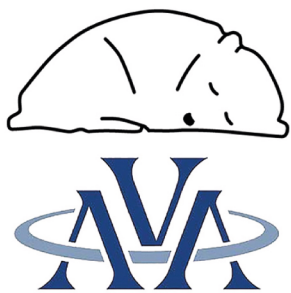


2022

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Program Book



2022

AVA Autumn Meeting

31. August -
2. September 2022

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CONGRESS COMMITTEE

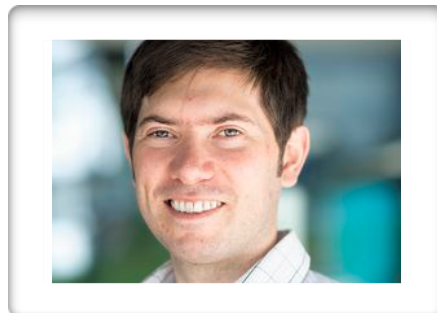
We would like to welcome you to the 2022 AVA Meeting in the beautiful city of Bern, Switzerland! We are very excited to present you a captivating program for the coming day. During the pre-congress day, experts will give insight and practical tips to optimize the perioperative care of exotic pets. For the main conference, we have been very fortunate to have several world-renowned pain experts present, who all pondered the same question: “What can we learn from animal models and humans to better understand and treat pain in veterinary patients?”

Our exiting program delves into the interpretation of translational research for veterinary medicine, neuropathic pain, optogenetics, glycine and sodium channels, as well as assessment and treatment modalities including the Facial Action Coding Systems (FACS), integrative medicine, and regional analgesia.

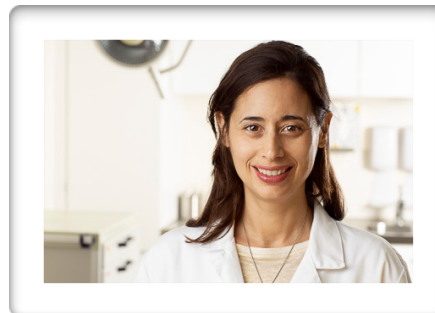
The medieval city of Bern has been designated as UNESCO world heritage site since 1983 and is located very close to the alpine peaks of the Bernese Oberland. The city is situated on a peninsula that is outlined by the sparkling river Aare. Therefore, make sure to pack your swimsuit because one of the highlights of summer in Bern is a refreshing swim in the Aare!



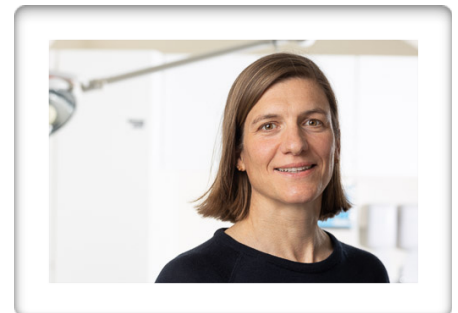
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Spadavecchia
Dipl. ECVAA, PhD



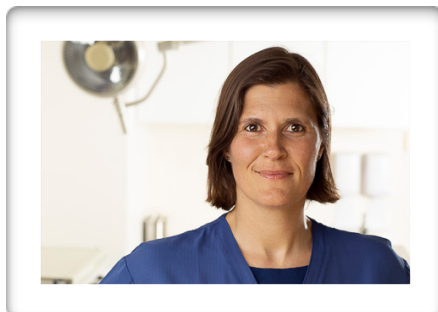
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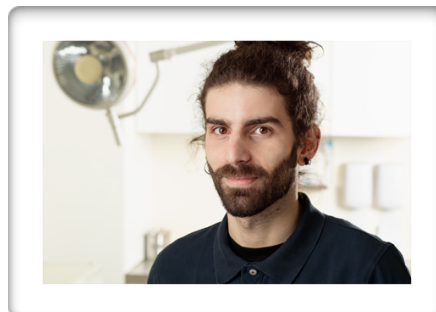
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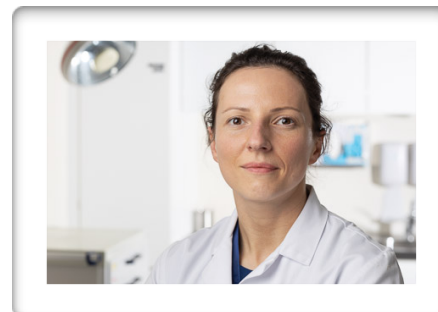
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Mirra
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Dr. med. vet. Marta Kantyka
Dipl. ECVAA

PRE-CONGRESS PROGRAM

<i>Time</i>	<i>Wednesday, August 31st, 2022</i>	
08:30 09:00	Registration	
09:00 10:00	* PERIOPERATIVE CARE OF AVIAN PATIENTS Moderator: M. Kantyka	S. Wenger
10:00 11:00	* PERIOPERATIVE CARE OF RODENTS Moderator: M. Kantyka	A. Bergadano
11:00 11:30	Coffee Break	
11:30 12:30	* PERIOPERATIVE CARE OF REPTILE PATIENTS Moderator: A. Mirra	S. Wenger
12:30 14:00	Lunch	
14:00 15:00	* TIPS AND TRICKS FROM A ZOO VET Moderator: M. Kantyka	S. Hoby
15:00 15:30	* PERIOPERATIVE CARE OF FERRETS Moderator: M. Kantyka	S. Wenger
15:30 16:00	Coffee Break	
16:00 17:00	* PERIOPERATIVE CARE OF RABBITS Moderator: A. Mirra	D. Casoni
17:00 17:30	* PERIOPERATIVE CARE OF AMPHIBIANS Moderator: A. Mirra	S. Wenger



MAIN CONFERENCE PROGRAM

Time	Thursday, September 1st, 2022	
08:30 08:45	Check-in opening	
08:45 09:00	* WELCOME, OPENING WORDS	C. Spadavecchia
09:00 09:45	* FROM ANIMAL MODELS TO HUMAN MODELS OF NOCICEPTION IN TRANSLATIONAL PAIN MEDICINE Moderator: A. Bergadano	M. Curatolo
09:45 10:30	* NOVEL INSIGHT INTO REGIONAL ANALGESIA Moderator: A. Bergadano	U. Eichenberger
10:30 11:00	Break, Exhibition, Posters	
11:00 11:45	* GLIA IN PAIN, FROM BENCH TO BEDSIDE Moderator: D. Pang	M. Suter
11:45 12:30	* PRINCIPLES OF NOCICEPTIVE CODING IN THE CORTEX Moderator: D. Pang	T. Nevian
12:30 14:00	Lunch, Exhibiton, Posters	
13:00 14:00	Optional Veterinary Hospital Clinic Visit	
14:00 15:00	* SODIUM CHANNELS AND IPS-CELL DERIVED SENSORY NEURONS FOR PAIN RESEARCH Moderator: C. Adami	A. Lampert
15:00 15:30	Break , Exhibition , Posters	
15:30 17:15	SHORT ORAL PRESENTATIONS	
	ROOM 1 • LABORATORY ANIMALS • Moderator: P. Kronen	ROOM 2 — ANALGESIA — Moderator: S. Luna
	* The effect of metoclopramide on food intake and faecal output in healthy rabbits undergoing sedation Mead SA * Evaluation of three doses of oral trazodone and its impact on handling, activity, and physiological parameters in rabbits: a prospective randomized blinded cross-over study Watanabe R * Pharmacopuncture: Comparison of the effects of dexmedetomidine administered at the GV20 acupoint, subcutaneously on the head or intramuscularly in laboratory rabbits Cruz Benedetti IC * Methadone versus buprenorphine in New Zealand white rabbits undergoing calvarium surgery Casoni D * Pharmacokinetics of gamma-hydroxybutyric acid in juvenile swine after intravenous and oral administration Cuypers C * Patient state index and suppression ratio response during nociception in pigs undergoing front-limb amputation Petrucchi M * Correlation of Sedline-generated variables with anaesthetic depth in propofol anaesthetized pigs Mirra A * Application of an AI technology based on image vision for objective assessment of activity in pigs receiving fentanyl or buprenorphine – a pilot study Ryden A	* Description and feasibility of a modified periconal block: a cadaveric study in dogs Faugier C * Anti-nociceptive and behavioural effects of butorphanol alone or in combination with detomidine in experimental calves. A prospective, randomized, blinded cross-over study Gámez Maidanskaia E * Applicability and repeatability of cutaneous cold stimulation to assess aversive threshold values in healthy dogs using four different cooling protocols Wittenberg-Voges L * Pharmacokinetics of buprenorphine and norbuprenorphine in isoflurane-anesthetized cats Pypendop BH * Effects of low-level laser therapy on impaired mobility in dogs with naturally occurring osteoarthritis Adami C * Machine learning – based analysis of intraoperative hypotension risk from two epidural dosing strategies in dogs undergoing abdominal surgery Millán Parreño C * Anaesthesia with midazolam, butorphanol and ketamine combined with isoflurane in harbour seals (<i>Phoca vitulina</i>) Wenger S * Effect of fentanyl on cough reflex and quality of endotracheal intubation in cats Martín Bellido V

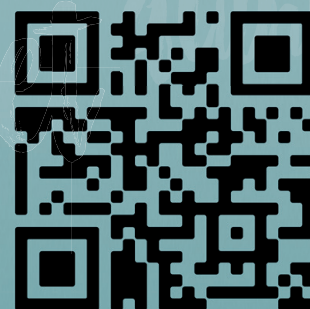
Time	Friday, September 2nd, 2022	
08:15 08:30	Check-in opening	
08:30 09:00	* ZEN BREAKFAST	Dechra
09:00 09:45	* GLYCINE AND GABA IN PAIN AND ITCH CONTROL Moderator: L. Zilberstein	U. Zeilhofer
09:45 10:30	* FACS IN ANIMALS AS A WAY TO QUANTIFY PAIN Moderator: L. Zilberstein	B. Waller
10:30 11:00	Break, Exhibition, Posters	
11:00 11:45	* INTEGRATIVE PAIN MEDICINE: EVIDENCE & PRACTICE IN HUMANS AND LINKS TO THE VETERINARY SETTING Moderator: H. Rohrbach	C. Berna-Renella
11:45 12:30	* BACK-TRANSLATING FROM HUMAN MODELS OF NOCICEPTION TO CLINICAL PAIN ASSESSMENT IN VETERINARY MEDICINE Moderator: H. Rohrbach	L. Arendt-Nielsen
12:30 14:00	Lunch, Exhibition, Posters	
14:00 15:30	SHORT ORAL PRESENTATIONS	
	ROOM 1 — RESPIRATORY — Moderator: Y. Moens	ROOM 2 — LARGE ANIMALS — Moderator: D. Casoni
	* Incidence of post-anaesthetic complications and their risk factors in 199 dogs undergoing surgery for Brachycephalic Obstructive Airway Syndrome (BOAS) Filipas M * Occurrence, drivers and definition of postanesthetic pulmonary complications in dogs, cats and horses in the current veterinary literature. A scoping review Braun C * Accuracy of three types of disposable PEEP valves Ambrisko TD * Reliability of respiratory compliance assessed by two spirometry monitors used in dogs and cats: the effect of resistance Ben-Aderet D * Respiratory mechanics and dead space effects of individualized levels of positive-end expiratory pressure in anesthetized cats Soares JHN * The effect of venous admixture on correction of Enghoff's towards Bohr's dead space fractions in anesthetized dogs: preliminary results Couto Bueno ML * Identifying endotracheal tube positioning and lumen restriction using computed tomography: preliminary results Lloyd F	* Prospective survey of checkout procedures of veterinary anesthesia equipment in Alberta, Canada Marchiori JJM * Incidence of peri-anaesthetic complications in bovine animals: a retrospective study to identify risk factors Micieli F * Investigation of an ultrasound-guided erector spinae plane block in cows: a cadaveric study d'Anselme O * Bupivacaine-induced antinociception after rectus abdominal sheath block in standing horses. Ishikawaa Y * The dose-response relationship between the patient state index and plasma propofol concentration in anesthetized dogs Chang K * Comparison of hemodynamic effects of propofol or alfaxalone during induction of anaesthesia in dogs: a preliminary study Lardone E * Anaesthetic management for surgical treatment of severe pulmonic stenosis under cardiopulmonary bypass in four French Bulldogs Rovatti I * Retrospective Evaluation of the Intraoperative Effects of Phenoxybenzamine Pre-Treatment in Dogs with Pheochromocytoma Willette C
15:30 16:00	Break, Exhibition, Posters	
16:00 16:30	* AETHER-O-MANIA 1847 IN EUROPE, REVISITED Moderator: C. Spadavecchia	Y.Moens
16:30 17:00	* PRESENTATION UPCOMING CONGRESSES * AWARDS: BEST PRESENTATIONS * CLOSING WORDS	

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KEYNOTE SPEAKERS

Prof Lars Arendt-Nielsen Dr. med., PhD

Co-founder and Director of the Center for Sensory-Motor Interaction (SMI) and Center for Pain and Neuroplasticity, Aalborg University, Denmark



The Center for Sensory-Motor Interaction (SMI) and Center for Pain and Neuroplasticity is an interdisciplinary, internationally recognized translational pain research unit employs 100 researchers from all over the world (50% are international researchers).

The research focuses on: 1) forward and backward translational experimental and clinical pain research, 2) human diagnostic pain biomarkers, and 3) mechanism-based clinical proof-of-concept in pain management and anaesthesiology. In recent years the focus has also included itch and parallel neuroplastic mechanisms.

Dr. Arendt-Nielsen's publication record includes 1,016 peer reviewed journal papers (H-index 80) and he has delivered over 460 keynote lectures at international meetings and seminars. He has also been a visiting professor in Japan, Sweden, Switzerland, USA, and Italy and has built a substantial network of international collaborations with universities and hospitals in 15 different countries, as well as the biomedical/ pharmaceutical industry (20 international companies).

Has served on the council of the International Association for the Study of Pain (IASP), president of the IASP Global Year Against Musculoskeletal Pain 2010, president of the IASP Global Year Against Joint Pain 2016, chair for IASP's Special Interest Group (SIG) on Musculoskeletal Pain, head of the IASP Grant Committee, and Editor-in-Chief of IASP

Press. Dr. Arendt-Nielsen is the current immediate Past-president of IASP (period 2020-22).

In 2007 he was knighted by the Danish Queen for his contribution to science.

Dr Alessandra Bergadano PD, DVM, Dr.Med.Vet., Dip.ECVAA, Dip. ECLAM, PhD **Head of Experimental Animal Center (EAC), Department of Biomedical Research,** **University of Bern, Switzerland**

Alessandra Bergadano graduated from the University of Torino, Italy in 1990 and Bern, Switzerland in 2003. She achieved her PhD degree and *venia docendi* in comparative models of nociception, pain diagnosis and analgesia from the Universities of Aalborg, Denmark and Bern, Switzerland. She is European specialist in both veterinary anesthesia and analgesia and laboratory animal medicine.

Dr. Bergadano has worked with small and large animals to include nonhuman primates in private practice, industry and academia as clinical patients, experimental animals or both. Since over 15 years she is fully dedicated to lab animal medicine and as of Jan 2018 she heads the Central Animal Facilities, DBMR, University of Bern, Switzerland.

She has authored and co-authored over 30 peer reviewed papers. Her current work is focused on developing the "culture of care" in Switzerland.

Currently she is board member of the exam ECLAM committee, serves as ad hoc Consultant for AAALAC International and is member of the Ethic committee of the Swiss academies.



Prof Chantal Berna Renella Dr. med., PhD

Head of the Center for Integrative and Complementary Medicine (CEMIC) and associated to the Pain Center, Lausanne University Hospital



Professor Berna Renella is a specialist in internal medicine, trained in psychosomatic medicine, clinical hypnosis, and interventional pain management (Fellowship at Massachusetts General Hospital, Harvard Medical School, Boston, USA) with a PhD in cognitive neuroscience of pain (University of Oxford, UK).

Since 2019, she is the head of the Center for Integrative and Complementary medicine at Lausanne University Hospital (CEMIC). CEMIC is the first academic integrative medicine center in French speaking Europe. It promotes the clinical practice, research and teaching of integrative medicine, which aims to combine evidence-based complementary and conventional treatments within a bio-psycho-socio-spiritual model. The clinical applications of integrative medicine at Lausanne University Hospital are mostly in pain management and oncology, but other areas are being progressively invested, such as anesthesiology, neurology, and obstetrics.

Professor Berna Renella's current research efforts are mainly directed towards the neuroscientific mechanisms of non-pharmacological pain management (e.g. hypnosis, meditation, mental imagery) and the implementation of complementary medicine in an academic setting.

Professor Berna Renella is a member of the committee of the Swiss Pain Society (SPS) and the Swiss councilor to the European Pain Federation (EFIC) (local/regional chapters of the International Association for the Study of Pain IASP).

Dr Daniela Casoni DVM, Dr.Med.Vet., DECVAA, PhD

Head of Experimental Surgery Facility (ESF) Department for Biomedical Research (DBMR), University of Bern, Switzerland

Daniela Casoni graduated cum laude with honours at the University of Bologna in 2001. At the same University, she achieved her PhD degree in critical care of small animals in 2005. After 5 years as clinical instructor and research fellow, she moved to the University of Pennsylvania in 2010 and then to University of Bern in 2011, where she completed her residency program in Veterinary Anaesthesia and Analgesia and her post-doc in experimental chronic pain.

She continued her academic career at the University of Helsinki as a clinical lecturer in anaesthesia, analgesia and critical care (2016-2017). Daniela returned to Bern in January 2018 as head of the Experimental Surgery Facility. Her current work is mainly focused on granting a high standard of care to animals undergoing experimental surgeries. Her scientific contribution is focused on evaluating intraoperative nociception and peri-operative pain in animal models. She is a member of the FELASA group for implementing guidelines regarding large animals anaesthesia and analgesia and a consulting anaesthesiologist for researchers at the University of Bern and Zürich as well as member of the AVA Ethical commission.



Prof Michele Curatolo MD, PhD

Professor for Anesthesiology and Pain Medicine at the University of Washington, Seattle, USA



Michele Curatolo is professor for Anesthesiology and Pain Medicine at the University of Washington, Seattle, USA, where he holds an endowed professorship in medical education and research.

Michele Curatolo received his M.D. at the University of Messina in Italy and continued his career in Switzerland. He received a Ph.D. in Biomedical Science and Engineering at the University of Aalborg in Denmark. In 2014, Dr. Curatolo also received an honorary doctorate from the University of Aalborg.

Prof. Curatolo has been the chief of the Division of Pain Therapy in the Department of Anesthesiology and Pain Therapy at the University of Bern, as well as acting chair of the department. He has served in a variety of leading roles in academic and political institutions. Editorial responsibilities include roles as section editor for the European Journal of Pain, associate editor of Pain and editorial board member of the Scandinavian Journal of Pain.

Prof. Curatolo's research focuses mainly on measuring nociceptive processes to understand mechanisms of human pain states and predict outcomes.

Prof Urs Eichenberger Dr.med.

Head of the Department of Anaesthesiology, Intensive Care and Pain Therapy at Balgrist University Hospital, Zurich, Switzerland

Urs Eichenberger received his MD at the University of Bern, Switzerland and completed his specialist training as a physician anaesthesiologist at Bern University. In 2009 he received his PD degree from the University of Bern. He has been the chief of the Division of Pain Therapy in the Department of Anaesthesiology and Pain Therapy at the University of Bern and head of the Department of Anaesthesiology, Intensive Care and Pain Therapy at Hirslanden Clinic St. Anna in Lucerne, Switzerland.

Since 2016 he is head of the Department of Anaesthesiology, Intensive Care and Pain Therapy at Balgrist University Hospital in Zurich and he received a titular professorship in Anesthesiology in 2017 from the University of Zurich.

He is currently co-president of the Swiss Society for Anaesthesiology and Perioperative Medicine (SSAPM) and serves as editor for the journal Regional Anesthesia and Pain Medicine (RAPM). In 2019, he received the ESRA Spain distinguished service award in recognition for outstanding clinical, educational and scientific achievements in anaesthesiology and for contributions to the increased knowledge and practice of regional anaesthesia.



Prof. Eichenberger's research focuses mainly on ultrasound-guided regional anaesthesia and interventional pain therapy.

Dr Stefan Hoby Dr.med.vet., Dip. ECZM Head zoo veterinarian of Tierpark Bern



Dr. Hoby graduated as a veterinarian from the University of Bern in 2002. Following his studies, he worked in a mixed practice in the Bernese Oberland for one year. He went on to complete his dissertation at the Centre for Fish and Wildlife Health (FIWI) Bern and the National Park Hohe Tauern, Austria from 2003-2005 and continued on as a Postdoc at the FIWI until 2007. From 2008-2017 he practiced as a zoo veterinarian at the Zoologischer Garten Basel and during this time became board certified in 2017 by the European College of Zoo Medicine (ESZM) in zoo health management and completed extra education in phytotherapy (2010-2014) and animal experimentation (LTK I+II, 2012).

Since 2018 he is the zoo veterinarian of the Tierpark Bern and has wide ranging experience in the medical management of free-living mammals, reptiles, fish, amphibians and birds in this scientifically guided zoo. He is responsible for research programs in the zoo and involved in different breeding programs of the European Association of Zoos and Aquaria. He also has experience in enclosure design and development, personnel management and training, is in charge of animal welfare issues and involved in public education and press relations.

Prof Angelika Lampert PD, Dr.med. Professor of Physiology (Neurophysiology), Uniklinik RWTH, Aachen University, Germany

Professor Lampert graduated as a medical doctor from the Universities of Jena and Strasbourg in France followed by residencies in internal medicine and physiology at the University of Tübingen in Germany. She has extensive experience as a researcher in physiology including a postdoctoral fellowship at the Center for Neuroscience and Regeneration Research at Yale University, New Haven, USA.

In 2012, she was awarded First Prize for Pain Research in the category „basic science“ by the German Society for the Study of Pain (DGSS).

Angelika Lampert's research focuses on voltage-gated sodium channels and their translational aspects in pain and cardiac disease. In recent years she applied detailed electrophysiological studies on iPS-cell derived sensory neurons, allowing to identify the contribution of sodium channel sub-classes to neuronal excitability.



Prof Yves Moens Prof. Dr.med.vet.,Dipl ECVAA, PhD, PD
Professor of Veterinary Anaesthesia and Intensive Care, University of Vienna, Austria



Yves Moens graduated as Doctor in Veterinary Medicine in Belgium (University of Ghent) in 1973 and was assistant at the surgical clinic. From 1980 to 1989 he was appointed Professor of veterinary surgery at the Veterinary Faculty of Lubumbashi (Democratic Republic of Congo) on behalf of the Belgium International Inter-University Cooperation. In 1989 he joined the Veterinary Faculty of the University of Utrecht (the Netherlands) and defended with success his PhD on horse anaesthesia and lung ventilation. From 1996 until 2003 he worked as Associate Professor in veterinary anaesthesia at the Vet Suisse Veterinary Faculty, campus Bern (Switzerland), and was granted the Habilitation (PhD) in 2003 for research on monitoring of gas exchange during equine anaesthesia. From 2003 to 2015 Yves Moens was full Professor and Director of the Clinic of Anaesthesiology and perioperative intensive care and Director of the emergency clinic at the Veterinary University of Vienna. From 2015 to 2020 he was Director of the veterinary nurse and technician school at the Campus of the Veterinary University of Vienna.

Yves Moens was invited specialist, founding member, president of the ECVAA (European College of Veterinary Anaesthesia and Analgesia) and holder of the ECVAA Morpheus Award ; Yves Moens is former president of the Association of Veterinary Anaesthetists and Honorary Member and also Honorary member of the European College of Emergency and Critical care.

Prof Dr Thomas Nevian Dr. rer. nat.
Professor of Neurophysiology, University of Bern, Switzerland

Thomas Nevian studied physics and biophysics in Heidelberg, Germany, St. Andrews, UK and at the Cornell University, USA. He performed his PhD work with Prof. Dr. Bert Sakmann at the Max-Planck-Institute for Medical Research in Heidelberg, investigating the calcium dynamics in dendrites of cortical neurons. After his dissertation in 2003 and two further years as post-doc in Heidelberg, he became a group leader in the Department of Physiology at the University of Bern. In 2010 he received a Research-Professorship of the Swiss National Science Foundation. In 2012 he was appointed Tenure-Track-Assistant Professor and 2014 Full Professor of Physiology at the University of Bern and Co-Director of the department. His research in Neuroscience was awarded with the Pfizer Research Prize twice (2008, 2016) and the Theodor-Kocher-Prize as best young researcher of the University of Bern (2012). In 2015 he received an ERC-Consolidator grant to study the neuronal networks involved in pain processing in the cerebral cortex.

Thomas Nevian investigates the fundamental mechanisms of signal processing in the brain using state-of-the-art microscopy and electrophysiology techniques. His research group investigates the biophysics of neurons, principles of memory formation and the development of chronic pain.



Dr Marc Suter MD

Attending physician and senior researcher, Pain Center, Department of Anesthesiology, University Hospital, Lausanne, Switzerland



Dr Suter is currently working at the Pain Center of the Department of Anesthesiology at the CHUV. He shares his time between the outpatient chronic pain clinic, the postoperative care in the hospital and basic research on neuroinflammation.

