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The following studies received ethical approval by institutional and/or national review committees, where appropriate.

Oral Presentations

Canine

Analgesic effect of compressive cryotherapy after orthopaedic surgery in dogs

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Introduction The benefits of cryotherapy are well described in human orthopedics (Kunkle et al., 2021), but no study to date evaluated the analgesic effect of compressive cryotherapy after orthopedic procedures in dogs.

Materials and methods Dogs with a cranial cruciate ligament rupture surgically managed by TPLO were randomly divided into 3 groups: Gr1 with compressive cryotherapy, Gr2 with simple cryotherapy, and Gr3 without cryotherapy. The cryotherapy sessions started immediately after surgery (D0) and were performed three times a day during the three days of hospitalization (D1, D2, D3) with a duration of 20 minutes each. Daily gait analysis,

circumference and infrared thermography measurements of the limb were performed. Pain was assessed with 4A-Vet pain scale, analgesic consumption, and mechanical nociceptive thresholds using a Von Frey electronic algometer. A *p*-value < 0.05 was considered significant.

Results 22 dogs were enrolled in the study. A better orthopedic recovery was demonstrated in the compressive cryotherapy group with a significantly improved kinetics of lameness (stance time +16% in Gr1 versus +3% in Gr2 and +4% in Gr3, p=0.049) at D3. A lower nociceptive threshold was noticed for Gr3 at D0 (p=0.049), compressive cryotherapy resulted in a significant increase in mechanical nociceptive thresholds at D2 (+16% in Gr1 versus -24% in Gr2, p=0.018) and a lower mean temperature reached (-10.1°C in Gr1 versus -6.2°C in Gr2, p<0.0001).

Discussion According to the result of this study, cold compression therapy seems to be more efficacious than standard cryotherapy and absence of cryotherapy, with higher mechanical nociceptive threshold and better functional outcome.

References

Kunkle BF et al. Orthopaedic Application of Cryotherapy: A Comprehensive Review of the History, Basic Science, Methods, and Clinical Effectiveness. *JBJS Rev*. 2021 Jan 26;9(1):e20.00016.

Nociception monitoring using the Surgical Pleth Index in anaesthetized dogs

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Introduction The Surgical Pleth Index (SPI) is a tool developed to assess intraoperative nociception, based on the photoplethysmographic analysis of the pulse wave and the heartbeat intervals. While validated in human patients (Jiao et al 2019), its performance in dogs remains to be evaluated.

Materials and methods Twenty-six healthy dogs anaesthetized for castration were recruited. During the procedure, SPI, invasive mean arterial pressure (MAP) and heart rate (HR) were continuously monitored. The occurrence or resolution of a haemodynamic reaction (HDR), defined as a 20% increase in HR and or MAP, was assessed at different times: cutaneous incision, testicle traction, cutaneous suture and fentanyl administration. The performance of the dynamic variation of SPI over 1 minute (ΔSPI) to predict HDR or its resolution within 3 or 5 minutes was assessed using receiver operating characteristic (ROC) curves analysis. A p-value < 0.05 was considered significant.

Results Following nociceptive events, the dogs presenting a HDR showed a significant +13% and +15% increase in SPI at 3 and 5 minutes respectively, whereas after fentanyl administration, a -22% and -27% significant decrease in SPI was noticed after 3 and 5 minutes. The ROC curves analysis indicated a moderate performance for ΔSPI to predict a HDR within 3 minutes (AUC: 0.68, threshold value: +15%) or its resolution within 3 minutes after fentanyl administration (AUC of 0.72, threshold value: -15%).

Conclusion The SPI varied according to perioperative nociceptive events and analgesic treatment. Its performance to anticipate a HDR within 3 minutes was moderate to fair.

References

Jiao Y, He B, Tong X, et al. (2019) Intraoperative monitoring of nociception for opioid administration: A meta- analysis of randomized controlled trials. *Minerva Anesthesiologica* 85(5): 522-530.

Postoperative pain in dogs after intraperitoneal and incisional ropivacaine

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Intraperitoneal (IP) and incisional (INC) administration of local anaesthetics is recommended for analgesia after visceral surgery, though evidence for its efficacy is insufficient.The objective of this prospective, randomized, blinded, controlled, clinical pilot trial was to assess postoperative pain and opioid requirements in dogs undergoing major abdominal surgery after receiving IP and INC ropivacaine. Sixteen client-owned dogs were randomized to one of two groups and anaesthetized with a standardized protocol including intravenous metamizole (30 mg kg^{-1}). At the end of surgery, the dogs in group ropivacaine (R) received ropivacaine IP (2 mg kg^{-1}, 0.27 ml kg^{-1}), and a subcutaneous splash (1 mg kg^{-1}, 0.13 ml kg^{-1}). The control group (C) received equal volumes of NaCl 0.9%. All dogs were administered pethidine (4 mg kg^{-1}) intramuscularly before extubation. At 0.5, 1, 2, 3, 4, 6, 8, 10 and 12 hours after extubation, sedation and postoperative pain were assessed using the Short Form of the Glasgow Composite Pain Scale (GCPS-SF), a dynamic interactive visual analogue scale (DIVAS) and mechanical nociceptive threshold testing (MNT). The heart rate (HR) was also recorded. Intravenous methadone (0.2 mg kg^{-1}) was used for rescue analgesia. Data was compared with ordinal regression and linear mixed models. P-values < 0.05 were deemed significant.

Methadone was given to 3/8 dogs in R, and to 0/8 dogs in C. In this pilot study, GCPS-SF and MNT were not different between groups. DIVAS was slightly higher in R (estimated effect (EE) 2 mm, p=0.012), and HR lower (EE 23 beats minute-1, p=0.02).
Undiluted IP and INC ropivacaine did not add any benefit to the postoperative analgesic protocol. The increased DIVAS and higher incidence of rescue analgesia in group R suggest that the current dosage, concentration and volume should not be investigated further. Information on optimal dosage, concentration and volume remains unclear.

Acknowledgments The authors acknowledge the help from the anaesthesiology team, the intensive care unit and the small animal surgeons with conduction of the study.

Sedation with intramuscular alfaxalone 4% w/v preserved solution in dogs

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Introduction The objective of this study was to evaluate the sedative effects of three different doses of an experimental formulation of alfaxalone 4% w/v in a preserved solution administered intramuscularly (IM) in healthy dogs.

Materials and Methods A randomized, blinded, crossover study was performed using six dogs. Dogs were each administered alfaxalone 4% at 5 mg kg^{-1} (A5), 7.5 mg kg^{-1} (A7.5) and 10 mg kg^{-1} (A10) IM into the epaxial musculature. Sedation time variables, quality of sedation (including onset of sedation and recovery), physiological variables, response to cephalic vein catheterisation and frequency of any undesirable events were recorded. Continuous data was compared between treatments (One- way ANOVA or Restricted Maximum Likelihood modeling) and within treatments (Tukey's test). Categorical data was

analysed between treatments (Kruskal-Wallis' test) and within treatments (Dunn's Test) ($p < 0.05$).

Results All dogs became sedated (laterally recumbent) and sedation onset was significantly faster in Groups A7.5 and A10 compared to A5 ($p = 0.03$, $p = 0.03$, respectively). The duration of sedation (onset of lateral recumbency until resuming sternal recumbency) was longer for Groups A7.5 and A10 compared with A5 ($p = 0.03$, $p = 0.01$, respectively). Dogs in Group A10 scored highest for the quality of sedation onset ($p = 0.03$). Sedation scores and quality of recovery from sedation were not significantly different between groups. Two dogs (2/6) in A5 were insufficiently sedated for cephalic catheterisation. Ataxia was the most frequently observed undesirable event with an overall frequency of 78% (14/18) and 89% (16/18) during sedation onset and recovery, respectively.

Conclusion Alfaxalone 4% at 7.5 mg kg^{-1} and 10 mg kg^{-1} IM resulted in sufficient sedation for IV catheterisation in dogs. Due to the ataxia observed during onset of sedation and subsequent recovery, it is recommended further research focus on sedatives/analgesics to be used in combination.

Acknowledgements We acknowledge Jurox Pty. Ltd - a part of Zoetis (Rutherford, NSW, Australia) for their input and for kindly sponsoring alfaxalone 4% w/v preserved solution.

Trazodone may reduce propofol induction dose and anxiety in dogs

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Trazodone is a multifunctional drug acting on serotonin and histamine mediated neural pathways with anaesthetic-sparing effects in dogs (Walters et al., 2022).

Seven dogs undergoing general anaesthesia for weekly radiotherapy have been enrolled and block randomised into a control (C) or trazodone (T) group. At every appointment, the anxiety on admission and recovery from anaesthesia were both scored by the same, blinded registered veterinary nurse. The validated Lincoln Canine Anxiety Scale was utilised for anxiety scoring. A blinded anaesthetist administered a standard protocol of intravenous alfentanil (10 ug kg^{-1}) and atropine (10 ug kg^{-1}) premedication, followed by propofol at a constant rate of 3 mg kg^{-1} $minute^{-1}$. After the initial 'baseline' radiotherapy session, dogs in group T received trazodone 2.5 – 5.0 mg kg^{-1} per os two hours before anaesthesia. Dogs in group C received no trazodone. The mean average was calculated for all results of subsequent sessions. A Wilcoxon signed- rank test was employed to determine a significant difference in propofol dose, anxiety and recovery scores between baseline and subsequent sessions in both groups.

In group T (n=3), mean average propofol induction dose reduced by 0.63 mg kg^{-1} (19%), anxiety score by 36% and recovery score improved by 50% following trazodone administration. In group C (n=4), propofol dose increased by 0.78 mg kg^{-1} (31%), anxiety score by 12% and recovery score worsened by 21% after the baseline session. Significance has not yet been reached; however, data collection is ongoing. Power size calculation determined 28 patients would be required per group to detect a 25% reduction in propofol induction dose.

Preliminary evidence supports previous findings that premedication with trazodone results in a propofol dose-sparing effect, possibly due to a direct anxiolytic action. Further data is required to confirm initial findings have statistical significance.

References

Walters, K., Gittel, C. and Brearley, J. C. (2022) 'The effect of preanaesthetic oral trazodone hydrochloride on the induction dose of propofol: a preliminary retrospective study', *Vet Anaesth Analg*, 49(5), pp. 458-462.

Anesthetic management and complications of severe subaortic stenosis balloon valvuloplasty in dogs

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Balloon valvuloplasty (BV) with a cutting high-pressure balloon is performed for severe subaortic stenosis (SSAS). This study aims to describe the anesthesia and complications observed during these procedures in canine patients.

A retrospective study was performed of animals undergoing BV for SSAS between 2018 and 2022. Data were assessed for normality with a Chi squared test (alpha < 0.05). An odds ratio (OR) was calculated for 40% reduction of the aortic pressure gradient (RAPG) being associated with major complications (MC) of asystole or third-degree atrioventricular block. Eleven dogs (6 male, 5 female) were included. The patients were 6.55 ± 3.9 months old weighing 17.3± 7.5 kg. Mixed breed dogs (*n* = 5) were most common. Premedication included opioids (butorphanol *n* = 5; hydromorphone *n* = 5), midazolam (*n* = 3), and alfaxalone (*n* = 2). Induction was performed with propofol (*n* = 6), etomidate (*n* = 4), or fentanyl (*n* = 1). Co- inductions included lidocaine (*n* = 6) and midazolam (*n* = 6). Maintenance was achieved using isoflurane with fentanyl (*n* = 7) and/or lidocaine (*n* = 9) infusions, averaging 242 ± 57 minutes. Hypotension occurred in all patients. Ventricular

tachycardia requiring procainamide occurred in one dog. Patients with >40% RAPG (*n* = 6; 55%) were more likely to have a MC (OR 5).

Anesthetic management of BV for SSAS requires intensive monitoring and timely intervention. There is a higher risk of MC with >40% reduction of pressure gradient.

Inter-individual agreement in canine pain assessment using the Glasgow- SF scale

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This research aimed to study the agreement in canine pain scoring using the Short Form Glasgow Composite Measure Pain Scale (CMPS-SF) between veterinary undergraduates, veterinary nurses, board-specialists in veterinary anaesthesia and analgesia and veterinary surgeons without specific training in pain scoring.

Forty-five client-owned dogs presented to a UK-based veterinary teaching hospital for a variety of treatments were enrolled in this prospective, observational study. Following treatment, a resident in veterinary anaesthesia and analgesia pain scored each patient using the CMPS-SF, while being video recorded for approximately 60 seconds. A total of twenty volunteers were recruited and asked to allocate a pain score all videos recorded. Recruited volunteers were divided into four groups based on experience: final-year veterinary undergraduates, registered veterinary nurses, board- specialists in veterinary anaesthesia and analgesia, and veterinary surgeons without specific training in pain scoring. Average scores between groups were compared with Related-Samples Friedman's Two-Way Analysis of

Variance, agreement within groups and agreement of average scores between groups were assessed by calculating intraclass correlation coefficient (ICC).

Undergraduates' average scores were significantly different from vets ($p<0.001$), nurses ($p<0.001$) and board-specialists ($p=0.048$). Overall agreement of pain assessment (all observers) was poor (ICC=0.494). Within groups, nurses had the best interobserver agreement (ICC=0.656), followed by board-specialists (ICC=0.540), veterinary surgeons (ICC=0.478) and veterinary undergraduates (ICC=0.432). Undergraduates' average scores were also significantly higher than all the other groups and their agreement with the other groups was the poorest. Best inter-group agreement was between veterinary surgeons or board-specialists and nurses (ICC=0.951).

This study showed poor agreement of pain assessment between different groups of observers with varying experience. Veterinary undergraduates tended to pain score higher and had poorer interindividual agreement. Pain assessment is key to ensure animal welfare and although the CMPS-SF is validated (Reid et al. 2007), veterinary training in this area should be reinforced to improve consistency.

References

Reid J, Nolan AM, Hughes JML et al. (2007) Development of the short-form Glasgow Composite Measure Pain Scale (CMPS-SF) and derivation of an analgesic intervention score. *Anim Welf* 16(S), 97-104.

Efficacy of xylocaine for intravenous catheter placement in dogs

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Objective: To assess the efficacy of xylocaine spray on reducing reaction at intravenous catheter (IVC) placement in sedated dogs.

Study Design: Prospective, randomized, blinded, placebo-controlled, clinical trial.

Animals: 10 client owned dogs.

Method: Dogs were randomly assigned to one of two groups – Xylocaine 10% spray or diluted ethanol (placebo). Dogs were clipped over a cephalic vein and a swab soaked in either xylocaine 10% pump spray or the placebo was placed on the clipped area and secured with cling film and vet wrap. Dogs were sedated with 3µg kg^{-1} medetomidine and 0.3mg kg^{-1} methadone intramuscularly in the cervical muscle. After 20 minutes dogs were sedation scored using a published sedation score (Martínez-Taboada & Redondo 2020). Dogs were then catheterized and IVC placement was filmed for review. IVC placement was assessed for reaction by three independent blinded reviewers using a binary score dependent on movement at IVC insertion. Data was analysed with student t-test, post hoc Fisher's exact test, chi-squared test and multivariate linear regression as appropriate.

Results: There was no difference between groups in terms of weight ($p = 0.53$), BCS ($p = 0.39$) and age ($p = 0.26$). Animals in the xylocaine group reacted less frequently than animals that received a placebo ($p = 0.03$). Dogs with moderate or profound sedation were less likely to react to catheter placement ($p= 0.01$). There was no association between xylocaine, sedation score and reaction to catheter placement in a multivariate analysis ($p=0.37$).

Conclusion: In this study, xylocaine spray was effective after only 20 minutes. Compared to a placebo of diluted alcohol, xylocaine spray was shown to have significance in reducing the pain stimulus during IVC placement.

