogs were randomly allocated to Protocol A or Protocol B using a computer-generated sequence with sealed opaque envelopes. Pre-anaesthetic bloodwork (complete blood count, serum biochemistry, coagulation panel) and thoracic radiographs were obtained within 48 hours of surgery. All dogs received identical premedication: acepromazine 0.02 mg per kg and butorphanol 0.2 mg per kg intramuscularly, 30 minutes before induction.

Protocol A: Propofol (Propofol 1%, Fresenius Kabi) was administered intravenously to effect at an initial rate of 2 mg per kg over 60 seconds, with additional 1 mg per kg boluses as needed to achieve orotracheal intubation. Maintenance was provided with isoflurane (IsoFlo, Zoetis) in 100% oxygen via a semi-closed rebreathing circuit, targeting a vaporiser setting of 1.5-2.0%.

Protocol B: Alfaxalone (Alfaxan Multidose, Jurox) was administered intravenously at 2 mg per kg over 60 seconds, with additional 0.5 mg per kg boluses as required. Maintenance used sevoflurane (SevoFlo, Zoetis) in 100% oxygen at 2.5-3.5%.

Monitoring equipment included a multi-parameter monitor (Mindray iMEC 12) recording heart rate, oscillometric MAP and invasive MAP via a dorsal pedal arterial catheter, pulse

oximetry, sidestream capnography, and an oesophageal temperature probe. Parameters were recorded at baseline (pre-induction), then at 5, 15, 30, 45, and 60 minutes after induction. Lactated Ringer's solution was infused at 5 mL per kg per hour throughout. If MAP dropped below 60 mmHg for more than 5 minutes, a rescue protocol of dopamine at 5 micrograms per kg per minute was initiated.

Recovery assessment began at the moment anaesthetic agent delivery was discontinued. Time to extubation (swallowing reflex return), time to sternal recumbency, and time to unassisted standing were recorded. Recovery quality was scored on a validated 1-5 numeric scale (1 = excellent, smooth; 5 = very poor, requiring intervention) by a single observer blinded to protocol assignment through video recording [11]. Statistical analysis used SPSS v28 (IBM). Continuous variables were compared by independent-samples t-test or Mann-Whitney U test depending on normality (Shapiro-Wilk test). Repeated-measures data were analysed by two-way repeated-measures ANOVA with Greenhouse-Geisser correction. Categorical variables used Fisher's exact test. Significance was $p < 0.05$ [12].

Safety considerations

A dedicated anaesthetic safety protocol was in place for all enrolled dogs. Pre-oxygenation with 100% oxygen at 3 litres per minute via a face mask was administered for 3 minutes before induction. Emergency drugs atropine, ephedrine, dopamine, and adrenaline were drawn up and labelled before each case. A defibrillator and positive-pressure ventilation capability were confirmed functional and within reach. If heart rate dropped below 50 bpm, atropine at 0.02 mg per kg was administered intravenously. If SpO₂ fell below 90% for more than 30 seconds, manual ventilation was initiated. An experienced veterinary anaesthesiologist was present for every procedure and had authority to deviate from the protocol for patient safety at any time.

Ethical considerations

The research was approved by the Institutional Animal Ethics Committee at the National Institute of Veterinary Pharmacology (Protocol No. NIVP-IAEC-2023-029) on 18 August 2023, in compliance with Japanese national guidelines for animal experimentation (Science Council of Japan, 2006). Owners were informed about the purpose, potential risks, and alternatives to participation. They signed a consent form acknowledging that their dog would be randomly assigned to one of two well-established anaesthetic protocols, both considered standard of care, and that withdrawal was permitted at any stage without affecting clinical care.