Clinically, Dr Suter trained in the Department of Anesthesiology of both Lausanne and Zurich University Hospital, Switzerland and in the Care Hospital, in Hyderabad, India. He obtained the Federal Diploma of Medicine in 1999, his MD in 2003, the Swiss Diploma of Anesthesiology (FMH) in 2005 and the European Diploma one year later. He is Privat-Dozent at the University of Lausanne since 2013, and MER since 2016.

Dr Suter is member of the Pain subcommittee of the European Society of Anaesthesiology and of the committee of the Swiss Pain Society (SPS) Chapter of the International Association for the Study of Pain (IASP), for which he participates in the publication of the Swiss guidelines for diagnosis and treatment of neuropathic pain published in 2011.

His basic research activities targets the mechanisms of development and maintenance of neuropathic pain and more specifically neuroinflammation and sodium channels. After developing a long term blockade of peripheral input to the spinal cord he applied this technique to observe its effect on neuroimmune changes in the spinal cord. From 2007 to

2008, he joined Professor Ru-Rong Ji's lab at the Harvard Medical School, in Boston, USA. There, Dr Suter could deepen its interest in intracellular pathways and glial activation in the spinal cord and showed that peripheral excitability triggers microglial reactivity after injury.

Prof Bridget M Waller PhD

Professor of Evolution and Behaviour, Evolution and Social Interaction Research Group, NTU Psychology, Nottingham Trent University, UK

Bridget Waller is Professor of Evolution and Social Behaviour and leads the Evolution and Social Interaction Research Group at Nottingham Trent University.

The overarching focus of her work is the evolution of social communication, and she is interested in how communication facilitates social interaction. She has particular expertise in human and non-human facial expression and uses species-specific modifications of FACS (Facial Action Coding System: www.animalfaces.com) to make anatomically based, systematic comparisons between species. She is also interested in the link between facial behaviour and emotion, and how/whether animals use facial expression to communicate internal states.

She has a PhD in Psychology (University of Portsmouth, UK), MSc in Evolutionary Psychology (University of Liverpool) and BSc Zoology (Royal Holloway University of London). She has published over 70 peer-reviewed papers and received funding from national and international funders including the EU, British Academy, Leverhulme Trust and British Psychological Society. Currently, she is working on European Research Council (ERC) Consolidator Grant FACEDIFF 'Individual differences in facial expressivity: Social function, facial anatomy and evolutionary origins' which focuses on humans and rhesus macaques. Her work is highly interdisciplinary and combines anatomical, behavioural and cognitive approaches.



Dr Sandra Wenger Dr.med.vet., DECVA, DACZM, MSc



After graduating in 1996, Sandra Wenger worked for one year at Singapore's Jurong BirdPark. This was followed by a 15-month internship in "small animal medicine" and 3-year residency in "veterinary anaesthesia", at the University of Bern, Switzerland. After finishing her MSc in Wild Animal Health in London in 2005, Sandra Wenger was employed for 10 months by the zoo in Bristol, and the rabbit referral clinic of the University of Bristol. She then spent nine interesting and fulfilling years at the Zurich zoo, and the Clinic for zoo animals, exotic pets and wildlife, University of Zurich, first as a resident and then as a senior lecturer. Sandra Wenger is a diplomate of the American College of Zoo Medicine (2012) and the European College of Veterinary Anaesthesia and Analgesia (2002).

Since July 2017, she divides her time between two small animal practices, specialising in exotic pets and anaesthesia.

Prof Hanns Ulrich Zeilhofer MD

Professor of Pharmacology, University of Zürich and ETH Zürich, Switzerland

Hanns Ulrich Zeilhofer studied medicine at the University of Erlangen-Nurnberg. In 1990, he received his MD before he trained in electrophysiology at the Max Planck-Institute for Biophysical Chemistry in Göttingen and in molecular biology at the Institute for Pharmacology and Toxicology at the University of Zurich. He received his habilitation in Pharmacology and Toxicology at the Institute of Experimental and Clinical Pharmacology and Toxicology at the University of Erlangen-Nurnberg in 1997, and board certifications in Pharmacology and Toxicology, and Clinical Pharmacology. In 2001, he was appointed as Associate Professor of Molecular Neuropharmacology at the University of Erlangen-Nurnberg, before he became Professor of Pharmacology at the University of Zurich and ETH Zürich.

His research focuses on the neurons and circuits that process and modulate nociception and pain at the level of the spinal cord. His group has a special interest in the contribution of inhibitory neurons and neurotransmitters in these processes. The lab uses a multidisciplinary approach including electrophysiological, anatomical, and behavioural methods often in combination with virus-based tracing techniques, optogenetic and chemogenetic techniques.



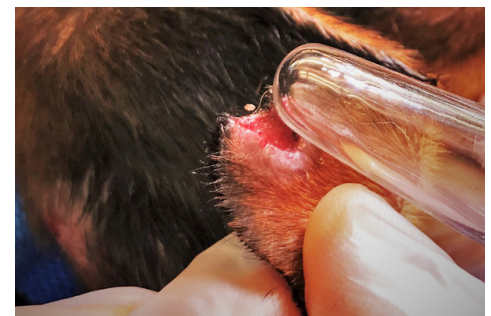
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The active principles of cold plasma therapy allow versatile use with post-operative rehabilitation patients. Studies have shown that various healing and regeneration processes can be improved and quickened, for example also the accelerated healing of sciatic nerve injuries in rats^{1,2}.



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PRE-CONGRESS KEYNOTE LECTURES

Perioperative care of avian patients

Sandra Wenger, Dr. med. vet., DECVA, DACZM, MSc

Common avian patients seen in veterinary practice include psittacines, passerines (finches and canaries), birds of prey, backyard poultry and ducks. They often require sedation or general anesthesia for diagnostic and surgical procedures. Anesthesia-related mortality has been reported to be higher in birds (3.6%) than in other animals, and the higher risk should be informed to the owners. In a study that included 352 birds undergoing inhalational anesthesia, 86% were alive at hospital discharge, 3.4% died during the anesthetic, 4.3% died postoperatively in the intensive care unit, and 6.3% were euthanatized after anesthesia.

Anatomy and physiology

The respiratory tract consists of nares, a trachea with complete cartilaginous rings, a syrinx (where vocalizations are produced), and 2 lungs firmly attached to the dorsal body wall. The air sacs (7-9) are not involved with significant gas exchange, but connect to the lungs and pneumatic bones, including the humerus and femur. As birds do not have a diaphragm, respiration is mechanically driven by the movement of the sternum and this should not be restricted during manual restraint or anesthesia.

Preanesthetic phase

A complete examination should be performed prior to anesthesia and an accurate body weight using a kitchen scale obtained. Birds, as prey animals, tend to hide clinical signs of disease. Preanesthetic food withdrawal is recommended because it reduces the risk of perioperative regurgitation and passive reflux; however, prolonged fasting predisposes young and small-sized birds to hypoglycemia. Fasting time depends on the size and species of bird; the crop should be empty prior to induction of anesthesia.

For IM injections, the pectoral muscles are commonly used. For IV injections, the jugular, ulnar and medial metatarsal (in waterfowl and poultry) veins are reasonable options. For intraosseous catheter placement, the nonpneumatic distal ulna or tibiotarsus are used.

Premedication

Benzodiazepines (e.g. midazolam) and alpha-2 agonists (e.g. medetomidine and dexmedetomidine) provide sedation and reduce the general anesthetic requirement for induction and maintenance of anesthesia. They can be combined with opioids such as butorphanol. Sedatives can be given IM oder intranasally.

Preoxygenation is recommended in critical patients, especially those with respiratory disease, or air sac compression secondary to intracoelomic organomegaly or ascites. Birds have minimal to absent functional residual capacity, and preoxygenation will increase the time to oxygen desaturation. A variety of sizes and shapes of facemasks should be readily available due to the differences in beak shapes.

Induction

Mask induction with isoflurane, sevoflurane or desflurane is commonly used in psittacines, passerines, birds of prey and backyard poultry. Intravenous or intramuscular induction anesthetics (e.g. propofol, alfaxalone or ketamine) are often preferred in waterfowl due to breath-holding during induction with inhalant agents.

Intubation is easy to perform. Birds have a trachea with complete cartilaginous rings and the glottal opening is wider than the distal trachea. This should be considered when selecting the size of the ETT to avoid damaging the trachea and the risk of post-operative tracheal strictures. Uncuffed ETT such as Cole tubes are preferred.

Maintenance

Anesthesia is maintained using either inhalant or IV anesthetics, or a combination of both. Inhalational anesthesia is the preferred technique for maintenance, because of greater safety and more rapid recoveries compared with other methods. The MAC of isoflurane is species-dependent and varies between 1.07 - 2.52%. Premedication can reduce the MAC. Both isoflurane and sevoflurane produce similar dose-dependent hypotension resulting from peripheral vasodilation and myocardial depression, and respiratory depression leading to hypercapnia and potential hypoxemia. Fentanyl CRI has a MAC-sparing effect in red-tailed hawks and has minimal effects on measured cardiovascular parameters. In contrast, fentanyl decreased the MAC in healthy Hispaniolan Amazon parrots, but this was accompanied by a depressive effect on heart rate and blood pressure. TIVA with propofol can be an effective anesthetic agent in different avian species if cardiopulmonary function is monitored and ventilatory support is provided.

Air sac perfusion anesthesia can be used in cases of tracheal obstruction or when full surgical access to the head is required. It is performed through cannulation, with an appropriately sized cannula or customized ETT, of the caudal thoracic or abdominal air sacs.

Monitoring

Anesthetic depth is assessed using muscular and cloacal tone, pupil responsiveness, toe pinch, response to nociception such as feather plucking, and palpebral and corneal reflexes. A surgical plane of anesthesia is characterized by a slow corneal reflex, muscle relaxation, lack of purposeful movement, and maintained cloacal tone. Sudden feather erection under anesthesia may indicate cardiac arrest rather than decreased anesthetic depth.

Heart rate can be monitored using auscultation (esophageal stethoscopes are practical) or by placing a doppler probe over a peripheral artery. Noninvasive blood pressure measurements are often inaccurate. Invasive BP using the ulnar or metatarsal arteries is only possible in larger species. Normal ranges for systolic BP in conscious and anesthetized psittacines are 90 to 180 mm Hg and 90 to 150 mm Hg, respectively. Birds have nucleated red blood cells and pulse oximetry underestimates values of oxygen saturation due to a greater absorption ratio. Pulse oximetry can be used to obtain HR and rhythm and observe oxygen saturation trends. Ventilation should be monitored by assessing respiratory rate and EtCO₂. Core body temperature and ECG should also be monitored.

Thermal support must be provided as hypothermia can lead to arrhythmias, profound anesthetic depth, and may substantially prolong the recovery and extubation times. Fluids (5 - 10ml/kg/hour) can be administered as bolus or CRI.

Analgesia

As in other species, adequate pain management is essential and should be pre-emptive and multimodal. Carprofen and meloxicam are routinely used in avian patients for alleviation of acute post-operative and traumatic pain. NSAIDs can cause gastrointestinal and renal side effects in avian species and should be used with caution in birds with renal, hepatic or perfusion problems. There is a lack of scientifically derived data on the concentration and distribution of the μ -, κ -, and δ -opioid receptors in different avian species' central nervous system. Butorphanol is a kappa-agonist and the most commonly used opioid to provide analgesia. Buprenorphine, a slow-onset, long acting opiate is a partial μ -agonist with mixed antinoceptive effects (e.g. providing analgesia in American kestrels but not in African grey parrots). Hydromorphone provided thermal nociception in American kestrels. Tramadol is a weak μ -agonist and has antinoceptive effects in birds, but there is great dose variation among different avian species.

Lidocaine, bupivacaine and benzocaine have been used effectively to provide local anaesthesia in avian patients. Birds may be more sensitive to the toxic side effects of local anaesthetics than mammals. Topical application of local anesthetics, local infiltration, brachial plexus block, sciatic and femoral nerve blocks have been described in birds.

Gabapentin PK studies conducted in Hispaniolan Amazon parrots and great horned owls suggest a dosing interval of every 8 hours. Gabapentin has been used in a falcon with neuropathic pain.

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Perioperative care of rodents

Alessandra Bergadano PD, DVM, Dr.Med.Vet., Dip.ECVAA, Dip. ECLAM, PhD

Rodents are mammals of the order Rodentia characterized by a single pair of continuously growing incisors in each of the upper and lower jaws ; they are the largest group of mammals, constituting almost half of the class Mammalia's approximately 4,660 species.

Common species used in research are mice and rats (wild types and genetically modified strains), and at a lesser extent hamsters, guinea pigs, gerbils, cotton rats, mole rats and chinchillas. These are also kept as pets or re-homed to be kept as pets.

While pet rodents represent a small percentage of the veterinary patients in clinical practice who will need anesthesia for diagnostic and surgical procedures, millions of rodents are anesthetised yearly for experimental procedures.

Each species has its anatomical and physiological peculiarities and it is important to master the species specific baseline values (1).

Anesthetic challenges and Suggestions for improvements

The anesthetic risk of pet rodents is reportedly high (2) while no comprehensive data on perianesthetic mortality of rodents used in research is available. The main risks of anesthesia in rodents are hypotension, hypoxemia, hypoventilation and hypothermia (3).

Possible causes of the high anesthetic risk are multifactorial and related to their small in size creating technical challenges for instrumentation and monitoring, the wide range of physiologic and pathologic conditions, high metabolic requirements, limited PK/PD data(4), batch anesthesia, limited specialist knowledge, long lasting procedures, ect...

Success is a sum of small improvements and caring measures throughout the perianesthetic period and is achieved by the collaboration among all stakeholders.

Pre-anesthetic preparation

- Rodents, as prey animals, tend to hide clinical signs of disease ; a complete examination should be performed prior to anesthesia. Health reports must be reviewed for research rodents and subclinical infections (i.e. with *Pneumocystis carinii* or other respiratory pathogens) ruled out to avoid respiratory impairment under anesthesia.
- Rodents do not regurgitate and therefore pre-anesthetic fasting is not required except for specific research needs.
- It is very important to perform anesthesia in an stress free environment which can be achieved by a thorough preparation of all steps of anesthesia, acclimatisation and careful husbandry (handling, housing, transport, circadian rythm ect).
- Accurate body weight using a calibrated scale and drugs diluted to allow appropriate dosing.
- The ACVAA, AAHA and ECVAA/AVA standards and guidelines for the safe practice of anaesthesia in clinical veterinary medicine should be implemented.

Choice of the anesthetic protocol

Based on the rodent species, requirements of the experimental model/clinical indication, duration, expected pain intensity, the equipment available and personal preference, one can choose between inhalation or injection anaesthesia or a combination of both.

For rodents used in research the anesthetic protocol plays an important role in the internal validity of the data obtained and must be carefully chosen, approved by the authorities and reported in the publications. This structured approach is endorsed by the PREPARE and ARRIVE guidelines (5, 6).

A balanced anesthetic protocol allows to achieve all the elements of anesthesia (hypnosis, immobilisation, analgesia and sympathetic stability) optimally and thanks to the synergistic effect allows to reduce the doses and the associated side effects. The concept of balanced anaesthesia was introduced by John Lundy in 1926 in which combinations of drugs are used to produce general anaesthesia, with each drug chosen for a specific effect.

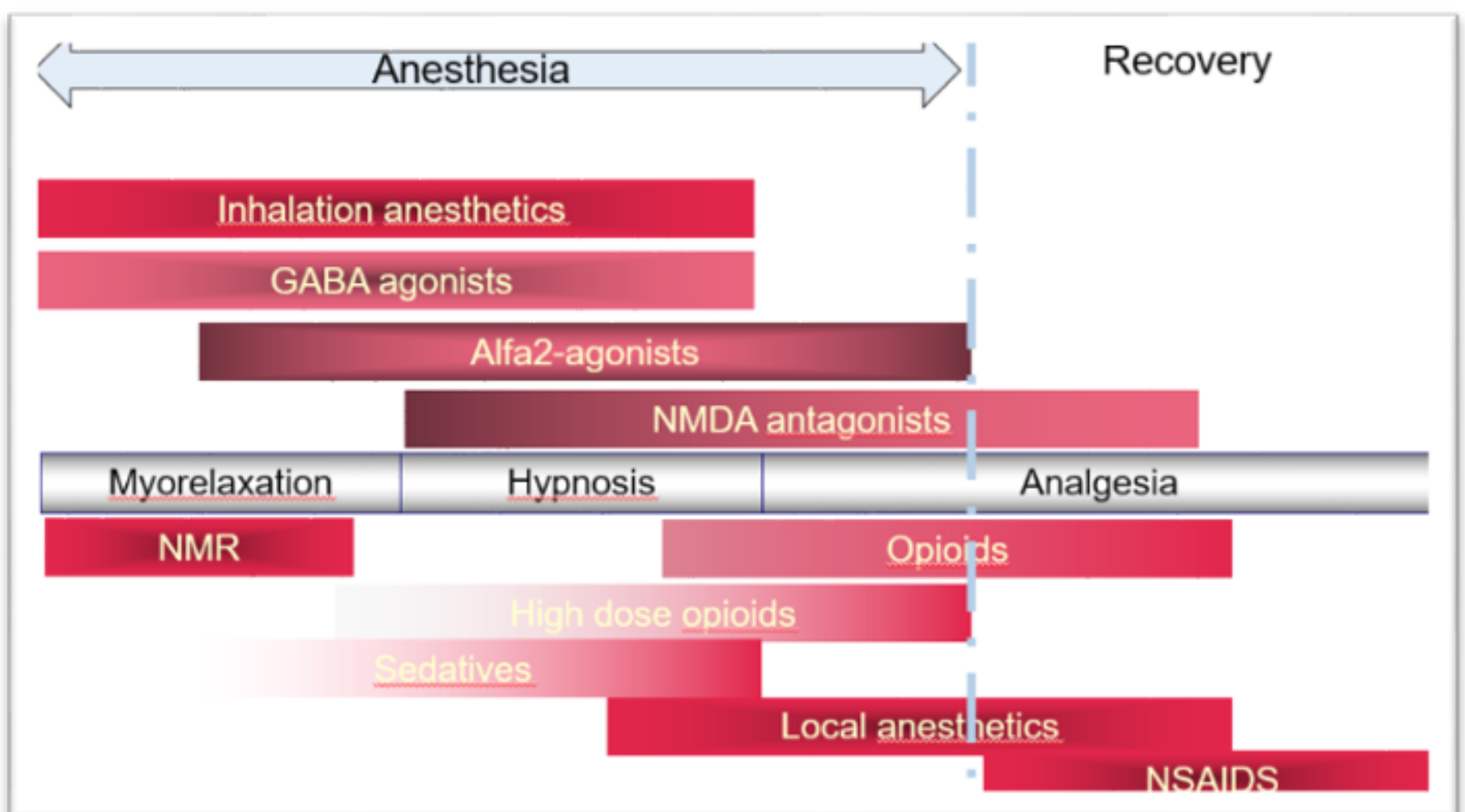


Figure 1 illustrates the role of the different drugs within a balanced anaesthetic protocol in the peri-anaesthetic period.

A question which arises often is if it is acceptable to avoid analgesics in the anaesthetic. This is acceptable for non-painful procedures (i.e. imaging) with short anaesthesia times. If painful procedures are performed, only for terminal (non-recovery) experiments with short anaesthesia times and if the activation of nociception has no impact on the measured parameters. Since depth of anaesthesia is dose-dependent, a correspondingly sufficient depth over an longer period of time can lead to severe respiratory and circulatory depression, especially with injectable mono-anaesthetics (e.g., propofol, alfaxalone, pentobarbital and etomidate) because of the narrow therapeutic index ; this can adversely impact the scientific data obtained and is associated with a high attrition rate due to deaths.

Monitoring

Clinical and instrumental monitoring of vital parameters can be achieved successfully also in small rodents with adequate equipment, as dedicated and knowledgeable personnel.

Specific monitors for rodents are available which adapt to the small sizing and are able to record high respiratory or cardiac rates (7).

Cardiovascular function

- Mucous membrane colour (MMC) and capillary refill time (CRT)
- Heart rate (HR)
- Electrocardiogram (ECG)

Oxygenation and respiratory function

- Oxygen saturation (SpO₂)
- MMC
- Respiratory rate (RR)

Anaesthetic depth : can be indirectly estimated by putting together HR, RR and

- Whiskers movements
- Pedal reflexes – pulls away if light and is feeling pain
- Sympathetic stability

Core temperature

Monitoring allows to evaluate the reaction of the animal to anesthesia, titrate it and take corrective actions to maintain normophysiology. All this improves the efficacy of the anesthetic and decreases mortality.

Respiratory support

Pre-oxygenation is an easy technique to augment the arterial partial pressure in oxygen (PaO₂) and therefore delay desaturation and should be applied as always feasible. It can be easily achieved by placing the animals in an induction box with O₂ supplementation while waiting that the premedication or injection anesthetic works.

Oxygen should be ALWAYS administered to support tissue oxygenation. The recommended inspiratory fraction of oxygen (FiO₂) is 0,3 and should be increased according to the oxygen saturation of the animal measured by pulse oximetry (SpO₂) (8).

Intubation and ventilation are not performed routinely as small size makes this procedure technically challenging. Oxygen and inhalation anaesthesia are administered via face masks in such small patients. Still intubation can be achieved blindly or video-guided with the right equipment and some training(9). Alternatively, laryngeal mask or nasal cone or intubation can be used.

Ventilatory support should be provided for procedures > 2h of duration to keep normocapnia. It is mandatory for thorax surgery, if intracranial hypertension should be avoided or if muscular blocking agents are used.

Piston ventilators are able to deliver the required « mini » tidal volumes and high respiratory rates. Settings can be calculated by allometric scaling of body weight according to metabolic rates (10).

Cardiovascular support

Remains limited in rodents as venous access and monitoring of blood pressure are difficult to achieve routinely. To counteract anesthesia and surgery related hypotension warmed fluids (5 – 10 ml/kg) can be administered as bolus subcutaneously (sc) or intraperitoneally (ip).

Temperature support

Due to their small size, rodents are more prone to hypothermia as they have a high weight/body surface ratio. Hypothermia during anaesthesia is very common because of: 1) a dose dependent inhibition of thermoregulation: ALL anaesthetics increase the hypothalamic cold threshold up to 20 times (from 0.2 to 2-4°C) and inhibit vasoconstriction (acepromazine, halogenates, propofol...)(11) and shivering (opioids and alpha2 agonists). 2) Furthermore, there is an increased heat loss from the patient's exposure to a cool environment of the operating room, skin preparation and surgery and 3) decreased heat production.

Mammals need to maintain a nearly constant internal temperature (T°) for optimal enzymatic activity (homoeothermic). Mild intraoperative hypothermia (1-2 °C) leads to numerous complications:

1. triples the risk of cardiac arrhythmias
2. triples surgical wound infections
3. prolongs hospitalisation by 20%
4. increases surgical blood loss (coagulopathy)
5. modulates pain perception
6. deepens anesthesia and delays recovery

In rodents the most effective and practical system are passive insulation with surgical draping (sealing wrap) and active warming with closed-loop electrical mats.

Recovery

It is an integral part of the peri-anaesthetic period. Recovery has to be monitored and supported until the animal is fully conscious, is able to maintain its normophysiology and express its species-specific behaviours. Depending on the species and the severity of the model, the first 24-48h are crucial but can range from a few hours to one week.

Overarching recommendations are:

- Consider antagonisation if recovery is delayed. Remember that antagonisation can antagonise analgesia.
- Place the animal in its home cage with soft bedding and known smell.
- Empty the bladder
- Easy access to feed and water.
- Provide critical care feed (Omnivore Emeraid <https://lafeber.com/vet/emeraid-omnivore-and-the-emeraid-critical-care-system-hand-and-gavage-feeding/>) an/or moist feed easy to chew on the bottom of the cage.
- Provide environmental warmth (32°C to 36°C) for 24-48h until the animal can maintain normothermia
- Check body T° regularly with the use of non-invasive IR thermometers
- Provide and monitor analgesia

Choice of the analgesic protocol

To date, it is good practice to provide « preventive analgesia » which includes pain treatment before, during and after surgery/painful event. This strategy minimizes central sensitisation and reduces the risk of chronic pain. Practically it reduces the post-operative pain sensation and reduces the analgesic requirements simplifying the postoperative care and increasing the animal's welfare.

Preventive analgesia integrates well in the balanced anesthesia protocol choice. The best analgesia is achieved with a multimodal strategy, where the main analgesics (NSAIDs, opioids, local anesthetics, α_2 agonists and NMDA antagonists) synergize.

Local anesthetics can be used topically, locally or locoregionally also in the smallest rodent and provide safe, effective analgesia with little influence on experimental read outs. Dosing must be accurate to avoid overdosing toxicity. Species specific dosages are available in the literature (4) and i.e. a recent recommendation document (GV Solas Pain management in laboratory animals 2020).

Intraoperative nociception can be evaluated by sympathetic activation, postoperative pain is best evaluated with a composite approach including physiologic and behavioural indicators. In rodents the appearance, appetite, facial grimaces (12), activity and nest building (13) are valid indicators of pain (14). Model specific signs can be included.