References

Martínez-Taboada F, Redondo JI (2020) The SIESTA (SEAAV Integrated evaluation sedation tool for anaesthesia) project: Initial development of a multifactorial sedation assessment tool for dogs. *PloS one*, 15(4), e0230799. https://doi.org/10.1371/journal.pone.0230799

Peri-operative acute kidney injury in dogs undergoing desexing surgery

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Introduction Acute kidney injury (AKI) is a potentially serious complication of anaesthesia and surgery. In dogs the incidence of peri-operative AKI is unknown.

Materials and Methods Prospective cohort study of 165 (71 male and 94 female) dogs admitted for castration or ovariohysterectomy at a university teaching hospital (institutional animal care and ethics committee approval: A16025). Inclusion criteria were owner consent and no prior cardiac or renal disease. Blood samples were obtained prior to anaesthesia; and 24 and 48 hours post- operatively for measurement of serum creatinine (sCr). AKI was defined by an increase (>25 μmol l^{-1}) in sCr from pre-operative to 24 or 48 hours post.

Results Mean ± SD age and body weight were 2.1 ± 1.7 years and 20.3 ± 10 kg. Pre-operatively all dogs were euhydrated based on physical examination, pack cell volume and total plasma protein measurements. Pre-operative mean sCr was 103.2 ± 23.2 (reference range 44 – 150 μmol l^{-1}). The mean change in pre sCr to 24 and 48 h was -3.8 ± 20.7 μmol l^{-1} and -3.8 ± 24.6 μmol l^{-1} respectively (p>0.05).

Creatinine increased > 25 µmol l^{-1} in four dogs at 24 hours and in an additional three dogs at 48 hours. Average increase for these dogs was 35.7 ± 31.1 µmol l^{-1} at 24 hours and 25.6 ± 5 µmol l^{-1} at 48 hours. In total seven dogs (4.3%) were classified as having AKI. One dog was grade 2 AKI (sCr 175 µmol l^{-1}) and the other 6 were grade 1 (sCr increase > 25 µmol l^{-1} but within reference range). In addition, four dogs had overt oliguria in the first 24 hours post-op, including the dog with grade 2 AKI and two dogs with grade 1 AKI.

Conclusions Peri-operative AKI may be a common complication of elective surgery in dogs.

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Changes in body temperature during general anaesthesia after premedication with medetomidine or acepromazine in dogs

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Changes in body temperature during anaesthesia are important. The aim of the presented study was to compare temperature changes in dogs after premedication with medetomidine or acepromazine during 60 minute period of general anaesthesia.

A total of seventy dogs were included in this prospective double-blind randomized study. For premedication, the dogs in the MED group (n = 35) received medetomidine 0.005 mg kg^{-1} and the dogs in the ACE group (n = 35) received acepromazine 0.01 mg kg^{-1}. In dogs of both groups, fentanyl 0.01 mg kg^{-1} intravenously followed by an infusion 0.01 mg kg^{-1} $hour^{-1}$ was administered. Anaesthesia was induced with propofol and maintained with isoflurane in oxygen-air. Dogs were ventilated and warmed using a warm-air system (37.8 °C). After induction (T0) and at ten minute intervals for 60 minutes (T10 – T60), oesophageal (T-E) and

rectal (T-R) temperature were recorded. The data were analysed using Shapiro-Wilk and ANOVA tests ($p < 0.05$).

Oesophageal temperature in the MED group significantly decreased at T30, T40, T50 and T60 compared to T0; in the ACE group, oesophageal temperature significantly decreased at T40, T50 and T60 compared to T0. In the Med group, oesophageal temperature was significantly higher compared to the ACE group at T0, T10 and T20. The rectal temperature in both the MED and ACE groups significantly decreased at T50 and T60 compared to T0. The decrease in oesophageal and rectal temperature was similar in both groups. Twenty minutes after anaesthesia induction, the oesophageal temperature in dogs premedicated with medetomidine was significantly higher compared to the oesophageal temperature in dogs premedicated with acepromazine.

Sedative and cardiovascular effects of topically administered tropicamide in puppies

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Tropicamide is used in dogs to induce mydriasis. The aim of the present study was to assess sedative and cardiovascular effects of topically administered tropicamide in puppies.

A total of 45 Shetland Sheepdog puppies aged 6 – 7 weeks and weighing 1.78 – 2.64 kg were included in the prospective clinical study. The puppies underwent examination for hereditary eye disease. In all puppies, sedation, heart rate (HR) and mean arterial pressure (MAP) were measured. In all puppies, one drop of 1% tropicamide was applied to each eye. Sedation was scored before (T0) and 30 minutes (T30) after tropicamide administration using a composite simple descriptive sedation scale giving a score of 0 (not sedated) to 13 (well sedated) as

described by Gurney et al. (2009). Heart rate and non-invasive MAP were recorded at T0 and T30. Shapiro-Wilk, t-test and Wilcoxon signed rank test were used ($p < 0.05$).

Sedation score at T30 was higher [2 (0 – 6)] compared to T0 [1 (0 – 4)] ($p = 0.002$). Heart rate at T30 decreased (126 ± 16 beats minute^{-1}) compared to T0 (136 ± 21 beats minute^{-1}) ($p = 0.003$). Mean arterial pressure at T30 decreased (93 ± 29 mmHg) compared to T0 (104 ± 26 mmHg) ($p = 0.021$).

In puppies, topically administered 1% tropicamide induces mild sedation with a decrease in heart rate and mean arterial pressure.

References

Gurney M, Cripps P, Mosing M (2009) Subcutaneous preanaesthetic medication with acepromazine- buprenorphine is effective as and less painful than the intramuscular route. *J Small Anim Pract* 50, 474–477.

Perianaesthetic mortality in dogs: a worldwide multicentric study

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The aim of this study was to establish a worldwide canine anaesthetic mortality and its risk and protective factors.

A prospective multicentric cohort study was undertaken in 405 veterinary centers from Spain, Argentina, France, United Kingdom, United States, Chile, Portugal, Australia, Peru and other

countries between 2016 and 2022. Anaesthetic-related death was defined as occurring after premedication and within 48 hours after extubation. A multivariable logistic regression modelling was used for establishing the demographic and clinical associations with the anaesthetic-related death (p<0.05). Euthanasia and surgery-related deaths were studied but excluded.

A total of 55022 anaesthetics were studied; 495 dogs died: 378 (0.69%) were anaesthesia-related and 117 (0.21%) died from surgery or pre-existing injuries. Another 360 (0.65%) were euthanised due to poor prognosis. 21 patients died during induction, 50 in maintenance, 43 during recovery in the operating theatre, 192 during the first 24 hours and 72 between 24-48 hours.

Increased mortality was observed in paediatric and geriatric patients, obese dogs, higher ASA status, unscheduled or emergency procedures, abdominal, orthopedic or neurosurgical, thoracic surgeries, and short anaesthesias. A reduction was observed when using acepromazine or alpha2 agonists as sedatives, pure opioids alone, or a combination of pure opioids, partial agonists, or agonist-antagonists plus NSAID as analgesics in premedication, when using sevoflurane instead of isoflurane for maintenance, and when locoregional techniques were employed.

The overall anaesthetic mortality index was 0.69%. Most deaths happened during the postoperative period. There are risk and protective factors that can help in clinical decision making.

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References

Brodbelt DC, Blissitt KJ, Hammond RA et al. (2008) The risk of death: the confidential enquiry into perioperative small animal fatalities. *Vet Anaesth Analg* 35, 365e373. https://doi.org/10.1111/j.1467-2995.2008.00397.x

Gil L, Redondo JI (2013). Canine anaesthetic death in Spain: a multicentre prospective cohort study of 2012 cases. *Vet Anaesth Analg* 40, e57–e67. https://doi.org/10.1111/vaa.12059

Shoop-Worrall SJW, O'Neill DG, Viscasillas J, Brodbelt DC (2022). Mortality related to general anaesthesia and sedation in dogs under UK primary veterinary care. *Vet Anaesth Analg* 49, 433–442. https://doi.org/10.1016/j.vaa.2022.03.006

Oxygen reserve index to predict oxygen status in anaesthetized dogs

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Oxygen reserve index (ORi) is a non-invasive continuous parameter ranging from 0 to 1 that positively correlates with arterial oxygen content (PaO_2) between 100-200 mmHg in humans. This prospective study investigated the relationship of ORi with PaO_2, and its use to predict oxygen content in dogs.

In 21 anaesthetised mechanically ventilated healthy dogs undergoing elective procedures, PaO_2 was measured by a blood gas analyser and at the time of blood collection the ORi recorded by Masimo multi-wavelength pulse CO-oximeter. Pearson coefficient (r) was used to assess the correlation between ORi and PaO_2. To identify if factors known to affect the pulse oximeter reading, such as the weight, local perfusion, pH, $PaCO_2$, and temperature, influenced ORi measurements, paired data were fitted in a linear model and the correlation between the model residuals and the confounders was calculated. Youden index was used to identify the ORi value that predicted $PaO_2 \geq 150$ mmHg with the highest sensitivity and specificity.

A total of 51 paired measurements of ORi and PaO_2 were collected, and a moderate positive correlation ($r = 0.6$) was found. Plethysmographic curve appeared to influence the accuracy of ORi rather than the perfusion index. Only body weight mildly affected ORi measurements ($r = 0.48$, $p < 0.05$). An ORi ≥ 0.48 indicated a $PaO_2 \geq 150$ mmHg with as sensitivity of 87%.

The oxygen reserve index may be used to titrate oxygen administration in anaesthetised dogs, although it does not replace blood gas analysis for arterial oxygen content measurement.

Feline

Intramuscular alfaxalone-butorphanol sedation with or without midazolam in hyperthyroid cats

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The sedation quality of intramuscular (IM) alfaxalone and butorphanol in combination with midazolam was investigated in hyperthyroid cats undergoing suitability assessment for radioioidine treatment.

Sixty hyperthyroid cats undergoing diagnostic investigations were randomly allocated to receive IM butorphanol 0.3 mg kg^{-1} and midazolam 0.2 mg kg^{-1} with alfaxalone 2 mg kg^{-1} (BMA2) or alfaxalone 3 mg kg^{-1} (BMA3), or butorphanol 0.3 mg kg^{-1} with alfaxalone 3 mg kg^{1} (BA3). If required, additional alfaxalone 0.2 mg kg^{-1} was administered intravenously. Cat Stress Score (Kessler & Turner 1997), response to injection, time to recumbency, sedation score (Young et al. 1990) at 10, 15, 20, and subsequent 10-minute intervals, additional alfaxalone requirements (AAR) and first administration, recovery quality (excellent, fair, poor) and adverse effects were assessed. Thyroxine levels, gabapentin treatment and assessors were recorded. Heart and respiratory rate and arterial haemoglobin saturation were monitored every 5 minutes. Data were compared using Chi-square and Kruskal-Wallis testing. Sedation score and predictors were analysed by a mixed effect and multivariable linear regression model, respectively ($p < 0.05$).

No significant predictors for sedation quality were identified. In all groups, median sedation score was considered good and median recovery score was fair. Sedation score over time across groups and other variables were not significantly different. In BA3, AAR occurred significantly earlier ($p = 0.043$). Fifty-three cats had AAR. Muscle twitching was common, but head pawing was significantly increased in BA3 ($p = 0.014$).

Sedation and recovery quality were satisfactory with all protocols but the addition of midazolam prolonged sedation.

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References

Kessler MR, Turner DC (1997) Stress and adaptation of cats (Felis silvestris catus) housed singly, in pairs and in groups in boarding catteries. *Anim Welf* 6, 243-254.

Young LE, Brearley JC, Richards DL et al. (1990) Medetomidine as a premedicant in dogs and its reversal by atipamezole. *J Small Anim Pract* 31, 554-559.

Transversus abdominis plane block provides analgesia in cats post- ovariohysterectomy

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Introduction:This study evaluated the postoperative analgesic efficacy of an ultrasound-guided transversus abdominis plane block (TAPB) with bupivacaine in cats undergoing elective ovariohysterectomy.

Materials and Methods: Twenty-nine adult female cats (3.1 ± 0.6 kg) were included in this prospective, randomized, masked clinical trial. After the administration of intramuscular acepromazine (0.03 mg kg^{-1}) and buprenorphine (0.02 mg kg^{-1}), anesthesia was induced with propofol to effect and maintained with isoflurane in oxygen. A bilateral 2-point (subcostal and lateral) TAPB (Garbin et al. 2022) was performed injecting 1 mL of 0.25% bupivacaine (0.25 ml per point) (treatment group, TG; n = 16) or the same volume of saline (control group, CG; n = 13).

Before premedication (baseline) and at 1, 2, 3, 4, 8, 10 and 24 hours post-extubation, pain was assessed using the UNESP-Botucatu Feline Pain Scale – short form. Buprenorphine (0.02mg kg^{-1} intravenously) and meloxicam (0.2 mg kg^{-1} subcutaneously) were administered when pain scores ≥ 4/12. Ten hours post-extubation, meloxicam was administered to cats that did not receive rescue analgesia. Data were analyzed with Chi-square test and linear mixed model with Bonferroni correction ($p < 0.05$).

Results: The prevalence of rescue analgesia was significantly higher in CG (n = 13/13) than TG (n = 3/16; $p < 0.001$). Pain scores were significantly different between groups at 2, 4 and 8 hours post-extubation. Pain scores (mean ± SD) were significantly higher in CG at 2 (2.0 ± 1.9), 3 (2.9 ± 1.6), 4 (3.0 ± 1.4) and 8 hours post-extubation (5.0 ± 0.6) than baseline (0.0 ± 0.3), but not in TG. One cat in CG required the administration of rescue analgesia twice.

Conclusion: A bilateral ultrasound-guided 2-point TAPB with bupivacaine in combination with systemic buprenorphine provided adequate and superior postoperative analgesia than buprenorphine alone in cats undergoing ovariohysterectomy.

References

Garbin M, Marangoni S, Finck C, Steagall PV (2022) An anatomical, sonographic, and computed tomography study of the transversus abdominis plane block in cat cadavers. *Animals* (Basel) 12(19), 2674. doi: 10.3390/ani12192674.

Respiratory mechanics in isoflurane-anesthetized cats: to paralyze or not paralyze?

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Neuromuscular blockade (NMB) is recommended to prevent the effects of respiratory muscles activity when investigating respiratory mechanics. Respiratory mechanics assessed in the presence or absence of paralysis were compared in six adult male cats anesthetized in four different experiments.

Anesthesia was induced with isoflurane 5% in oxygen and maintained with 1.3 MAC. Each cat was ventilated with tidal volume of 10 mL kg^{-1} and no PEEP. Respiratory system, lung and chest wall compliances (Crs, CL and Ccw, respectively) and resistances (Rrs, RL and Rcw, respectively) were recorded before and approximately 5 minutes after the administration of rocuronium 0.6 mg kg^{-1} IV, at a train-of-four ratio < 30 %. Respiratory mechanics variables assessed before and after paralysis were compared by Bland-Altman analysis for repeated measurements.

Two measurements in cats without NMB were excluded due to spontaneous effort. Mean biases (limits of agreement) were 0.03 (-0.03, 0.09), 0.09 (-0.04, 0.21), 0.02 (-0.29, 0.32) mL kg^{-1} cmH_2O^{-1} for Crs, CL and Ccw, and -0.13 (-1.3, 1.03), -0.18 (-1.1, 0.7), and 0.14 (-0.45, 0.72) cmH_2O L^{-1} $second^{-1}$ for Rrs, RL and Rcw, respectively. The 95% confidence interval of the limits of agreement of all respiratory mechanics variables were within 15% of the mean, except for Rcw.