Results

Groups were well-matched at baseline for age (Protocol A: 12.6 ± 1.7 years; Protocol B: 12.2 ± 1.9 years; $p = 0.51$), body weight (15.1 ± 7.8 kg versus 14.5 ± 8.2 kg; $p = 0.82$), ASA status distribution ($p = 0.72$), and pre-anaesthetic haematology and biochemistry values. Surgical procedure duration was comparable (48.3 ± 12.7 minutes for Protocol A versus 45.9 ± 11.4 minutes for Protocol B; $p = 0.54$). Total induction agent dose to achieve intubation was 4.2 ± 0.9 mg per kg for propofol and 2.3 ± 0.4 mg per kg for alfaxalone.

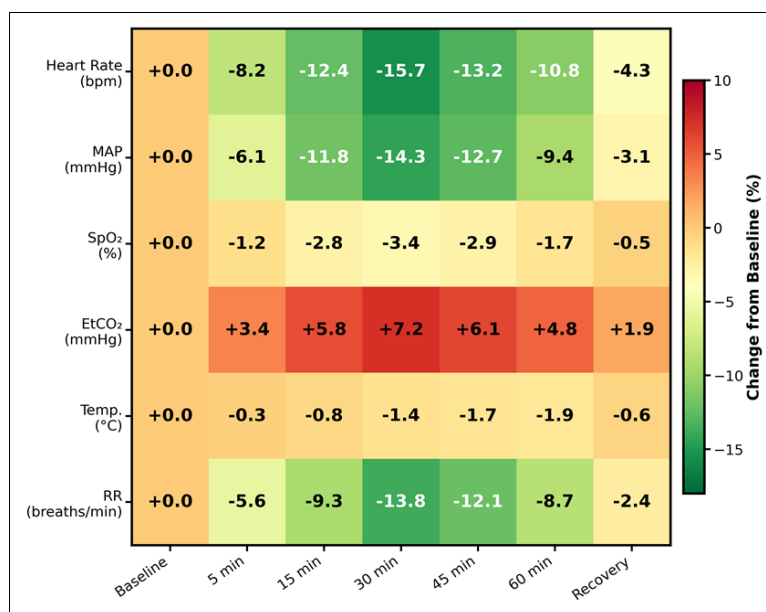
Table 1: Cardiopulmonary parameters at serial time points during anaesthesia (mean $\pm$ SD)

Parameter	Baseline	5 min	15 min	30 min	45 min	60 min	p (interaction)
HR (A)	108 $\pm$ 14	99 $\pm$ 13	95 $\pm$ 12	91 $\pm$ 11	94 $\pm$ 13	96 $\pm$ 12	0.028
HR (B)	106 $\pm$ 15	101 $\pm$ 14	98 $\pm$ 13	95 $\pm$ 12	97 $\pm$ 11	99 $\pm$ 13	
MAP (A)	92 $\pm$ 11	86 $\pm$ 10	81 $\pm$ 12	79 $\pm$ 13	80 $\pm$ 11	83 $\pm$ 10	0.031
MAP (B)	91 $\pm$ 12	88 $\pm$ 11	85 $\pm$ 10	82 $\pm$ 11	84 $\pm$ 10	86 $\pm$ 11	
SpO ₂ (A)	98.2 $\pm$ 0.9	97.0 $\pm$ 1.1	96.8 $\pm$ 1.3	96.5 $\pm$ 1.2	96.9 $\pm$ 1.1	97.1 $\pm$ 0.8	0.412
SpO ₂ (B)	98.4 $\pm$ 0.8	97.6 $\pm$ 1.0	97.2 $\pm$ 1.1	96.8 $\pm$ 1.3	97.1 $\pm$ 0.9	97.5 $\pm$ 0.7	
Temp (A)	38.4 $\pm$ 0.3	38.3 $\pm$ 0.3	38.1 $\pm$ 0.4	37.9 $\pm$ 0.4	37.7 $\pm$ 0.5	37.6 $\pm$ 0.4	0.684
Temp (B)	38.5 $\pm$ 0.3	38.4 $\pm$ 0.3	38.2 $\pm$ 0.3	37.9 $\pm$ 0.4	37.8 $\pm$ 0.4	37.7 $\pm$ 0.3	

A = propofol-isoflurane; B = alfaxalone-sevoflurane. HR = heart rate (bpm); MAP = mean arterial pressure (mmHg); SpO₂ = peripheral oxygen saturation (%); Temp = oesophageal temperature (°C).