The use of score sheets allows for a structured and objective recording over time, helps reducing inter-observer variability and allows the setting of action and endpoints.

Terminal anaesthesia

Both in clinical practice and in experimental setting, anesthesia can be performed with the purpose of performing euthanasia or continues until the animal is euthanized at the termination of the experimental procedure. In all cases, anaesthesia must be sufficiently deep (surgical anaesthesia) and at no point during the procedure the animal is permitted to regain any level of conscious pain perception. The choice of the drugs depends on their influence on the experimental readout. As a rule of thumb 3 times the anaesthetic dose or >MACbar is adequate for terminal anaesthesia.

Death occurs secondary to irreversible respiratory and cardiovascular depression for pentobarbital but a physical method must be used to confirm death. In other cases, a secondary chemical (i.e., i.v. injection of K⁺) or a physical method must be used to induce death.

Conclusion

Despite the technical challenges, it is possible and it is an ethical must to perform state of the art anesthesia in rodents according to accepted veterinary guidelines and standards. The role of the veterinary anesthetists is outmost important not only to provide state of the art anesthesia, but also to advice and teach scientists and other stakeholders. Furthermore it contributes to develop a Culture of Care at the research facility or practice which improves animal welfare, scientific quality (15), satisfaction of the staff and clients (16) and transparency for the stakeholders.

Species specific anesthesia – protocols suggestions

Mice (17, 18)

Balanced

- Buprenorphine (B) 0.1 mg/kg i.p /s.c 30 min before induction + Isoflurane/sevoflurane 1.2- 1.5 x MAC
- Fentanyl 0.04 mg/kg + midazolam 4 mg/kg s.c. 20 min before induction + Isoflurane/sevoflurane 1.2- 1.5 x MAC
Fentanyl to be repeated hourly
- S-ketamine 40 mg/kg s.c. 1-2 min before induction + Isoflurane/sevoflurane 1.5 x MAC
Ketamine to be repeated ½ dose hourly

Injection

- MMF (Medetomidine 0,5 mg/kg + Midazolam 5 mg/kg +) Fentanyl 0,05 mg/kg + isoflurane 0.5-1%
- Atipamezol 2.5 mg/kg+ flumazenil 0,5 mg/kg + naloxon 1.2 mg/kg or buprenorphine 0.1 mg/kg
- 5-10 mg/kg xylazine + 80-100 mg/kg ketamine IP

Rat (19, 20)

Balanced

- Buprenorphine (B) 0.05 mg/kg s.c 30 min before induction + Isoflurane/sevoflurane 1.2- 1.5 x MAC
- Fentanyl 0.02 mg/kg + midazolam 5 mg/kg s.c. 20 min before induction + Isoflurane/sevoflurane 1.2- 1.5 x MAC
Fentanyl to be repeated every 2 h

Injection

- Medetomidine 0.25-0.5 mg/kg + Ketamine 70 mg/kg SC
- FMM Medetomidin 0,15 mg/kg + midazolam 2 mg/kg+ 0,005 mg/kg fentanyl
- Atipamezol 0.75 mg/kg+ flumazenil 0,2 mg/kg + naloxon 0.12 mg/kg or buprenorphine 0.05 mg/kg SC, IP
- Surgical anesthesia after 10 min., duration 45 min

Guineapig (21-23)

Balanced

- Buprenorphine 0.05 mg/kg + Isoflurane (MAC 1.15 +/- 0.05 vol%) (22), sevoflurane

Injection

- Ketamine 50 mg/kg + 5 mg /kg xylazine IP
- Ketamine 50 mg/kg + dexmedetomidine 0,25 mg/kg SC or IP
- Ketamine 50 mg/kg + midazolam 1 mg/kg SC
- Alfaxalone 15 mg/kg + dexmedetomidine 0,25 mg/kg + buprenorphine 0.05 mg/kg SC
- Medetomidine 0,2mg/kg + midazolam 1 mg/kg+ 0,025 mg/kg fentanyl
- Atipamezol 1 mg/kg+ flumazenil 0,1 mg/kg + naloxon 0.03 mg/kg or buprenorphine 0.05 mg/kg SC, IP
- Surgical anesthesia after 15 min., duration 35 min

Hamster (16, 24)

Balanced

- Isoflurane/sevoflurane

Injection

- Xylazine 7 mg/kg + Ketamine 100 mg/kg

- Medetomidine 0.25 mg/kg + S-ketamine 50 mg/kg sc
- 1.5 mg/kg atipamezole
- Dexmedetomidine 0.1 mg/kg + ketamine 20 mg/kg + midazolam 1 mg/kg + hydromorphone 0.4-0.8 mg/kg
- MMF Medetomidin 0,33 mg/kg + midazolam 3.3 mg/kg+ 0,033 mg/kg fentanyl
- Atipamezol 1.7 mg/kg+ flumazenil 0,33 mg/kg + naloxon 0.8 mg/kg or buprenorphine 0.05 mg/kg SC, IP
- Surgical anesthesia after 10 min., duration 10 min

Gerbil (25, 26)

Balanced Inhalation

- Isoflurane/ sevoflurane

Injection

- Ketamine: 75 mg/kg + Dexmedetomidine: 0.25 mg/kg
- MMF Medetomidin 0,15 mg/kg + midazolam 7.5 mg/kg+ 0,03 mg/kg fentanyl
- Atipamezol 0.4 mg/kg+ flumazenil 0,4 mg/kg + naloxon 0.5 mg/kg or buprenorphine 0.05 mg/kg SC, IP
- Surgical anesthesia after 10 min., duration 10 min

Chincilla (27, 28)

- Dexmedetomidine 0.015 mg/kg + ketamine 4 mg/kg
- Medetomidin 0,33 mg/kg + midazolam 3.3 mg/kg+ 0,033 mg/kg fentanyl
- Atipamezol 1.7 mg/kg+ flumazenil 0,33 mg/kg + naloxon 0.8 mg/kg or buprenorphine 0.1 mg/kg SC, IP
- Surgical anesthesia after 10 min., duration 10 min

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Interesting resources

1. [eu21 e-learning modules](#)
2. [Lafebervet](#)
3. [Eslav_summerschool_2022](#)
4. <https://az.research.umich.edu/animalcare/guidelines/guidelines-anesthesia-and-analgesia-guinea-pigs>
5. [ULAM Hamster Anesthesia and Analgesia Guidelines](#).
6. [GV Solas Pain management in laboratory animals 2020](#)
7. [Mouse Ventilators for Laboratories | Kent Scientific](#)
8. https://research.utexas.edu/wp-content/uploads/sites/7/2020/02/Gerbil_Anesthesia_Guidance_ARC_112519.pdf

Perioperative care of reptile patients

Sandra Wenger, Dr. med. vet., DECVA, DACZM, MSc

Common reptile patients seen in veterinary practice include chelonians (turtles and tortoises) and squamates (snakes and lizards). They may require sedation or general anesthesia for physical restraint in larger uncooperative animals, or for diagnostic and surgical procedures. The information published on safe and effective protocols in reptiles continues to grow. However, interspecies variation in anatomy, physiology, and response to sedative and anesthetic drug protocols limits the ability to extrapolate from a published study performed in one species to another.

Anatomy and physiology

The metabolic rate is 1/10 to 1/3 lower than mammals and can vary quite a bit with species, temperature, age, diet, and gender. Reptiles are ectothermic and should therefore be kept within their preferred optimal temperature zones (usually between 25 - 35°C) during the perianesthetic period. If temperature decreases, metabolism will slow and prolong time to reach maximal effects, increase the duration of administered drugs and prolong recovery.

The heart is 3-chambered with 2 anatomically separated atria and a single ventricle that is functionally divided by a muscular ridge into 2 main chambers, the cavum dorsale and cavum pulmonale. Reptiles are able to shunt blood from the systemic to pulmonary circulation, and vice versa. For example, periods of apnea during diving will lead to an increase in pulmonary vascular resistance with shunting of blood “away” from the nonfunctional lung to the systemic circulation. The ability to shunt is relevant to anesthesia. R-L shunt may prolong induction and recovery when using inhalant anesthetics, make capnography difficult to interpret and affect stability and depth of anesthesia.

The glottis is typically located at the base of the tongue, quite rostrally in the oral cavity. The trachea has complete cartilaginous rings in chelonians and incomplete rings in squamates. Reptiles lack a true diaphragm and rely on thoracic and abdominal musculature for ventilation. In chelonians a pseudodiaphragm is present, which separates the lungs from the celomic cavity, and limb movements stretch this septum downward resulting in lung expansion. Immobilization during anesthesia will lead to ventilatory depression and therefore positive pressure ventilation is generally recommended in anesthetized reptiles during prolonged anesthesia. In general, gas exchange occurs in the cranial portion of the lung, while the caudal portion may be reduced to an air sac-like structure. Reptiles are predisposed to respiratory disease because of their inability to cough and their poorly developed mucociliary apparatus, and inflammatory exudates can accumulate in the dependent portion of the lungs and worsen gas exchange.

Preanesthetic phase

A complete examination should be performed prior to anesthesia and an accurate body weight obtained using a kitchen scale. A basic assessment of the cardiovascular system should include HR or pulse rate using a Doppler probe. If possible, reptiles should be acclimatized and maintained at their POTZ prior to drug administration. Fasting before anesthesia is recommended in lizards for 24 to 48 hours to ensure that gastric emptying is complete.

For IM injections, the pectoral, triceps, or caudal aspect of the biceps muscles are commonly used in chelonians and lizards and the epaxial muscles on either side of the spine, just cranial to the heart in snakes. For large volumes, the SC route is preferred. For IV injections, the jugular and tail veins are reasonable options in chelonians, the ventral tail vein is preferred in squamates and intracardial injections can also be used in snakes. For intraosseous catheter placement, the humerus, femur and tibia are used in lizards. Due to the presence of the renal and hepatic portal systems, drugs with hepatic or renal metabolism will undergo a hepatic first pass and result in lower plasma concentrations. Anesthetic and analgesics are

preferably administered in the cranial half of the body. However, IV administration of anesthetics in the ventral tail vein of lizards does not result in a hepatic first effect since the coccygeal vein in lizards drains directly into the caudal vena cava. The intracoelomic route can be used to administer isotonic crystalloids to dehydrated, ill, or anesthetized snakes.

Premedication

Alpha-2 agonists provide sedation, muscle relaxation and analgesia. They can be combined with opioids or ketamine. Sedatives are usually administered IM or seldom IV and IN.

Benzodiazepines administered alone provide sedation in only some species. Therefore they are more commonly combined with ketamine to decrease its dose, counteract muscle rigidity and avoid prolonged recoveries.

Opioids can be added to a premedication protocol to provide analgesia.

Induction

General anesthesia is generally induced with hypnotic agents, such as propofol and alfaxalone. It is recommended to avoid administering high dosages of a single anesthetic agent (e.g. ketamine or alfaxalone). Instead, protocols in which multiple drugs are combined with synergistic actions, thereby requiring lower dosages for each drug, should be considered. Propofol administered IV or IO at dosages of 5 - 10 mg/kg will cause induction in 1 to 5 minutes. Marked respiratory depression is seen with propofol. Duration is dose-dependent and lasts longer than 30 minutes with higher doses. Alfaxalone has similar effects as propofol, but can be administered both IM and IV. Dose-dependent respiratory depression is the most frequently reported side effect of alfaxalone. Ketamine can be administered IV, but the IM route is more commonly used. Moderate ketamine dosages are associated with increased heart rate, hypertension and respiratory depression. The main problems with ketamine anesthesia in reptiles are poor effect at low dosages and extended recovery periods at higher dosages. Therefore ketamine should be combined with midazolam or alpha-2-agonists.

Induction with inhalant anesthetics is often avoided because R-L shunting and potential breathholding will limit anesthetic uptake, leading to longer and more variable anesthetic induction. In lizards, the time to initial relaxation and loss of righting reflex breathing 5% isoflurane is typically 4 - 9 minutes, while the time to complete relaxation is 13 - 20 minutes depending on the species. In snakes, induction times with mask induction tend to be slightly longer.

Intubation is straightforward to perform. Owing to tracheal anatomy, short and uncuffed ETT should be used in chelonians and is preferred in lizards and snakes. For small reptiles, appropriately sized tubes can be made from IV or feeding catheters connected to an ETT adapter. The tongue of chelonians is extremely friable and should not be pulled or manipulated with hands or forceps.

Maintenance

Anesthesia is maintained using either inhalant or IV anesthetics, or a combination of both. Inhalational anesthesia can be unpredictable due to R-L shunting. The minimum alveolar concentration of isoflurane at 30°C to 35°C has been reported to be 1.9% in rat snakes, 1.8 - 2.1% in iguanas, and 1.54% in monitors. Vaporizer settings of 2 - 2.5% should be appropriate to maintain surgical anesthesia in most reptiles. There is a wide margin of safety with inhalants in reptiles. MAC decreases over time in iguanas indicating that inhaled gas levels should be decreased toward the end of lengthy procedures to fasten recovery.

Monitoring

Monitoring can be challenging in reptiles. Depth of anesthesia can be assessed by evaluating the corneal and palpebral reflexes, head withdrawal in chelonians, muscle tone, movements and reaction to painful stimuli. Muscle relaxation typically starts at the mid-body, then head, and finally reaches the tail. Cardiac monitoring can be done with an esophageal stethoscope, Doppler probe, electrocardiography (ECG), or pulse oximeter. Respiratory monitoring in reptiles is performed visually or through capnography. Pulse oximetry may be employed for oxygen trends, but is often unrewarding.

Esophageal or cloacal probes can be used and temperature should be maintained within the POTZ. Thermal support should be provided to prevent hypothermia (which will lead to decreased metabolism and prolonged recoveries). Fluids (20 - 30ml/kg) can be administered SC, IV, IO or intracoelomic.

Analgesia

Analgesia in reptiles is a developing science. Different groups of reptiles tend to respond differently to a given analgesic drug. As in other species, adequate pain management is essential and should be pre-emptive and multimodal. Opioids have been shown to be the best analgesics for reptiles. Butorphanol was commonly used in reptiles, but several papers suggest that it does not provide analgesia in reptiles. Morphine, hydromorphone, methadone and pethidine have antinoceptive effects in lizards and chelonians. Buprenorphine does not seem to be effective in reptiles. Tramadol has antinoceptive effects in reptiles and causes less respiratory depression than morphine. Tramadol is a good option for treatments at home by the owners, as it can be given orally.

NSAIDs are commonly used, but there is little scientific evidence regarding their analgesic effects. A recent article in snakes determined that COX-2 was not involved in inflammation, while COX-1 did increase with inflammation; therefore, at least in snakes, selective COX-2 inhibitors may not be effective. Because there have been no efficacy studies and few pharmacokinetic investigations with respect to NSAID administration in reptile species, appropriate dosages and frequency of administration can only be extrapolated. NSAIDs should be used with caution in reptiles with renal, hepatic or perfusion problems.

Topical application of local anesthetics, local infiltration and intrathecal anesthesia have been described in reptiles. When performed properly, intrathecal anesthesia can provide desensitization to the tail, cloaca (including phallus and clitoris), and pelvic limbs in chelonians.

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Tips and Tricks from a Zoo Vet

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When handling potentially dangerous zoo and wild animals, the safety of all creatures involved must be ensured. Special precautions and emergency protocols are strongly recommended when using highly potent opioids and alpha-2 agonists. An important task is to study the anatomical and physiological characteristics of the different taxa relevant to anesthesia and to consider seasonal variations in metabolism. Capture often requires drug delivery via remote drug delivery equipment. Major sources of injury may arise from dart impact trauma, high-velocity injection of dart contents, and inaccurate dart placement. In many settings, specially made capture gear can facilitate handling and reduce the risk of injury and stress. For transports and adaption to novel environments, the use of long-acting tranquilizers may be beneficial. Typically, these agents are of the phenothiazine, butyrophenone, or benzodiazepine drug class. The use of checklists for specific capture and anesthetic procedures is strongly recommended, and recordkeeping is essential for any anesthetic procedure, particularly to review what did or did not work, and to allow exchange of information. Most of the modern zoos use the Zoological Information and Management System (ZIMS) for data recording, and numerous useful tools related to anaesthesia are provided for zoo and wildlife veterinarians, such as species-specific anaesthesia protocols and weight estimates. Anaesthesiologists working with zoo and wild animals are also referred to the growing number of publications and textbooks. The aim of this presentation is to share some of the personal experiences gained in two scientifically managed Swiss zoos during the last years.

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Perioperative care of ferrets

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Domestic ferrets are a common pet species belonging to the Mustelid family. They often require sedation or general anesthesia for diagnostic, dental and surgical procedures. Compared with rabbits and rodents, they have a lower anesthetic-related risk of death with 0.33%. In the last ten years relatively few papers have been published specific to ferret anesthesia and analgesia.

Preanesthetic phase

Most pet ferrets are gentle and can be examined with a small amount of restraint similar to a cat. More fractious animals need to be scruffed at the back of their neck while dangling the animal in the air. A complete examination should be performed prior to anesthesia and an accurate body weight obtained. Sinus arrhythmia is common and normal heart rate varies between 180 - 250 bpm. Ferrets hide sickness and pain. Fluid deficits should be corrected prior to induction of anesthesia. Ferrets have a short gastrointestinal transit time and are prone to hypoglycemia. Therefore, fasting prior to anesthesia should be limited to 2 - 4 hours. They can still regurgitate even when fasted. If possible, blood analyses should be performed pre-operatively in elderly and ill ferrets. Minimal diagnostics include packed cell volume, total plasma protein, glucose and blood urea nitrogen.

Premedication

Premedication is advised, as in any other species, to reduce stress, anxiety and the amount of drugs required for induction, maintenance and recovery. Benzodiazepines (e.g. midazolam) and alpha-2 agonists (e.g. medetomidine) often in combination with an opioid (e.g. butorphanol, buprenorphine, methadone, fentanyl) are the most used premedications. The drugs are administered subcutaneously, intramuscularly or intravenously 10 - 15 minutes before placing a venous catheter, inducing GA or performing short diagnostics. I like to use a combination of 0.2 - 0.3 mg/kg midazolam and 0.2 - 0.3 mg/kg butorphanol administered subcutaneously in elderly ferrets. Transmucosal detomidine is an alternative route of administration to effectively sedate ferrets for physical examination and venipuncture.

Induction

Intravenous induction anesthetics that may be considered include propofol, alfaxalone, ketamine, and the less commonly used etomidate. Propofol and ketamine are routinely used in a similar fashion to cats and dogs. Alfaxalone in combination with medetomidine provided safe and effective anesthesia in ferrets. In contrast, alfaxalone, alone or in combination with tramadol, did not produce satisfactory results as an anesthetic.

Mask induction of unpremedicated individuals should be approached judiciously as this method produces a substantial degree of stress, potentially greater cardiopulmonary alterations during the induction of anesthesia, and in other species has been associated with a greater complication rate. Whenever possible, ferrets should have appropriate premedication before attempting mask induction.

Intubation is straightforward and easy to perform. Ferrets are not prone to laryngospasms, but it is still recommended to spray the laryngeal structures with lidocaine. The endotracheal tube should be secured behind the head and the forelimbs because of the ferret's craniocervical anatomy.

Maintenance

Inhalant agents are commonly used for maintenance of anesthesia. The MAC of isoflurane in ferrets is 1.5 - 1.7% and of sevoflurane is 2.6%. Both isoflurane and sevoflurane are potent negative inotropes and cause splenic capsule relaxation. Both inhalants are also potent vasodilators, a mechanism thought to underlie much of the hypotension induced by these drugs. Unpremedicated ferrets anesthetized with isoflurane became hypotensive at 1 MAC, and progressively more hypotensive at 1.5 and 2 MAC. Respiratory depression occurs in ferrets maintained on isoflurane across doses routinely administered in clinical practice. Data are not available for sevoflurane; however the side effects are suspected of being similar to isoflurane.

Total intravenous anesthesia has not been reported in ferrets.

Monitoring

Anesthetic depth monitoring includes eye position (which is usually central) and jaw tone. As hypotension is commonly seen, blood pressure should be monitored. To measure BP indirectly, a Doppler flow probe can be placed on the tail with a number 1 neonatal size cuff tightly wrapped at the base of the tail. Values below 90mmHg should be considered as hypotension as this method of BP measurement is documented to underestimate systolic BP. Oscillometric methods of detecting BP are not accurate and often do not detect a flow signal. Pulse oximetry gives information about oxygen saturation and pulse rate. Pulse oximetry is also recommended in the post-operative phase to assess if supplemental oxygen is required. Ventilation should be monitored by assessing respiratory rate and EtCO₂. Core body temperature and ECG should also be monitored.

Common anesthetic complications include a light plane of anesthesia, hypotension, hypoventilation, hypo- and hyperthermia and hypoglycemia.

Analgesia

As in other species, adequate pain management is essential and should be pre-emptive and multimodal. NSAIDs are commonly used in ferrets. Both meloxicam and carprofen are considered to be relatively safe for ferrets and can be administered orally or by subcutaneous injection. Pre-operative NSAIDs should be used with caution as intraoperative hypotension is a common complication in ferrets. Different types of opioids have been used in ferrets. Morphine can cause nausea and vomiting in ferrets and should be used with caution. Methadone, buprenorphine and butorphanol are better tolerated. Fentanyl CRI is most often used peri-operatively for painful surgeries. The analgesic efficacy of tramadol has not been described in ferrets. CRI of ketamine combined with CRI of fentanyl during and after surgery has been clinically described to provide good analgesia for the ferret.

Locoregional techniques that can be used in ferrets include incisional line blocks, local infiltration, ring blocks, splash blocks, topical application, conductive nerve blocks and epidural anesthesia. Care must be taken not to exceed maximum doses of local anesthetics, often requiring dilution of the drug to obtain an adequate volume. Specific dental blocks in ferrets include the infraorbital, mental, mandibular, and maxillary nerve blocks.

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Perioperative care of rabbits

Dr Daniela Casoni DVM, Dr.Med.Vet., DECVAA, PhD

When it comes to anaesthesia, rabbits show many similarities with horses. Not only mortality and morbidity are exceptionally high, compared to other veterinary species, but also the typical challenges of horses' anaesthesia can be surprisingly found while performing rabbits anaesthesia. We will discuss and examine the most relevant of them. In particular, we will focus on sensitivity to stress and importance of correct handling and sedation, intra-operative hypotension, usually accompanying surgical anaesthesia depth, V/Q mismatches, intra-operative and post-operative hypoxemia, intestinal motility and its impairment. There is a paucity of literature in rabbits' anaesthesia, therefore also a limited understanding of what is para-physiologic, but without consequences on the anaesthesia safety and what, at the contrary, must be promptly addressed to avoid detrimental short and long-term consequences.

Other typical challenges of rabbits' anaesthesia as endotracheal intubation and pain assessment will be examined. Tracheal intubation in rabbits is difficult, but with adequate knowledge, some tips and tricks and practice, it can be performed routinely, although a back-up plan to manage the airways in case of failure should be always decided, before commencing anaesthesia.

Evaluation of nociception and pain is definitively more challenging than in other domestic species, but with multimodal approaches that integrate subjective and objective evaluations, a satisfactory evaluation and therefore control of post-operative pain can be achieved. During this phase, it is also very important to appreciate and respect the social behaviour and exigencies of rabbits, as overlooking them could bring about very biased conclusions.

As anaesthetists, we might face the challenge of being consulted or called to lead an anaesthetic for laboratory rabbits or for exotic pets, being the first ones more standardized and having in general lower anaesthetic risk according to ASA classification, but undergoing anaesthetic for very invasive or challenging procedures. The peculiar considerations that an anaesthetist should make when working with laboratory rabbits will be examined and compared with the ones made before planning a clinical rabbit anaesthesia.

Questions will be warmly welcomed!

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Perioperative care of amphibians

Sandra Wenger, Dr. med. vet., DECVA, DACZM, MSc

In the class of amphibians are included anurans (toads and frogs), urodeles (newts and salamanders) and caecilians. They may require sedation or general anesthesia for physical restraint, diagnostic and surgical procedures.

Anatomy and physiology

Amphibians are heterothermic and should therefore be kept within their preferred optimal temperature zones (usually room temperature) during the perianesthetic period. Amphibians have 4 modes of respiration, depending on species and life stage. Tadpoles and neotenic adults use gills for branchial respiration. Adult amphibians rely on buccopharyngeal, pulmonary, and cutaneous respiration (the primary mode of respiration under a surgical plane of anesthesia) to varying degrees. In most anurans, the trachea is short or absent, with the lungs opening directly into the buccopharyngeal cavity. The amphibian integument is highly permeable and has several important functions, including fluid uptake and gas and electrolyte exchange. Many terrestrial anurans have a patch of highly permeable skin on their ventrum.

Physical restraint

Physical restraint for preanesthetic evaluation or induction can be achieved with clean, clear plastic containers. When manual restraint is required, moistened, powder-free, nonlatex gloves must be worn to reduce the risks of trauma to the amphibian skin, exposure of the patient to commensal flora of human skin, and/or transfer of residues that may be present on human hands.