In the absence of respiratory muscle activity, Crs, CL, Ccw, Rrs and RL evaluated in nonparalyzed anesthetized cats provided values in agreement with the ones achieved in individuals paralyzed with rocuronium. In isoflurane-anesthetized cats, paralysis may not be necessary when investigating the most important respiratory mechanics variables.

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Influence of needle type on epidural injection performance in cats

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Lumbosacral epidural injection in cats carries a significant risk of inadvertent intrathecal injection due to the small size of the epidural space. The use of smaller needles with a short bevel could potentially reduce this problem.

Epidural injections in cats between February and October 2022 were evaluated. Patient data, needle type (22G with Quincke tip or 25G with Crawford tip), presence of CSF, blood, tail twitch (Y/N), POP-sensation (0 = none – 5= clear), procedural success and number of attempts were evaluated. Groups were compared using Mann-Whitney-U-Test or Fisher's exact test with $p < 0.05$ considered significant.

In total 52 records were evaluated, using 22G spinal needle in 25 cases and 25G epidural needle in 27 cases. Subjective POP-sensation was documented in 39 cases and was higher using the 25G needle (p=0.01). The number of attempts was higher with 22G (1.24 versus 1.01, p=0.09) but the presence of CSF with the 22G needle was lower 4% (1/25) versus 7.5% (2/27) with 25G (p=0.61). Blood was visible in 3/25 cases using the 22G and in no case with 25G (p=0.1), twitching of the tail occurred in 6/25 22G cases and 6/27 25G cases (p=1.0). In one cat the procedure failed twice using a 25G needle and was then performed using a 22G needle, which resulted in intrathecal injection. Patellar reflex was lost in all cats after injection of local anesthetics.

Epidural injection performance was similar with both needle types. Larger prospective trials are needed to evaluate potential differences.

Perianaesthetic mortality in cats: a worldwide multicentric study

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The aim of this study was to establish a worldwide feline anaesthetic mortality and its risk and protective factors.

A prospective multicentric cohort study was undertaken in 405 veterinary centers from Spain, Argentina, France, United Kingdom, United States, Chile, Portugal, Australia, Peru and other countries between 2016 and 2022. Anaesthetic-related death was defined as occurring after premedication and within 48 hours after extubation. A multivariable logistic regression modeling was used for establishing the demographic and clinical associations with the anaesthetic-related death (p<0.05). Euthanasia and surgery-related deaths were studied but excluded from the analysis.

A total of 14962 anaesthetics were studied; 115 cats died: 94 (0.63%) were anaesthesia-related and 21 (0.14%) died from surgery or pre-existing injuries. Another 98 (0.65%) were euthanised due to poor prognosis. Six patients died during induction, 18 in maintenance, 13 during recovery in the operating theatre, 41 during the first 24 hours and 16 between 24-48 hours.

Increased mortality was observed cachectic cats, higher ASA status, abdominal, orthopaedic or neurosurgical procedures, thoracic surgeries, and in ventilated patients. A reduction in the odds of death was observed when using alpha2 agonists as sedatives or pure opioids alone as analgesics in premedication.

The overall anaesthetic mortality index in cats was 0.63%. Most deaths happened during the postoperative period. There are both risk and protective factors that may help in clinical decision making in cat anaesthesia.

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References

Brodbelt DC, Pfeiffer DU, Young LE, et al. (2007) Risk factors for anaesthetic-related death in cats: results from the confidential enquiry into perioperative small animal fatalities (CEPSAF). *Br J Anaesth* 99, 617–623.

Levy JK, Bard KM, Tucker SJ, et al. (2017) Perioperative mortality in cats and dogs undergoing spay or castration at a high-volume clinic. *Vet J* 224, 11–15. https://doi.org/10.1016/j.tvjl.2017.05.013

Correlation between rectal and thermographic skin temperature in anesthetized cats

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Introduction Thermographic skin temperature measurement is a non-invasive, widely applicable technique. This study evaluated the correlation between rectal and thermographic skin temperature in anesthetized cats.

Materials & Methods Ten healthy cats (five female, five male, 3.3 ± 2.0 years of age, 3.5 ± 0.7 kg) were anesthetized 3 times each (14-day intervals). Cats were sedated with alfaxalone (4 mg kg^{-1} IM) for catheter placement and then anesthesia was induced with alfaxalone (2 mg kg^{-1} IV) and maintained with isoflurane for 90 minutes. Rectal temperature, measured with a

calibrated thermistor probe and skin thermographic images, obtained with an infrared camera were collected at immediately after induction and then at 15-minute intervals during anesthesia. Thermographic images were obtained from four different anatomical sites (muzzle, pinna, thigh, and trunk) and analyzed by camera-specific software. Regions of interest were manually drawn over the anatomic sites on the images and maximum temperature (Tmax) from each were recorded. Pearson correlation coefficients were calculated between rectal temperature and each anatomical site temperature. A $p < 0.05$ was used for significance.

Results The anatomic site Tmax with the highest correlation coefficient to rectal temperature was the muzzle ($r^2 = 0.8229$, $p < 0.0001$). The correlation coefficients for the other anatomic sites were $r^2 = 0.7710$ for the pinna, $r^2 = 0.6511$ for the thigh, and $r^2 = 0.3880$ for the trunk (all p values < 0.0001).

Conclusions In anesthetized cats, muzzle thermographic Tmax correlates highly with rectal temperature and may be a useful alternative method for monitoring changes in body temperature.

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Deep-learning-based prediction of facial landmarks using the Feline Grimace Scale©

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This study aimed to use deep neural network models to predict facial landmark positions in cats for a future automated pain assessment tool.

A total of 3447 face images of painful and pain-free cats collected from five different studies and submitted through the Feline Grimace Scale© (FGS) mobile phone application were used. Each image was manually annotated with 37 facial landmarks based on the FGS action units (AU). The dataset was augmented by introducing random geometric and/or color-space modifications. An initial set of models was based on well-known convolutional neural network architectures and pre-trained Keras models. These models were trained and benchmarked according to their accuracy, inference time and model size. The effect on predictive performance of pre-processing based on face alignment and filters for edge detection was calculated using normalized root mean squared error (NRMSE) of the distance between the predicted and ground truth landmarks.

The ShuffleNetV2 (NRMSE = 16.76%) and EfficientNetB0 (NRMSE = 16.89%) architectures showed the best predictive performance and were considered suitable for future automated mobile phone applications. Models using filter-based pre-processing and face alignment improved the predictive performance, which was lower for whiskers changes when compared with other AUs in all the models studied. All models showed the most accurate predictions for landmarks related to orbital tightening and muzzle tension.

This study reported the use of deep learning-based predictors of facial landmark positions in cats that can be used for automated acute pain assessment based on the FGS.

Machine learning models for prediction of Feline Grimace Scale© scores

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This study aimed to apply machine learning models to predict Feline Grimace Scale© (FGS) scores for acute pain assessment in cats.

A total of 3447 face images of painful and pain-free cats from five studies and those submitted through the FGS mobile phone application were used. Scores for each action unit (AU) and total FGS scores were assigned by one or more raters for the majority of images. Each image was manually annotated with 37 facial landmarks. Angles, ratios of distances between specific landmarks and area ratios of quadrilaterals were used as geometric descriptors (GD, n = 35). Machine learning models were trained for predicting scores; predictive performance was evaluated for accuracy (painful/not painful according to rescue analgesia) and using mean square error (MSE) (total FGS scores and scores for each AU).

A binary classification model provided an accuracy of 95.5% and MSE was 0.0104 using all GD. Accuracy was 94%, 93.3% and 91% and MSE was 0.0121, 0.0127 and 0.0149, when GD related to whiskers position, head position or these both AU were excluded, respectively. Ordinal classification models showed the largest and lowest prediction errors for muzzle tension and whiskers change, and ear position and orbital tightening scores, respectively; these models for predicting single AU scores presented superior MSE than regression models for total FGS scores.

These machine learning models presented excellent accuracy to differentiate painful and non-painful cats using three or more AU. Prediction errors were reduced by excluding AU whiskers and muzzle position.

Equine

Salbutamol *versus* salmeterol comparison to improve oxygenation in anaesthetized horses

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Salbutamol has shown satisfactory results to treat hypoxaemia in anaesthetized horses. Salmeterol, a long-acting β_2-adrenergic agonist, has demonstrated bronchodilatory properties in awake asthmatic horses but has never been studied under general anaesthesia.

One hundred and eight client-owned horses received a standard protocol consisting of acepromazine (intramuscularly 0.1 mg kg^{-1} or intravenously (IV) 0.05 mg kg^{-1}) and xylazine (0.6 mg kg^{-1} IV), except for horses anaesthetized for colic and caesarean section surgeries that only received xylazine. Anaesthesia was induced with midazolam (0.06 mg kg^{-1} IV) and ketamine (2.2 mg kg^{-1} IV) and maintained with isoflurane in oxygen/air mixture (inspired oxygen fraction 70 %). Volume-controlled ventilation was provided immediately using the following ventilator settings: respiratory rate 8 breaths $minute^{-1}$, tidal volume 10 mL kg^{-1}, inspiratory-to-expiratory time ratio 1:2, no positive end-expiratory pressure. If arterial partial pressure of oxygen (PaO_2) <13.3 kPa, either salbutamol (2 µg kg^{-1}) or salmeterol (0.5 µg kg^{-1}) was administered by inhalation. Arterial blood gas analysis was repeated 15 and 30 minutes after treatment. PaO_2 at 15 and 30 minutes were compared between treatments using Mann- Whitney U test; $p < 0.05$.

Sixty horses received salbutamol, 65 % and 60 % responded successfully (≥ 1.2 times increase of PaO_2) at 15 and 30 minutes, respectively. Forty-eight horses received salmeterol, 35 % responded successfully at 15 and 30 minutes. PaO_2 was significantly higher after salbutamol than salmeterol at 15 and 30 minutes.

Salbutamol was more effective than salmeterol in improving oxygenation in anaesthetized horses with PaO_2 < 13.3 kPa.

Pharmacokinetics of bupivacaine during abdominis rectus sheath block in horses

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Quantifying the plasma concentration of bupivacaine after a rectus sheath (RS) in horses is important to assess the risk of systemic toxicity. We hypothesized that RS block with 2 mg kg^{-1} of bupivacaine does not reach high plasma concentrations.

The treatment was injected into the RS with ultrasonography guidance in 6 sedated horses. The volume of bupivacaine was expanded to 1 mL kg^{-1} with 0.9% NaCl. The block was performed in 4 points paramedian to the abdominal midline. Blood was collected at baseline, 5, 10, 15, 30, 45, 60, 90, 120, 240, 480, 720, and 1440 minutes after treatment. Plasma concentrations were measured by liquid chromatography. Time to peak concentration (Tmax), peak plasma concentration (Cmax), area under the plasma concentration curve (AUC), and extrapolated area under the plasma concentration curve (AUCext) were calculated with non-compartmental analysis.

No bupivacaine was detected at baseline. The concentration Tmax peaked at 2.2 ± 0.9 hours with a Cmax of 83.8 ± 16.0 ng mL^{-1}. The AUC was 1797.5 ± 467.0 h ng mL^{-1} with an AUCext extrapolation of 36.6 ± 24.2%. The values obtained in this experiment at any time point were lower than the concentration that causes toxicity.

The AUCext was higher than the 20% threshold recommended for pharmacokinetic analysis, suggesting that more data points are necessary for future studies. Our findings indicate that RS block with 2 mg kg^{-1} of bupivacaine will not reach toxic plasma levels in sedated horses. Prospective clinical research is warranted for surgical colic cases.

Concentration of transdermally administered fentanyl in equine synovial fluid

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Introduction Administration of fentanyl via transdermal patch may result in concentration of fentanyl at the site of patch location. It is unknown whether application of the patch directly over a joint will result in concentration of the drug within the synovial fluid.

Methods Six healthy adult horses were enrolled. Each horse had two 10 mg fentanyl matrix patches applied for 48 hours over one, randomly assigned, carpometacarpal joint. Whole blood and bilateral carpal synovial samples were obtained over the following 48 hours. Fentanyl concentrations were measured via liquid chromatography-mass spectrometry. Fentanyl concentrations in blood and synovial fluid were compared using a mixed effects model.

Results All subjects achieved detectable concentrations of fentanyl in both plasma and synovial fluid. Time to peak concentration was 12 hours. At 6 hours, the synovial concentration in the untreated carpus (0.104 ± 0.106 ng mL^{-1}) was lower than plasma fentanyl concentrations (0.31 ± 0.27 ng mL^{-1}) (p = 0.036). At 12 hours, both treated and untreated synovial fluid fentanyl concentrations (0.55 ± 0.3 ng mL^{-1}, 0.53 ± 0.28 ng mL^{-1}, respectively) were lower than plasma concentrations (0.87 ng mL^{-1} ± 0.48) ($p < 0.001$ and p = 0.001, respectively). Synovial concentrations of fentanyl were never significantly different between treated and untreated joints.

Conclusions Application of fentanyl matrix patches directly over the carpometacarpal joint did not result in increased fentanyl concentrations in the synovial fluid of the treated middle carpal joint in healthy adult horses.

Comparison between xylazine bolus *versus* infusion during equine colic anaesthesia

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This retrospective study investigated the effect of xylazine bolus or xylazine infusion on recovery quality and duration in horses after colic surgery under partial intravenous anaesthesia (isoflurane and lidocaine infusion).

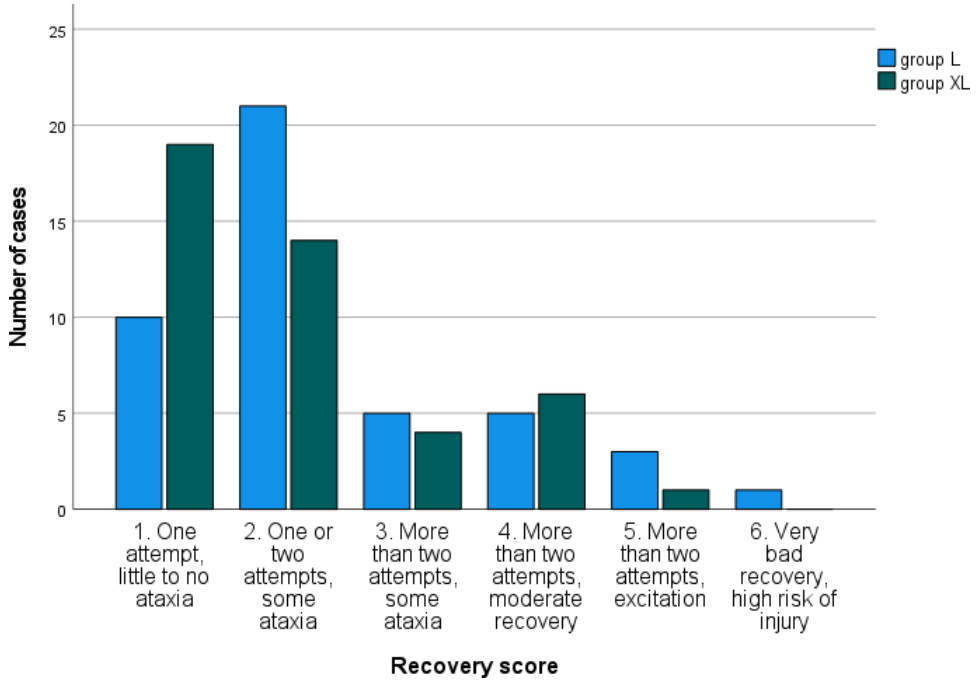
Anaesthetic records of horses undergoing colic surgery were reviewed from a similar period of 7 months in 2021 and 2022. In both groups, after sedation with xylazine 0.7 mg kg^{-1} IV and induction with ketamine 2.2 mg kg^{-1} and midazolam 0.06 mg kg^{-1} IV, anaesthesia was maintained with isoflurane and lidocaine (bolus 1.5 mg kg^{-1} IV, infusion 2 mg kg^{-1} $hour^{-1}$). The first group (L) (2021) received xylazine 0.2 mg kg^{-1} IV before recovery, the second

group (XL) (2022) received xylazine 0.5 mg kg^{-1} $hour^{-1}$ IV during the maintenance of the anaesthesia. Registered data consisted of breed, age, weight, duration of anaesthesia, extubation time, time in lateral and sternal position, time from end of anaesthesia to first attempt to stand, time from end of anaesthesia to stand, number of attempts, recovery score (1, best recovery, to 6, worst recovery) and whether recovery was assisted. Data was determined as parametric or non- parametric before respectively applying an independent samples t-test or Mann-Whitney U test (alpha = 0.05).