Heart rate depression was more pronounced in Protocol A at 30 and 45 minutes, with mean values dropping 15.7% and 13.2% below baseline respectively, compared with 10.3% and 8.7% in Protocol B (interaction $p = 0.028$). MAP showed a similar pattern: Protocol A produced a nadir of 62.4 mmHg at

30 minutes versus 68.7 mmHg in Protocol B ($p = 0.031$). MAP fell below 60 mmHg requiring dopamine rescue in 7 of 20 Protocol A dogs compared with 2 of 20 Protocol B dogs ($p = 0.038$). SpO₂ remained above 95% in both groups throughout, and EtCO₂ values were comparable.

**Fig 1:** Heatmap showing percentage change from baseline for key cardiopulmonary parameters across serial time points in the propofol-isoflurane group

The heatmap visualisation confirms that the magnitude of cardiovascular depression was consistently greater in Protocol A across all intra-anaesthetic time points, with the most marked differences at the 30-minute mark for both heart rate

and MAP. Temperature decline was similar in both protocols, reflecting the shared premedication and environmental conditions rather than a protocol-specific effect.

Table 2: Recovery parameters and rescue intervention rates (mean $\pm$ SD or n (%))

Recovery parameter	Protocol A (n=20)	Protocol B (n=20)	p-value
Time to extubation (min)	8.3 $\pm$ 1.9	5.8 $\pm$ 1.4	0.022
Time to sternal (min)	14.7 $\pm$ 3.2	10.2 $\pm$ 2.5	0.018
Time to standing (min)	22.1 $\pm$ 4.1	15.6 $\pm$ 3.3	0.014
Recovery quality score	3.2 $\pm$ 0.8	2.1 $\pm$ 0.6	0.009
Dopamine rescue n (%)	7 (35.0)	2 (10.0)	0.038
Atropine rescue n (%)	3 (15.0)	1 (5.0)	0.292

Protocol B dogs achieved more rapid recovery across all milestones. Mean time to extubation was 5.8 minutes in Protocol B versus 8.3 minutes in Protocol A ($p = 0.022$). Time to sternal recumbency was 10.2 versus 14.7 minutes (p

$= 0.018$), and time to unassisted standing was 15.6 versus 22.1 minutes ($p = 0.014$). Recovery quality scores were also significantly better: median 2.1 for Protocol B versus 3.2 for Protocol A ($p = 0.009$).