Anesthetic agents

Tricaine methanesulfonate (MS-222) is an isomer of benzocaine and is routinely used in different species and life stages. It is available as a white, water-soluble powder and is dissolved in bottled, distilled or clean tank water. As it is acidic it should be buffered using twice the amount of sodium bicarbonate. MS-222 is an amide anesthetic that blocks sodium-gated ion channels impeding the conduction of action potentials. Its mechanism of central nervous system depression is not fully understood. Fully aquatic amphibians may be induced by complete immersion with access to air, but partial immersion is recommended for all other species to avoid drowning. Concentrations between 0.2 - 2g/L are described depending on species and life stage. MS-222 induction times usually are less than 30 minutes, with higher MS-222 concentrations leading to shorter induction times. Once the desired anesthetic plane is achieved, or at 30 minutes, the patient is removed from the MS-222 induction solution and rinsed with anesthetic-free water to prevent excessive anesthetic depth. If a patient's anesthetic plane subsequently lightens prior to conclusion of the procedure, immersion in a bath at half the induction concentration can be used to increase anesthetic depth. MS-222 causes respiratory depression and RR decreases. MS-222 is excreted by the kidneys and/or skin; therefore, keeping the skin moistened with anesthetic-free water can hasten anesthetic recovery. For aquatic amphibians, gently rocking the animal may hasten recovery by encouraging gas exchange.

Benzocaine and essential oils such as clove oil have also been used successfully to anesthetize amphibians. They are used in a similar manner to MS-222, but do not need to be buffered.

In amphibians, they have been administered topically, via immersion (bath), injection, and inhalation.

Administration of 2 - 5% isoflurane in oxygen into an airtight chamber has been reported to induce surgical anesthesia within 5 - 20 minutes. Amphibians often resume spontaneous movement as soon as they are removed from the induction chamber, limiting the clinical usefulness of these protocols. Placing cotton or gauze-soaked inhalant on the animal may be more effective. Although animals often exhibit excitement initially when exposed to isoflurane-soaked gauze, induction of anesthesia is rapid within a few minutes. Duration of anesthesia may be up to 40 minutes and recovery time may be prolonged.

Injectable anesthetics generally are considered unreliable in amphibians and can be associated with narrow margins of safety. Propofol may be administered to amphibians IV, intracoelomically, or by immersion, but results generally are inconsistent. Ketamine is associated with muscle contractions and rigidity and prolonged recovery times (up to 12 - 18 hours). Medetomidine alone did not produce sedation and caused cardiopulmonary depression in leopard frogs. In juvenile blue poison dart frogs, dexmedetomidine and midazolam combined with either ketamine or alfaxalone resulted in a rapid loss of righting reflex. Alfaxalone can be used to sedate amphibians via IM and SC routes and by immersion. As in other species, alfaxalone has no analgesic effects.

Monitoring

Anesthetic depth should be monitored. A loss of the righting reflex often is the first indication of sedation or induction of anesthesia. In most species, light anesthesia is indicated by loss of withdrawal reflex, cessation of gular respiration, and loss of the corneal reflex. Under a surgical plane of anesthesia, all reflexes, including response to deep pain and abdominal respirations, are absent. Deep pain can be assessed by firmly pinching a digit, being careful to not damage the tissue.

Gular pumping and abdominal breathing are monitored to assess the respiratory system. Maintaining moist skin promotes gas exchange and prevents dehydration. Heart rate is monitored by visual observation, ultrasonography, or Doppler ultrasound. A significant decrease in HR from baseline (>20%) may suggest the patient is in a deep plane of anesthesia. ECG is not recommended because leads may be traumatic and the use of alcohol can be deleterious. A pulse oximetry device may be used to collect HR and rhythm, but is unreliable for oxygen assessment in amphibians.

Analgesia

All mammalian opioid receptors (μ , δ , and κ) are present in the central nervous system of amphibians. Relative to mammals, extremely high doses are required to achieve analgesia, onset of effect is longer and sedation has not been a reported side effect. Alpha-2 agonists provide analgesia without sedation. Onset of effect is rapid and long lasting, with peak effect occurring by 60 minutes and lasting for 6 - 8 hours or more. Little good data exist using NSAIDs in amphibians. Local anesthetics have been sparsely investigated in amphibians. In American bullfrogs, topical lidocaine caused dose-dependent sedation without evidence of local antinociception at the site of application.

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From Animal Models to Human Models in Translational Pain Medicine

Prof Michele Curatolo

Human models of pain typically consist in delivering a stimulus and recording a response related to pain. Many methods are available, virtually all derived from animal models. Most of them explore modulatory processes. Examples include methods to assess facilitation of pain (temporal summation), endogenous pain inhibition (conditioned pain modulation), thermal or mechanical pain sensitivity, and allodynia (pain with innocuous stimuli).

Human models have been invaluable in elucidating mechanisms of human pain, such as sensitization, augmentation, and inhibition. They have been also used to evaluate the efficacy of medications in healthy volunteers, and explore mechanisms underlying their action. Human models have limitation. They do not provide information on pathways and molecular mechanisms. Human models have been studied as potential predictive and prognostic biomarkers, but the results are preliminary and inconsistent. When the efficacy of medication is evaluated in healthy volunteers, sensitivity and specificity to predict drug efficacy in patients may be insufficient.

There are, however, perspectives. Human models can be studied as part of biomarker signatures, rather than being considered as sole potential biomarkers. Methods to study mechanisms of human pain are greatly improving and include, among others, RNA sequencing, epigenetics, and omics. In human studies on molecular mechanisms, pain models can be very useful to phenotype patients. This can shed light on which molecular and functional characteristics cause patient-relevant phenotypes. This paradigm shift is currently applied to running investigations that involve sampling of human tissues from thoroughly phenotyped surgical patients and organ donors.

Novel insight into regional analgesia

Prof Urs Eichenberger

Regional anaesthesia and especially regional analgesia by delivering local anaesthetics continuously over small catheters are old and effective methods for perioperative pain control in humans and animals. Over the last decades the techniques to bring the local anaesthetic to the target - the nerve to be blocked - have changed from landmark methods over the stimulation of motor nerve fibres by applying electrical current over the needle tip to the direct visualization of the needle, the catheters and the injected solution by using real time ultrasound imaging. Ultrasound guidance offers several advantages compared to the other techniques such as higher success rates, the ability to block only sensory nerves and a reduction in complications related to the puncture. Furthermore, an increase in the specificity of the nerve blocks could be achieved because the volume of the injected drug can be reduced significantly. This leads to a more specific diagnostic block in chronic pain patients and lowered the rate of local anaesthetic systemic toxic events in the field of regional anaesthesia. Nevertheless, it was up to date not possible to prove a reduction in nerve injuries by using ultrasound guidance compared to older methods. The successful use of ultrasound to block nerves is not easier to learn than other techniques mentioned above. But the possibility to directly visualize what we do under the surface of the body by using ultrasound is a direct motivation and stimulates to learn, to teach and helped to spread regional anaesthetic and analgesic knowledge during the past years in human and veterinarian medicine.

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Glia in pain, from bench to bedside

Dr Marc Suter

Glia, the non-neuronal cells of nervous system, are now clearly established participants to the development and maintenance of chronic pain processes. Microglia in the spinal cord modify their phenotype following peripheral nerve injury. This encompasses a more amoeboid shape, proliferation, and new expression of markers and cytokines. Newly, we also showed a short-lived hyperpolarization of their membrane potential due to increased potassium channel at the membrane, which could trigger proliferation. Modulating membrane potential of microglia could be a more desirable approach than fully inhibiting their changes.

Peripheral electrical activity is one source of microglial modification, but the type of nerve fibers involved is still unclear. There is an interest in identifying which fibers need to be blocked in order to prevent changes after surgery or trauma. Using genetically modified animals, we try to unravel if small nociceptive or large fibers play the major role in this signaling.

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Principles of nociceptive coding in the cortex

Prof Dr Thomas Nevian

The perception of pain is a multidimensional sensory and emotional/affective experience arising from distributed brain activity (1). However, the involved brain regions are not specific for pain (2). Thus, how the cortex distinguishes nociception from other aversive and salient sensory stimuli is not fully understood (3). Additionally, the resulting consequences of chronic neuropathic pain on sensory processing have not been characterized fully. There are a multitude of neuronal plasticity mechanisms occurring during the transition to chronic pain that might change neuronal network function (4). We will discuss some of these plastic changes and how they influence the neuronal network dynamics in the cortex (5-7). Using *in vivo* calcium imaging with cellular resolution in mice, we elucidated the principles of nociceptive and sensory coding in the anterior cingulate cortex (ACC), a region essential for pain processing and pain affect. Population activity, not single cell responses, allowed discriminating nociceptive stimuli and associated behavioral responses, ruling out the existence of nociception-specific neurons in this brain area. Additionally, single-cell stimulus selectivity was highly dynamic over time, but stimulus representation at the population level remained stable. Peripheral nerve injury-induced chronic neuropathic pain led to dysfunctional decoding of sensory events by enhancing saliency-detection and impairment of pattern separation and stimulus classification. Analgesic treatment with gabapentin restored normal network function. These findings provide a novel interpretation for altered cortical sensory processing in chronic neuropathic pain and shed light onto the effects of systemic analgesic treatment in the cortex.

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Sodium channels and iPSC-cell derived sensory neurons for pain research

Prof Angelika Lampert

Neuropathic pain is a health burden for humans and animals alike and effective treatment is hard to find. We use pig DRGs, also because their skin and innervation of it is similar to humans, especially as they are displaying sleeping nociceptors much more frequently compared to rodents. We apply specific stimulation paradigms during patch clamp and collect each recorded cell for scRNAseq (PatchSeq). This in-depth characterization will hopefully help to functionally and genetically classify sensory neurons to link these findings to neuropathic pain.

Genetically encoded pain syndromes offer the chance to study mechanisms of chronic pain on a cellular level: induced pluripotent stem cells (iPSC) from patients carrying pain-causing mutations can be reprogrammed and differentiated into nociceptors in the dish. This system allows us to study the role of voltage gated sodium channels, e.g. Nav1.7, in action potential firing. Using patch-clamp electrophysiology, we find that Nav1.7 is not active during subthreshold depolarizations, but that its activity defines the action potential threshold and contributes to the action potential upstroke.

Ultimately, our goal is to identify personalized medicine for individual, treatment-resistant patients using iPSC derived nociceptors. In a case of a Caucasian patient suffering from severe small fiber neuropathy (SFN), we can report a first example of *in-vitro* predicted individualized treatment success. Using iPSC-derived patient nociceptors, we can identify patient specific firing patterns which can be directly correlated to clinical findings. Multi-electrode array recordings and transcriptomic approaches support diagnostics and functional/genetic characterization on a cellular level. This approach could open a way for successful companion diagnostics and personalized medicine.

Glycine and GABA in Pain and Itch Control

Prof Hanns Ulrich Zeilhofer

The spinal dorsal horn serves as the first site of synaptic integration of nociceptive and pruritoceptive information in the CNS. At this site, sensory fibers make synaptic contacts with nociceptive and non-nociceptive projection neurons and a large variety of excitatory and inhibitory interneurons. These dorsal horn interneurons serve pivotal functions in pathological pain and likely also in pathological itch conditions. Excitatory interneurons form microcircuits which connect incoming non-nociceptive (mainly tactile) fibers with normally nociceptive-specific projection neurons giving rise to touch-evoked pain, also known as allodynia. These excitatory pathways are normally silenced by inhibitory interneurons which use GABA and/or glycine for fast inhibitory neurotransmission [1,2]. Work from several laboratories including ours has identified molecular pathways that disinhibit the normally silent allodynia provoking microcircuits [3]. Preclinical work in rodents suggests that restoring inhibitory control in the spinal dorsal horn using subtype specific GABA_A and glycine receptor modulators should be well-suited to reduce symptoms in pathological pain and itch conditions [4,5].

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Can FACS be used to quantify pain in animals?

Prof Bridget M Waller

Facial expressions are ubiquitous among social primates, including humans, often appearing physically and functionally similar across species. As human facial expressions can be associated with emotion, there is a strong temptation to try and use these expressions as indicators of internal state (including pain) in other animals. However, I argue that associating these behaviours with emotion a priori can bias our interpretation of meaning and cause us to overlook function. The development of species-specific anatomically based coding systems (Facial Action Coding Systems: FACS) has greatly facilitated within-species and cross-species comparisons, which removes the focus on emotion and instead allows us to analyse the form and function of signals in detail, examining the role of subtle changes in facial movement during a social interaction. FACS can also be used to quantify expressivity in a species and explore its relationship with socio-ecological variables in related species, thus helping us understand the evolutionary function. Overall, our initial studies using such tools are helping to build an evolutionary framework for a better understanding of facial expression, its relationship with emotion and how it can and cannot be used in applied settings.

Integrative pain medicine: evidence & practice in humans and links to the veterinary setting

Prof Chantal Berna Renella

The principles of integrative medicine will be presented. This discipline proposes to combine evidence-based complementary medicine with conventional medical care (Fortney et al., 2010). It involves a bio-psycho-socio-spiritual model. Attention to the therapeutic alliance and other factors that can amplify non-specific treatment effects, as well as promotion of self-care are also key (Maizes et al., 2009).

The application of integrative medicine to pain management will be described (Zurron & Berna, 2019). Integrative pain medicine has grown thanks to different elements, which we will take time to examine, including the growing evidence regarding effective analgesic complementary medicine techniques (Nahin et al., 2016; Tick et al., 2018), new understanding about the physiopathology of chronic pain (e.g. Simons et al., 2014), and concerns regarding the risks of chronic medication use (Volkow & McLellan, 2016). Examples from the practice of integrative pain medicine at Lausanne University hospital will be provided. This will open to conceptual links to the veterinary field.

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Back-translating from human models of nociception to clinical pain assessment in veterinary medicine

Prof Lars Arendt-Nielsen. Dr. med., PhD

Over the last four decades the number of research papers on nociception and pain has increased enormously, leading to impressive advances in the basic knowledge. Studies in animals have been highly successful in providing mechanistic knowledge leading to a better 1) understanding of fundamental pain mechanisms, 2) finding new targets for analgesic compounds, and 3) helping characterisation of clinical signs and symptoms which together has led to a more rational use of available treatments. Although parts of this knowledge have been translated into the benefit of human patients, the treatment of chronic pain is still generally unsatisfactory.

This forward-translation approach has been the traditional approach but as human mechanism-based pain assessments for diagnostic purposes have progressed significantly more and more focus has been paid to back-translation of knowledge from human clinical sciences into veterinarian pain diagnostics and management.

Human, clinical, quantitative pain assessment based on psychophysical (based on the patient's feedback) quantitative sensory testing (QST) or electrophysiological pain biomarker methods have been applied to systematically document alterations and reorganisation in nervous system function and in particular the nociceptive system.

Human pain biomarkers can be related to a single painful stimulus or to a more advanced stimulus paradigms which will activate different mechanisms such as temporal summation, descending pain modulation, reflex receptive fields and referred pain. Such human validated models have now been successful back-translated into veterinarian sciences as behavioural or electrophysiological tests. In recent years the field has taken a new direction where environmentally provoked epigenetic alterations have been found in humans and leaving them more sensitive to pain and development of chronic pain. This field may in the future likewise be investigated in veterinarian pain sciences.

Human, mechanistic, experimental and clinical pain research have provided concept to bridge 1) the gap between traditional rodent basic research into veterinarian pain sciences and 2) the gap between human clinical pain sciences and veterinarian pain sciences and management. New human pain bio-marker approaches are in the horizon waiting to be back-translated into veterinarian pain sciences and management.

Aether-o-mania 1847 in Europe, revisited

Prof Yves Moens

WG Morton administered -successfully - ether by inhalation to a patient scheduled for surgery on 16 October 1846 at the General Massachusetts Hospital in Boston, USA. The news of this first public demonstration took 2 months to reach London but from this moment first ether anaesthesia performances happened in European countries at an incredible speed beginning with UK, France, and Germany. By mid 1847 there were thousands of interventions in hundreds of hospitals in many European countries. The speed was largely spread via newspapers, medical journals and personal communication. Whereas in North America disputes about patents and inventorship dominated in the beginning this did not play a role in Europe. Here an investigative approach both clinically and experimentally, dominated and so promoted a steep learning curve. In 1847 hundreds of monographies and dissertations about ether were published.

This presentation highlights very briefly the work of three maybe lesser-known protagonists: one surgeon and two veterinarians, who all starting very early in 1847, contributed with both experimental and clinical work.

Nicolai Ivanovich Pirogoff is a monument in medical history in Russia and Ukraine. He started early in 1847 surgical interventions under ether in humans using his own designed apparatus. He performed experiments on dogs to elucidate the mechanism of action of ether. He defined 4 stages of ether anaesthesia and introduced the technique of rectal application of ether in humans.

Théodore Thiernes was Professor at the Veterinary school of Cureghem (Brussels) in Belgium. He performed and documented in great detail clinical surgical procedures under ether anaesthesia in domestic animals using specifically designed apparatus. Similarly, he produced well documented experimental work on mammals, birds, fish, amphibians and insects.

Joseph Seifert was surgeon, blacksmith, veterinarian of the Imperial Court and Director of the Imperial Stables in Vienna. He performed numerous surgeries in horses under classic ether anaesthesia using specific apparatus but explored the technique of rectal anaesthesia as well. He examined the over the time presence of ether in venous blood and examined the organoleptic properties of meat and milk in ruminants who underwent ether anaesthesia and the influence on the living foetus.

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- ✓ Choice between volume or pressure controlled
- ✓ PEEP
- ✓ 5 liter breathing bag (smaller sizes on request)

ORAL SESSIONS

The effect of metoclopramide on food intake and faecal output in healthy rabbits undergoing sedation

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This study aimed to investigate whether metoclopramide affected food intake and faecal output. Reduced feed intake and faecal output are associated with ileus, a complication of rabbit anaesthesia (Oglesbee and Lord. 2020).

In this randomized, blinded, crossover study, fourteen female New Zealand White Rabbits aged 25-27 weeks undergoing sedation for radiography were divided into two groups: MET (metoclopramide 0.5 mg kg⁻¹ SC) and CONTROL (no treatment). After 30-minute sedation with medetomidine (200 µg kg⁻¹), fentanyl (5 µg kg⁻¹) and midazolam (0.5 mg kg⁻¹) IM, atipamezole (0.5 mg kg⁻¹ IM) was administered and metoclopramide according to group allocation (T0). At T4, 8, 12, and 20 hours, faeces were collected and weighed. Pelleted food was weighed, and intake calculated. Two weeks later, the study was repeated in crossover groups. Food was not withheld at any time pre- or post-sedation. Data were analysed using Wilcoxon signed-rank tests for matched samples; significant if $p < 0.05$.

No significant differences were detected between the groups in food intake and faecal output at any time point. Ten rabbits in CONTROL and nine rabbits in MET ate hay by T4. Nine rabbits in CONTROL and eight rabbits in MET ate pelleted food by T4. Nine rabbits in each group produced faeces by T4, all rabbits produced faeces by T8.

Metoclopramide did not change markers of GI motility in healthy rabbits after sedation. The dose range for metoclopramide is large (0.1 – 2 mg kg⁻¹) (De Vito et al. 2015) and therefore alternative dosing regimens should be investigated.

De Vito V, Kim TW, Rota S et al. (2015) Pharmacokinetics of metoclopramide after intra-arterial, Intramuscular, Subcutaneous, and per-rectal administration in rabbits. J Exot Pet Med 24, 361-366

Oglesbee, BL, Lord B (2020). Gastrointestinal Diseases of Rabbits. Ferrets, Rabbits, and Rodents, 174–187.

Evaluation of three doses of oral trazodone and its impact on handling, activity, and physiological parameters in rabbits: a prospective randomized blinded cross-over study

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Trazodone reduces stress in many species. In rabbits, however, no study has determined the minimal effective dose of trazodone required to induce behavioral changes and its safety profile.

This study aimed to determine the minimal effective dose of trazodone on handling and activity in rabbits and to evaluate changes in physiological and arterial blood gas parameters. Eight intact female New Zealand White rabbits (2-month-old; 1.66 ± 0.12 kg) were included in this prospective, blinded, randomized cross-over study. After 6-days of acclimation, rabbits randomly received placebo or trazodone 10, 20 or 30 mg kg⁻¹ orally (TRAZ10, TRAZ20, TRAZ30; T0) with a 1-week wash-out period. Compliance scoring (dynamic interactive visual analog scale; DIVAS), activity levels measured with accelerometry (T0 - T600), physiological parameters (temperature, HR, f_R), and arterial blood gas parameters (up to T240) were evaluated. Compliance scores, accelerometry, physiological and arterial blood gas parameters and the prevalence of hypoxemia ($PaO_2 < 60$ mmHg) were analyzed using linear mixed models and Chi-squared tests, respectively ($p < 0.05$).

When compared with placebo, DIVAS scores were significantly higher at T80-120, T40-120 and T120-200 in TRAZ10, TRAZ20 and TRAZ30 post-administration, respectively. When compared with baseline, DIVAS scores were significantly higher from T80-160, T40-240 and T80-200 in TRAZ10, TRAZ20 and TRAZ30, respectively. All other parameters were not significantly different. In TRAZ30, hypoxemia was observed in 2/8 rabbits ($p = 0.06$).

In conclusion, oral trazodone improved rabbit compliance at all studied dosages. At 20 mg kg⁻¹ trazodone improved rabbit compliance for over three hours without causing hypoxemia.

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Pharmacopuncture: Comparison of the effects of dexmedetomidine administered at the GV20 acupoint, subcutaneously on the head or intramuscularly in laboratory rabbits

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This prospective, randomized, blinded, cross-over study aimed to explore the efficacy of a low dose of dexmedetomidine injected SC on the head (GV20 acupoint and non-acupoint) and IM in rabbits.

Eight intact female New Zealand White rabbits (5-month-old; 3.29 ± 0.23 kg) were randomly administered $10 \mu\text{g kg}^{-1}$ of dexmedetomidine SC on the GV20 acupoint, SC lateral to the ear and IM (lumbar muscles) with a 24-hour wash-out period. A blinded evaluator assessed onset of action and degree of sedation every 5 minutes up to 60 minutes, with a validated sedation Numerical Rating Scale (NRS; Raulic et al. 2021) and a Dynamic Interactive Visual Analogue Scale (DIVAS). Physiological parameters (HR, fR, temperature) and adverse events were also recorded. Multiple pairwise comparisons and Benjamini-Hochberg corrections were performed among times and treatment-groups after data was log-transformed for normal distribution ($p < 0.05$).

Regardless of the administration route, rabbits were safely sedated with dexmedetomidine (time effect $p \leq 0.001$). Two rabbits showed abnormal behaviors and the sedation was repeated after one week. Sedation level was not different between groups ($p = 0.150$ and $p = 0.442$; NRS and DIVAS respectively). Time and treatment affected changes in HR ($p \leq 0.001$ and $p = 0.004$) and temperature ($p \leq 0.001$ and $p = 0.016$) respectively. Only time affected fR ($p \leq 0.001$ and $p = 0.112$; time-treatment respectively).

In conclusion, in rabbits a low dose of dexmedetomidine administered GV20 or SC on the head produced mild sedation similar to that observed after IM administration.

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, 549-555.

Funding: The research project was supported by internal funds of the Department of Clinical Sciences, Faculty of Veterinary Medicine of the University of Montreal.

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

Ethical approval: This project was approved by the Institutional Animal Care and Use Committee of the University of Montreal (21-Rech-2135).

Conflict of Interest: The authors have no conflict of interest to declare.

Methadone versus buprenorphine in New Zealand white rabbits undergoing calvarium surgery

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Buprenorphine has gained widespread popularity in rabbits, while much less is known about methadone. Our aim was to compare sedative, anti-nociceptive and respiratory effects of methadone and buprenorphine as part of balanced anaesthesia.

Forty-eight New Zealand White rabbits undergoing calvarium defects were randomly equally assigned to receive either 0.03 mg Kg⁻¹ buprenorphine (group B) or 0.3 mg Kg⁻¹ methadone (group M) in combination with 15 mg Kg⁻¹ ketamine and 0.01 mg Kg⁻¹ dexmedetomidine SC. Fifteen minutes after, sedation was scored (modified from Raekallio et al. 2002). A laryngeal mask was placed, anaesthesia was maintained in spontaneous breathing with isoflurane in oxygen (maximal Et Isoflurane 1.3%). Rescue analgesia was administered if MAP or RR increased at least 20% from baseline. Arterial blood gases were analysed intraoperatively and 30 minutes after removal of the laryngeal mask. The relative risk (rR) of receiving rescue analgesia was calculated. Intraoperative PaO₂, PaCO₂ (mmHg), pH, degree of sedation, postoperative pH and PaCO₂ were compared between groups with Mann-Whitney test.

Results are presented in table as median and interquartile range:

	Group M	Group B	p
Sedation score	9 (7.25 – 10)	8 (6 – 9)	0.026
Intraoperative pH	7.29 (7.27-7.32)	7.29 (7.27-7.33)	0.632
Intraoperative PaO ₂	365.5 (317.25- 406.5)	313 (204.5- 399)	0.132
Intraoperative PaCO ₂	69.05 (60.82- 76.12)	74.1 (64.72- 83)	0.122
Post-operative pH	7.44 (7.4 – 7.48)	7.44 (7.4- 7.47)	0.854
Post-operative PaCO ₂	52.5 (47.5-57.65)	55.7 (49.5-59.25)	0.28
rR rescue analgesia	1.4		0.739

Groups M and B showed non-different short-term respiratory acidosis and anti-nociception, with deeper sedation in group M.