A total of 45 cases with anaesthetic protocol L (all assisted recoveries) and 44 cases with protocol XL were identified (41 assisted recoveries). There were significant differences for time in lateral (L: 30 (5-190), XL: 36.5 (15-100) minutes, p = 0.032) and time to first attempt (L: 30 (10-190), XL: 38 (15-92) minutes, p = 0.041). There were 10 recoveries scored 1 with protocol L and 19 with protocol XL (Graphic 1).

A xylazine infusion delayed the first attempt to stand, but not the time to finally stand and resulted in almost twice as many excellent recoveries compared to infusion of only lidocaine.

Graphic 1 Number of cases according to recovery score in group L (lidocaine) and XL (xylazine and lidocaine)



Exploratory correction of Enghoff's dead space in isoflurane-anesthetized horses

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Bohr's dead space fraction (VDBohr/VT) is considered the true physiologic dead space but is not commonly available in clinical practice. Alternatively, Enghoff's dead space fraction (VDEnghoff/VT) is available in clinical monitors but is highly influenced by venous admixture. Different indexes of pulmonary gas exchange were tested in regression models to correct VEnghoff/VT towards VDBohr/VT using data from six adult horses mechanically ventilated with tidal volume of 15 mL kg^{-1}.

Approximately 1.5 hours after anesthetic induction, an alveolar recruitment maneuver was followed by a decremental positive end-expiratory pressure titration (PEEP) from 20 to 0 cmH_2O in steps of 5 cmH_2O maintained for 20 minutes each. At each PEEP level, volumetric capnography data, shunt fraction, PaO_2/FIO_2, and $PaCO_2$ minus $PE´CO_2$ ($P(a-E´)CO_2$) were recorded. Linear regression models including each gas exchange index were compared by adjusted coefficient of determination (R2adj) and Akaike's information criteria (AIC).

Mean VDBohr/VT (0.39 ± 0.07) was significantly lower than VDEnghoff/VT (0.53 ± 0.05). The simple linear regression model of VDBohr/VT as a function of VDEnghoff/VT presented a R^2adj of 0.51. The multiple linear regression model with the highest R^2adj (0.95) and highest AIC difference from the simple model (59.3) was VDBohr/VT = a × VDEnghoff/VT + b × P(a-E´)CO_2 + c, where a, b, and c are constants.

Our results suggest that among the gas exchange variables investigated on this exploratory study, P(a-E´)CO_2 could be used for approximating VDEnghoff/VT to VDBohr/VT. Although, further studies are necessary to clarify the applicability of this model in different clinical scenarios.

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Lessons from Confidential Enquiry into Perioperative Equine Fatalities 4

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In 2002 Confidential Enquiry into Perioperative Equine Fatalities (CEPEF) 2 evaluated equine anaesthetic risk from 41,824 cases (noncolic mortality 0.9%) (Johnston et al 2002). Preliminary CEPEF4 results (19,796 cases after 14 months) indicate reduced mortality (Gozalo-Marcilla et al 2022). We assess qualitatively what has changed in the intervening 20

years. For this prospective, observational, internet-based study, data were collected, cleaned and processed with the statistical software R.

Over 2 years, 33,704 cases were collected from 94 centres. Of these cases, anaesthesia was maintained with partial intravenous anaesthesia (PIVA) in 19,408, inhalation only (INH) in 11,899 and total intravenous anaesthesia in 2,377. Mortality rates within seven days of general anaesthesia were: overall 0.9%, 0.6% in noncolics and 3.1% in colics. Common anaesthesia practices include: i) sedation with drug combinations, primarily alpha-2-agonists/opioids acepromazine (69.3%); ii) induction with ketamine/benzodiazepines (85.3%); iii) isoflurane as the most common inhalant (87.2% of inhalant-based anaesthetics); iv) PIVA (62.0%) is used more commonly than INH (38.0%) for inhalant-based protocols; and recovery v) light sedation including alpha-2-agonists (68.9%), vi) either with ropes (45.9%), free (44.8%) or manually-assisted (9.2%). Finally, vi) monitoring usually included electrocardiogram (91.9%), pulse-oximetry (87.8%), end-tidal carbon dioxide (86.3%) and invasive blood pressure (81.8%). Arterial blood gases were taken in 51.1% of horses, 74.4% if undergoing colic surgery.

Horses still die unexpectedly, but fewer than in 2002. More deaths now occur from recovery accidents rather than as a result of suspected cardiovascular effects during anaesthesia. Current anaesthetic practices have evolved; featuring increased use of opioids, ketamine/benzodiazepine induction, isoflurane maintenance with PIVA and more comprehensive monitoring.

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References

Johnston GM, Eastment JK, Wood JLN et al. (2002) The confidential enquiry into perioperative equine fatalities (CEPEF): mortality results of Phases 1 and 2. *Vet Anaesth Analg* 29, 159 – 170. https://doi.org/10.1046/j.1467- 2995.2002.00106

Gozalo-Marcilla M, Bettschart-Wolfensberger R, Johnston GM et al. (2022) A step forward in the fourth Confidential Enquiry into Perioperative Equine Fatalities (CEPEF4): data collection over 14 months using an internet-based method. Proceedings of the Spring meeting of the Association of Veterinary Anaesthetists, Nafplio, Greece, May 18th – 20th 2022, p. 57.

Clinical effects and pharmacokinetics of low-dose butorphanol intravenously in donkeys

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Although butorphanol is widely used in equids for sedation, its clinical effects and pharmacokinetics have been poorly investigated in donkeys. This study evaluated the pharmacokinetics of low dose of butorphanol and its effects on heart and respiratory rate, intestinal motility and sedation in donkeys.

Eight healthy donkeys aged 2-5 years undergoing non-painful clinical procedures were enrolled. All animals received butorphanol 0.03 mg kg^{-1} intravenously and blood samples were collected before and 5, 10, 15, 30, 45, 60, 90, 120, 180, 240, 300 and 360 minutes after administration. At every timepoint, heart and respiratory rate and intestinal sounds were evaluated, and the sedative effect assessed using two composite scales. Plasma butorphanol concentrations were measured using Liquid Chromatography Tandem Mass Spectrometry, and analyzed using Xcalibur 2.0.

All plasma concentrations were above the limit of quantification (0.25 ng ml^{-1}), and the mean ± SD of mean residence time, area under the curve, clearance and elimination half-life were 0.88 ± 0.46 hours, 52.1 ± 17.0 hour μg L^{-1}, 0.64 ± 0.22 L $hour^{-1}$ kg^{-1}, 2.10 ± 0.52 hours, respectively. Level of sedation was mild 15 minutes after drug administration and absent at 45 minutes; no other statistically significant changes were observed in the physiologic parameters.

This study suggests that low dose of butorphanol in donkeys may provide mild short-term sedation without affecting heart and respiratory rate or enteric motility. Pharmacokinetics parameters support clinical observations, as more than 60% of the dose was removed from plasma 53 minutes after injection.

Ruminant

Lumbosacral subarachnoid anaesthesia in calves: effect of needle design

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Lumbosacral subarachnoid anaesthesia has been reported to provide abdominal antinociception of good quality in calves (Condino et al. 2010). Needle tip design has been shown to impact dural trauma (Nath et al. 2017). The objective of the study was to assess the nature of dural punctures in calves comparing hypodermic and spinal needles.

Sixteen one to six week, 31 to 60 kg calves used for surgical teaching laboratories on omphalectomy and subsequently euthanized 48 hours post-surgery for necropsy training were allocated randomly to receive under sedation (xylazine 0.1 mg kg^{-1} IM) a lumbosacral subarachnoid anaesthesia (xylazine 0.2 mg kg^{-1}, procaine 4 mg kg^{-1}) with needles commonly used by bovine practitioners (18G x 40 mm hypodermic and 20G x 88 mm Quincke type spinal needles). Anesthesia quality was assessed with a visual analog scale. The necropsic assessment of the lumbosacral vertebral canal was standardized to obtain pictures of dural punctures with a ten fold magnifying 32 mm graduated optical lens placed in contact with the dura and hooked to a smartphone. Dural puncture surfaces were measured in triplicate with a free and open source image editor. A Mann-Whitney-Wilcoxon test was used to compare non parametric data with $p < 0.05$. Results are expressed in median (min-max).

No difference in the block efficacy was found. All punctures were identified but one in the spinal group. Dural puncture surface areas but not shapes were significantly different between hypodermic and spinal needles, 0.5231 mm^2 (0.2150-0.6815) versus 0.2581 mm^2 (0.2150- 0.3698) respectively. Impact of dural trauma extent on anaesthesia quality, side effects and dural healing needs further investigation.

References

Condino MP, Suzuki K, Taguchi K (2010) Antinociceptive, sand cardiopulmonary effects of subarachnoid and epidural xylazine-lidocaine in xylazine-sedated calves. *Vet Anaesth Analg* 37: 70-8. doi: 10.1111/j.1467- 2995.2009.00494.x.

Nath S, Badhiwala JH, Alhazzani W, Nassiri F, Belley-Cote E, Koziarz A, Shoamanesh A, Banfield L, Oczkowski W, Sharma M, Sahlas D, Reddy K, Farrokhyar F, Singh S, Sharma S, Zytaruk N, Selim M, Almenawer SA (2017) Atraumatic versus traumatic lumbar puncture needles: a systematic review and meta-analysis protocol. *BMJ Open* 7:e014478. doi: 10. 1136/bmjopen-2016-014478.

Ultrasound-guided perineural injection of the saphenous nerve in goat cadavers

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Experimental surgery of the goat stifle joint requires good perioperative analgesia, ideally without affecting motor function in the postoperative period.

The objective was to describe an ultrasound-guided technique for injection of local anaesthetic around the saphenous nerve in goats. Eleven fresh goat cadavers were used, all female, median and range body weight and age 60.5 (17-71.5) kg and 4 (0.6-4) years. The cadavers were positioned in lateral recumbency with the limb to be blocked lowermost. A high-frequency linear transducer (6-12 MHz) was used to localise the saphenous nerve on the medial aspect of the thigh, caudal to the proximal femoral region. In 22 pelvic limbs 0.1 mL kg^{-1} of methylene blue was injected around the saphenous nerve under ultrasound guidance, followed by gross anatomical dissection. The length of circumferentially stained nerve was measured. Success rate is presented with its 95% confidence interval (CI).

All 22 saphenous nerves were sonographically identified within the perivascular fat, cranial to the femoral artery, caudal to the rectus femoris and vastus medialis muscles, and ventral to the sartorius muscle. During anatomical dissection, the dye solution distribution was graded as complete in 17/22 limbs (95% CI [0.598, 0.948)], partial in 3/22 limbs and failed in 2/22 limbs (Portela *et al*. 2017).

As confirmed by anatomical gross dissection, the 77.3% (95% CI [0.598, 0.948)] success rate shows that an ultrasound-guided technique can be used to perform perineural injections of the saphenous nerve in goats. Further in-vivo studies are necessary to assess the clinical efficacy of the block.

References

Portela DA, Campoy L, Otero PE, Martin-Flores M, Gleed Robin D. (2017) Ultrasound-guided thoracic paravertebral injection in dogs: a cadaveric study. *Vet Anaesth Analg* 44, 636-645.

Porcine

Fentanyl increases locomotion, stiff gait, and repetitive behaviours in pigs

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Analgesic effects of fentanyl have been investigated using behaviour. Behavioural effects of fentanyl and possible serotonergic influence is less studied. We aimed at investigating behavioural effects of fentanyl, and the effect of a serotonin antagonist ketanserin, in pigs. Fifteen mixed breed pigs, weighing 17-25 kg were included in a randomised blinded prospective, balanced two-group study. Ten pigs received first 5 and then 10 µg kg^{-1} of fentanyl intravenously. Later ketanserin 1 mg kg^{-1} or saline was given intravenously as a third injection. While five control pigs received three injections of saline. Behaviour was video recorded. Distance moved was automatically measured by commercially available software, and behaviours manually scored in retrospect. Distance moved after fentanyl or saline injections was compared in a linear mixed model. Median and range for frequency and duration of distinct behavioural patterns were calculated. Alpha was set at 0.05.

Fentanyl inhibited resting and playing, and induced different repetitive behaviours. The mean (SD) distance moved in the control group and fentanyl group was 21.3 (13.0) and 57.8 (20.8) metres respectively ($p<<0.05$ for pairwise comparison). A stiff gait pattern was seen after fentanyl injection for median (range) 254 (165-305) seconds per 10 minutes, which was reduced to 0 (0-4) seconds after ketanserin administration.

Conclusion: Direct motor and behavioural effects induced by fentanyl can potentially interfere with post operative pain evaluation in pigs. There is a possible involvement of serotonin in fentanyl-induced psychomotor effects in pigs.

Serotonin antagonist ketanserin reverse fentanyl induced shivering in pigs

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Shivering in anaesthetised pigs is an acknowledged phenomenon and has been coupled to fentanyl (Ringer et al. 2016; Haga et al. 2021). The study aim was to elucidate the mechanism behind fentanyl induced shivering by administering ketanserin and naloxone. Twelve mixed breed pigs, weighing 22-31 kg were included in a randomised, balanced, blinded prospective, two group study. Isoflurane anaesthetised pigs were administered fentanyl at 7.5 µg kg^{-1} $hour^{-1}$ for 40 minutes intravenously, followed by injection of naloxone 0.1 mg kg^{-1} or ketanserin 1 mg kg^{-1} intravenously. The experiment was video recorded. An accelerometer attached to the neck recorded movement continuously. At baseline, at the end of the fentanyl infusion and two minutes after antagonist administration acceleration was quantified as an average rectified mean value over one minute. Using an alpha of 5 % the change in acceleration within groups between these time points were tested by Wilcoxon Signed-Rank tests.

Data are reported as median (interquartile range). At baseline acceleration was 0.128 (0.097-0.224) m/s^2 and increased significantly to 0.233 (0.111-0.538) m/s^2 after fentanyl infusion accompanied by visually evident shivering. Ketanserin significantly reduced acceleration to 0.132 (0.093-0.194) m/s^2, and abolished shivering. Naloxone gave a non-significant reduction of acceleration to 0.165 (0.127-0.359) m/s^2, and reduced shivering in four, while increased shivering in two pigs.

These results suggest that one mechanism for fentanyl induced shivering in pigs is dependent upon serotonin. This knowledge contributes to the general understanding of the motor effects of fentanyl and especially the problem of shivering in anaesthetised pigs.

References

Haga HA, Lervik A, Nordgreen J (2021) Inhibition and facilitation of nociceptive evoked muscular activity by fentanyl or dexmedetomidine in isoflurane-anaesthetized pigs. *Vet Anaesth Analg* 48, 230-238.

Ringer SK, Spielmann N, Weiss M et al. (2016) Fentanyl bolus induces muscle tremors in sevoflurane- anaesthetized piglets. *Lab Anim* 50, 312-314.

Behavioural and physiological effects of carbon dioxide inhalation in pigs

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Pre-slaughter stunning by carbon dioxide (CO_2) inhalation is controversial since it is aversive, and loss of consciousness is not immediate. Excitatory behaviours are commonly observed during the process. It is still unknown which behaviour indicates when loss of consciousness first appears.

