



— ASSOCIATION OF —
VETERINARY ANAESTHETISTS



Staying Alive

You, Your patient and Your Planet

Spring Meeting 2020

Wednesday 11th – Friday 13th March

UNIVERSITY COLLEGE DUBLIN, IRELAND

Please Note: Press ctrl and click on the relevant page number to jump to that section. To return to the beginning of the document, please click your “Home” button on your keyboard.

Welcome letter.....	5
Programme for Wed 11th March 2020 (Pre-Congress day)	8
Programme for Thurs 12th March 2020 (Main Congress Day 1).....	9
Programme for Fri 13 th March 2020 (Main Congress Day 2)	10
Abstracts programme Thurs 12 th March. 14.30 to 15.30	11
Abstracts programme Thurs 12 th March. 16.00 to 17.00	13
Abstracts programme Fri 13 th March. 14.30 to 15:30	14
Abstracts programme Fri 13 th March. 16.00 to 17:00	15
Poster Listing.....	16
Congress Speakers	19
Kieran Borgeat	19
Donal Buggy	19
Daniel Davies.....	20
Íde Delargy	20
Daniel J. Fletcher	21
Blánaid Hayes.....	21
Matthew McMillan	22
Tom Pierce	22
Robert Shiel.....	23
Antonella Puggioni	23
Emma Tobin	24
Pre-Congress Day Lectures	25
Lectures 1 & 2: When radiographs talk to the Anaesthetist.....	25
Lecture 3: CT and MRI for the Anaesthetist.....	36
Lecture 4: ECGs for the Anaesthetist	40
Lecture 5 Cardiac ultrasound for the Anaesthetist.....	49
Lecture 6: A-FAST & T-FAST for the Anaesthetist	55
Keynote Lectures	60
CPR: Basic Life Support (BLS) / Advanced Life Support (ALS)	60
Wellbeing and burnout prevention in clinicians.....	67
Can anaesthetic technique during cancer surgery influence risk of recurrence?	67
Why things go wrong in anaesthesia	69
Reducing our carbon footprint	84

Abstracts	85
114.01	85
114.02	86
114.03	87
114.04	88
114.05	90
114.06	91
114.07	92
114.08	93
114.09	94
114.10	95
114.11	97
114.12	98
114.13	99
114:14	100
114:15	101
114:16	102
115:01	103
115:02	104
115:03	105
115:04	106
115:05	107
115:06	108
115:07	109
115:08	110
115:09	111
115.10	112
115.11	113
115.12	114
115:13	115
115:14	116
115:15	117
115.16	118

Posters 1-25	119
Poster 1	119
Poster 2	120
Poster 3	121
Poster 4	122
Poster 5	123
Poster 6	124
Poster 7	125
Poster 8	126
Poster 9	127
Poster 10	128
Poster 11	129
Poster 12	130
Poster 13	131
Poster 14	132
Poster 15	133
Poster 16	134
Poster 17	135
Poster 18	136
Poster 19	137
Poster 20	138
Poster 21	139
Poster 22	140
Poster 23	141
Poster 24	142
Poster 25	143
Sponsors and Exhibitors	144

Welcome letter

Dear AVA, NAVAS, ECVAA members and other Colleagues,

It is with great pleasure that we welcome you to the AVA Spring Meeting 2020, in University College Dublin, Ireland from Wednesday 11th March to Friday 13th March 2020.

University College Dublin (UCD) is the largest university in Ireland with the only veterinary college on the island of Ireland. The university grounds are situated just 4 km south of the city centre. You are surrounded by nature on this purpose-built campus on 330 acres (133 hectares) of beautifully landscaped grounds. The sea is only 20 minutes' walk away and the mountains are a short drive away. There are numerous hotels and other accommodations in close proximity to the university and the campus is served by many buses from all around the city.

The venues for the Congress were chosen to showcase some of the university's modern buildings – O'Reilly Hall (main congress lectures), O'Brien Centre for Science (pre-congress day) and the Veterinary School (abstract sessions).

The Pre-Congress day focuses on '**Diagnostics for the patient undergoing anaesthesia**', with lectures on diagnostic imaging (radiology, ultrasound, MRI and CT) and cardiology. These topics are very relevant for all veterinary anaesthetists, nurses and general practitioners, whether at the beginning of training or if you need a refresher.

The theme for the main Congress is '**Staying Alive – You, Your Patient and Your Planet**'. The keynote lectures will be given by specialists from both veterinary and human medicine.

Staying Alive: You: most of us realise that anaesthesia is a stressful career and lectures from two medical doctors (Dr Íde Delargy and Dr Blánaid Hayes) on wellbeing, addiction and burnout prevention in doctors and anaesthetists should stimulate discussions on caring for ourselves and maintaining a work-life balance.

Staying Alive: Your patient: our patients benefit when we maintain our skills in key areas. Staying Alive is at its most relevant when discussing cardiopulmonary resuscitation (i.e. RECOVER guidelines), and we are fortunate to have Dr Daniel Fletcher to speak on this topic. Dr Donal Buggy is a medical anaesthetist whose recent research career has focused on how anaesthesia affects the outcome for cancer in people, something that we will all have to consider as the research widens to include veterinary patients; he will provide us with the current state of play. Dr Matt McMillan co-authored the book 'Errors in Veterinary Anaesthesia' and is excellently placed to help us prevent anaesthetic-related accidents. With improved focus on clinical governance in the veterinary industry, Dr McMillan's discussion promises to be applicable to all conference delegates.