Raekallio, M., Ansah, O. B., Kuusela, E., Vainio, O. (2002) Some factors influencing the level of clinical sedation induced by medetomidine in rabbits. J. Vet. Pharmacol. Therap, 25,39-42

Pharmacokinetics of gamma-hydroxybutyric acid in juvenile swine after intravenous and oral administration

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Gamma-hydroxybutyric acid (GHB) is an endogenous neuromodulator with sedative and protective effects during hypoxia in humans and animals. The pharmacokinetics of GHB were studied in juvenile swine after IV and PO administration. Six juvenile swine received 500 mg kg⁻¹ GHB IV, and 500 and 750 mg kg⁻¹ GHB PO, in a randomized cross-over design. Dried blood samples were analyzed using a gas chromatography-mass spectrometry method followed by non-compartmental pharmacokinetic modeling.

Mean peak plasma concentrations after PO administration were 2471 ± 312 and 3904 ± 1028 µg ml⁻¹ for 500 and 750 mg kg⁻¹ respectively. These were respectively recorded at 1.30 ± 0.25 and 1.49 ± 0.39 hours after PO administration. Maximal plasma concentration after IV administration was 13295 ± 2014 µg ml⁻¹, with a volume of distribution of 55 ± 9 mL kg⁻¹ and clearance of 23.06 ± 4.29 mL kg⁻¹ h⁻¹. Elimination half-lives for IV and PO 500 and 750 mg kg⁻¹ were 1.26 ± 0.34 , 0.98 ± 0.19 and 0.96 ± 0.39 hours respectively. The bioavailability for 500 mg kg⁻¹ PO administration was 41%. Area under the curve / dose for PO 500 and 750 mg kg⁻¹ were 17.8 ± 1.8 and 19.9 ± 7.0 kg h L⁻¹ respectively. No clear sedation was seen after PO administration. Deep sleep was seen in 1 animal after IV administration, other animals showed head pressing and ataxia.

The pharmacokinetic analysis suggests linear kinetics, which differs from findings in other species, but further research is needed to confirm this.

Patient state index and suppression ratio response during nociception in pigs undergoing front-limb amputation

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The utility of processed EEG monitors in assessing intraoperative nociception is still debated (García et al. 2021). We aimed at evaluating the influence of nociception on patient state index (PSI), suppression ratio (SR) and HR in pigs.

Fifteen pigs undergoing front-limb amputation in general anaesthesia were enrolled. After IM dexmedetomidine 0.02 mg kg⁻¹, ketamine 10 mg kg⁻¹ and methadone 0.2 mg kg⁻¹, anaesthesia was induced with IV ketamine 1 mg kg⁻¹ and propofol to effect and maintained with isoflurane in oxygen and air. Paravertebral cervical block was performed. Nociception (N) was defined as MAP increase $\geq 20\%$ compared to baseline. Values of PSI, SR and HR were recorded at N, 5 (5AN) and 10 (10AN) minutes after N and compared with ANOVA on rank.

Twenty-two nociceptive events were recorded. No significant differences were found for PSI and SR ($p = 0.306$; $p = 0.059$).

Heart rate was significantly lower at N, 5AN and 10AN compared to baseline ($p < 0.001$).

MAP (mmHg)	Median	25 %	75 %
Baseline	66	61.7	69.5
N	92	83.2	102
5AN	88	81	98
10N	86	78.7	98
PSI	Median	25 %	75 %
Baseline	22	21	25
N	22.5	20	26.2
5AN	21.5	18.7	24
10AN	21	19	24.5
SR	Median	25 %	75 %
Baseline	0	0	0
N	4	0	15
5AN	6	0	24
10AN	4	0	23
HR	Median	25 %	75 %
Baseline	111.5	105.7	125.7
N	97.5	84	104.7
5AN	97.5	85.7	108.2
10AN	97	87.5	108

Nociceptive stimulus triggered a decrease in HR without being mirrored by PSI. Suppression ratio showed a positive trend.

García PS, Kreuzer M, Hight D et al. (2021) Effects of noxious stimulation on the electroencephalogram during general anaesthesia: a narrative review and approach to analgesic titration. *Brit J Anaesth* 126, 445–457.

Correlation of Sedline-generated variables with anaesthetic depth in propofol anaesthetized pigs

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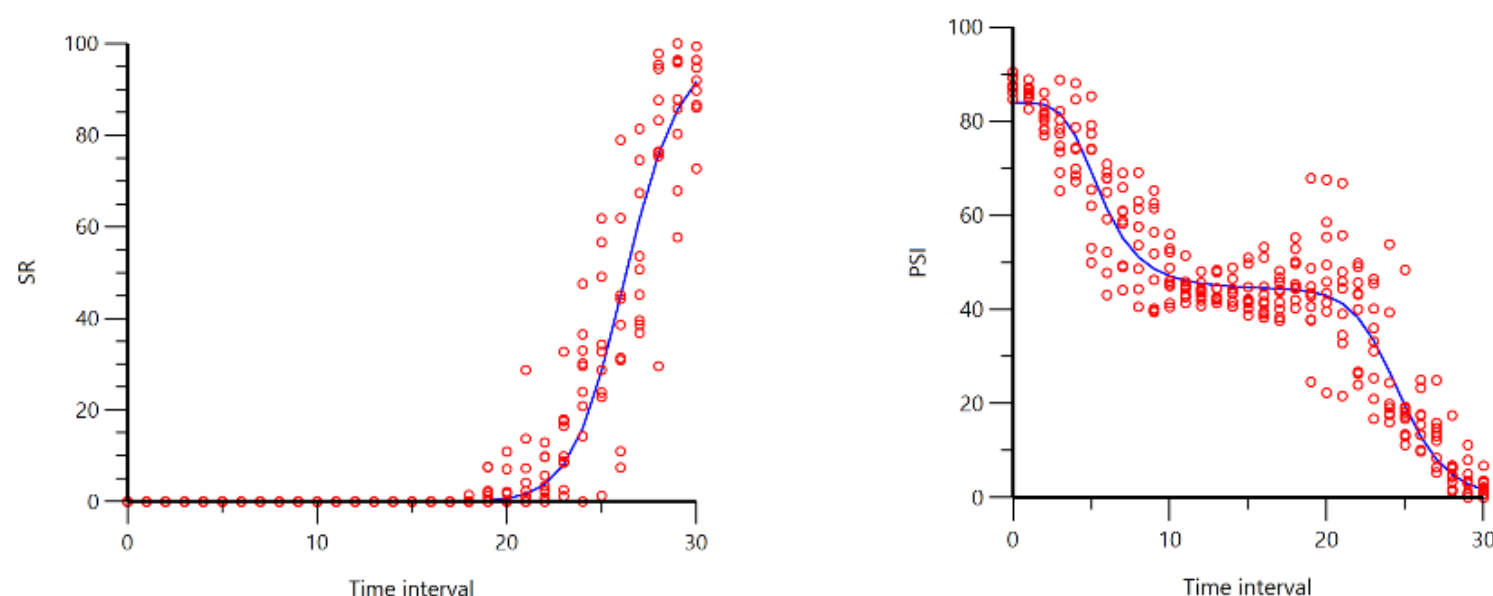
Few depth of anaesthesia (DoA) monitors have been studied in pigs. We investigated the dose-effect relationship between increasing propofol dose and variables generated by the EEG-DoA monitor Sedline.

Nine pigs (11 ± 0.5 weeks old; 30 ± 4.6 kg) were included. An ethical approval was obtained. Propofol infusion was administered at $10 \text{ mg kg}^{-1} \text{ h}^{-1}$, increased by $10 \text{ mg kg}^{-1} \text{ h}^{-1}$ every 15 minutes, and stopped when an EEG suppression ratio (SR) $>80\%$ was reached. Endotracheal intubation was performed as deemed appropriate by the anaesthetist. At the end of the investigation, the animals were euthanised. The best pharmacodynamic model was assessed for patient state index (PSI), SR and spectral edge frequency (SEF) 95% in response to propofol administration, by visual analysis of goodness-of-fit plots, -2LL significance ($p < 0.05$), Akaike and Bayesian information criterion. Anaesthesia duration was normalized among pigs (30 time intervals) to compare data at equipotent propofol doses.

The decrease of PSI best fitted an inhibitory double-sigmoid model (including a plateau at $\text{PSI} = 44$); the increase of SR fitted a typical sigmoid E_{max} model (Fig.1). No relevant relationship could be identified between SEF 95% and propofol administration.

The relationship between propofol dose and PSI/SR described can be used for prediction in future investigations.

Fig 1. Observed data (circles) and prediction from the final population model (line) for PSI and SR values during increasing propofol infusion rate. The time axis shows the normalized time intervals.



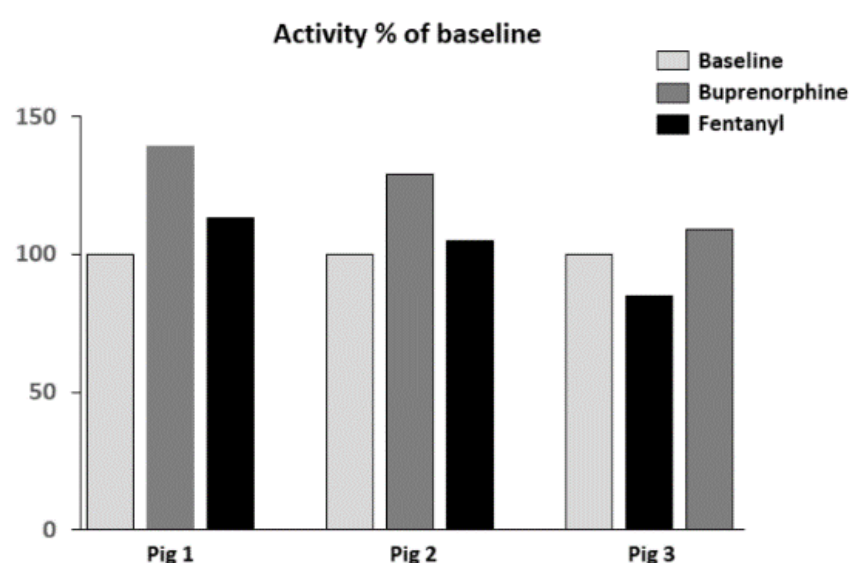
Application of an AI technology based on image vision for objective assessment of activity in pigs receiving fentanyl or buprenorphine – a pilot study

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Pigs should have adequate pain relief when surgical procedures are performed. Pain evaluation has so far been based on direct observations of pain-related behaviours, and evaluation of recordings of activity and behaviours (Malavasi et al. 2005; Luna et al. 2020).

An artificial intelligence (AI) technique based on image vision was adapted for the monitoring of pigs' activity. The average activity three days prior to anaesthesia without surgery or noxious stimulus was compared to average activity three days post-anaesthesia. The pigs were randomly allocated to treatment with fentanyl patch ($100 \mu\text{g h}^{-1}$) or buprenorphine injectable solution (0.03 mg kg^{-1}). Baseline measurements were collected during three days before anaesthesia and the start of treatment. The pigs were treated three days with either transdermal fentanyl or buprenorphine injections. Plasma concentrations of the drugs were analysed.



Based on the AI data, activity levels could be analysed. After treatment with transdermal fentanyl, the activity of the animals increased compared to baseline by 13% and 5% in two pigs and decreased with 15% in one pig. When pigs received buprenorphine, their activity levels based on the data increased by 39%, 29% and 9% respectively. Treatment with both opioids, resulted in plasma concentrations above the suggested therapeutic levels.

The study showed that the use of AI technology for measurement of activity was promising. In the future, the technique might be used as a tool to evaluate activity among pigs expressing pain or discomfort.

Average activity of three pigs post-anaesthesia measured with AI technique as percent of baseline.

Luna, S.P.L., de Araújo, A.L., da Nóbrega Neto, P.I., Brondani, J.T., de Oliveira, F.A., Azerêdo, L., Telles, F.G. & Trindade, P.H.E. (2020). Validation of the UNESP-Botucatu pig composite acute pain scale (UPAPS). PLoS One, 15(6), e0233552.

Malavasi, L.M., Augustsson, H., Jensen-Waern, M. & Nyman, G. (2005). The effect of transdermal delivery of fentanyl on activity in growing pigs. Acta Vet Scand, 46(3), 149-57.

Description and feasibility of a modified periconal block: a cadaveric study in dogs

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This prospective, randomized, blinded, exploratory study described the injectate spread following a modified periconal block technique using an over-the-needle intravenous catheter.

A dye-lidocaine solution was injected into 10 thawed canine heads (20 eyes) using a catheter inserted subconjunctival at the medial third of the dorsal eyelid and slid to the apex of the extraocular muscle cone (EOMC). The eyes of each dog were injected randomly with low volume (LV; 0.1 mL cm⁻¹ cranial length) or high volume (HV; 0.2 mL cm⁻¹ cranial length) (Klaumann et al. 2018). Sixteen eyes were dissected and the injectate spread was scored as 0%, 25%, 50%, 75%, 100% based on its approximate contact area around the EOMC apex and the globe. In two dogs, gadodiamide was added to the injectate and magnetic resonance imaging (MRI) was performed post-injection. Comparisons between HV and LV were performed using Wilcoxon signed-rank test ($p < 0.05$).

Mean cranial length was 14 ± 0.93 cm, LV and HV were 1.43 ± 0.09 and 2.85 ± 0.18 mL, respectively. MRI and dissections showed an injectate pattern around the EOMC. HV and LV resulted in a median (IQ25-IQ75) spread of 100% (100-100%) and 100% (75-100%) ($p = 0.125$) at the EOMC apex, and 75% (50-100%) and 50% (6-50%) ($p = 0.046$) around the globe, respectively.

This periconal technique is feasible in dogs. The two volumes resulted in a similar spread around the EOMC and the globe, but HV produced a wider spread than LV, therefore its efficacy should be evaluated clinically.

Klaumann PR, Moreno JCD, Montiani-Ferreira F (2018) A morphometric study of the canine skull and periorbita and its implications for regional ocular anesthesia. *Vet Ophthalmol.* 21: 19–26.

Anti-nociceptive and behavioural effects of butorphanol alone or in combination with detomidine in experimental calves. A prospective, randomized, blinded cross-over study

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Aim of this study was to evaluate the antinociceptive efficacy of butorphanol alone or combined with detomidine in calves, using the electrically evoked trigemino-cervical reflex (TCR) model (Casoni et al. 2019).

Eight calves, aged 61.5 (41.3-73.5) days, were included. Baseline values for TCR threshold (TCRt), sedation (0 = no sedation to 3 = maximum sedation) and excitation (0 = no excitation; 3 = maximum excitation) were recorded. Then, butorphanol alone (SB; 0.1 mg kg⁻¹) or combined with detomidine (DB; 0.02 mg kg⁻¹) was administered IV. Finally, median values and interquartile ranges of TCRt, sedation and excitation scores, over at least 120 minutes post-injection, were calculated. Differences within groups were evaluated with Wilcoxon signed rank test, differences between groups with Mann Whitney U test.

Values for TCRt, sedation and excitation scores are reported in Table 1.

In clinical settings, the combination of butorphanol and detomidine can be recommended as premedication. Butorphanol administered alone should be used cautiously as it might evoke excitatory behaviours.

Table 1. Values for TCR threshold, sedation, and excitation scores for butorphanol (SB) and butorphanol-detomidine (DB) groups.

	Baseline		Post-injection	
	SB	DB	SB	DB
TCRt	11.1 (9.8, 13.6)	10.4 (8.2, 13.8)	15.5 (12.8, 21.6)*,‡	29 (19.3, 37)*,‡
Sedation score	0 (0, 0)	0 (0, 0)	0 (0, 0)‡	1 (1, 2)*,‡
Excitation score	0 (0, 1)	0 (0, 1)	1 (0, 2)*,‡	0 (0, 0)‡

*significant difference compared to baseline

‡significant difference between groups

Casoni, D., Mirra, A., Suter, M.R., Gutzwiller, A., Spadavecchia, C., 2019. Can disbudding of calves (one versus four weeks of age) induce chronic pain? *Physiol Behav* 199, 47–55. <https://doi.org/10.1016/j.physbeh.2018.11.010>.

Applicability and repeatability of cutaneous cold stimulation to assess aversive threshold values in healthy dogs using four different cooling protocols

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Cold stimulation is used to assess chronic and neuropathic pain in humans. Aim of the study was to evaluate the applicability and repeatability of cold stimulation in dogs.

Ten Beagles were used in this experimental, randomized, blinded study. Measurements were performed in triplicate at neck, lumbosacral-area, elbow and knee. The probe was placed on the skin and temperature decreased according to cooling-protocols: three cooling-rates (0.5; 1 and 5 °C second⁻¹, 32 to 10 °C) and latency measurement (11 °C, 60 seconds maximally). The stimulation was discontinued when avoidance reactions were detected. Thermal threshold or time-to-reaction were recorded. The experiment was performed three times per animal in week one, two and five. Feasibility of cold stimulation was scored (0 - 5). Data were analyzed with mixed logistic regression.

There were no significant differences in the number of avoidance reactions between cooling-rates. Significantly more reactions ($p < 0.001$) were observed in week one compared to week two and five. Thermal thresholds were 13 ± 2.6 °C, 17.7 ± 4 °C and 16.3 ± 4.6 °C for 5, 0.5 and 1 °C second⁻¹, respectively. Latency to reactions could be determined in 37% of measurements. The mean time-to-reaction was 13 ± 11 seconds. In 85% of measurements a feasibility score of 0 (best feasibility) was assigned.

The applicability of the method was satisfying, although habituation to the stimulus could not be excluded. It was not possible to recommend one protocol over the others. Future studies should include dogs with neuropathic changes to assess altered sensitivity.

Pharmacokinetics of buprenorphine and norbuprenorphine in isoflurane-anesthetized cats

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Buprenorphine is commonly used perioperatively in cats. The pharmacokinetics have not been reported in cats during inhalant anesthesia.

Six healthy adult cats were used. Anesthesia was induced and maintained with isoflurane in oxygen. Catheters were placed in a jugular vein for blood sampling and in a medial saphenous vein for drug administration. Isoflurane concentration was set at 0.7 MAC and subsequently adjusted to prevent spontaneous movement. Buprenorphine, 40 $\mu\text{g kg}^{-1}$ was administered IV over 5 minutes. Blood was sampled before administration and at various times for 8 hours. Cats were allowed to recover from anesthesia and an additional blood sample was obtained approximately 12 hours after buprenorphine administration. Plasma buprenorphine and norbuprenorphine concentrations were measured using liquid chromatography/mass spectrometry. Compartment models were fitted to the data using nonlinear mixed effect modeling.

A 5-compartment model (3 compartments for buprenorphine, 2 compartments for norbuprenorphine) fitted the data best. Typical value (% interindividual variability) for the 3 buprenorphine volumes of distribution, and the metabolic clearance to norbuprenorphine, the remaining metabolic clearance and the 2 distribution clearances were 153 (38), 772 (29) and 1325 (60) mL kg^{-1} , and 1.5 (110), 19.6 (12), 58.2 (29) and 5.6 (23) $\text{mL minute}^{-1} \text{kg}^{-1}$, respectively. Typical value (% interindividual variability) for the 2 norbuprenorphine volumes of distribution, and the norbuprenorphine metabolic and distribution clearances were 387 (58) and 2626 (71) mL kg^{-1} and 11.0 (142) and 72.8 (120) $\text{mL}^{-1} \text{minute}^{-1} \text{kg}^{-1}$, respectively.

The pharmacokinetics of buprenorphine were characterized by a medium clearance and a moderate volume of distribution.

The study was funded by the Center for Companion Animal Health, School of Veterinary Medicine, University of California, Davis

The study was approved by the Institutional Animal Care and Use Committee (protocol 22440)

Effects of low-level laser therapy on impaired mobility in dogs with naturally occurring osteoarthritis

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Osteoarthritis (OA) is a common condition in dogs resulting in impaired mobility and chronic pain. The main objective of this study was to determine whether low-level laser therapy (LLLT) would increase physical activity in dogs with OA.

Twenty-two dogs with osteoarthritis underwent six consecutive weekly laser treatments. Forty-eight hours before the first LLLT session (baseline), each dog was instrumented with an accelerometer validated for use in dogs with OA (Brown et al. 2010), to record their daily steps and activities during the whole six-week study period. The accelerometer epoch length was set at 1 minute (Dow et al. 2009). Dog owners were instructed to maintain a standard level of activity of their dogs, in terms of both length of daily walks and daily time off the lead/in open spaces.

The number of daily activities increased during week 2 (161674 ± 103666) and remained higher than baseline (93481 ± 107878) until week 6 (179309 ± 126044 ; $p < 0.001$). Daily step count increased from week 1 (4472 ± 3427) compared to baseline (1109 ± 1061) and remained higher than the baseline until the end of week 6 (8416 ± 3166 ; $p < 0.001$). Average energy expenditure during the study period was $179 [2 - 536]$ kcal/day; there were no statistically significant differences in this variable between weeks of treatment.

Low-level laser therapy increased mobility in dogs with natural occurring OA and could be an adjunctive treatment in canine OA to improve subjects' quality of life.

Brown DC, Boston RC, Farrar JT, et al. (2010) Use of an activity monitor to detect response to treatment in dogs with osteoarthritis. *J Am Vet Med Assoc* 237, 66-70.

Dow C, Michel KE, Love M, et al. (2009) Evaluation of optimal sampling interval for activity monitoring in companion dogs. *Am J Vet Res* 70, 444-448.

Optimisation of cat neutering anaesthesia protocols for use in the community

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This abstract was presented in the Nafplio, Greece AVA Spring Meeting 2022

Anaesthesia with midazolam, butorphanol and ketamine combined with isoflurane in harbour seals (*Phoca vitulina*)

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Anaesthesia in pinnipeds can be challenging due to numerous anatomical und physiological adaption such as the dive response.

Within one year, three female and one male captive harbour seals were anaesthetized for transport related, dental and ocular procedures. The animals were aged between 3 - 30 years and weighed between 50 - 76 kg. One seal was anaesthetized twice and in total five anaesthesias were performed.

In total, 0.39 mg kg⁻¹ midazolam (0.28 - 0.49), 0.27 butorphanol mg kg⁻¹ (0.22 - 0.34) and 2.07 ketamine mg kg⁻¹ (1.6 - 2.6) were administered via blow dart for the first procedure and then via dartgun for the following seals. Once a deep sedation was achieved, the animals were masked down with isoflurane in oxygen to allow intubation. Anaesthesia was maintained with 1 - 2 % isoflurane for 30 - 95 minutes. All seals were given intermittent positive pressure ventilation as necessary to aim for FE'CO₂ below 80 mmHg and SpO₂ above 91 %. Body temperature, HR, fR, FE'CO₂ and SpO₂ were monitored throughout anaesthesia. At the end of the procedure, midazolam was antagonized with 0.014 mg kg⁻¹ sarmazenil IM in two seals.

Onset of deep sedation varied from 13 - 45 minutes. Body temperature varied from 33.9 - 36.1°C, HR 43 - 123 beats minute⁻¹ and fR 2 - 13. All animals recovered uneventfully within 20 minutes from antagonization or turning isoflurane off.

Effect of fentanyl on cough reflex and quality of endotracheal intubation in cats

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Fentanyl reduced the incidence of cough reflex during endotracheal intubation (ETI) in dogs (Re Bravo et al. 2020) but its effect is unknown in cats. This randomized blinded negative controlled clinical trial assessed the effects of IV fentanyl on cough reflex and quality of ETI in cats.

After dexmedetomidine (2 µg kg⁻¹ IV) administration, 30 cats received either fentanyl (3 µg kg⁻¹, group F) or saline (group C). Anaesthesia was induced with alfaxalone (1.5 mg kg⁻¹ IV). After spraying 2% lidocaine on the larynx, ETI was attempted: if unsuccessful within 30 seconds, alfaxalone (1 mg kg⁻¹ IV) was administered and ETI re-attempted. This process was repeated until successful ETI. The variables reported in table 1 were recorded. Student’s t-test or Mann-Whitney U-test and Fisher’s Exact test were used: *p* < 0.05 was considered statistically significant.

Results are reported on table 1.

In cats sedated with dexmedetomidine, fentanyl reduced the alfaxalone dose to allow ETI, the cough reflex, and improved the overall quality of ETI.

Variables	Group C (n = 14)	Group F (n = 16)	P value	Relative Risk (95% CI)
Alfaxalone (mg kg ⁻¹)	2.5 (1.5 – 4.5)	1.5 (1.5 – 2.5)	0.001	
ETI attempts (n)	3 (1 – 12)	1 (1 – 4)	0.041	
Cough reflex	11 Yes – 3 No	6 Yes – 10 No	0.033	2.1 (1.10 – 4.41)
Quality of ETI (0 = easy; 6 = difficult)	3 (1 – 4)	1 (0 – 3)	0.001	
Post-induction apnoea (n)	5 Yes – 9 No	3 Yes – 13 No	0.417	

Re Bravo V, Palomba N, Corletto F, et al. (2020) Comparison between intravenous lidocaine and fentanyl on cough reflex and sympathetic response during endotracheal intubation in dogs. Vet Anaesth Analg 47, 481-489.