Our study objective was to investigate loss of consciousness by linking physiological variables to behaviours observed during CO_2 inhalation.

Ten cross-bred pigs weighing 24-32kg were included in the study, and anaesthetized using sevoflurane before placing a tracheostomy tube, intravenous and arterial catheters. Two video cameras recorded behaviours of the pigs. An anaesthetic monitor was connected for recording of electrocardiography, spirometry, invasive blood pressure and multi-gas analyses. After recovery for at least 30 minutes, baseline arterial blood was sampled. Using a non-rebreathing anaesthetic circuit 90-95 % CO_2 in air was administered at a flow of 8 L minute^{-1}. Arterial blood was sampled consecutively and physiological variables from the anaesthetic monitor were automatically downloaded. Descriptive statistics in the form of range (min-max) were calculated.

The video recordings were analysed for behavioural traits and the behaviours were classified in an ethogram for objective assessment. We observed a repetitive trait in the behaviours exhibited, with vigorous general movement first occuring at 5-26 seconds, opisthotonos at 20- 43 seconds and agonal gasping at 31-73 seconds. At first occurrence of vigorous movements, opisthotonos and agonal gasping the physiological variables were respectively pH: 6.74-7.33, 6.66-6.96 and 6.65-6.87, PaCO2: 4.6-42.2, 24.4-51.4 and 29.1-47.6 kPa, CaO2: 5.3-14.6, 2.4-9.6 and 1.1-7.9 mL dL^{-1}, mean arterial pressure 88-158, 87-162 and 56-162 mmHg.

Based upon the highest pH and the lowest $PaCO_2$ values at onset of the behaviours, the pigs were likely unconscious at the start of opisthotonos and agonal gasping. However, the earlier observed vigorous movements were likely not associated with unconsciousness in all pigs.

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Evaluation of lingual oscillometric blood pressure measurement in anaesthetised pigs

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The agreement between lingual oscillometric and invasive blood pressure was evaluated in anaesthetised pigs as an alternative to limb or tail measurement sites. This abstract presents the preliminary results.

Seven pigs undergoing experimental procedures which required arterial cannula placement were recruited. A blood pressure cuff with width approximately 40% of the tongue circumference was used. Paired systolic (SAP), mean (MAP) and diastolic (DAP) arterial blood pressures were recorded oscillometrically (OBP) and invasively (IBP) every five minutes throughout procedures. The American College of Veterinary Internal Medicine (ACVIM) guidelines for validation of blood pressure measurement devices were used (Brown et al 2007). Mean bias, precision (standard deviation of mean bias) 95% limits of agreement (LOA), correlation coefficients and percentage of measurements within 10 and 20 mmHg of IBP were calculated. Agreement was examined using Bland-Altman analysis. Percentage of readings when oscillometric measuring failed were calculated.

Forty-nine, 54 and 50 paired measurements were obtained for SAP, MAP and DAP respectively. The mean bias, precision and LOA for SAP were 12.4 10.6 (-8.5 to 33.3), for MAP 6.5 6.9 (-7.0 to 20.0) and for DAP 8.1 10.1 (-11.8 to 28.0) mmHg. Correlation coefficients were less than 0.9 for all pressures. More than 50% of measurements were within 10 mmHg of IBP for MAP and DAP only. More than 80% of measurements were within 20 mmHg of IBP for all pressures.

These preliminary results showed this technique failed to satisfy the ACVIM guidelines when measuring SAP, MAP and DAP.

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References

S. Brown, C. Atkins, R. Bagley, A. Carr, L. Cowgill, M. Davidson, B. Egner, J. Elliott, R. Henik, M. Labato, M. Littman, D. Polzin, L. Ross, P. Snyder, and R. Stepien (2007) Guidelines for the Identification, Evaluation, and Management of Systemic Hypertension in Dogs and Cats. J Vet Intern Med 21, 542–558

Lapine

Bioavailability of subcutaneous fentanyl in rabbits

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Introduction Fentanyl is sometimes administrated subcutaneously (SC) in rabbits for premedication despite unknown bioavailability. Plasma concentrations ≥2.2 ng mL^{-1} have been reported to reduce the isoflurane minimum alveolar concentration (MAC) in rabbits (Barter et al. 2015). One aim of this study was to investigate if fentanyl at 15 µg kg^{-1} SC would result in MAC-reducing plasma concentrations.

Material and methods Six male New Zealand white rabbits (5-6 months old) were administered 15 µg kg^{-1} fentanyl SC and intravenously (IV) with a 14 day wash-out period, in an experimental, prospective, randomized cross-over study. Plasma was sampled at 2 (IV), 5, 10, 15, 30, 60, 90, 120 (IV), 300 (SC) and 390 (SC) minutes and analyzed by low molecular mass spectrometry. A person blinded to treatment scored sedation after 10 minutes on a scale from 0-3. Oxygen was supplemented if the oxygen saturation was <90%.

Results Intravenous administration produced recumbency in 5/6 rabbits and 2/6 rabbits required oxygen. The bioavailability for SC fentanyl was 58% and Tmax was 29 (range 15-68) minutes. Mean ± SD for Cmax and t1/2 after SC administration was 0.3 ± 0.2 ng mL^{-1} and 228 ± 166 minutes. The t1/2 for IV administration was 59 ± 17 min. Median sedation score was higher (p = <0.05, Wilcoxon) after IV (3) than SC administration (1).

Conclusion The maximum plasma concentration after SC administration of 15 µg kg^{-1} fentanyl did not reach previously reported isoflurane MAC-reducing concentrations.

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References

Barter LS, Hawkins MG, Pypendop BH (2015) Effects of fentanyl on isoflurane minimum alveolar concentration in New Zealand White rabbits (Oryctolagus cuniculus). *Am J Vet Res* 76, 111-115.

The effect of trazodone on alfaxalone induction dose in rabbits

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Trazodone reduces stress in many species, including rabbits. It has been shown to reduce anaesthetic induction doses in dogs (Walters et al 2022). This study therefore aimed to investigate whether the administration of oral trazodone would reduce the dose of alfaxalone required to place a supraglottic airway device (V-gel) and to evaluate physiological parameters. Eight intact four-months old female New Zealand White rabbits weighing 3.0 ± 0.2 kg were enrolled in this prospective, blinded, randomized cross-over study. The rabbits randomly received placebo or trazodone 20 or 30 mg kg^{-1} orally (TRAZ20, TRAZ30) with a 1-week wash-out period. Anaesthesia was induced using alfaxalone 5.0 mg $kg^{-1}minute^{-1}$ for the first minute followed by 2.5 mg kg^{-1} $minute^{-1}$ until V-gel placement was possible. Physiological parameters (temperature, HR, fR, direct blood pressure, SpO_2 and $ETCO_2$) were evaluated at baseline, before- and after induction, and 20 minutes following extubation. Dexmedetomidine 5 μg kg^{-1} was administered intravenously before recovery. Physiological parameters, alfaxalone requirement, and prevalence of complications were analysed using repeated measures ANOVA and chi-squared tests, respectively ($p < 0.05$). One rabbit did not ingest the treatment and was excluded.

Alfaxalone requirement was not significantly different in placebo and TRAZ20 and TRAZ30 groups (3.87, 3.72, 3.80 with a standard deviation of 1.08 mg kg^{-1}, respectively), nor were significant differences observed in physiological parameters and the prevalence of complications between treatment groups.

Preanesthetic administration of trazodone did not affect the alfaxalone induction dose nor physiological parameters in rabbits.

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References

Walters K, Gittel C, Brearley JC. The effect of preanaesthetic oral trazodone hydrochloride on the induction dose of propofol: a preliminary retrospective study. *Vet Anaesth Analg*. 2022 Sep;49(5):458-462. doi: 10.1016/j.vaa.2022.01.010. Epub 2022 May 7. PMID: 35715325.

Wild Animal

Case series evaluating the efficacy of alfaxalone 4% injection in pinnipeds

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Alfaxalone is a rapid-acting neurosteroid that produces anesthesia in a variety of domestic and exotic species. The use of alfaxalone in marine mammals is limited and restrictive due the large drug volume required for intramuscular injection.

A concentrated version of alfaxalone (40 mg mL^{-1}) was made available by the manufacturer (Jurox Pty Ltd [Zoetis]) and used for premedication prior to anesthesia induction with isoflurane and oxygen inf two New Zealand Fur Seals (Arctocephalus forsteri), two Californian sea lions (Zalophus californianus) and two Australian sea lions (neophoca cinerea) undergoing lensectomy surgery. Alfaxalone 4% (0.5-1 mg $kg^{-1)}$ was combined with midazolam (50 mg mL^{-1}; 0.25 mg kg^{-1}) and pethidine (50 mg mL^{-1}; 2.0 mg kg^{-1}) in the same syringe and administered intramuscularly. Additional supplemental alfaxalone and

midazolam were administered intramuscularly in one animal to achieve immobilization. Patient monitoring and anesthetic variables were monitored and documented for each animal including arterial blood pressure in three animals. Supplemental isoflurane in oxygen was administered via mask prior to intubation of all animals and general anesthesia was maintained on sevoflurane and oxygen.

Anesthetic induction time to intubation for the six animals was 5 to 45 minutes (range) (mean 27 minutes). Alfaxalone administered at 0.5 mg kg^{-1} intramuscularly resulted in delayed and variable onset of sedation in the first three animals; therefore, the alfaxalone dose was increased to 1 mg kg^{-1}. Physiological parameters were within normal limits for each animal except for hypotension (n=1) and bradycardia (n=1). Duration of anesthesia ranged from 234 to 301 minutes (mean time 287 minutes). Recovery times defined as time isoflurane off to extubation, standing and spontaneously breathing ranged from 25 to 61 minutes (mean 26 minutes). No injection pain or injection site reactions were observed in any animal.

Investigation of anesthesia methods in Paper Kite Butterflies (*Idea leuconoe)*

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Despite the commonality of invertebrates in research, zoological, and personal collections, anesthetic techniques remain poorly studied. This study assessed anesthetic techniques in paper kite butterflies (*Idea leuconoe*).

Thirty-six adult butterflies were individually placed in 1.9 L air-tight containers and randomly exposed to one of six treatments (n=6/group): 5% isoflurane via vaporizer (2 L minute^{-1}, FiO_2 1.0) [V], 0.5 mL [CB0.5] or 3.0 mL [CB3] liquid isoflurane via cotton ball (FiO_2 0.21), carbon dioxide via flowmeter (2 L minute^{-1}) [CO_2], cooling at 2.78°C [°C], or no treatment (control) [C]. Three (V, CB0.5, CB3, CO2) or 10 (°C) minutes following recumbency, butterflies were removed from exposure. Time at recumbency and upright and response to manipulation were recorded. Collected data were compared ($p < 0.05$).

Except in C, all butterflies achieved recumbency. Median (range) time to recumbency was 1.2 (0.5-3.7), 2.8 (1.6-4.6), 1.7 (0.9-2.9), 1.2 (0.8-2.2), and 1.3 (1.0-3.5) minutes in V, CB0.5, CB3, CO_2, and °C, respectively. One butterfly in V and CO_2 responded to manipulation at end- exposure. Median (range) time to upright was 9.2 (0.7-15.2), 13.8 (6.0-24.0), 14.9 (8.2-26.6), 1.3 (0.9-9.0), and 9.6 (3.6-30.0) minutes in V, CB0.5, CB3, CO_2, and °C, respectively ($p =$ 0.0189). All butterflies recovered.

This is the first evaluation of anesthesia techniques in butterflies.

Equipment

Comparative performance of veterinary low-flow, Penlon and Tec-5 Sevoflurane Vaporisers

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Vaporiser accuracy at low gas flows permits safe use of anaesthesia breathing systems with oxygen flow rates more appropriate for the size range of small animals commonly presenting to veterinary hospitals, reducing waste gas production, operational cost and environmental atmospheric emissions. International standards for vaporisers used in human medicine require a delivered concentration +/- 20% of the dial setting without back pressure, typically at gas flows from 0.5 to 5 L minute^{-1}. Small animals could use gas flows well below 0.5 L minute^{-1}. Accordingly purpose-built temperature and flow compensated sevoflurane (Sevo) vaporizers (S-Vap) designed to run at gas flows down to 0.2 L minute^{-1} were compared to standard Tec-5 and Penlon Sigma-Delta (S-Delta) vaporisers.

Five new S-Vap's were compared to 5 new S-Delta's and 3 "in-service" Tec-5's. All vaporisers were filled with Sevo and output tested over several days at oxygen flows of 3, 1 and 0.2 L minute^{-1} at room temperature and 1 L minute^{-1} at 34^{o}C at each dial setting from 0% to 8% using an Artema Ion infra-red calibrated gas analyser set to test for Sevo with side-stream sampling at 100 ml minute^{-1}. Vaporisers were tested twice at each flow, with 3 to 5 days between tests at that flow. Data were grouped by vaporizer type, flow rate and dial setting and mean and standard deviation (SD) calculated, with SD used to indicate output variability.

The SD of S-Vap at all flow rates and temperatures was between 0.02 - 0.28 (under 0.12 up to 6% settings) compared to S-Delta 0.06-0.76 and Tec-5 0.04-0.29 with both under 0.12 only at 0.6%; and 0.6%-2% settings respectively.

In conclusion S-Vap was accurate across the entire output range at all gas flows and temperatures and more precise compared to S-Delta and Tec-5; S-Vap can be reliably used at 0.2 L minute^{-1}.

Minimum Dead-Space Y-Piece facilitates circle system use in 1kg animals

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Circle breathing systems use fresh gas flows of 30 mL kg^{-1} $minute^{-1}$ or less, reduce animal heat loss, operational cost and environmental emissions of waste gas. One limitation for their use in very small animals is rebreathing of expired carbon dioxide (CO_2) due to larger machine dead space compared to non-rebreathing systems, mostly from the Y piece, elbows and mainstream end tidal (ET) CO_2 connectors.

A novel Y-piece (MDS-Y) was designed to reduce volume, therefore dead space and need for an additional elbow connector. It was compared to standard Y-pieces with either 22mm outer diameter (OD) (Adult-Y) or 15mm OD tubing connections (Pediatric-Y), with or without an additional elbow connector or mainstream $ETCO_2$ connector. Volume of Y-pieces, elbow and $ETCO_2$ connectors were measured using water displacement. Y-piece dead space was estimated as the common volume prior to Y-limb separation. Dead space was determined for Adult-Y (5mL), Pediatric-Y (3.4mL) MDS-Y (1.5mL), elbow connector (9.8mL) adult (7.5mL) and pediatric (1.2mL) $ETCO_2$ adapters. The combined dead space of set-up a) MDS-Y & pediatric $ETCO_2$ adapter = 2.7mL, compared to b) Pediatric-Y & elbow & pediatric $ETCO_2$ adapter = 14.4mL or c) to Adult-Y & elbow & adult $ETCO_2$ adapter = 22.3mL. Assuming anatomic and machine dead space should not exceed 50% of Tidal volume, and anatomic dead space is approximately 1/3 of Tidal volume, then machine dead space accounts for 17% of Tidal Volume, so a) could be used with 16mL breaths; b) with 85mL and c) with 130mL.

Conclusion: A novel Y-piece (MDS-Y) would facilitate circle breathing systems being used on animals down to 1kg.

Variability of Sevoflurane Vaporisers compared to Isoflurane Vaporisers

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Sevoflurane (Sevo) may have better environmental credentials than other inhalation agents, but lower vapor pressure, higher boiling point and higher concentration needed for anaesthesia mean vaporisers could require higher gas flows to achieve predictable output, reducing the environmental "advantage".