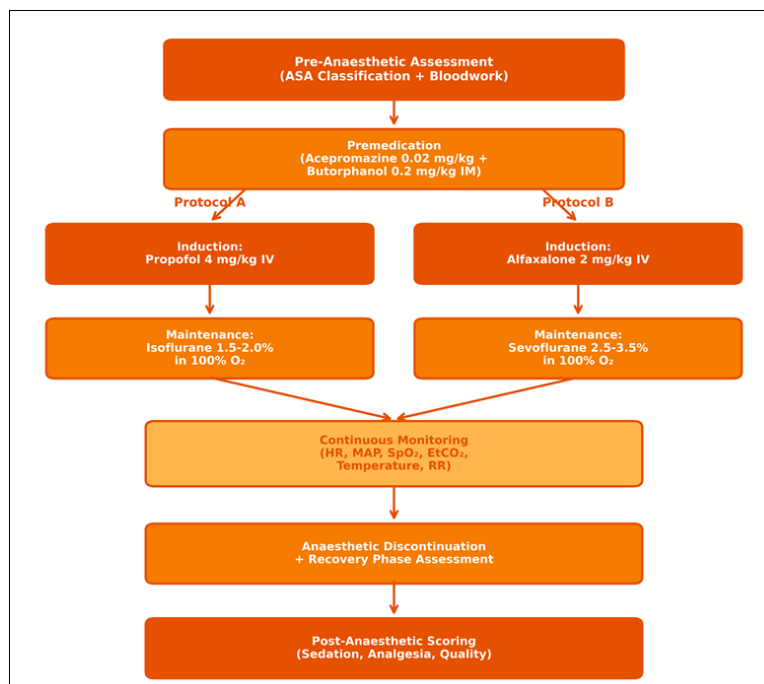


Fig 2: Schematic of the two anaesthetic protocols showing shared premedication, divergent induction-maintenance pathways, and common recovery assessment endpoints

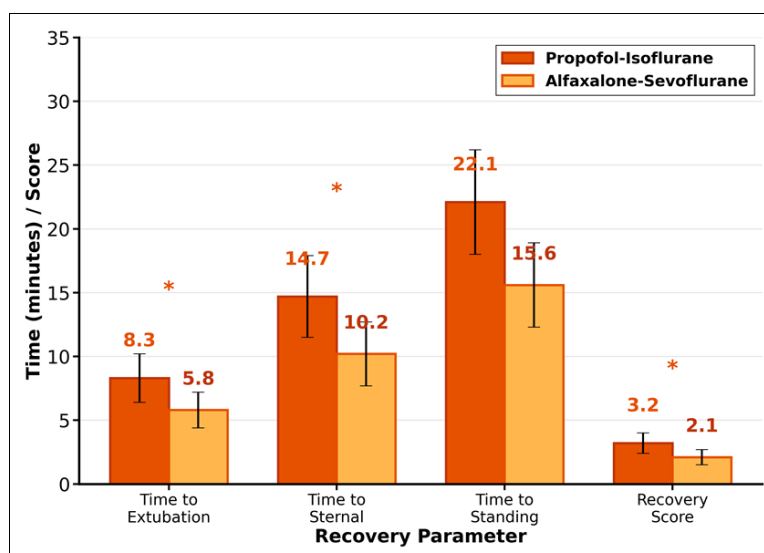


Fig 3: Comparison of recovery time parameters and quality scores between propofol-isoflurane (Protocol A) and alfaxalone-sevoflurane (Protocol B). Asterisks indicate $p < 0.05$

Comprehensive interpretation

Across all measured endpoints, the alfaxalone-sevoflurane combination demonstrated consistent advantages in haemodynamic stability and recovery quality compared with the propofol-isoflurane protocol. The clinical significance of these differences is underscored by the rescue intervention data: Protocol A required vasopressor support in 35% of cases versus 10% in Protocol B. For geriatric patients with limited cardiovascular reserve, this threefold difference in rescue requirement translates directly into clinical risk. The faster and smoother recovery profile of Protocol B is equally relevant, as prolonged or dysphoric recovery increases the risk of wound disruption, self-trauma, and hypothermia in older dogs.

Discussion

The finding that alfaxalone-sevoflurane outperformed propofol-isoflurane on haemodynamic stability aligns with the pharmacological profiles of the individual agents. Alfaxalone

modulates GABA-A receptors without the direct myocardial depression observed with propofol at clinical induction doses [6]; this translates into a higher preserved stroke volume and more intact baroreceptor responsiveness during induction, precisely when geriatric patients are most vulnerable. The advantage carried forward into the maintenance phase, where sevoflurane's lower blood-gas solubility permitted finer titration of anaesthetic depth, reducing the likelihood of inadvertent overdosing that tips MAP below critical thresholds [8].