Occurrence, drivers and definition of postanesthetic pulmonary complications in dogs, cats and horses in the current veterinary literature. A scoping review

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Postanesthetic pulmonary complications (PPCs) are considered a substantial risk in veterinary medicine with 30-40% of anesthesia related mortalities in dogs and 40-50% in dogs considered due to PPCs (Brodelt et al. 2015). This scoping review aims to summarize occurrence, drivers and definitions of PPCs in veterinary peer reviewed literature in dogs, cats and horses.

Five data banks (vetmedseeker, PubMed, Scopus, Science Direct, Web of Science) were searched using key words postoperative/postanesthetic pulmonary/respiratory complications/arrest, dog, cat, horse, veterinary medicine, lung oedema, pneumonia. After title and abstract screening full articles were assessed for type of article, species, PPCs mentioned including definition of PPCs, surgery type and anesthetics.

Out of 39 articles included, ten were retrospective, 13 prospective studies, nine reviews and eight case reports. Dogs appeared in 26 articles, horses in 12 and cats in eight. Most frequently mentioned PPCs in dogs / cats / horses, respectively, were pneumonia (12/3/2), pulmonary oedema (4/2/9) and hypoxemia (11/4/1). Airway surgeries (4/1/0), laparotomies (3/0/1) and neurosurgery (4/1/1) were named, among others, in association with PPCs. Main mentioned drugs were opioids (3/0/2) and alpha-2-adrenergic-agonists (0/1/3), but also ketamine, lidocaine, propofol, acepromazine and cisapride (1 each in dogs). In only three articles PPCs were explicitly defined including hypoxemia, hypoventilation, dyspnea, acute respiratory distress, respiratory failure, pulmonary atelectasis and acute infectious or inflammatory pulmonary disease.

The current veterinary literature does not reflect the considered importance of PPCs. Further, particularly prospective studies are needed to correctly classify, help identify and treat PPCs in veterinary medicine.

Accuracy of three types of disposable PEEP valves

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Disposable PEEP valves with pressure adjustment possibility are often used in combination with manual resuscitator bags. Despite their potential usefulness when incorporated in anesthesia breathing systems as pressure relief or PEEP devices, their accuracy has not been examined.

Three types of PEEP valves were tested (red: Ambu; green: SunMed; blue: CareFusion). Twelve units were tested from each type. The devices were attached to a non-rebreathing system (NRS; Dispomed) at the neck of the reservoir bag. Pressures within the NRS were measured using blood pressure transducers. Two L min⁻¹ fresh gas flow was used. The adjustable pressure limit valve and the patient port were closed. One PEEP valve was tested at a time using different PEEP settings (5, 10, 15 and 20 cmH₂O). The order of device types and PEEP settings were randomized. The differences between the measured pressures and the settings of the PEEP valves were plotted against the PEEP settings and Bland-Altman analysis was performed.

Biases [limits of agreements (LOA)] were 0.4 [-1.1 1.9], -1.0 [-3.9 2.0] and 1.1 [-0.1 2.4] cmH₂O and the 95% confidence intervals for the LOAs were 0.38, 0.74 and 0.32 cmH₂O for the red, green and blue devices, respectively. The red and the blue devices were accurate according to the *a-priori* definition (error <3 cmH₂O).

Some of the adjustable PEEP devices may be suitable for use with anesthetic breathing systems.

Respiratory mechanics and dead space effects of individualized levels of positive-end expiratory pressure in anesthetized cats

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Positive end-expiratory pressure (PEEP) selected by maximal respiratory system compliance (PEEP_{maxCrS}) can improve respiratory function. This study evaluated respiratory mechanics and dead spaces in six male adult healthy cats ventilated for 180 minutes with no PEEP (ZEEP), PEEP_{maxCrS}, PEEP_{maxCrS} minus 2 cmH₂O (PEEP_{maxCrS-2}) and PEEP_{maxCrS} plus 2 cmH₂O (PEEP_{maxCrS+2}).

Each treatment was tested in each cat in separate experiments. Anesthesia was induced and maintained at 1.3 times MAC of isoflurane. Respiratory mechanics and dead spaces were recorded at 5, 30, 60, 120 and 180 minutes of ventilation. Data were compared between and within treatments by mixed-model ANOVA followed by Tukey's and Dunnet's tests and Friedman's followed by Dunn's test for parametric and nonparametric data, respectively.

Weight-normalized respiratory system (C_{rs}) and lung (C_L) compliances were higher in PEEP_{maxCrS} than ZEEP until 60 min of ventilation. The highest values of C_{rs} were 2.1 ± 0.2 and 1.7 ± 0.1 mL cmH₂O⁻¹ kg⁻¹ and of C_L were 4.7 ± 0.5 and 3.2 ± 0.4 mL cmH₂O⁻¹ kg⁻¹ for PEEP_{maxCrS} and ZEEP at 5 minutes of ventilation, respectively. In all treatments, C_{rs} and C_L significantly decreased after 120 min. Increasing PEEP progressively increased physiologic (V_{DPhys}) and anatomic (V_{DAnat}) dead spaces at all time points, with no significant difference in alveolar dead space (V_{DAIv}).

Ventilation of healthy cats with PEEP_{maxCrS} improved C_{RS} and C_L with mild increase in V_{DPhys} and V_{DAnat} but no significant increase in V_{DAIv}. None of the PEEP levels prevented the deterioration of C_{RS} and C_L after two hours of ventilation.

The effect of venous admixture on correction of Enghoff's towards Bohr's dead space fractions in anesthetized dogs: preliminary results

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Enghoff's dead space fraction ($V_{D\text{Enghoff}}/V_T$) is easier to assess than Bohr's ($V_{D\text{Bohr}}/V_T$). However, the first is significantly affected by venous admixture. Using data from anesthetized dogs ventilated with $\text{FiO}_2 > 0.94$, we evaluated if a linear regression including $\text{PaO}_2/\text{FiO}_2$, as a measure of venous admixture may be used to estimate $V_{D\text{Bohr}}/V_T$ from $V_{D\text{Enghoff}}/V_T$.

Forty-five adult dogs of different breeds (4.5 to 71.6 kg) anesthetized for various procedures that required mechanical ventilation and arterial catheterization were included in this study. During stable ventilation and cardiovascular function, volumetric capnography and PaCO_2 were collected to calculate $V_{D\text{Bohr}}/V_T$ and $V_{D\text{Enghoff}}/V_T$. Data was analyzed with stepwise least-squares linear regression of $V_{D\text{Bohr}}/V_T$ using $V_{D\text{Enghoff}}/V_T$ with or without $\text{PaO}_2/\text{FiO}_2$.

Fifteen dogs were excluded due to capnogram artifacts. Median $\text{PaO}_2/\text{FiO}_2$ was 538 (122 to 628 mmHg), $V_{D\text{Bohr}}/V_T$ was 0.51 ± 0.10 , and $V_{D\text{Enghoff}}/V_T$ was 0.59 ± 0.10 . The coefficient of determination was 0.71 for the model $V_{D\text{Bohr}}/V_T = a \times V_{D\text{Enghoff}}/V_T + b$, and 0.83 for the model $V_{D\text{Bohr}}/V_T = a \times V_{D\text{Enghoff}}/V_T + b \times \text{PaO}_2/\text{FiO}_2 + c$ (a, b, and c are constants of the models). The difference in Akaike Information Criteria was 12.7 favoring the model including $\text{PaO}_2/\text{FiO}_2$.

The addition of $\text{PaO}_2/\text{FiO}_2$ significantly improved the regression model of $V_{D\text{Bohr}}/V_T$ from $V_{D\text{Enghoff}}/V_T$ and suggests that such parameter may be a good proxy for venous admixture when correcting $V_{D\text{Enghoff}}/V_T$ calculated at different levels of shunt. The continuation of data collection for this study will further clarify this relationship and its possible clinical implications in anesthetized dogs.

Reliability of respiratory compliance assessed by two spirometry monitors used in dogs and cats: the effect of resistance

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Accuracy of respiratory compliance (C_{rs}) may be affected by respiratory resistance (R_{rs}). This study investigated the reliability of C_{rs} assessed by ECAIOV modules (Datex-Ohmeda, C_{ECAIOV}) and NM3 monitors (Philips Healthcare, C_{NM3}) using a test lung simulating cats and dogs with normal and increased R_{rs} . Resistance was increased by adding resistors between breathing system and test lung. For each R_{rs} level, the lung was ventilated with V_T of 50 and 300 mL, C_{rs} ranging from 1 to 10, and 5 to 80 mL cmH₂O⁻¹ for the cat and dog settings, respectively. Static compliance (C_{stat}) was calculated at the end of each trial. Bland-Altman plots and concordance correlation coefficient (ρ_c) were used to evaluate agreement between C_{stat} and C_{rs} , and four-quadrant plots for trend ability analysis.

For the cat settings, ρ_c was 0.8899 and 0.8776 with a bias of -12.6 and -15.6 %, limits of agreement from -48.9 to 23.7% and -38 to 6.7% for C_{ECAIOV} and C_{NM3} , respectively. For dog settings, ρ_c was 0.9271 and 0.9385 with a bias of -10.7 and -1.3 %, limits of agreement from -46.8 to 25.5% and -38 to 6.7% for C_{ECAIOV} and C_{NM3} , respectively. The trend ability of C_{ECAIOV} and C_{NM3} for both settings was good (concordance rate > 97.8%). At normal R_{rs} , C_{ECAIOV} and C_{NM3} presented acceptable agreement for both settings, but unacceptable agreement as R_{rs} increased. Trend ability was maintained independently of R_{rs} .

When variations in R_{rs} occur, C_{rs} assessed by these two monitors is not reliable. However, their trend ability remained good.

Incidence of post-anaesthetic complications and their risk factors in 199 dogs undergoing surgery for Brachycephalic Obstructive Airway Syndrome (BOAS)

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The aims of this study were to determine the incidence of post-anaesthetic aspiration pneumonia and requirement for temporary tracheostomy in dogs undergoing BOAS surgery, and their risk factors. It was hypothesised that lower functional BOAS grade, lower body condition score (BCS) and postoperative sedation would be associated with a lower risk of complications.

Data retrieved from 199 records (2019 to 2021) were analysed. Binary logistic univariate regression, followed by multiple logistic regression, was used to identify associations between independent covariates and two dependent variables (postoperative aspiration pneumonia and tracheostomy). The quality of model-fit was assessed using the Likelihood Ratio test. $P < 0.05$ was considered statistically significant.

Survival to discharge was 98.5%; one dog died from cardiac arrest and two were euthanised owing to clinical deterioration and diagnosis of laryngeal neoplasia, respectively. Binary logistic regression showed an association between postoperative aspiration pneumonia, which developed in 6% of the dogs, and BCS and ASA status; however, when these covariates were evaluated in the multiple logistic regression model, significance was not maintained (Likelihood Ratio Test $p = 0.029$). Risk factors for tracheostomy, which was performed in 5% of the dogs, were pre-operative and post-operative aspiration pneumonia ($p = 0.014$) and high BOAS grade ($p = 0.045$; Likelihood Ratio Test $p < 0.001$). Postoperative sedation was not correlated with the development of post-anaesthetic complications.

In this study population, the incidence of post-anaesthetic complications was lower than previously reported. Higher BOAS grade and aspiration pneumonia may be regarded as risk factors for postoperative tracheostomy.

He Y, Wang Z and Xu G (2021) 'A Note on the Likelihood Ratio Test in High-Dimensional Exploratory Factor Analysis', *Psychometrika*, 86(2), pp. 442–463.

Hosmer DW, Lemeshow SA and Sturdivant RX (2013) 'Applied logistic regression', 3rd edition, Hoboken, NJ, Wiley.

Lindsay B, Cook D, Wetzel JM et al. (2020) 'Brachycephalic airway syndrome: management of post-operative respiratory complications in 248 dogs', *Australian Veterinary Journal*, 98(5), pp. 173–180.

Machine learning – based analysis of intraoperative hypotension risk from two epidural dosing strategies in dogs undergoing abdominal surgery

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Post – epidural hypotension risk was investigated, comparing volume calculation based on occipital – coccygeal distance (OCD) or body weight (BW) with machine learning – based analyses.

Two cohorts of dogs undergoing abdominal surgery, where lumbosacral epidural was performed, were retrospectively selected according to epidural dosing strategy: OCD (n = 110, using the nomogram (Otero et al. 2010) or BW (n = 100). These two were the main inclusion criteria. One case was excluded due to acepromazine premedication. Data recorded: premedication, sex, age, body weight, type of surgery, oesophageal temperature, mean arterial blood pressure (MABP), anaesthesia maintenance agent, inhalant agent's minimum alveolar concentration (MAC), ASA status, intraoperative fentanyl, and epidural volume. Predictors of post epidural hypotension were identified using multivariable logistic regression and counterfactual modelling.

Hypotension (MABP < 60 mmHg) was reported in 49.1% vs 33.0% of OCD and BW patients, respectively (p = 0.018). Logistic regression identified the following associations with increased intraoperative hypotension risk: females, hypothermia, lower MABP pre – epidural, lower MAC, and premedication with methadone alone. Non – linear modelling, capable of detecting more complex associations, additionally identified OCD – derived dosage as the most influential risk factor.

Counterfactual simulation – model application under a causal framework – showed that, if all OCD patients instead received epidural volume according to BW, hypotension would have been prevented in 56% of the observed hypotensive patients (vs 21% of normotensive patients becoming hypotensive).

This study suggests the existence of modifiable risk factors linked to post – epidural hypotension, including inclusion of dexmedetomidine in premedication and epidural dosing strategy.

Otero PE, Tarragona L, Ceballos M et al. (2010) Epidural cephalic spread of a local anesthetic in dogs: A mathematical model using the column length. J VAA 37, 35 – 36

The dose-response relationship between the patient state index and plasma propofol concentration in anesthetized dogs

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The patient state index (PSI) is an EEG-based monitor of consciousness that correlates with the propofol-induced anesthetic depth in humans. Dose-response relationships between measured plasma propofol concentrations (CP_M) and PSI, HR, and MAP were investigated in dogs.

In a prospective experimental study, six healthy, intact adult male Beagles were sedated with acepromazine and methadone. Anesthesia was induced and maintained with a target-controlled infusion at 8, 6, 4, and 2 $\mu\text{g mL}^{-1}$ and held for ten minutes at each target. The CP_M , PSI, HR, and MAP were obtained at baseline, five and ten minutes after reaching the plasma propofol targets, and five and sixty minutes following discontinuation of the propofol infusion. The presence of burst suppression in the raw EEG was recorded. The effects of CP_M on PSI, HR, and MAP were analyzed with mixed-effect models. The PSI half-maximal inhibitory propofol concentration (IC_{50}) was estimated with nonlinear regression.

Baseline PSI was 90.2 ± 1.8 and decreased as propofol concentrations increased ($p < 0.001$). The IC_{50} (95% confidence interval) was 4.5 (3.6 to 5.4 $\mu\text{g mL}^{-1}$). No burst suppression was detected at any of the targeted propofol concentrations. Baseline HR was 66.7 ± 10.4 beats minute^{-1} and increased with higher CP_M ($p = 0.048$). Baseline MAP was 94.5 ± 12.0 mmHg and decreased with higher CP_M ($p < 0.001$).

Increased propofol concentrations were associated with deeper anesthetic depth, lower MAP, and higher HR. There was no evidence of excessive anesthetic depth at the highest propofol CP_M in the present study population.

Prospective survey of checkout procedures of veterinary anesthesia equipment in Alberta, Canada

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In veterinary medicine, it is recommended that an anesthetic equipment checkout procedure be performed before anesthesia (Mosley. 2015). If equipment is not checked, risk of patient morbidity and mortality increases (Arbous et al. 2005). The goals of this prospective survey were to evaluate veterinary anesthetic machines in Alberta (Canada) for problems identifiable with use of a standardized anesthetic machine checkout procedure, and to document use of checkout procedures by clinics.

One-hundred anesthetic machines at 30 private veterinary clinics were evaluated consecutively by the same technician (as part of a service contract) using a standardized checkout procedure. There was a median of 3 machines (range, 1 –12) per clinic. Each item of the checkout procedure was assessed and scored as a “pass”, “fail” or “not applicable”. Clinic identifiers were anonymized before analysis. The number of items assessed varied according to machine configuration.

A secondary oxygen supply was available on 10% (10/100) of machines, no machines had an oxygen supply pressure alarm, 31% (27/87) had a leak identified in the rebreathing system, 17% (16/94) had a leak in the non-rebreathing system and 39% (39/100) of machines did not have a high pressure circuit alarm. During scavenging tests, 52% of non-rebreathing systems (39/75) and 32.1% (26/81) of rebreathing systems had pressure build up (> 10 cmH₂O). Two clinics (6.7%) maintained a record of machine checkout procedures.

These results highlight the frequency of easily identifiable anesthetic machine deficiencies and the value in performing a checkout procedure.

Arbous SM, Meursing AEE, van Kleef JW et al. (2005). Impact of anesthesia management characteristics on severe morbidity and mortality: Are we convinced? *Anesthesiology* 102(1), 257–268.

Mosley, CA 2015, ‘Anesthetic Equipment’, in Grimm KA, Lamont LA, Tranquilli WJ et al. (eds), *Veterinary Anesthesia and Analgesia*, Wiley Blackwell, pp.61.

Incidence of peri-anaesthetic complications in bovine animals: a retrospective study to identify risk factors

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Evaluation of peri-anaesthetic complications is essential to improve quality and safety of anaesthesia (Itami et al. 2017). The aim of this study was to analyse peri-anaesthetic complications occurring in bovine animals undergoing general anaesthesia at a referral hospital.

Three hundred and eighteen bovine anaesthesia records collected between January 2016 and June 2021 were screened. Mortality rate, incidence of complications, risk factors and responsiveness to pharmacological treatment were analysed. The effect of the risk factors on complications, odds ratios and 95% confidence intervals were calculated with logistic regression and stepwise selection. Statistical significance was set at $p < 0.05$.

Anaesthesia related mortality rate due to complications occurring within 72 h was 0.4%. Reported complications (and their incidence) were: hypotension (52.3%); hypertension (38.5%); PaO₂/FiO₂ ratio < 300 (17.2%); regurgitation (11%); difficult intubation (10%); hypothermia (5.7%); laryngospasm (5.6%); radial paralysis (0.9%) and hyperthermia (0.6%). The use of thiopental at induction was significantly associated with higher risk of difficult intubation. Hypotension was significantly associated with dorsal recumbency, while hypertension with increase in body weight, surgery time and intraoperative ketamine infusion. A PaO₂/FiO₂ < 300 was significantly associated with increase in age. For hypotension and hypertension, responsiveness to pharmacological treatment was 70% and 13%, respectively.

The high incidence of complications found in the current study indicates that there is room for improvement in bovine anaesthesia safety. Anaesthesia-related mortality rate was rather low, but prospective, multicentric studies are necessary to confirm these findings on a larger scale.

Itami T, Aida H, Asakawa M, et al. (2017) Association between preoperative characteristics and risk of anaesthesia-related death in dogs in small-animal referral hospitals in Japan. *Vet Anaesth Analg*. 44, 461-472.

Investigation of an ultrasound-guided erector spinae plane block in cows: a cadaveric study

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The goal of the present study was to develop and investigate an ultrasound-guided erector spinae plane block (ESPB) in comparison to a blind proximal paravertebral nerve block (PPNB) in cow cadavers.

In 10 cadaver specimens, injections of methylene blue-lidocaine (1:1) were made at the level of T13, L1, and L2 vertebrae, on one side using a ESPB, and on the other side a PPNB. Five cadavers were injected with a high (40 mL per injection for PPNB, 20 mL for ESPB) and 5 with a low (20 and 15 mL, respectively) volume injectate. For the ESPB, the ultrasound probe was oriented craniocaudally and the ventral-cranial aspect of the articular processes (T13, L1, L2) was targeted for injection. Dye spread was evaluated by dissection.

The landmarks for ultrasound-guided injection were easily visualized, but injections were accidentally performed at T12, T13 and L1. Nevertheless, L2 was stained in 60% of ESPBs (table). Epidural spreading was observed with both techniques and volumes. Viscera puncture was reported in two PPNBs.

The ESPB resulted in similar nerve staining compared to the PPNB, using less volume of injectate. Even better staining is expected with a T13-L2 instead of a T12-L1 ESPB approach.

Table

	Rami dorsales			Rami ventrales		
	T13	L1	L2	T13	L1	L2
PPNB 40 mL	5/5	5/5	5/5	4/5	5/5	4/5
PPNB 20 mL	5/5	5/5	5/5	3/5	3/5	3/5
ESPB 20 mL	5/5	5/5	3/5	5/5	5/5	3/5
ESPB 15 mL	5/5	5/5	3/5	5/5	5/5	3/5

Anderson DE, Edmondson MA (2013) Prevention and management of surgical pain in cattle. *Veterinary Clinics: Food Animal Practice*, 29, 157-184.

Delgado OBD, Louro LF, Rocchigiani G et al. (2021) Ultrasound-guided erector spinae plane block in horses: a cadaver study. *Vet Anaesth Analg*, 48, 577-584.

Kramer AH, Doherr, MG, Stoffel MH et al. (2014) Ultrasound-guided proximal paravertebral anaesthesia in cattle. *Vet Anaesth Analg*, 41, 534-542.

Pharmacokinetics of bupivacaine injected within the internal abdominis rectus sheath in horses

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The rectus abdominis sheath (RAS) block anesthetizes the abdominal midline (Fernandes et al. 2021), potentially providing analgesia for equine colic surgery.

In a prospective, experimental, randomized, masked, cross-over design, 1 mL kg⁻¹ of 0.9 % NaCl (placebo) or 0.2 % bupivacaine divided into four points was injected in six healthy horses sedated with xylazine (0.6 to 2.3 mg kg⁻¹). The right cranial RAS was located with a linear 15-6 MHz probe, and one-quarter of the treatment was injected with a 100 mm 18-gauge spinal needle using an in-plane technique. The administration was repeated in the left caudal, right cranial, and right caudal RAS. The mechanical nociceptive threshold (MNT) was the maximal force tolerated from a 1-mm blunt probe protruded remotely. The MNTs were measured in triplicate at the xiphoid-umbilicus midpoint at baseline and from 30 minutes to 8 hours after treatments.

The placebo and bupivacaine baseline MNT were 12.6 ± 1.6 N and 12.4 ± 2.4 N ($p = 0.717$). After treatments, the overall bupivacaine MNT was higher than the placebo ($p = 0.001$). Compared to baseline, placebo MNTs were 18.9 ± 5.8 N at 30 minutes ($p = 0.010$) and from 9.4 to 15.3 N after this time point ($p > 0.521$). The bupivacaine MNT was higher than baseline at all time points (21.1 to 24.9 N, $p < 0.001$).

The antinociception provided by bupivacaine indicates the potential use of RAS block in the analgesic management of surgical celiotomies in horses. Further investigations in anesthetized clinical cases are necessary.

Fernandes HDS, Azevedo AS, Ferreira TC et al. (2021) Ultrasound-guided peripheral abdominal wall blocks. Clinics (Sao Paulo) 76, e2170.

Identifying endotracheal tube positioning and lumen restriction using computed tomography: preliminary results

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Endotracheal intubation is an essential practice in the anaesthesia of cats and dogs, but little is known about the problems that occur with endotracheal tubes (ETT). Computed tomography (CT) imaging can detect changes in endotracheal tube positioning and luminal diameter (Pincirolì et al. 2013; Mietto et al. 2014).

Visual assessment for mispositioning and narrowing of ETTs using 'Clear Canvas' software was conducted on CT images of the head, neck and/or thorax from 816 anaesthetised cats and dogs from one University hospital (2017-2019 inclusive). The cross-sectional area of the ETT lumen was measured digitally and location and cause of narrowing recorded. The ETT was defined as 'too caudal' when extending beyond the first rib and 'too rostral' when protruding beyond the incisors (which could increase deadspace).

Narrowing was present in 168/816 (20.5%) of cases, with 6/168 (3.6%) intraluminal (attributable to material within ETT lumen) and 162/168 (96.4%) extraluminal. Narrowing occurred within the oral cavity in 137/162 (84.6% of extraluminal narrowing), with causes identified as the use of a radiotherapy mouth gag (63/137, 39%), ETT tie (33/162, 20%), teeth (29/162, 18%) or tongue (1/162, 0.6%) or unidentified cause in 35/162 (22%). Too caudal positioning of the ETT was identified in 131/515 cases where assessment was possible (25%). Too rostral positioning was present in 145/277 assessable cases (52%).

Narrowing of the ETT lumen was relatively common in this population. Care should be taken with the use of mouth gags, position of teeth and using ties to secure ETTs in particular.

Pincirolì, R., Mietto, C. and Berra, L. (2013) 'Use of high-definition computed tomography to assess endotracheal tube luminal narrowing after mechanical ventilation', *Anesthesiology*, 119(1), p. 202. doi: 10.1097/ALN.0b013e318291022d.

Mietto, C. *et al.* (2014) 'Tracheal Tube Obstruction in Mechanically Ventilated Patients Assessed by High-resolution Computed Tomography', *Anesthesiology*, 121(6), pp. 1226–1235.