We compared the output of 2 groups of Sevo Vaporisers to 2 similar groups of Isoflurane (Iso) vaporisers. In each group were 8 agent specific Penlon Sigma-Delta (P-Delta) vaporisers and 8 veterinary specific low-flow vaporisers (V-Vap) designed to run down to 0.2L minute^{-1}. All vaporisers were filled with their specific agent and output tested over several days at oxygen flows of 3, 1 and 0.2L minute^{-1} at room temperature and 3L minute^{-1} at 34°C at each dial setting using an Artema Ion infra-red calibrated gas analyser set to test for the specific agent with side-stream sampling at 100mL minute^{-1}. Vaporisers were tested once at each flow. Data were grouped by agent, vaporiser type, flow rate and dial setting and mean and standard deviation (SD) calculated, with SD used to indicate output variability.

The SD of P-Delta Iso was between 0.11-0.46 at room temperature at 1 and 5L minute^{-1} flows and 0.1-0.55 at 34°C 5L minute^{-1} compared to V-Vap Iso 0.03-0.1 at 0.2, 1 & 3L minute^{-1} and 0.04-0.29 at 34°C 3L minute^{-1}.The SD of P-Delta Sevo was between 0.06-0.68 at room temperature at 1 and 5L minute^{-1} flows and 0.08-0.48 at 34°C 5L minute^{-1} compared to V-Vap Sevo 0.02-0.2 at 0.2, 1 and 3L minute^{-1} and 0.03-0.22 at 34°C 3L minute^{-1}.

In conclusion both Iso and Sevo V-Vap's were similarly accurate and precise across the entire output range at all gas flows and temperatures. Both Iso and Sevo P-Delta's were similarly more than twice as variable, worsening with increasing concentration. These results suggest each vaporiser type performed equally with Iso and Sevo, but the V-Vap's were more accurate, particularly at low gas flows.

Retrospective investigation on equine low flow anaesthesia: economics and environment

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Low flow anaesthesia (LFA), defined as 10 mL $kg^{-1}minute^{-1}$ of oxygen flow, has many environmental and economic benefits. In 2022, veterinarians administering general anesthesia (GA) in a single practice were trained to reduce oxygen flow from 10 L $minute^{-1}$ to 10 mL kg^{-1} $minute^{-1}$ after 15 minutes. This study aimed to retrospectively assess the impact of this training on oxygen and isoflurane consumption, CO2 equivalent emissions (CO2ee), and the cost of isoflurane and oxygen.

All GA records from May 2021 (prior to training) and May 2022 (following training) were included. All GAs were maintained with isoflurane vaporized in 100 % oxygen delivered with a large animal circuit and a 30 L bag in a bottle pressure-limited ventilator. For GAs from May 2021 and May 2022, the following were calculated: the median consumption of oxygen (mL kg^{-1} $minute^{-1}$), and the median consumption of isoflurane (mL) for a hypothetical horse under GA for 60 minutes (H500kg) (Biro, 2014). The cost (£) of isoflurane and oxygen consumption, and CO_2ee (t) for H500kg were also calculated (Pierce, 2014). Data from elective and emergency cases were compared.

Forty-four and 40 GAs were performed in May 2021 and May 2022 respectively. The majority of GAs were elective procedures (29 and 26in May 2021 and May 2022 respectively). Results are shown in Table 1.

Conclusion Training in LFA reduced the consumption in oxygen, isoflurane, the cost of GA and CO_2ee.

	May 2021		May 2022	
	Elective	Emergency	Elective	Emergency
Oxygen consumption (mL kg^{-1} $minute^{-1}$)	19.23 [16.48-21.98]	18.09 [13.36-22.82]	13.15 [11.47-14.82]	13.43 [11.49-15.37]
Isoflurane consumption (mL)	94.20 [60.56-127.84]	94.47 [61.41-127.53]	74.25 [51.70-96.80]	62.94 [31.15-94.73]
Cost of oxygen and isoflurane (£)	12.21	12.07	8.75	7.65
CO_2ee (t)	0.072	0.072	0.057	0.048

Table 1: Consumption of oxygen and isoflurane, cost of oxygen and isoflurane and CO_2ee(t) for H500kg, in May 2021 and May 2022 in elective and emergency cases. Data are expressed as median [range].

References

Pierce, J (2014) Calculator for inhalant anaesthetic agents http://www.sduhealth.org.uk/documents/publications/anaesthetic_gases_research_v1.pdf. Accessed November 2022.

Biro, P. (2014) Calculation of Volatile Anaesthetics Consumption from Agent Concentration and Fresh Gas Flow. *Acta Anaesthesiologica Scandinavica*, 58, 968-972.

Isoflurane air pollution during equine anaesthesia: problems to solutions

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Avoiding anesthesia pollutants in the operating room is essential for the health and safety of medical staff. Two ppm is defined as a limit for isoflurane concentration in air for human medicine in France, but there is no determined limit for anesthetic gas vapors in vet practice yet. Work is in progress with national and regional health authorities (CARSAT, CRAMIF) and isoflurane pollution measurements were organized during equine anesthesia.

Ambient sampling was performed by fixed sensors in the surgical room, induction and recovery boxes and mobile ones positioned on the anesthetist, nurses and surgeon, all at human respiratory tract level.

Six horses were anesthetized for routine surgeries: 5 arthroscopies, 1 foot exploration, mean duration 74.3 minutes, same anesthetist, 2 horses per day, 3 days. After IV induction (romifidine and ketamine), anesthesia was maintained with isoflurane in oxygen and air with either Alpha 400 or MK2 ventilator (Minerve). Two types of tracheal tubes, as well as 2 vaporizers, passive and active waste gas extractions were compared. Each clinical step was recorded to correlate results with special events with time.

Isoflurane concentration on people (n=21) ranged 0.3 - 3.9 and 0.5 - 1.7 ppm for the anesthetist and nurses respectively. Ambient measurements (n=34) recorded 0.31-2.5 and 2.6-8 ppm in the surgical room and recovery box respectively.

Evolution with time underlines risky periods: tracheal tube disconnection, recovery, ventilator cleaning, vaporizer refilling. MK2 machine, new tubes and active extraction allowed to decrease isoflurane pollution under 2 ppm. Education for good practices seems to be essential.

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Effect of resistance on dynamic compliance: comparison between two methods

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Dynamic compliance (Cdyn) can be evaluated by different methods, which can have various degrees of interference from resistance (R). This study compared two methods of evaluating Cdyn in conditions of normal or increased resistance using a test-lung.

The test-lung was ventilated at various levels of compliances (C – 10 to 50 mL cmH_2O^{-1}) in volume control with tidal volume (VT) of 300 mL, respiratory rate of 10 breaths $minute^{-1}$, and no positive end-expiratory pressure (PEEP). At each level of compliance, ventilation was maintained for 2 minutes and Cdyn was calculated by VT/(Ppeak – PEEP) (CdynPpeak), where Ppeak is peak airway pressure, and by 1/E (CdynMLR), where E is elastance estimated by multiple linear regression of the model $Paw = R\times\dot{V} + E\times V + P0$, where Paw is airway pressure, $\dot{V}$ is flow, V is volume and P0 is Paw at zero $\dot{V}$ and V. Each method of Cdyn

evaluation was compared between 5 and 40 $cmH_2O\ L^{-1}\ second^{-1}$ of resistance using Bland-Altman plots. Percentage biases were compared by t-test, and $p < 0.05$ was considered significant.

Sixty pairs of CdynPpeak and CdynMLR in each R were obtained. Mean percentage bias (limits of agreement) were 6.4 % (-6.4, 19.2) and -32.3 % (-50.9, -13.4) for CdynMLR and CdynPpeak, respectively. Percentage bias was higher for CdynPpeak than CdynMLR ($p < 0.0001$).

When choosing a method to evaluate Cdyn, CdynMLR seems to provide an assessment with less influence of resistance than CdynPpeak. Future studies are necessary to clarify the implications of these findings in live individuals.

Acknowledgements This study was supported by the Centre of Companion Animal Health of the University of California Davis.

Fabrication of A Low-cost 3D-printed Video Laryngoscope with Borescope

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The goal of the study is to model a low-cost three-dimensional (3D) printed veterinary use video laryngoscope (VL_{VET}) with a commercial borescope and evaluate the VL_{VET} in Beagle dogs.

The VL_{VET} consisted of a Miller-type laryngoscope and a detachable camera holder that could be attached to various locations along the blade and was printed using a black polylactic acid filament through a 3D printer. Each dog was anesthetized using intravenous medetomidine (15 μg kg^{-1}) and alfaxalone (1.5 mg kg^{-1}) in sternal recumbency. The camera was located 2, 4, 6, 8 and 10 cm from the blade tip positioned on the larynx ($distance_{LARYNX-CAM}$ treatment), and the scores of laryngeal visualization and intubation were evaluated on screen and by the naked eye simultaneously. Only at 10 cm $distance_{LARYNX-CAM}$, laryngeal visualization was scored at 10, 8, 6, 4 and 2 cm inter-incisor distances ($distance_{INTER-INCISOR}$ treatment). The scores were analyzed using a Kruskal–Wallis test.

Six Beagles (11.6 ± 1.1 kg and 3.0 ± 1.0 years) were enrolled, and their maximum inter-incisor distance and the length of the oral cavity were 10.2 ± 0.5 and 12.1 ± 0.7 cm, respectively. The $distance_{LARYNX-CAM}$ could be adjusted within 5–10 seconds; then the VL_{VET} could be reused immediately without further reinforcement. At all $distance_{LARYNX-CAM}$, whole glottis and intubation were observed on screen and by the naked eye, except for naked eye view at 2 cm $distance_{LARYNX-CAM}$ (all $p < 0.005$). On both views, the visualization scores were higher at ≥ 6 cm $distance_{INTER-INCISOR}$ than 2 cm $distance_{INTER-INCISOR}$ (all $p < 0.005$), and glottis was observed at ≥ 4 cm $distance_{INTER-INCISOR}$ except for one laryngoscopy on naked eye view.

During laryngoscopy and intubation, VL_{VET} enabled both video and direct laryngoscope to be used simultaneously, at various $distance_{LARYNX-CAM}$ in Beagles with ≥ 6 cm $distance_{INTER-INCISOR}$.

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In-silico study of endotracheal tubes and supraglottic devices in cats

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Airway management in cats is commonly performed with endotracheal tubes (ETTs) or supraglottic airway devices (SGADs) (van Oostrom et al 2013, Hecker-Turkovic et al 2022). The aim of this study was to evaluate and compare upper airway resistances in cats with ETT or SGAD using computational fluid dynamics (CFD).

Retrospectively, computed tomography (CT) scans of the head, neck and thorax of twenty client owned cats were included in this study. Ten cats were intubated with an ETT and ten with a SGAD. A three-dimensional geometry of the airways and devices was reconstructed. Each model was discretized with tetrahedral elements obtaining a computational mesh from which *in silico* simulations were performed. Two inspiratory flows (2.4 and 4 L minute^{-1}) were imposed to the models. Velocity (m/s) and pressure (cmH_2O) parameters were measured so that general and regional resistances (cmH_2O L^{-1} minute^{-1}) were calculated (see Table 1). A Mann- Whitney U-test for independent samples was used to compare the medians

of the resistances between the two devices and flows. Values of $p < 0.05$ were considered statistically significant.

No significant differences were observed between SGADs or ETTS in general resistances at either flow rate (p = 1.000; p = 0.912). As visible in Table 1, regional resistances (B) in the glottis area were significantly higher compared to the ETT bevel in the trachea at both flows (p = 0.01; p <0.001).

With CFD it was possible to non-invasively evaluate the pressure drop and flow changes within the feline airways localizing areas of increased resistances based on CT images.

Flow	2.4 L minute^{-1}		4 L minute $^{-1}$	
Resistance (cmH_2O L^{-1} minute^{-1})	ETT	SGAD	ETT	SGAD
General	0.46 (0.16-0.91)	0.29 (0.08-4.30)	0.23 (0.08-1.22)	0.31 (0.08-2.89)
Region A	0.08 (0.03-0.19)	0.01(0.01-0.34)	0.13 (0.05-0.32)	0.01 (0.01-0.04)
Region B	0.01 (0.01-0.04)	0.14 (0.01-1.45)	0.02 (0.00-0.06)	0.15 (0.01-1.37)

Table 1 General and regional* resistances expressed in median (range) at 2.4 and 4 L minute^{-1} inspiration flows.

ETT: Endotracheal Tube; SGAD: supraglottic airway device. *Region A: ETT or SGAD connexion with the breathing system; Region B: 2 cm cranial and caudal to the glottis in the SGAD and 1 cm cranial and caudal to the ETT bevel.

References:

van Oostrom H, Krauss MW, Sap R. A comparison between the v-gel supraglottic airway device and the cuffed endotracheal tube for airway management in spontaneously breathing cats during isoflurane anaesthesia. *Vet Anaesth Analg*. 2013 May;40(3):265-71. doi: 10.1111/vaa.12015. Epub 2013 Feb 19. PMID: 23421440.

Hecker-Turkovic K, Hartmann K, Dörfelt R. Success of placement and complications during v-gel placement and maintenance of anaesthesia. *J Feline Med Surg*. 2022 Aug;24(8):800-805. doi: 10.1177/1098612X211050612. Epub 2021 Oct 19. PMID: 34663126; PMCID: PMC9315189

Miscellaneous

Student interest in veterinary anesthesiology

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Veterinary anesthesiology often has fewer qualified applicants than residency positions available, suggesting a possible lack of interest in the specialty. The purpose of this study was to identify the perceptions students have of the discipline of anesthesiology.

In this cross-sectional, multi-institutional study, an online survey was sent to students from nine universities in the United States and Canada following IRB approval. Participation was voluntary and anonymous. The survey was available between April 6th and July 16th, 2021 and conformed to CHERRIES guidelines. The survey instrument was reviewed by eight anesthesiologists and pilot tested with six veterinary students.

Respondents included 228 students who were not interested in specializing and the survey concluded for them. There were 303 who were interested in specializing on which the data is based. Twenty-six surveys were incomplete. Most students were satisfied with their anesthesia education (66%) and clinical rotation (72%). Only half (49%) found their anesthesia course enjoyable. Most respondents (98%) believed that anesthesia was very or extremely important for their career. Fourteen students interested in specializing in anesthesia indicated that interest in physiology and working with a variety of species was important. Limited career options, lack of patient follow-through, no client interaction, stressful/intimidating, boring, math, and pharmacology were aspects that made students less interested in specializing in anesthesia.

While students acknowledge the importance of anesthesia for their career, many did not find their course enjoyable. Some of their reasons given for not pursuing anesthesia may reflect a gap between perception and reality.

Specialist contribution to general practice anaesthesia: a European campaign

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Anaesthesia is fundamental to animal health and welfare. Specialist anaesthesia should improve skills in veterinary anaesthesia (ECVAA 2013) but may appear detached from the reality of routine general practice. We describe an approach to address this discrepancy. The Federation of European Companion Animal Veterinary Associations (FECAVA) "Basic Practices in Anaesthesia and Analgesia" initiative for education and knowledge transfer was developed. Two veterinary anaesthesia specialists (PS/PT) developed a knowledge transfer campaign in collaboration with FECAVA and supported by the industry. The campaign was announced in October 2020 via press release, social media and the FECAVA website. The main objective was to improve basic standards in small animal anaesthesia and analgesia using simple, practical, cost-effective fundamental measures to reduce anaesthetic-induced morbidity and mortality.