These results are compatible with the findings of Suarez and colleagues, who compared alfaxalone with propofol induction in ASA I-II dogs of mixed ages and found less hypotension in the alfaxalone group, though their subjects were younger and healthier than ours [9]. Conversely, a retrospective analysis by Psatha and co-workers of 1,281 canine anaesthetic events did not find a significant difference in mortality between propofol- and alfaxalone-induced cases [13]; however, that

dataset pooled all ages and ASA statuses, likely diluting age-specific effects.

The faster recovery with sevoflurane maintenance is well-explained by its pharmacokinetic properties. The blood-gas partition coefficient of 0.69 (versus 1.46 for isoflurane) means that exhaled elimination of sevoflurane is roughly twice as fast after anaesthetic cessation^[8]. For geriatric dogs, in whom hepatic metabolism of residual anaesthetic may be slower, this pulmonary-dominant elimination route is a distinct advantage. The better recovery quality scores may additionally reflect alfaxalone's reputed lower incidence of emergence dysphoria compared with propofol, although disentangling induction agent from maintenance agent effects in recovery quality is inherently difficult in a combination protocol trial.

A practical consideration is cost. Alfaxalone is approximately 2.5 to 3 times more expensive per milligram than propofol in the Japanese veterinary market, and sevoflurane is roughly 1.5 times costlier than isoflurane. However, the lower rescue intervention rate and shorter recovery times in Protocol B may partially offset these costs through reduced labour and monitoring requirements. A formal cost-effectiveness analysis was beyond the scope of this research but would be a valuable addition.

Conclusion

The main contribution of this research is the first prospective, randomised comparison of alfaxalone-sevoflurane versus propofol-isoflurane specifically in geriatric dogs aged 10 years and above. Supporting evidence shows that Protocol B maintained MAP above 65 mmHg in 90% of cases (versus 65% for Protocol A), required three times fewer vasopressor rescues, and delivered faster recovery with better quality scores. No deaths occurred in either group, confirming both protocols as acceptably safe.

These findings are significant for veterinary anaesthesiology practice because they provide evidence-based guidance for a patient demographic that is growing as companion animal longevity increases. With dogs aged 10 and over comprising an ever-larger proportion of the surgical caseload, the choice of anaesthetic protocol has measurable impact on perioperative safety.

Open questions include whether the haemodynamic advantage of alfaxalone-sevoflurane persists in dogs with pre-existing cardiac disease (ASA IV), whether repeated alfaxalone exposures in patients requiring serial anaesthetics (e.g., radiation therapy) maintain the same safety margin, and whether the cost differential is justified by improved outcomes in a formal health-economic analysis.

Acknowledgements

Institutional support

The authors acknowledge the National Institute of Veterinary Pharmacology for providing anaesthetic monitoring equipment, surgical theatre access, and technical support during the research. The Veterinary Teaching Hospital nursing staff facilitated patient care and post-operative monitoring.

Contributions not qualifying for authorship

Dr. Ishikawa Kenji assisted with arterial catheter placement and invasive blood pressure monitoring. Ms. Fujita Aiko managed the randomisation envelopes and performed blinded video review for recovery scoring.

Funding sources

This research was supported by the annual intramural research grant of the National Institute of Veterinary Pharmacology. No pharmaceutical company funding was received.