Comparison of hemodynamic effects of propofol or alfaxalone during induction of anaesthesia in dogs: a preliminary study

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To compare the hemodynamic effects of propofol and alfaxalone for induction of anaesthesia.

Dogs were premedicated with acepromazine (0.015 mg kg⁻¹ IM) and methadone (0.15 mg kg⁻¹ IM) randomly and received propofol 5 mg kg⁻¹ over 30 seconds followed by 25 mg kg⁻¹hour⁻¹ IV (Group-P, n=9) or alfaxalone 2 mg kg⁻¹ over 30 seconds followed by 10 mg kg⁻¹hour⁻¹ IV (Group-A, n=9) for anaesthesia induction. Heart rate, invasive arterial pressures, and the velocity time integral (VTI) of the left ventricular outflow tract obtained by transthoracic echocardiography were recorded before induction and every 15 seconds for 3 minutes. Minute distance (VTI*HR) was calculated (Cattai et al. 2018; Blanco 2020). A Friedman test was used to assess the variances within groups and Kruskal-Wallis test between groups. Significance was set at $p < 0.05$.

All dogs were intubated between 60 and 120 seconds. Transient hypotension (MAP < 60 mmHg) was detected in 3/9 (33%) and 1/9 (11%) subjects respectively in group-P and group-A ($p > 0.05$). Group-P showed the following significant variations compared to baseline: HR increased between 45-105 and decreased between 165-180 seconds, MAP decreased between 30-75 and between 135-180 seconds, VTI*HR decreased between 135-180 seconds. Group-A showed the follows significant variations compared to baseline: HR increased between 45-135 and VTI*HR between 30-120 seconds, MAP decreased at 60 and between 135-180 seconds (all $p < 0.001$). Between groups there were no differences.

In healthy dogs premedicated with acepromazine and methadone induction of anaesthesia with alfaxalone and propofol showed similar hemodynamic profile.

Blanco P (2020) Rationale for using the velocity-time integral and the minute distance for assessing the stroke volume and cardiac output in point-of-care settings. *Ultrasound J* 21, 21.

Cattai A, Rabozzi R, Ferasin H, et al. (2018) Haemodynamic changes during propofol induction in dogs: new findings and approach of monitoring. *BMC Vet Res* 14, 282.

Anaesthetic management for surgical treatment of severe pulmonic stenosis under cardiopulmonary bypass in four French Bulldogs

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Pulmonic stenosis (PS) is one of the most common cardiovascular malformations in dogs (Oliveira et al. 2011). Surgical repair of severe PS under cardiopulmonary bypass (CPB) is a newly feasible procedure; anaesthetic management can be challenging.

Four French Bulldogs underwent patch grafting for PS under CPB; sildenafil (1.5 mg kg⁻¹) orally, chlorphenamine (0.5 mg kg⁻¹) IM and maropitant (1 mg kg⁻¹) SC were administered before premedication with methadone (0.3 mg kg⁻¹) and dexmedetomidine (3 mg kg⁻¹) IM. Dexamethasone (1 mg kg⁻¹) and pantoprazole (1 mg kg⁻¹) were administered IV before induction of general anaesthesia achieved with propofol (1 mg kg⁻¹) and midazolam (0.3 mg kg⁻¹) IV. General anaesthesia, during the off-pump period, was maintained with isoflurane in 100% oxygen whereas during CPB a total-intravenous anaesthesia technique with propofol and ketamine and/or fentanyl was used. Mechanical ventilation was initiated and adjusted to maintain FE_{CO2} <45 mmHg; during CPB, a fR of 4 breaths min⁻¹ and VT of 10 ml kg⁻¹ were set. Monitoring included HR, invasive blood pressure, temperature, spirometry, end-tidal isoflurane, arterial and venous blood gases.

In all dogs, episodes of hypotension (MAP <60mmHg) were encountered and treated with noradrenaline and dobutamine IV; in one case only, hypotension was experienced during CPB. All dogs recovered uneventfully.

This case series describes the anaesthetic management for surgical repair of PS under CPB, supporting that open-heart surgeries are feasible procedures in dogs. Further studies are warranted to clarify the impact of the anaesthetic management and the ventilation strategies on post-operative complications and outcome.

Bristow P, Sargent J, Luis Fuentes V, et al. (2018) Surgical treatment of pulmonic stenosis in dogs under cardiopulmonary bypass: outcome in nine dogs. *J Small Anim Pract* 59, 38-44.

Fujiwara M, Harada K, Mizuno T, et al. (2012) Surgical treatment of severe pulmonic stenosis under cardiopulmonary bypass in small dogs. *J Small Anim Pract* 53, 89-94.

Oliveira P, Domenech O, Silva J, et al. (2011) Retrospective review of congenital heart disease in 976 dogs. *J Vet Intern Med* 25, 477-483.

Retrospective Evaluation of the Intraoperative Effects of Phenoxybenzamine Pre-Treatment in Dogs with Pheochromocytoma

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Phenoxybenzamine is a systemic alpha-antagonist used to treat hypertension, often as pre-treatment in dogs undergoing adrenalectomy for suspected pheochromocytoma. Data regarding perioperative mortality and intraoperative effects in dogs are limited (Herrera et al. 2008).

This is a retrospective, multicenter case-control study comparing 65 records: 34 dogs with phenoxybenzamine pre-treatment (median 0.46 mg kg⁻¹, range 0.08-2 mg kg⁻¹) (group PT) and 31 dogs without (group N). Our objective was to evaluate phenoxybenzamine pre-treatment effects on intraoperative variables and anesthetic interventions in dogs undergoing adrenalectomy for pheochromocytoma. Statistical analysis included Shapiro-Wilks to test normality, and two-way ANOVA and Mann-Whitney U to evaluate normally and non-normally distributed data, respectively (p < 0.05).

Results are presented in table 1.

In dogs undergoing adrenalectomy for suspected pheochromocytoma, phenoxybenzamine pre-treatment produced a higher range of systolic arterial pressures and number of hypertensive episodes, without producing significant intra-operative benefits.

Intraoperative Variable	Group N	Group PT	p-value
Maximum SAP	169.1 (49.1)	185.8 (44.6)	0.15
Maximum MAP	125.8 (31.6)	129 (32.9)	0.69
Minimum SAP	71.5 (17.7)	68.7 (18.5)	0.52
Minimum MAP	53 (9.3)	51.2 (10.6)	0.46
Delta SAP*	90.0 (60.0)	116 (66.0)	0.04
Delta MAP*	72.8 (30.4)	77.8 (33.9)	0.53
Duration of hypotension (minutes)*	20.0 (30.0)	30.0 (45.0)	0.1
Number of hypotensive episodes*	2.0 (2.0)	2.0 (4.0)	0.17
Duration of hypertension (minutes)*	20.0 (10.0)	15.0 (15.0)	0.58
Number of hypertensive episodes*	0.0 (0)	1.0 (2.0)	0.0076
Sinus tachycardia duration (minutes)*	17.5 (20.0)	55.0 (65.0)	0.12

Table 1. Mean (SD) or median (IQR)* of intraoperative variables in dogs undergoing adrenalectomy.

Herrera, M. A., Mehl, M. L., Kass, P. H., Pascoe, P. J., Feldman, E. C., & Nelson, R. W. (2008). Predictive factors and the effect of phenoxybenzamine on outcome in dogs undergoing adrenalectomy for pheochromocytoma. *Journal of veterinary internal medicine*, 22(6), 1333–1339. <https://doi-org.proxy.lib.ohio-state.edu/10.1111/j.1939-1676.2008.0182.x>

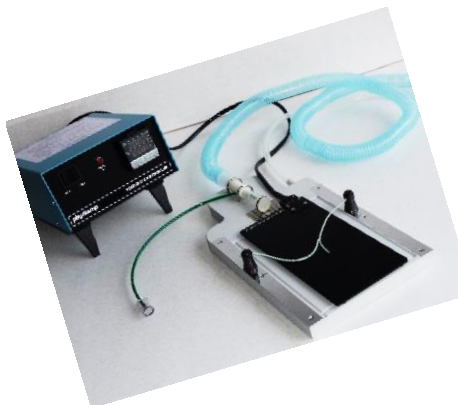


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POSTER SESSIONS

Effect of buprenorphine on the minimum alveolar concentration of isoflurane in cats

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The effect of continuous administration of buprenorphine on MAC have not been reported.

Six adult healthy cats were anesthetized with isoflurane in oxygen. Catheters were placed in a jugular and a medial saphenous vein for blood sampling and drug administration. Body temperature was maintained within 38.5 – 39.5°C. Buprenorphine was administered using a target-controlled infusion to maintain 8 concentrations ranging from 0.5 to 64 ng mL⁻¹, using pharmacokinetic data obtained during isoflurane anesthesia. Four concentrations were selected randomly and administered in an ascending order. The remaining concentrations were administered in an ascending order at least 2 weeks later. Isoflurane MAC was determined in duplicate using the bracketing method and tail clamping at baseline (separate experiment) and each buprenorphine concentration. Blood was sampled after the last MAC determination at each buprenorphine concentration for plasma buprenorphine concentration measurement using liquid chromatography/mass spectrometry.

Total anesthesia time was 371 ± 67 minutes. Baseline MAC was 1.94 ± 0.23 %. Plasma buprenorphine concentrations of 0.32 ± 0.21 , 0.37 ± 0.1 , 1.05 ± 0.50 , 2.53 ± 0.85 , 6.41 ± 1.57 , 13.17 ± 3.00 , 30.33 ± 6.20 and 62.79 ± 9.95 ng mL⁻¹ reduced MAC by 9 ± 7 , 9 ± 10 , 10 ± 8 , 19 ± 13 , 10 ± 10 , 10 ± 9 and 5 ± 9 %, respectively. Individual maximum % MAC reduction (buprenorphine ng mL⁻¹) was 18 (3.17), 34 (4.75), 12 (5.59), 2 (0.25), 34 (8.15) and 27 (0.33).

The effect of buprenorphine on MAC was variable, with no clear dependence on plasma concentration.

The study was funded by the Center for Companion Animal Health, School of Veterinary Medicine, University of California, Davis

The study was approved by the Institutional Animal Care and Use Committee (protocol 22440)

Ultrasound-guided sciatic nerve block in two alpacas (*Vicugna pacos*) as part of an opioid-free anaesthesia plan for hind-limb fractures

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An ultrasound-guided sciatic nerve block was performed as part of a balanced anaesthetic protocol in two alpacas (ASA II, 72 and 110 kg) undergoing surgical repair of a fracture of the distal hind limb. In case 1 this was a displaced, complete, closed, non-articular, oblique fracture of the mid-metatarsus III/IV, in case 2 a closed, acute, comminute, complete, displaced fracture of the mid-diaphysis of the left tibia.

Endotracheal intubation was performed 10 minutes after medetomidine 30 µg kg⁻¹ and ketamine 5 mg kg⁻¹ IM administration. Anaesthesia was maintained with sevoflurane in 60-65% oxygen. The sciatic nerve was visualised with a 12 MHz linear ultrasound probe at the level of the mid-thigh as an elliptical hypoechoic structure surrounded by a hyperechoic rim, medially to the biceps femoris muscle and laterally to the adductor muscles. A 19-gauge spinal needle was inserted caudo-cranially, in plane with the probe. Bupivacaine 0.5% (0.07 ml kg⁻¹ (Case1) and 0.09 ml kg⁻¹ (Case2)) was injected around the nerve. Correct positioning of the local anaesthetic was assessed by its spread around the nerve. Both animals received meloxicam 0.5 mg kg⁻¹ IV and ceftiofur 2.2 mg kg⁻¹ IM.

End-tidal sevoflurane was maintained between 1.9-2.2% (Case1) and 1.8-2.0% (Case2). Cardiorespiratory variables remained stable throughout surgery. General anaesthesia lasted 205 (Case1) and 255 (Case2) minutes. Endotracheal extubation was performed 12 (Case1) and 6 (Case2) minutes after discontinuing sevoflurane.

In the two cases described, the ultrasound-guided sciatic nerve block promoted opioid free intra-operative analgesia during surgical fracture repair of distal hindlimb.

Foster A, Mcsloy A & Monticelli P. (2020) Ultrasound-guided psoas compartment and sciatic nerve blocks for pain management of hind limb procedures in the alpaca. *Open Vet J* 10, 120-127.

Portela DA, Verdier N & Otero, PE. (2018) Regional anesthetic techniques for the pelvic limb and abdominal wall in small animals: A review of the literature and technique description. *Vet J*, 238, 27-40.

Smith JS, Schleining J & Plummer P. (2021) Pain Management in Small Ruminants and Camelids: Analgesic Agents. *Vet Clin North Am Food Anim Pract*, 37, 1-16.

Evaluation of the effects of laser therapy on the recovery period in dogs undergoing thoracolumbar hemilaminectomy: a pilot study

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Low level laser therapy (LLLT) is suggested to have anti-inflammatory, wound healing, and analgesic properties (Wardlaw et al. 2018). This study aimed to assess the effects of LLLT on wound healing and postoperative pain as additional treatment in dogs undergoing hemilaminectomy for thoracolumbar intervertebral disc extrusion (TLIVDE).

Nine dogs with TLIVDE undergoing hemilaminectomy were randomly allocated into group LLLT (n = 5) or SHAM (n = 4). Postoperative pain management was under clinician discretion for all dogs (Zidan 2020). The LLLT occurred 24-, 48-, 72- and 96-hours post-surgery. Pain was measured using Glasgow Composite Pain Scale (GCPS) and mechanical thresholds with an electronic Von Frey by a blinded operator the afternoon after surgery (baseline) and 2 hours after each LLLT. Wound healing was assessed using a 3D wound camera and processed to obtain the % of reduction in wound size. Success in wound reduction area was considered if there was 50% reduction from baseline to discharge. Generalised Estimated Equations and Chi square test were used.

Wound reduction success was significantly higher in LLLT (80%) than in SHAM (0%). There was no significant difference between LLLT and SHAM for GCPMS scores or mechanical thresholds. Group size n = 12 for a future study was estimated to obtain a mean difference in GCPS scores of 1.5 ± 0.9

Laser therapy appears to positively affect wound reduction in the early post-operative period in canine hemilaminectomy patients. Further research with a greater sample size is required to investigate the effect of LLLT on pain.

Wardlaw JL, Gazzola KM, Wagoner A, et al. (2018) Laser Therapy for Incision Healing in 9 Dogs. *Frontiers in Veterinary Science* 5:349.

Zidan, N., Medland, J. and Olby, N. (2020) Long-term postoperative pain evaluation in dogs with thoracolumbar intervertebral disk herniation after hemilaminectomy. *Journal of veterinary internal medicine*, 34(4), pp.1547-1555

Experience of veterinary practitioner and owners following referral to a dedicated veterinary pain clinic for medical management of degenerative lumbosacral stenosis

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Human Pain Clinics are well-established services providing individualised and multimodal treatment (Crombie et al.1994; Kosson et al. 2019). This descriptive study aimed to determine the awareness and experience of veterinary practitioners and owners after referring or visiting a Pain Clinic for treatment of canine degenerative lumbosacral stenosis (DLSS).

Data were collected from 18 dogs treated for DLSS (De Risio 2000) over a 5-year period at a dedicated veterinary Pain Clinic. All dogs received at least one epidural injection of steroids. Further injections and introduction of additional treatments were based on clinical response. Telephone interviews with practitioners and owners consisted of 12 and 38 questions, respectively. Questions were formulated to be answered as yes/no or with a scale from 0 to 10.

Of the 18 practitioners, 14 participated. Of these, 12 reported clinical improvement based on clinical notes, 10 were aware of the Pain Clinic prior to referral and 13 considered referral to the Pain Clinic in future.

Of the 18 owners, 13 took part. Of these, 10 felt that their expectations for attending the Pain Clinic were met. Twelve understood the aims of the treatment and 11 felt that their pet was undergoing individualised treatment. Owners' ratings (10-0) varied from 10 (11 owners) to 5 (1 owner) for the care to themselves and the approachability of the anaesthesiologists. Twelve owners would recommend the Pain Clinic to others.

Initial results about Veterinary Pain Clinics and the treatments offered are promising and might provide a valuable source of therapy for pets with DLSS.

Crombie, I.K., Davies, H.T.O. & Macrae, W.A. (1994) Entering the Loop: Assessing the Contribution of Pain Clinics in Northern Britain. *Quality of Life Research*, 3, S35-S38.

De Risio, L., Thomas, W.B. & Sharp, N.J.H. (2000) Degenerative Lumbosacral Stenosis. *Veterinary Clinics of North America: Small Animal Practice*, 30(1), 111- 132.

Kosson, D., Kolacz, M., Galazkowski, R., et al. (2019) The Effect of the Treatment at a Pain Clinic on the Patients' Assessment of Their Pain Intensity and the Incidence of Mental Disorders in the form of Anxiety, Depression, and Aggression. *International Journal of Environmental Research and Public Health*, 841 16(4).

Simulated clinical evaluation of the University of Surrey MAdTCI™, a manually adjusted system for target controlled infusion of propofol in dogs

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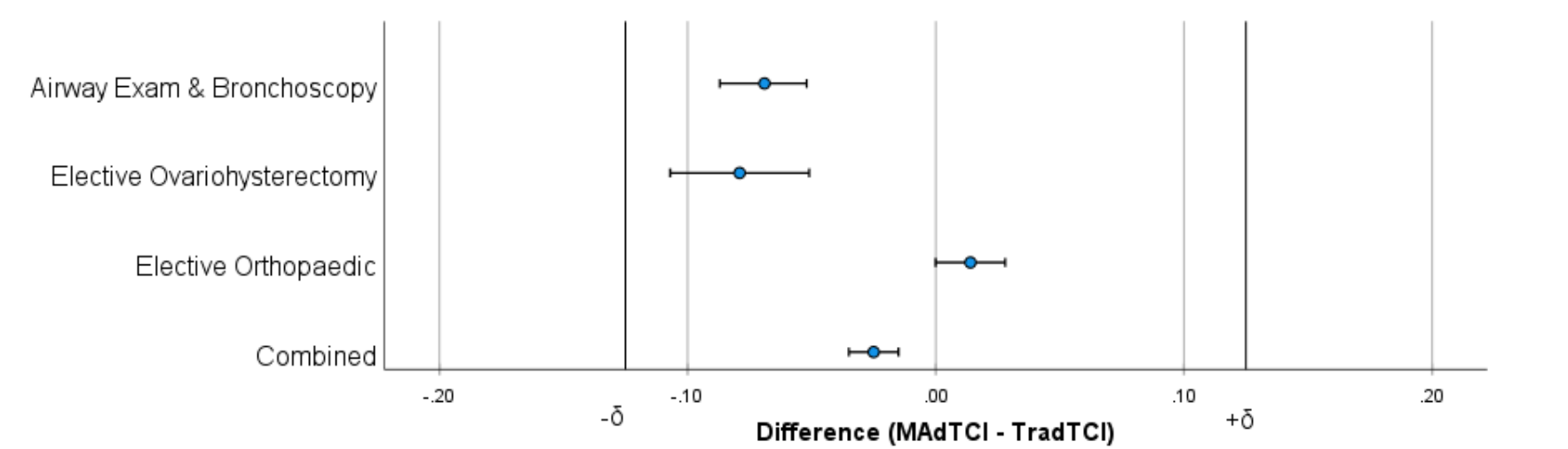
The study aimed to determine if a manually adjusted system for target controlled infusion (MAdTCI) of propofol in dogs performed similarly to a traditional target controlled infusion (TradTCI) in simulated clinical cases.

The MAdTCI consists of a spreadsheet based on the manual slide rule system described by Bruhn et al. (2003) adapted for use in dogs (Langton 2019). Plasma targets and timings were created for three cases (Elective Ovariohysterectomy, Airway Examination & Bronchoscopy and Elective Orthopaedic surgery). Pharmacokinetic simulations were conducted for each case with dogs of body mass 10-50 kg, in 10 kg increments, using both MAdTCI and TradTCI. Simulated plasma concentration was recorded every 10 seconds, with deviation from target calculated as simulated concentration minus target concentration. The two one sided test procedure was used to test for equivalence with respect to deviation from target. The equivalence margin (δ) was defined as $0.125 \mu\text{g mL}^{-1}$, giving a $\pm \delta$ interval of $0.25 \mu\text{g mL}^{-1}$, half of the smallest increment that plasma target may be adjusted during TradTCI.

Mean $\pm$ 90% confidence interval for difference in deviation from target between MAdTCI and TradTCI (Figure 1) was within the equivalence zone for each case and for all cases combined.

In the pharmacokinetic simulation of these cases the performance of the MAdTCI with respect to deviation from target was equivalent with TradTCI, the established technique.

Figure 1 – Mean $\pm$ 90% Confidence Interval (CI) for difference in deviation from target ($\mu\text{g mL}^{-1}$). The equivalence zone is defined as $\pm \delta$.



Bruhn J, Bouillon TW, Röpcke H et al. (2003) A manual slide rule for target-controlled infusion of propofol: development and evaluation. Anesth Analg 96, 142-147

Langton S D (2019) Development and initial evaluation of a manual slide rule based system for target controlled infusion of propofol in dogs. In: Proceedings of the Association of Veterinary Anaesthetists Spring Meeting 2019 Bristol pp 52

Comparison of peri-operative behaviour and gastrointestinal motility in rabbits receiving a brachial plexus block or lidocaine CRI for orthopaedic surgery

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This prospective, randomized study describes a nerve stimulator-guided brachial plexus blockade (BPB) in rabbits undergoing orthopaedic surgery and compares the BPB to systemic lidocaine.

After IM medetomidine ($100 \mu\text{g kg}^{-1}$), fentanyl ($5 \mu\text{g kg}^{-1}$) and midazolam (0.5 mg kg^{-1}), anaesthesia was induced (propofol IV) and maintained with isoflurane. Nine rabbits received a BPB with lidocaine (2%; 0.3 ml kg^{-1}), and eight received lidocaine constant rate infusion (CRI) ($2 \text{ mg kg}^{-1} \text{ IV}$, followed by $100 \mu\text{g kg}^{-1} \text{ minute}^{-1}$). Fentanyl ($5 \mu\text{g kg}^{-1} \text{ IV}$) was used as rescue analgesia. Carprofen ($4 \text{ mg kg}^{-1} \text{ IV}$) was administered at the end of surgery. Post-operative pain was assessed with the Rabbit Grimace Scale (RGS) and a composite pain scale (CPS) (Benato et al. 2021). Buprenorphine ($0.05 \text{ mg kg}^{-1} \text{ SC}$) was administered if RGS was $> 5/10$ or latest at T120. Rabbits were filmed during T0-120 to record distance travelled and behaviours. Food intake and faecal output were measured. Groups were compared using Mann Whitney-U and Spearman Rank tests (significant if $p < 0.05$).

BPB had lower RGS scores than CRI at T90 (median 3 (range 1-7) vs 4 (4-6), $p = 0.041$) and 120 (3 (1-5) vs 4 (3-5), $p = 0.026$) and required fewer intraoperative fentanyl boluses (0 (0) vs 2 (1-3)). There were no differences in food intake or faecal production over 18 hours, and no differences in distance travelled, or behaviours examined during T0-120. Both groups had similar CPS and buprenorphine requirements.

BPB seems superior for intraoperative analgesia. Postoperatively both groups were comparable.

Benato L, Murrell J, Knowles TG et al. (2021) Development of the Bristol Rabbit Pain Scale (BRPS): A multidimensional composite pain scale specific to rabbits (*Oryctolagus cuniculus*). PLoS ONE 16(6): e0252417. <https://doi.org/10.1371/journal.pone.0252417>

The impact of the use of local anaesthetic nerve blocks on the incidence of post-operative regurgitation in brachycephalic dogs following orthopaedic surgery

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Regurgitation and gastro-oesophageal reflux (GOR) are commonly reported complications in dogs in the perioperative period, with brachycephalic dogs and dogs undergoing orthopaedic surgery being at higher risk than others (Downing and Gibson 2018, Lamata et al. 2012). In humans undergoing orthopaedic surgery, locoregional anaesthesia reduces complications, including post-operative nausea and vomiting (PONV) (Jin et al. 2020). Potentially, similar benefits may be seen in brachycephalic dogs by reducing pain, stress and opioid requirements post-operatively. This study aimed to identify whether brachycephalic dogs receiving femoral and sciatic nerve blocks had a lower incidence of regurgitation postoperatively following orthopaedic surgery than those that did not.

This is a single-centre retrospective study. Medical records were searched between 2017-2019; forty-seven brachycephalic dogs undergoing routine pelvic limb surgery were included in the study. Dogs were assigned to two discrete groups: dogs receiving pelvic limb nerve blocks (n = 26) and those that did not (n = 21). A positive result was recorded if an animal regurgitated in the post-operative period in hospital. Fisher's exact test was used to test for significance.

The group receiving nerve blocks had a lower incidence of regurgitation at 15% (4/26), than the group that did not (38% [8/21]); however, this was not statistically significant (p=0.07).

Local anaesthesia remains a gold standard for pain relief in the peri-operative period. This study suggests that their use in brachycephalic patients may reduce the incidence of regurgitation postoperatively. Further studies and greater case numbers are needed to confirm whether this finding is significant.