A series of six ready-to-use, open-access (FECAVA 2022) printable posters suitable for lamination and use in clinical practice was prepared. Each poster was supported by a short "user's guidance note" and has been translated in up to 13 languages. Topics for each poster were published over two years and covered preparation for anaesthesia, pain assessment/management, basic local anaesthetic blocks, monitoring, minimising complications and case based examples of anaesthetic protocols. The campaign culminated with presentations at a FECAVA Special Symposium in Prague, Czech Republic in June 2022. Further lectures in Eastern Europe are planned. The website page is visited regularly and has received 5743 visits since October 2020. The final product has been used for teaching students at City University of Hong Kong and is endorsed by the World Small Animal Veterinary Association- Global Pain Council guidelines.

This campaign was developed through collaboration between veterinary specialists, FECAVA and the industry. Thousands of general practitioners have expressed interest. The impact on anaesthetic morbidity and mortality in small animal practice has yet to be assessed.

References

ECVAA Constitution (2013) https://www.ecvaa.org/regulations

FECAVA 2022 https://www.fecava.org/policies-actions/fecava-basic-practices-in-anesthesia-and-analgesia/

Poster presentations

Canine

Retrospective study of trazodone administration in dogs undergoing interventional cardiology

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Trazodone decreases propofol induction dose and has MAC-sparing effect in dogs (Hoffman et al 2018, Walters et al 2022). Trazodone has not been evaluated in dogs with cardiovascular disease.

Anaesthetic records of dogs undergoing interventional cardiac procedures from June 2020 to November 2022 were reviewed. Dogs were divided into two groups, premedicated with trazodone (TRAZODONE) or not (CONTROL). Data collected included demographic information, type of procedure, degree of sedation (0 alert, 1 light, 2 moderate, 3 deep), induction agent and dose (mg kg^{-1}) needed for endotracheal intubation, and use of co-induction drugs (lidocaine, midazolam and/or fentanyl). Cardiovascular variables (heart rate and arterial blood pressure) were analysed at three time points: before and after premedication, and after the anaesthetic induction. Any adverse event was recorded. Statistical software (SPSS v.28) was used for data analysis. Kolmogorov-Smirnov was used to test for normality, and Mann- Whitney U test for independent variables for group comparison.

Data from forty-eight anaesthetic records were analysed. TRAZADONE group were all premedicated with an opioid (n=28) and included 15 dogs undergoing PDA and 13 balloon valvuloplasty. CONTROL group (n=20) received an opioid alone (18/20) or combined with acepromazine (2/20) and included 7 dogs undergoing PDA, 11 balloon valvuloplasty, one sick sinus syndrome and one heartworm removal. No differences were observed in sedation score between groups [2 (0-3)]. No adverse events were reported with trazodone administration. Dose of induction agents (alfaxalone, propofol or etomidate) did not vary between groups. Heart rate and systolic arterial pressure post sedation were significantly lower in the CONTROL group (p=0.036 and p=0.034 respectively).

The administration of trazodone did not decrease the induction dose of any agent, probably due to administration of multiple co-induction drugs. A prospective randomized study with standardised anaesthetic protocol, differentiation between pathologies and procedures is needed for further conclusions.

References

Walters K, Gittel C, Brearley JC. (2022) The effect of preanaesthetic oral trazodone hydrochloride on the induction dose of propofol: a preliminary retrospective study. *Vet Anaesth Analg* 49, 458-462.

Hoffman EA, Aarnes TK, Pereira CHR, et al. (2018) Effect of oral trazodone on the minimum alveolar concentration of isoflurane in dogs. *Vet Anaesth Analg* 45, 754-759.

Canine & Feline

Inter-observer agreement classifying the death cause in anaesthetised small animals

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Understanding the cause of death in studies assessing mortality in small animal anaesthesia is challenging. Information is scarce and different evaluators might have different points of views based on the same information. The aim of this study is to establish the inter-observer agreement classifying the cause of death in anaesthetised animals.

The study included 432 deaths, 83 cats and 349 dogs. Three experienced veterinary anaesthesiologists assessed individually, based just on their professional experience, whether the death was related to anaesthesia or not. The information was retrieved from questionnaires and included the signalment, reason for anaesthesia, ASA status, drugs, anaesthetic procedures, and the comments written by the veterinarian who submitted the case.

Light's Kappa was used to measure interrater agreement between the three evaluators, meanwhile Kappa's Cohen was used to measure interrater reliability between two raters. The evaluators A, B and C described 302/432 (69.9%), 268/432 (62.0%) and 54/432 (12.5%) of the cases as anaesthesia-related deaths, respectively. Agreement among the three evaluators was 128/432 (29.6%) [Fleiss' Kappa: 0.17, p-value = 0.00026]; 50/128 cases for anaesthesia and 78/128 for surgery. Agreement between two evaluators were 310/432 (71.7%). Agreement between raters A and B was 36.0% [Kappa's Cohen: 0.25, $p < 0.00001$], between A and C, 12.8% [Kappa's Cohen: 0.10, $p < 0.00001$] and between B and C, 21.4% [Kappa's Cohen: 0.16, $p < 0.00001$].

Based on our results, the strength of agreement performed by the evaluators is slight. An objective tool would be needed to find a more consensual agreement.

Feline

Food intake is decreased in painful kittens after ovariohysterectomy

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This study compared food intake in kittens undergoing ovariohysterectomy using an opioid-free anesthetic protocol with or without multimodal analgesia.

In a prospective, randomized, blinded, clinical trial, twenty-nine healthy kittens between 10 and 24 weeks old (1.55 ± 0.46 kg) were included. Anesthesia was performed with intramuscular dexmedetomidine-ketamine-midazolam. In the multimodal group [MMG], cats (n = 14) received subcutaneous meloxicam and intraperitoneal bupivacaine, whereas the same volume of saline was administered in the control group [CG] (n = 15). Postoperative pain was assessed up to 24 hours using the UNESP-Botucatu multidimensional feline pain scale – short form. Rescue analgesia was administered when pain scores ≥4/12. Soft food was offered before surgery (T0), and at 1 (T1), 8 (T8) and 24 hours (T24) postoperatively (% intake calculated after 2 and 60 minutes). Statistical analyses were performed with linear models and Benjamini-Hochberg corrections ($p < 0.05$).

The prevalence of rescue analgesia was significantly higher in CG (n = 15/15) than MMG (n= 1/14). Food intake (%) was significantly higher in MMG than CG for 2 minutes (15.2 ± 13.4 and 4.2 ± 5.3, respectively), and 60 minutes (58.9 ± 30.0 and 29.9 ± 22.9, respectively), with all time points considered. In CG, food intake was significantly lower at T1 than T0 after 2 minutes (1.4 ± 2.3 and 7.0 ± 6.0, respectively). In MMG, intake after 60 minutes was significantly higher at T1 (71.9 ± 29.3), T8 (67.6 ± 30.9) and T24 (61.0 ± 27.7) than T0 (39.6 ± 20.7). Food intake after 2 and 60 minutes was significantly higher at T1 in MMG (10.4 ± 9.1 and 71.9 ± 29.3, respectively) than CG (1.4 ± 2.3 and 13.9 ± 7.5, respectively).

Food intake was decreased in painful kittens after ovariohysterectomy and increased when opioid-free multimodal analgesia was used.

The Feline Grimace Scale© website as a knowledge dissemination tool

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The Feline Grimace Scale© (FGS) is a tool for acute pain assessment in cats based on changes in facial expressions. This abstract describes the development of the FGS website as a tool for knowledge sharing and dissemination about feline pain assessment.

The authors obtained the domain www.felinegrimacescale.com in 2017 during the development and validation of the FGS. After the publication (Evangelista et al. 2019), two veterinarians (BPM and PVS) and a web designer developed the website content and design for desktop and mobile device using the platform WIX. An individual was hired to produce the "Practice your Skills" content and several volunteers were involved in the website translation (10 languages). A two-minute YouTube video for cat caregivers was developed by a private company. Infographics were produced for download. Information regarding the work performed at the Steagall laboratory were added including links to media and scientific publications, videos and FGS training manual. A "Frequently Asked Questions" section was developed for cat caregivers and veterinarians. A FGS Facebook and Instagram page disseminated website updates.

With the support of internal and industry grants, the website was launched on July 2020 and advertised via several social media platforms. According to Google Analytics, 115,553 users accessed the website by November 15th, 2022: 71,038 via mobile device; 39,926 via desktop and 4,528 via tablet with a total of 147,823 sessions and 214,403 page views. Top users by country were: United States (34,026), Canada (20,884), United Kingdom (6,184), Germany (5,677), Brazil (5,138) and Spain (3,987). Most visits (13,344) occurred in January 2022 after the launch of the FGS mobile phone application. The 30-day active user trend (average) is 5,513. The YouTube video had 19,763 views.

The FGS website has been an important tool for knowledge dissemination on acute pain assessment in cats.

Acknowledgments The FGS website was possible due to an unrestricted grant by Zoetis and an internal grant by the Université de Montréal for knowledge mobilisation.

References

Evangelista, M.C., Watanabe, R., Leung, V.S.Y. et al. Facial expressions of pain in cats: the development and validation of a Feline Grimace Scale. *Sci Rep* 9, 19128 (2019).

Implementation of a German Feline Glasgow Composite Measure Pain Scale

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The aim of the study was to evaluate the agreement between veterinary professionals (VPs) of different specialities and training levels during introduction of a German version of the feline Glasgow Composite Measure Pain Scale (f-GCMPS).

In a randomised, clinical trial 10 healthy and 45 diseased cats were scored by 15 VPs unaware of the cats' medical history. A specialist, a resident, an intern and a nurse from the department of anaesthesia, surgery, internal medicine and neurology participated. Examiners were not trained before data collection. Deviating from the normal process of pain scoring, cats were scored in groups of 3-5 persons to reduce stress to the cat. To gain a reference value a trained main investigator (AC) scored with each group. Intra- and inter-rater reliability were tested using intraclass correlation (ICC). Alpha was set at 5%.

Overall, including all participants inter-rater reliability was moderate (ICC-VP: 0.59) and intra- rater reliability was good (ICC-AC: 0.88).

All healthy cats were classified as “non-painful” (VP: 0.77 ± 0.67, AC: 1.09 ± 0.83). Pain scores assigned to cats with a medical disease (VP: 3.06 ± 2.33, AC: 3.52 ± 2.34) did not differ significantly from that for cats with surgical problems (VP: 3.78 ± 2.38, AC: 4.02 ± 2.72).

The German version of the f-GCMPS showed good applicability and moderate interrater reliability. Results were not altered by specialty or level of experience of the investigators. Patients with surgical and medical disease were reliably evaluated.

Equine

Remifentanil constant rate infusion combined with sevoflurane- medetomidine anesthesia in horses

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Introduction: The aim of this study was to evaluate the clinical effects and pharmacokinetics of remifentanil constant rate infusion (CRI) combined with sevoflurane and medetomidine CRI in horses.

Materials and methods: Eighteen Thoroughbred horses undergoing internal fixation were premedicated with intravenous (IV) medetomidine (5.0 - 7.0 μg kg^{-1}) and midazolam (0.02 mg kg^{-1}) and induced with IV ketamine (1.0 mg kg^{-1}) and propofol (1.0 mg kg^{-1}). Anesthesia was maintained with sevoflurane and constant rate infusion (CRI) of medetomidine (3.0 μg

kg^{-1} $hour^{-1}$) (SM) (group C: n = 9), SM in combination with remifentanil CRI (3.0 μg kg^{-1} $hour^{1}$) (group R3: n = 5) or SM in combination with remifentanil CRI (6.0 μg kg^{-1} $hour^{-1}$) (group R6: n = 4). End-tidal sevoflurane concentration (ETSEVO) was adjusted to 2.8 ± 0.2% within 15 minutes after induction, followed by remifentanil CRI. Plasma remifentanil concentration was measured by LC/MS/MS and pharmacokinetic parameters were analyzed using the one- compartment model. Tukey's test was employed to compare between the three groups.

Results: ETSEVO required for keeping sufficient anesthetic depth was significantly lower in group R6 (2.5 ± 0.2%) than in group C (2.8 ± 0.1%) and R3 (2.9 ± 0.1%). There was a moderate correlation between the reduction rate of ETSEVO and plasma remifentanil concentration (r = 0.75). No significant differences were found in heart rate, mean arterial blood pressure, dobutamine infusion rate or recovery quality between the three groups. Recovery time was significantly shorter in group R6 (35 ± 15 minutes) than in group C (57 ± 10 minutes). The elimination half-life of remifentanil was 0.23 ± 0.05 hour.

Conclusion: Remifentanil CRI at 6.0 μg kg^{-1} $hour^{-1}$ reduces the sevoflurane requirement and provides good recovery.

Hydroxyethyl-starch (130/0.4/9 and 70/0.55/4) infusion in standing and anesthetized horses

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Introduction: The aim of this study was to compare the pharmacokinetic and hemodynamic parameters of hydroxyethyl-starch (HES) 130/0.4/9 and 70/0.55/4 infusion in standing and anesthetized horses.

Materials and methods: Experiment (Expt)-1: Six Thoroughbred horses received HES130/0.4/9 (HES130; 10 mg kg^{-1}), HES70/0.55/4 (HES70; 10 mg kg^{-1}) or lactated Ringer's solution (LRS; 10 mg kg^{-1} as control) randomly three times at one-week intervals. Blood samples were collected during the 48 hours after infusion to measure hematocrit (Ht) and total protein (TP) . Blood HES concentrations were determined by hydrolysis of HES in each sample to glucose, and pharmacokinetic parameters were analyzed. Expt-2: Six Thoroughbred horses randomly received HES130 (10 mg kg^{-1}), HES70 (10 mg kg^{-1}) or saline (10 mg kg^{-1} as control) over 30 minutes under sevoflurane anesthesia (end-tidal concentration at 2.8 ± 0.1%). Blood samples were collected as in Expt-1. Hemodynamic parameters were measured during two hours of anesthesia. Tukey's test and the Wilcoxon signed-rank test were applied to compare between the drugs ($p < 0.05$).

Results: Expt-1: Ht and TP were significantly lower for HES130 (32.9±3.6 % and 5.7±0.4 g/dL) and HES70 (33.5±2.5 % and 5.4±0.3 g/dL) than for control (38.1±2.9 % and 6.3±0.5 g/dL) at one hour after infusion. The elimination half-life of HES130 (21±3 minutes) was significantly shorter than that of HES70 (39±11minutes) ($p = 0.01$). Expt-2: As in Expt-1, mean Ht and TP during anesthesia were significantly lower for HES130 (23.7±0.4 % and 4.6±0.0 g/dL) and HES70 (25.3±0.3 % and 4.7±0.0 g/dL) than for control (28.2±0.2 % and 5.1±0.0 g/dL). There were no significant differences in arterial blood pressure between the three drugs.

Conclusion: HES130 has similar hemodynamic effects to HES70 in both standing and anesthetized horses, but the elimination half-life was shorter than HES70.

Total intravenous anesthesia with or without remifentanil in horses

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Introduction: The aim of this study was to evaluate the clinical efficacy of total intravenous anesthesia (TIVA) with propofol-ketamine-xylazine combined with or without remifentanil in horses.

Materials and methods: Twenty-four Thoroughbred horses undergoing castration were premedicated with intravenous (IV) xylazine (0.8 - 1.4 mg kg^{-1}) and midazolam (0.02 mg kg^{-1}), and induced with IV ketamine (1.5 - 2.3 mg kg^{-1}) and propofol (1.0 mg kg^{-1}). Surgical anesthesia was maintained at a constant infusion of propofol (3.0 mg kg^{-1} $hour^{-1}$)-ketamine (3.0 mg kg^{-1} $hour^{-1}$)-xylazine (1.0 mg kg^{-1} $hour^{-1}$) (PKX) (group C: n = 8), PKX plus remifentanil (3.0 μg kg^{-1} $hour^{-1}$) (group R3: n = 8) or PKX plus remifentanil (6.0 μg kg^{-1} $hour^{-1}$) (group R6: n = 8).