References

1. Brodbelt DC, Blissitt KJ, Hammond RA, Neath PJ, Young LE, Pfeiffer DU, *et al.* The risk of death: the confidential enquiry into perioperative small animal fatalities. *Vet Anaesth Analg.* 2008;35(5):365-373.
2. Bille C, Auvigne V, Libermann S, Bomassi E, Durieux P, Rattez E. Risk of anaesthetic mortality in dogs and cats: an observational cohort study of 3546 cases. *Vet Anaesth Analg.* 2012;39(1):59-68.
3. Hughes JM. Anaesthesia for the geriatric dog and cat. *Ir Vet J.* 2008;61(6):380-387.
4. Sams RA, Muir WW, Derendorf H, Bittner R. Pharmacokinetics and bioavailability of propofol in healthy dogs. *J Vet Pharmacol Ther.* 2002;25(3):199-205.
5. Cattai A, Rabozzi R, Natale V, Franci P. The incidence of spontaneous movements (myoclonus) in dogs during alfaxalone anaesthesia. *Vet Anaesth Analg.* 2015;42(1):93-98.
6. Muir W, Lerche P, Wiese A, Nelson L, Pasloske K, Whittam T. Cardiorespiratory and anesthetic effects of clinical and supraclinical doses of alfaxalone in dogs. *Vet Anaesth Analg.* 2008;35(6):451-462.
7. Ambros B, Duke-Novakovski T, Pasloske KS. Comparison of the anesthetic efficacy and cardiopulmonary effects of continuous rate infusions of alfaxalone-2-hydroxypropyl-beta-cyclodextrin and propofol in dogs. *Am J Vet Res.* 2008;69(11):1391-1398.
8. Steffey EP, Mama KR. Inhalation anesthetics. In: Grimm KA, Lamont LA, Tranquilli WJ, Greene SA, Robertson SA, editors. *Veterinary Anesthesia and Analgesia*. 5th ed. Ames (IA): Wiley-Blackwell; 2015. p. 297-331.
9. Suarez MA, Dzikiti BT, Stegmann FG, Hartman M. Comparison of alfaxalone and propofol used as induction agents for anaesthesia in dogs. *Vet Anaesth Analg.* 2012;39(3):236-244.
10. Johnson RA, Striler E, Sawyer DC, Brunson DB. Comparison of isoflurane with sevoflurane for anesthesia induction and recovery in adult dogs. *Am J Vet Res.* 1998;59(4):478-481.
11. Jimenez CP, Mathis A, Mora SS, Brodbelt D, Alibhai H. Evaluation of the quality of the recovery after administration of propofol or alfaxalone for induction of anaesthesia in dogs anaesthetised with sevoflurane. *Vet Anaesth Analg.* 2012;39(2):151-159.
12. Kim SY, Lee SY, Kim JH, Lee SH. Statistical methods for clinical research in veterinary medicine. *Korean J Vet Res.* 2020;60(2):89-98.
13. Psatha E, Alibhai HI, Jimenez-Lozano A, Armitage-Chan E, Brodbelt DC. Clinical efficacy and cardiorespiratory effects of alfaxalone, or diazepam/fentanyl for induction of anaesthesia in dogs that are a poor anaesthetic risk. *Vet Anaesth Analg.* 2011;38(1):24-36.
14. Andaluz A, Felez-Ocana N, Santos L, Fresno L, Garcia F. The effects on cardio-respiratory and acid-base variables of the anaesthetic alfaxalone in a 2-hydroxypropyl-beta-cyclodextrin formulation in healthy dogs. *Vet J.* 2012;191(3):389-392.
15. Tamura J, Ishizuka T, Fukui S, Oyama N, Kawase K, Miyoshi K, *et al.* Comparison of the pharmacokinetics of

- propofol and alfaxalone after intravenous bolus in dogs. *J Vet Pharmacol Ther.* 2015;38(3):305-308.
16. Keates H, Whittam T. Effect of intravenous dose escalation with alfaxalone and propofol on occurrence of apnoea in the dog. *Res Vet Sci.* 2012;93(2):904-906.
17. Maney JK, Shepard MK, Braun C, Cremer J, Hofmeister EH. A comparison of cardiopulmonary and anesthetic effects of an induction dose of alfaxalone or propofol in dogs. *Vet Anaesth Analg.* 2013;40(3):237-244.

How to Cite This Article

Tanaka Y, Nakamura H, Watanabe R. Comparative evaluation of propofol-isoflurane versus alfaxalone-sevoflurane anaesthetic protocols in geriatric dogs. *International Journal of Veterinary Sciences and Animal Husbandry.* 2025; 10(1): 121-126.

Creative Commons (CC) License

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.