Downing, F. and Gibson, S. (2018), Anaesthesia of brachycephalic dogs. *J Small Anim Pract*, 59: 725-733.

Jin Z, Gan TJ, Bergese SD. (2020) Prevention and Treatment of Postoperative Nausea and Vomiting (PONV): A Review of Current Recommendations and Emerging Therapies. *Ther Clin Risk Manag*, 16:1305-1317.

Lamata C, Loughton V, Jones M, et al. (2012) The risk of passive regurgitation during general anaesthesia in a population of referred dogs in the UK. *Vet Anaesth Analg*, 39(3):266-274

Risk of burnout and depression: A survey of Veterinary Anaesthesia specialists-in-training during the COVID-19 pandemic

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This study was designed to investigate risk, risk factors, and effects on patient care and safety, of burnout and depression in Veterinary Anaesthesia residents.

A link to access an online questionnaire, which included the Maslach Inventory-Human Services Survey (MBI-HSS; Lin et al. 2022), the Harvard National Depression Screening Day Scale (HANDS; Baer et al. 2000), and 28 questions developed to assess adherence to adequate clinical standards, was sent by email to 185 residents. The components of the MBI-HSS, namely emotional exhaustion (EE), depersonalisation (DP) and reduced personal accomplishment (RPA) were analysed separately. The Checklist for Reporting Results of Internet E-Surveys (CHERRIES) was used. Data were analysed with Chi-square test and two-step regression statistical modelling. Significance was set at $p < 0.05$.

Response rate was 48%, with 89/185 responses. Based on HANDS and MBI-HSS scores, high risk for both depression and burnout was found in 49% of the residents (44/89). These residents expressed greater concern of delivering inadequate patient care ($p < 0.001$), of decreased supervision quality during Covid-19 ($p = 0.038$), and of negative impact of the pandemic on their training program ($p = 0.002$) than residents at low-to-moderate risk. Clinical work ≥ 60 hours/week was a risk factor for depression ($p = 0.016$) and EE ($p = 0.022$), while female gender was a risk factors for EE only ($p = 0.018$).

An alarmingly high proportion of residents is at high risk of depression and burnout; the pandemic seems to have contributed to this.

Baer L, Jacobs DG, Meszler-Reizes J, et al. (2000) Development of a brief screening instrument: the HANDS. *Psychother Psychosom* 69, 35-41.

Lin CY, Alimoradi Z, Griffiths MD, et al. (2022) Psychometric properties of the Maslach Burnout Inventory for Medical Personnel (MBI-HSS-MP). *Heliyon* 1, 8(2):e08868.

Ultrasound-guided brachial plexus block in a Miniature Shetland Pony: a case report

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Ultrasound-guided (USG) brachial plexus (BP) blocks are commonly used in small animal practice to provide optimum analgesia, improving welfare. There is space for improvement in loco-regional techniques in equidae (Gozalo-Marcilla et al. 2021). We describe a BP block in a Miniature Shetland Pony.

A 9-year-old, 105 kg gelding Miniature Shetland Pony presented for arthrodesis of the right scapulohumeral joint. Pre-anaesthetic medication consisted of IV acepromazine 0.03 mg kg⁻¹, romifidine 0.08 mg kg⁻¹ and morphine 0.2 mg kg⁻¹. General anaesthesia was induced (ketamine 2.2 mg kg⁻¹ and diazepam 0.06 mg kg⁻¹) and maintained with sevoflurane in 100% oxygen (FE'Sevo 1.9 - 2.1) and a romifidine CRI 0.04 mg kg⁻¹ h⁻¹. Once in left lateral recumbency, a linear transducer was placed medial to the right scapulohumeral joint in a parasagittal plane, with depth adjusted to 5 cm. Mixed echogenicity tissue corresponding to the BP was identified adjacent to the brachial vessels. A 21-gauge 100 mm insulated needle was inserted cranially, in plane with transducer, and advanced under continuous USG until the tip was adjacent to the BP. Bupivacaine 0.2 mg kg⁻¹ and mepivacaine 0.4 mg kg⁻¹ (volume 5 mL) were injected with minimal resistance, demonstrating hydrodissection of perineural tissues.

The plane of anaesthesia was stable throughout surgery (145 minutes), with no increase from baseline in monitored physiologic variables that suggest nociception. Recovery from anaesthesia was uneventful. Rescue analgesia was required 6 hours after the BP block.

Ultrasound-guided BP blocks can form part of a multimodal analgesic approach in ponies undergoing shoulder surgery.

Gozalo-Marcilla M, Bettschart-Wolfensberger R, Johnston M et al. (2021) Data Collection for the Fourth Multicentre Confidential Enquiry into Perioperative Equine Fatalities (CEPEF4) Study: New Technology and Preliminary Results. *Animals* (Basel). Aug 30;11(9):2549.

Accuracy and safety of placing neuroaxial catheters in pigs: preliminary results

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Placing accurately and safely an epidural catheter might be difficult (Gamble et al. 2014). We aimed at evaluating the likelihood of safely achieving a targeted thoraco-lumbar location.

In 24 pigs (53.63 ± 6.1 kg) undergoing general anaesthesia for thoracotomy, lumbosacral puncture with an 18 G Tuohy needle was carried out by the same anaesthesiologist. Correct placement was defined by hanging drop and loss and lack of resistance. A 20 G catheter was then slid to T13-L1, after measuring landmarks' distance. If the needle's tip reached the sub-arachnoid space (CSF present), the catheter was placed spinally. For each insertion, the prediction of the anaesthesiologist regarding catheter's (epidural versus spinal) and tip's location was recorded. After euthanasia, the lumbar region was dissected until the tip of the catheter was visualized. Epidural and subarachnoid placements were compared with Fisher-Exact test.

The catheter was found 13/24 and 11/24 times epidurally and spinally respectively, with an accurate prediction of 83.33%. Catheter's tip was found in the targeted location 10 times, with an accurate prediction of 62.5%. In 4 cases (3 epidural and 1 subarachnoid placements) the catheter's tip turned caudally and in 1 (epidural) went outside the canal, through an intervertebral foramen. There was no significant difference in the likelihood of predicting correctly either catheter's or tip's location between epidural and sub-arachnoid placement. Hematomas or damages to the spinal cord were never macroscopically observed.

Lumbo-sacral puncture in pigs might easily result in sub-arachnoid catheter's placement. Catheter's position could be predicted more accurately than tip's position.

Gamble JJ, Ambros B, Séguin P, Benmansour P, Simko E. Stimulating thoracic epidural placement via a lumbar approach causes significant spinal cord damage in a porcine model. *Can J Anaesth*. 2014

Can descending pain pathway function be evaluated using a conditioning stimulus in awake dogs?

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This experimental study aimed to elaborate a method for functional testing of the endogenous descending inhibitory system for clinical use.

On four occasions, 12 healthy adult beagles were tested. An electrical stimulus (1ms train-of-five-square-wave pulse at 200 Hz) applied to the metatarsus, starting with 0.2 mA and increasing the current until a clear avoidance response occurred, was used as a test stimulus. After baseline determination, a mechanical conditioning stimulus was applied to the contralateral antebrachium using a commercially available pressure algometer (3 mm blunt tip) (Prod algometer limb actuators, Topcat Metrology), to generate a force of maximal 22 ± 1 N for 1 or 5 minutes. Electrical stimulation was reevaluated 0, 2, 5, 10, 15, 30, 45, and 60 minutes after conditioning.

The number of dogs showing an elevated electrical threshold compared to baseline and the magnitude of increase were analysed using the Wilcoxon signed-rank test ($\alpha = 5\%$).

In 90.9% of measurements ($n = 40$), increased thresholds up to 60% above baseline ($p < 0,0001$) could be detected, but there was high variability in magnitude and time of threshold increase.

It seems that descending inhibitory system could be activated. However, at present high variability limits clinical use. Further, despite the dogs appearing calm, an interference between stress response and results cannot be completely excluded. In the future, altered conditioning times and force need to be investigated.

Perioperative analgesic effects of an ultrasound-guided transversus abdominis plane block with bupivacaine in rabbits undergoing elective ovariohysterectomy: a pilot study

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This prospective, blinded, randomized study aimed to evaluate the perioperative analgesic effects of a transversus abdominis plane block (TAPB) with bupivacaine administered to rabbits undergoing elective ovariohysterectomy.

Eight 9-month-old female New Zealand White rabbits were premedicated IM with dexmedetomidine, methadone, and ketamine. Anesthesia was induced with IV alfaxalone and maintained with isoflurane. Post-induction, meloxicam was administered SC. An ultrasound-guided bilateral 2-point (subcostal and lateral) TAPB was performed by injecting 1 ml kg⁻¹ of 0.25% bupivacaine (BUPI group, n = 4) or the same volume of saline solution in controls (CTR group, n = 4) about 20 minutes before surgery. A 20% increase in HR or MAP intraoperatively was treated with remifentanyl (1 µg kg⁻¹, IV). Before premedication and for 6 hours post-extubation, pain was assessed with the Rabbit Grimace Scale (RbtGS; Miller et al. 2022). For RbtGS > 4/10, methadone 0.3 mg kg⁻¹ was administered IV. Data were analyzed with a generalized linear mixed model and Kendall's T coefficient ($p < 0.05$).

Two rabbits in the CTR group and 2 rabbits in the BUPI group were administered 2 and 3 doses of remifentanyl, respectively. All rabbits required rescue analgesia postoperatively. Rabbits in the CTR and the BUPI group received 8 and 4 doses of methadone, respectively ($p = 0.47$). No correlation was observed between the intra- and postoperative rescue analgesia in either group.

Although the BUPI group required less postoperative analgesia, this was not statistically significant, therefore further clinical studies are warranted to evaluate the efficacy of TAPB in rabbits.

Miller AL, Clarkson JM, Quigley C et al. (2022) Evaluating pain and analgesia effectiveness following routine castration in rabbits using behavior and facial expressions. *Front Vet Sci* 9, 782486.

This project was funded by the *Fonds en santé des animaux de compagnie*, supported by Zoetis, of the Université de Montréal.

Assessing diagnosis of pain in pigs according to behavioural changes by applying weightings based on machine learning algorithm

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We investigated the effects of the inclusion of weightings from a machine learning-based algorithm on the discriminatory capacity of the Unesp-Botucatu pig acute pain scale (UPAPS) to detect pain in pigs according to the area under the curve (AUC) of sensitivity and specificity.

Pain scores of 45 pigs from the study validating UPAPS were used (Luna et al. 2020). Pigs were filmed before orchiectomy, 3-4h after orchiectomy (performed under local anaesthesia), 5h after orchiectomy (1h after flunixin and morphine IM), and 24h after surgery. Four experienced 'blind' evaluators randomly assessed the footages, indicated whether they would provide analgesia according only to their experience and scored UPAPS. Assessments were repeated after 30 days. A machine learning-based algorithm was conducted with random forest using the UPAPS behaviors (feature variables) to classify pigs who needed analgesia or not (target variable). The algorithm was created/trained with 70% of the randomly selected data, using four k-folds, two repeats, 1,001 trees, and two variables randomly sampled for each split. Pig remaining data was used to test and cross-validate the algorithm.

There was no difference in the AUC of the algorithm compared to the original UPAPS (0.97; $p > 0.05$). The five behaviors with the greatest power to diagnose pain were 'changes posture, protects the affected area', 'head down', 'sits with difficulty', 'wags tail', and 'shows little interest in the surroundings', suggesting no improvement in pain diagnosis with the algorithm.

In conclusion, although the algorithm indicated the importance of each behavior, there was no improvement in AUC.

Luna SPL, Araújo AL, Nóbrega Neto, PI; Brondani JT; Oliveira FA, Azerêdo LMS, Telles FG, Trindade, PHE (2020). Validation of the UNESP-Botucatu pig composite acute pain scale (UPAPS). PLoS One 15, p.e0233552.

The study was approved by the Ethical Committee for the Use of Animals in Research of the School of Veterinary Medicine and Animal Science, Unesp, Botucatu, Brazil, under protocol number 102/2014 and follows the Brazilian Federal legislation of CONCEA (National Council for the Control of Animal Experimentation).

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Evaluation of postoperative analgesia after intraperitoneal and incisional administration of ropivacaine in dogs undergoing ovariohysterectomy

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Intraperitoneal administration of local anaesthetics can reduce postoperative pain after ovariohysterectomy in dogs (Carpenter et al. 2004). The objective of this study was to compare postoperative analgesia and opioid requirements following intraperitoneal and incisional ropivacaine versus 0.9 % NaCl.

Forty-three client-owned dogs were included in this randomized, blinded, clinical study. Dogs were administered acepromazine (0.03 - 0.05 mg kg⁻¹) and dexmedetomidine (0.01 mg kg⁻¹) intramuscularly. Anaesthesia was induced with propofol to effect and ketamine (1 mg kg⁻¹) intravenously and maintained with isoflurane in oxygen. Intraoperative analgesia included carprofen (4 mg kg⁻¹) subcutaneously and morphine (0.2 mg kg⁻¹) intravenously. Each dog received either a ropivacaine intraperitoneal and incisional splash (2 mg kg⁻¹ and 1 mg kg⁻¹, respectively), or an equal volume of 0.9 % NaCl. Buprenorphine (0.02 mg kg⁻¹) was administered intramuscularly once the uterus was removed. Sedation and pain were assessed at 0.5, 1, 2, 4, 6 and 8 hours after extubation, using a sedation scale (Grint et al. 2009), the Short Form of the Glasgow Composite Pain Scale (SF-GCPS) and a dynamic interactive visual analogue scale (DIVAS). Buprenorphine (0.01 mg kg⁻¹) was administered intravenously if dogs scored > 5/24 on SF-GCPS.

Ordinal mixed effects models showed no difference in pain scores between the groups. Fisher's exact test revealed no significant difference regarding postoperative buprenorphine requirements between group NaCl (3/22 dogs) and group ropivacaine (1/21 dogs). Additionally, lower sedation scores were associated with higher DIVAS scores.

In this multimodal analgesic protocol, ropivacaine provided no superior analgesia to 0.9 % NaCl.

Carpenter, R.E., Wilson, D.V., Evans, A.T., 2004. Evaluation of intraperitoneal and incisional lidocaine or bupivacaine for analgesia following ovariohysterectomy in the dog. *Vet Anaesth Analg* 31, 46–52.

Grint, N.J., Burford, J., Dugdale, A.H.A., 2009. Does pethidine affect the cardiovascular and sedative effects of dexmedetomidine in dogs? *J Small Anim Pract* 50, 62-66.

Evaluation of paravertebral single-site anaesthetic injection in experimental pigs undergoing forelimb amputation

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Multimodal analgesia is required in pigs used as models of invasive surgeries. We aimed to investigate the feasibility and success of a paravertebral single-site injection, in pigs undergoing forelimb monolateral or bilateral amputation.

Twenty-three pigs for a total of 30 forelimb amputations received IM dexmedetomidine 20 $\mu\text{g kg}^{-1}$, ketamine 10 mg kg^{-1} and methadone 0.2 mg Kg^{-1} , followed by IV ketamine and propofol to allow tracheal intubation. General anaesthesia was maintained with isoflurane in oxygen and air. With the animal in lateral recumbency, transverse processes and vertebral bodies of C6 and C7 were ultrasonographically visualised. A needle connected to a nerve stimulator was inserted caudally to the transverse process of C6 and directed caudo-medially to puncture the deep cervical fascia and anaesthetise the two ventral branches emerging from C7. When carpal extension was obtained at 0.7 mA and lost at 0.3 mA, 0.2 ml kg^{-1} ropivacaine 0.75% mixed with 0.2 ml patent blue V were injected. Staining was verified before amputation. The target was considered achieved when at least 1 cm of the ventral branches was stained, partially achieved when at least 1 cm of one ventral branch was stained, otherwise failure was declared.

Target was achieved in 12 amputations (40%), partially achieved in 12 (40%) and failed in 6 (20%). Out of the 6 failures, staining was found 4 times superficially to the deep fascia, while twice post-mortem in the epidural space.

At this volume, a single-site injection could be a complementary option to provide analgesia of forelimbs.

Effects of vatinoxan on heart rate, mean arterial pressure and respiratory rate in dogs premedicated with medetomidine and butorphanol followed by sevoflurane anaesthesia – a randomized clinical study

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Administration of vatinoxan maintains HR and reduces MAP in medetomidine-butorphanol sedated dogs (Salla et al. 2014). We aim to investigate the effects of vatinoxan in medetomidine- butorphanol premedicated dogs during sevoflurane anaesthesia.

Dogs (n = 28) scheduled for surgical castration were randomly IV premedicated with medetomidine (0.125 mg m⁻²) and butorphanol (0.2 mg kg⁻¹) (MB), or medetomidine (0.25 mg m⁻²), butorphanol (0.2 mg kg⁻¹) and vatinoxan (5 mg m⁻²) (MB-VATI). Anaesthesia was induced 15 minutes later with propofol and maintained with sevoflurane. Intratesticular lidocaine (2 mg kg⁻¹) and IV meloxicam (0.2 mg kg⁻¹) was administered for analgesia. End-tidal sevoflurane concentration (F_E'Sevo), HR, f_R and MAP were recorded at selected timepoints. Data was analysed with mixed model of ANOVA.

Results are given in the table.

Despite the higher dosage of medetomidine, vatinoxan alleviated the decrease in HR and MAP was lower in MB-VATI than in MB group.

Table

Variable	Group	BL	Surgery start	Surgery end
HR (beat minute ⁻¹)	MB	100 ± 23	61 ± 16*	58 ± 12*
	MB-VATI	108 ± 23	93 ± 23	73 ± 10
MAP (mmHg)	MB	111 ± 21	70 ± 14*	69 ± 10
	MB-VATI	110 ± 22	58 ± 12	62 ± 13
f _R (breaths minute ⁻¹)	MB	na	10 ± 6	15 ± 11
	MB-VATI	na	7 ± 2	14 ± 15
F _E 'Sevo (%)	MB	na	1.5 ± 0.2	1.5 ± 0.2
	MB-VATI	na	1.4 ± 0.2	1.5 ± 0.2

*Significant difference between groups ($p < 0.05$); na = not assessed; BL = baseline

Salla K, Restitutti F, Vainionpää M et al. (2014) The cardiopulmonary effects of a peripheral alpha-2-adrenoceptor antagonist, MK-467, in dogs sedated with a combination of medetomidine and butorphanol. *Vet Anaesth Analg* 41, 567-574.

Endotracheal intubation in pigs: which animal positioning is the best?

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Endotracheal intubation (ETI) is challenging in pigs. We aimed at comparing perception of ETI ease and performance time with the animal positioned in dorsal (DR) or sternal (SR) recumbency.

Thirty-three participants were grouped: undergraduates (veterinary students), graduates (veterinarians without specific anaesthesia training) and experts (veterinary anaesthesiologists). Each participant intubated one pig cadaver (28.9 ± 4.7 kg; euthanised for another study; total number = 16) in DR and SR. Attempts and time to correctly perform ETI, and answers to three Likert-scale questions (score from 0 = worst score to 5 = best score) were recorded. Effect of recumbencies within groups was tested with the Wilcoxon signed-rank test.

Results are presented in the table.

		Undergraduates (15)	Graduates (10)	Experts (8)
Attempts (number)	DR	3 (2, 6)	5 (1, 6.25)	1.5 (1, 2.75)
	SR	1 (1, 2)*	1 (1, 2)	1 (1, 1)
Time (seconds)	DR	154 (80, 439)	223 (93.2, 314.5)	41.5 (29, 81.5)
	SR	33 (19, 80)*	22 (14.5, 168.5)*	16.5 (9, 45.5)
Larynx visualization (score)	DR	2 (2, 4)	3 (2, 4)	4 (2.25, 5)
	SR	5 (5, 5)*	5 (4, 5)	5 (4, 5)
Endotracheal tube introduction (score)	DR	3 (2, 3)	3 (2, 4)	5 (3.5, 5)
	SR	4 (4, 5)*	4 (2, 5)	4 (3.25, 4.75)
Endotracheal tube advancement (score)	DR	4 (3, 4)	3.5 (2, 4)	4.5 (4, 5)
	SR	4 (3, 4)	4 (2, 5)	3 (2, 4)

*statistical difference between recumbencies (p <0.05)

Intubation in SR seems preferable, but only for inexperienced personnel.

Depth of anaesthesia assessment in experimental pigs: a scoping review

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Despite the large use of pigs in research, no gold standard depth of anaesthesia (DoA) indicator is available. We undertook a scoping review to investigate and summarize the evidence that sustains or contradicts the use of DoA indicators adopted in pigs.

Medline, Embase and CAB abstract were searched up to March 19th 2020. No time and language limitations were set. Only original articles reporting in vivo studies using pigs or minipigs under general anaesthesia were included. The DoA indicators found in the selected papers were divided in two categories: A, indicators investigated as methods to assess DoA; B, indicators used to assess DoA, whose outcomes were merely reported.

Out of 12304 papers, 92 were selected for final analysis.

Category A: 15 DoA indicators were found in 17 papers. Studies were conducted using inhalant anaesthetics in the majority of the cases (11/17), while 3/17 using propofol. The most investigated DoA indicators were: bispectral index (8/17), spectral edge frequency 95% (4/17) and median frequency (3/17). Contrasting results about the reliability of the DoA indicators were reported, making difficult to draw final conclusions.

Category B: 21 DoA indicators were found in 81 papers. The most reported DoA indicators were: motor response following a stimulus (31/81), bispectral index (16/81), DoA scales (16/81), and spectral edge frequency 95% (9/81).

Results highlight the current lack of scientifically valid and reliable indicators to ensure an adequate DoA in pigs. Further research should be conducted, especially targeting DoA induced by intravenous anaesthetic agents.

Lipopolysaccharid administration in equine 15 hours prior to isoflurane/lidocaine anaesthesia – description of perianaesthetic complications in lean and obese body condition

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Obesity might alter individual responses to lipopolysaccharide (LPS) administration. Perianaesthetic complications in lean and obese equine after preanaesthetic induction of endotoxemia is described.

Twenty healthy lean geldings gained body weight over 2 years for the main project. On 3 occasions (1 year apart) laparotomy and subcutaneous tissue sampling was performed 15 hours after intravenous LPS administration (10 ng/kg body weight). A common anaesthetic protocol was applied (isoflurane/lidocaine, mechanical ventilation, 100% oxygen) for 2.5 hours. Cardiorespiratory parameters and blood gases were monitored. Perianaesthetic morbidities in Y1, Y2 and Y3 are assessed via descriptive analysis.

Hypotension in 89% of the animals in Y1 (moderate-severe) necessitated implementation of a strict cardiovascular support protocol. Preanaesthetic crystalloids, earlier dobutamine administration and frequent colloids if unresponsive, decreased severity and incidence during obesity (82% and 76% in Y2 and Y3, respectively).

In Y1, one horse was euthanized due to inability to stand in recovery. One pony (Y3) showed a sudden loss of reflexes and decrease in blood pressure (by 32 mmHg) after 75 minutes of anaesthesia but recovered uneventful after treatment. Tachycardia occurred during lean and obese body condition (Y1 13/20, Y2 8/19, Y3 12/19). In obese equine, preanaesthetic packed cell volumes were increased (7/19) and Methemoglobinemia detectable (Y2 17/19, Y3 15/19). Lactic acidosis was observed in 2/20 (Y1), 3/19 (Y2) and 2/19 (Y3) animals.

One horse was hypoxemic throughout the years, severity increased.

Cardiovascular stability under anaesthesia is impaired in lean and obese endotoxic equine. The impact of obesity remains unclear based on our data.

Rectal temperature variation in dogs undergoing 3-Tesla MRI during general anaesthesia

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While inadvertent hypothermia is common in small animals undergoing anaesthesia, high field MRI can potentially increase body temperature, which is also reported in children of comparable size as small animals.

In this prospective observational trial dogs scheduled for 3-Tesla MRI in anaesthesia between February and October 2020 in a veterinary teaching hospital were eligible for enrolment. Data recorded included breed, body mass, body condition score, age, quality of fur, rectal temperature before and after MRI, time in MRI room, scan area, application of contrast medium, choice of anaesthetic agents, blankets and infusion therapy. Groups were compared using Mann-Whitney-U-test or Kruskal-Wallis-Test with $p < 0,05$ considered as significant.

Inclusion criteria were matched by 174 dogs. Body temperature before MRI was $38,2 \pm 0,6$ °C, mean temperature after MRI was $37,7 \pm 0,8$ °C, temperature difference was $- 0,6 \pm 0,6$ °C ranging from $- 2,3$ °C to $+ 0,9$ °C. Mean MRI duration was $50,2 \pm 18,6$ minutes.

Temperature loss greater 0,1 °C was observed in 123 (70,6 %) dogs, 29 (16,7 %) dogs kept their temperature within 0,1 °C constant and 22 (12,6 %) dogs gained more than 0,1 °C. Factors that were associated with higher temperature after MRI were higher bodyweight, thick fur and application of α -2-agonists and ketamine.

Temperature loss is most likely in dogs undergoing MRI in general anaesthesia. However, in larger dogs and in dogs with thick fur rise in body temperature is possible and more common than generally anticipated, while clinically irrelevant in most cases.