Results: No limb movements were observed during anesthesia in any cases, but traction of the cremaster muscles was observed in five, two and two horses in group C, R3 and R6, respectively, and one horse in group C needed a double infusion rate of PKX to continue the surgical procedure. Adverse effects of remifentanil (trembling of nose tip or tongue) were observed in one and three horses in group R3 and R6, respectively, but disappeared soon after ceasing remifentanil infusion. Cardiovascular parameters were well maintained in all groups. Controlled ventilation was applied to three, four and five horses in group C, R3 and R6, respectively. Recovery scores in group C were excellent in four, good in three and fair in one horse, while all horses in group R3 and R6 were judged excellent.

Conclusion: TIVA with PKX combined with remifentanil (3.0 μg kg^{-1} $hour^{-1}$) could provide sufficient anesthetic depth with fewer adverse effects than that remifentanil (6.0 μg kg^{-1} $hour^{1}$).

Anaesthesia in a pony during balloon valvuloplasty of pulmonary stenosis

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A 266 kg, 19 months old female pony was presented with a left pansystolic 5/6 and right pansystolic 4/6 murmur. Echocardiography revealed valvular and supravalvular pulmonary valve stenosis, with dilatation of the right ventricle and pulmonary artery. Literature about anaesthesia for this procedure in horses is limited to a case report in a neonatal foal (Junge et al 2021).

Balloon valvuloplasty, by three simultaneously inflated balloons, was scheduled as treatment. Premedication consisted of acepromazine 20 µg kg^{-1} IM 90 minutes before romifidine 80 µg kg^{-1}, butorphanol 10 µg kg^{-1} IV, flunixin meglumine 1.1 mg kg^{-1}, penicillin 20 000 IU kg^{-1} and gentamicin 6.6 mg kg^{-1} IV. Anaesthesia was induced with ketamine 2.2 mg kg^{-1} and midazolam 0.06 mg kg^{-1} IV and maintained with isoflurane and lidocaine 2 mg kg^{-1} $hour^{-1}$ IV. Dobutamine was administered as required. If nystagmus was observed, ketamine 100 mg IV was given. Mechanical ventilation was needed to maintain normocapnia. Heparin 60 IU kg^{-1} IV was given after anaesthesia induction and repeated every 2 hours at 30 IU kg^{-1} IV depending on activated clotting time. During the distension of the three balloons right ventricular pacing at 200 per minute was performed to reduce output. Romifidine 10 µg kg^{-1} IV and phenylephrine intranasally were given for the recovery. Total anaesthesia time was 385 minutes and recovery time was 63 minutes. Anaesthesia and recovery were uneventful. The pony was discharged 15 days after the procedure.

In the current pony, an anaesthetic protocol routinely used for orthopaedic and soft tissue surgery appeared suitable for balloon valvuloplasty.

References

Junge HK, Glaus T, Matos JN et al. Balloon valvuloplasty of valvular pulmonary stenosis in a neonatal foal. *J Vet Cardiol* (2021) 36, 48-54.

Prospective comparison of desflurane with isoflurane in equine clinical anaesthesia

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Serious injury during recovery from equine anaesthesia is a recognised hazard. Smooth, rapid recovery should reduce the risk. Desflurane has potential for shorter and smoother recovery than isoflurane. These agents were compared under clinical conditions.One hundred horses undergoing elective surgery were recruited into a prospective clinical trial. Premedication and induction of anaesthesia followed a standard acepromazine/ romifidine/morphine/ketamine/midazolam protocol. Horses were randomly assigned to receive isoflurane (I) or desflurane (D) for maintenance of anaesthesia with end tidal (ET) isoflurane (1.2–1.5%) or desflurane (7-8%). Horses were ventilated to normocapnia and received haemodynamic support (dobutamine to maintain mean arterial blood pressure [MAP] > 60 mmHg). Recovery was timed and video-recorded for offline evaluation (quality score 0-5 and number of standing attempts) by two “blinded” experienced clinicians. Romifidine 20 μg kg^{-1} was given intravenously when the horse reached the recovery box. Appropriate parametric or nonparametric statistical analyses were used.

There was no significant difference between groups in characteristics (age 8±4 years, weight 545±80 kg), cardiopulmonary variables (HR 35 [22-56] $minutes^{-1}$, MAP 63 [54-82] mmHg, $ETCO_2$ 40 [32-60] mmHg or haemodynamic support required nor in quality of recovery. Recovery time to standing was significantly shorter after D (30 [10-67]) than I (41 [27-74] minutes and D horses made fewer attempts to stand (2 [1-9]) than I (4 [1-12]).

Required haemodynamic support during anaesthesia and overall recovery quality were similar with desflurane and isoflurane. However D horses required fewer attempts to stand in the shorter recovery time suggesting that this anaesthetic may lead to fewer recovery injuries.

Dexmedetomidine increases equine jejunal longitudinal contractility independent of enteric nerves

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Alpha2-agonists are known to inhibit gastrointestinal motility, but they are frequently used in context with equine colic. The aim of this study was to determine the effect of dexmedetomidine (DEX) on small intestinal contractility in vitro after ischaemia and reperfusion (IR).

Experimental segmental jejunal ischaemia was induced in 12 horses (15.9 ± 7.4 years) under general anaesthesia (5 µg kg^{-1} DEX; 0.05 mg kg^{-1} diazepam; 2.2 mg kg^{-1} ketamine; isoflurane in 100% oxygen plus DEX 5 µg kg^{-1} h^{-1}). Intestinal samples were taken pre-ischaemia, 2 hours following ischaemia and 2 hours following reperfusion. Spontaneous and electrically evoked contractile activity of the circular smooth muscles (CSM) and longitudinal smooth muscles (LSM) was determined with and without the addition of DEX (1 µM). Tetrodotoxin (TTX; 1 µM) was used to block fast neuronal voltage gated sodium channels. Paired t-test and ANOVA for repeated measures were used for statistical analysis (*p-value < 0.05).

Contractility of CSM was not affected by IR, whereas in LSM both spontaneous and evoked contractile activity increased after IR. Pre-ischaemia, DEX increased evoked contractile activity in LSM (amplitude 54.2 ± 13.3 mN vs 67.1 ± 18.1 mN*), but not in CSM (177 ± 55 mN vs 168 ± 55 mN). After IR, the addition of DEX caused an increase in spontaneous contractile activity of LSM, which was not affected by TTX.

Equine intestinal longitudinal smooth muscle contractility is increased by DEX independent of the enteric nervous system. This effect was still present after ischaemia-reperfusion injury.

Ruminant

Reliability of a new scale for pain assessment in cattle

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This clinical study evaluated the intra- and inter-reliability of a new instrument for perioperative pain assessment in cattle.

Thirty-six animals were used. The Pain Group (n = 26) included patients undergoing a variety of orthopaedic or soft tissue surgeries using different anaesthetic protocols. Animals were video recorded pre- and post-operatively at four time-points and received rescue analgesia with butorphanol. The Control Group (n = 10) included healthy blood donors that were video recorded at two time-points. A total of 118 videos (duration of 6 minutes each) were randomized and analysed using the new tool, after content validity, by four evaluators, unaware of groups, time-points, and procedures, in two phases, with a five-week interval. Statistical analysis was performed using the intra-class correlation coefficient for the full scale a total of 9 items and 27 sub-items) and Cohen's kappa coefficient for the items.

The intra-reliability of the full scale was 0.83, 0.94, 0.91, and 0.89 for evaluator 1, 2, 3 and 4, respectively. For items, it varied from 0.97 to 0.51 with most of them > 0.65. The inter-reliability for evaluator 1 versus 2, 3, and 4, was 0.70, 0.75 and 0.73; for evaluator 2 versus 3 and 4, was 0.73 and 0.65, respectively; for evaluator 3 versus 4, it was 0.80. For items it varied from 0.94 to 0.22.

The new instrument showed very good intra- and good inter-reliability. The instrument will now undergo refinement, criterion and construct validity, and responsiveness testing before it can be used for clinical pain assessment.

Porcine

Dexmedetomidine microcirculatory effects in a piglet model of septic shock

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Dexmedetomidine has been used for sedation of septic patients with a potential beneficial effect on the outcome (Pandharipande et al., 2010). However, its effect on microcirculation remains to be elucidated.

Seventeen piglets were anesthetized and assigned to three groups: “Sepsis-Dex” (n=6) received dexmedetomidine in association with bacterial infusion, “Sepsis” (n=6) received bacterial infusion with saline and “Dex” (n=5) received dexmedetomidine infusion only.

Haemodynamic parameters, oxygen delivery (DO_2), oxygen consumption and lactate were recorded over eight 30-minutes periods. Videomicroscopy was used on ileal mucosa and sublingual areas to estimate mean flow index (MFI), heterogeneity index (HI), ratio of perfused villi (PV) for the gut area, and MFI, HI, proportion of perfused vessels (PPV), perfused vessel density (PVD) and De Backer Score (DBS). Resuscitation maneuvers were performed following a defined algorithm. Repeated-measures ANOVA was used to detect differences in measured parameters between treatment groups and over time by use of a mixed-model procedure, a p-value of 0.05 was considered as significant.

Both septic groups presented a significant decrease in CI during bacterial infusion but piglets of group Sepsis-Dex maintained higher SVR (+10 %, p=0.03). No significant inter-group difference was noticed between Sepsis and Sepsis-Dex groups regarding sublingual microcirculation, but gut MFI was significantly higher in Sepsis-Dex group (1.7 vs 1.1, p=0.01 respectively). The piglets of Sepsis-Dex group had a lower noradrenaline requirement compared to those of Sepsis group (p=0.05).

Dexmedetomidine administration improved microcirculatory parameters in non-septic animals, it improved intestinal microcirculation and decreased noradrenaline requirement in septic animals.

References

Pandharipande, P. P., Sanders, R. D., Girard, T. D., McGrane, S., Thompson, J. L., Shintani, A. K., et al. (2010). Effect of dexmedetomidine versus lorazepam on outcome in patients with sepsis: an a priori-designed analysis of the MENDS randomized controlled trial. *Critical Care*, 14(2), R38.

Rodent

Identifying factors causing stress during inhalant chamber induction in rats

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Introduction: For anaesthesia in laboratory rats, chamber induction with inhalants without premedication is common practice, even though this method is known to be stressful for animals. The aim was to identify factors influencing stress and set up the best model for evaluating the effects of premedication.

Material and Methods: This study followed a large factorial experimental design. Forty-eight Wistar-Han rats were anaesthetised to evaluate the following factors during induction and recovery: sex (MALE or FEMALE), volatile agent (isoflurane: ISO 5% or sevoflurane: SEVO 8%), fresh gas flow (FGF100% or FGF50% of chamber volume minute^{-1}) and light-dark cycle (NORMAL or REVERSED). Anaesthesia was maintained by mask at surgical depth for 30 minutes. Behaviour during anaesthesia induction and recovery, and time to recumbency and recovery were recorded. Blood was sampled for measurement of glucose and corticosterone levels at 5, 15 and 30 minutes. Part of the data from 23 rats (October 2022) was analysed for statistical significance by ANOVA.

Results: Most animals displayed excitatory behaviour during induction and recovery. The FGF had a significant overall effect on time to recumbency ($p = 0.01$). Time was longer in FGF50% than FGF100% for ISO in MALE (mean 127 versus 64 seconds). It was also longer in MALE than FEMALE for FGF50% and ISO (mean 127 versus 86 seconds). Sex had an

overall effect on glucose at 5 minutes ($p = 0.04$). Glucose was higher in MALE than FEMALE for ISO in NORMAL (mean 10.7 versus 7.9 mmol L^{-1}).

Conclusion: According to our preliminary results, the combination of ISO, FGF 50%, MALE and NORMAL is suitable for future studies evaluating the effect of premedication on stress caused by chamber induction.

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Lapine

Atipamezole via GV20-acupoint or intramuscularly reversed dexmedetomidine sedation in laboratory rabbits

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Introduction: Sedation with dexmedetomidine administered GV20-SC has been reported (Benito et al. 2022). This study examines the effectiveness of atipamezole applied in the GV20- acupoint (GV20-SC) on the head of rabbits to reverse dexmedetomidine sedation.

Materials and Methods: Eight intact female New Zealand White rabbits (6 months old; 3.74 ± 0.22 kg) were used in this prospective, randomized, blinded, cross-over study. Twenty minutes after sedation with dexmedetomidine (25 μg kg^{-1} intramuscularly, IM), rabbits received atipamezole (0.75 mg kg^{-1}) at GV20-SC and IM (lumbar muscles) with a 24-hour wash-out period between treatments. A blinded evaluator assessed the degree of recovery every 5 minutes for up to 25 minutes with a validated sedation Numerical Rating Scale (NRS; Raulic et al. 2021) and a Dynamic Interactive Visual Analogue Scale (DIVAS). Adverse events were also recorded. Multiple comparisons among times and groups were analyzed using the two-way ANOVA test and linear mixed models ($p < 0.05$).

Results: Regardless of the administration route, rabbits were safely recovered with atipamezole after dexmedetomidine-sedation. Total time of recovery (12 ± 6 versus 10 ± 9 minutes; $p = 0.5625$) and overall recovery score (1[1-2] versus 2[1-3]; $p = 0.1250$) were not different between groups (GV20-SC and IM, respectively). The difference in recovery between groups was influenced by time rather than treatment (NRS and DIVAS scales analysis). Two rabbits showed abnormal behaviors after IM injections.

Conclusion: Administration of atipamezole at the GV20-acupoint is feasible and provides comparable recoveries to those following IM atipamezole administration in laboratory rabbits.

Acknowledgements: We would like to thank the staff of the laboratory animal facility that was responsible for our rabbit colony.

References

Benito J, Garbin M, Gibert A et al. (2022) Pharmacopuncture: Comparison of the effects of dexmedetomidine administered at the GV20 acupoint, subcutaneously on the head or intramuscularly in laboratory rabbits. Proceedings AVA Bern, page 68 (Abstract).

Raulic J, Sy Leung V, Doss GA et al. (2021) Development and testing of a sedation scale for use in rabbits (Oryctolagus cuniculus). *J Am Assoc Lab Anim Sci* 60(5), 549-555.

Equipment

Neonatal cuff sizes cause error in non-invasive blood pressure measured in cats

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The Non-Invasive Blood Pressure (NIBP) technique relies on a pneumatic cuff wrapped around a limb or the tail to compress it by inflation, transferring the cuff's expanded volume as force through the skin and tissues to apply uniform pressure along the length of the artery. Guidelines from the American Heart Association include applying a cuff with a bladder length of 80% and width of 40% of the arm circumference. NIBP measurement in small animals is associated with considerable variability, particularly cats and relies on use of human neonatal cuffs.

We obtained standard human neonatal NIBP cuffs from 3 manufacturers as well as 1 set from a veterinary manufacturer. In all cases sizes 1 to 5 had published circumferential ranges of 3-6; 4-8; 6-11; 7-13 and 8-15cm respectively. Cuff geometry was the same for each manufacturer. Based on the actual pneumatic balloon width and a 40% circumference guideline ± 15%, a correct range would be 4.7-6.3; 5.7-7.8; 7.9-10.6; 9.8-13.2; 11.3-15.2. Published thoracic limb circumferences in 16 cats are 8.3 ± 0.9cm, suggesting an NIBP cuff is required exactly mid- way between size 2 & 3. A cuff that is too small (size 2) or too big

(size 3) both result in errors of measurement, but these errors are not simply additive or multiplicative, depending on longitudinal wall and tissue stresses contributing to the balance of forces from the cuff and blood pressure.

In conclusion, the range of standard human neonatal cuffs is not adequate for accurate NIBP determination in small animals, particularly cats; data obtained using human neonatal cuff sizes 2 and 3 in cats are associated with errors of measurement that are not predictable.