Staying Alive: Your planet: never before have we been so aware of the detrimental effect our life and work habits have on the planet. It is time for anaesthetists to demonstrate that they wish to contribute to reducing our carbon footprint. Dr Tom Pierce is a UK expert in this area, and in this era of climate change and awareness of waste, we will have a lecture in how to improve the carbon footprint of anaesthesia.

The social programme of the Congress has been designed to allow you meet up with friends and also to meet new colleagues. There are over 60 delegates for whom this is their first AVA Congress so please say hello! The welcome reception (in the conservatory of O'Reilly Hall) on Wednesday 11th at 17:30 is very relaxed and is free for all delegates. Enjoy a light supper, a glass of wine and a catch-up, serenaded by some traditional Irish music performed by some of our veterinary final year students.

Instead of a formal gala dinner we are hosting an Irish Evening on Thursday 12th. This will be held in Ireland's largest thatched pub - the historic Taylor's Three Rock in the foothills of the Dublin mountains, only 30 minutes away. Immediately after the afternoon abstract sessions, buses will transport you from UCD to the venue. Please 'come as you are', relax, eat, drink, dance and enjoy the craic. For those who need even more dancing, the party will continue with a disco after the main entertainment. Buses will leave at various times to bring you back to the Conference hotels and St Stephen's Green in the city centre.

The organising committee of the AVA Spring Meeting 2020 wish to acknowledge and thank all our sponsors, without whose assistance this conference would not be possible. Please visit the trade stands in O'Reilly Hall and take part in the quiz to win €100 (flyer in your bag).

We are very pleased that you have been able to join us at the AVA Spring meeting on the Emerald Isle.

Lynne Hughes
(Chairperson)



Vilhelmiina
Huuskonen



Joei Potter



Claire Loughran



Maria Chie Niimura



Georgina Murphy



Laura Gomez



Julia Pentsou



360° Product Range

Chanelle Pharma offers a large range of Anaesthesia, Sedation and Analgesia products.



Revertor®
Contains: Atipamezole

Insistor®
Contains:
Methadone Hydrochloride



Iso-Vet®
Contains: Isoflurane



Chanelle Pharma is a partner of choice in the development and manufacturing of pharmaceutical products for both human and veterinary channels.

Headquartered on an 18 acre campus in Galway, Ireland, the company has three manufacturing facilities and five research and development laboratories – one of which is located in Jordan.

For further information on our range please contact your Key Account Manager or email enquiries@chanellgroup.ie

chanelle
PHARMA

Programme for Wed 11th March 2020 (Pre-Congress day)

Diagnostics for the Anaesthetist.

O'Brien Centre for Science, ground floor, Moore Auditorium

<u>Time</u>	<u>Duration</u>	<u>Topic (speaker)</u>
08.30 – 9.00	30 mins	Registration in the foyer at bottom of stairs
09.00 – 10.15	75 mins	Thoracic radiology for the Anaesthetist (Puggioni)
10.15 – 10.45	30 mins	Break & tea/coffee - Foyer
10.45 – 11.30	45 mins	Abdominal radiology for the Anaesthetist (Puggioni)
11.30 – 12.30	60 min	CT and MRI for the Anaesthetist (Davies)
12.30 – 14.00	90 min	Lunch
14.00 – 15.00	60 min	Cardiac Ultrasound for the Anaesthetist (Borgeat)
15.00 – 15.30	30 min	Break & tea/coffee - Foyer
15.30 – 16.30	60 min	Cardiology for the Anaesthetist (Shiel)
16.30 – 17.15	45 min	Ultrasound T-FAST and A-FAST (Tobin)
17.30 – 19.30	Welcome Reception in The Conservatory, O'Reilly Hall. Light supper and drinks	

Programme for Thurs 12th March 2020 (Main Congress Day 1)

Staying Alive – You, Your Patient and Your Planet.

O'Reilly Hall: Keynote lectures, trade exhibition, posters, tea/coffee/lunch and ECVAAGM

Veterinary Sciences Building, ground floor, rooms 114 and 115: Abstracts

<u>Time</u>	<u>Duration</u>	<u>Topic (speaker)</u>
08.00		Registration opens
08.50 – 09.00		Opening Ceremony
09.00 – 10.30	90 min	Current guidelines in CPR for dogs and cats (Fletcher)
10.30 – 11.00	30 min	Tea/coffee, posters & trade exhibition
11.00 – 12.00	60 min	Addiction in Doctors and Anaesthetists (Delargy)
12.00 – 13.00	60 min	Wellbeing and burnout prevention in Clinicians (Hayes)
13.00 – 14.30	90 min	Lunch, posters & trade exhibition
13.30 – 14.30	60 min	ECVAAG General Meeting (ECVAAG & ACVA Dips only)
14.30 – 15.30	60 min	Abstracts: 114.1 to 114.4 and 115.1 to 115.4
15.30 – 16.00	30 min	Tea/coffee, posters & trade exhibition
16.00 – 17.00	60 min	Abstracts: 114.5 to 114.8 and 115.5 to 115.8
17.15		Please assemble in the foyer of the Veterinary Sciences building immediately after the abstracts end. Buses depart from the carpark outside Veterinary Sciences for the Irish Night at Taylors Three Rock. Please note that there is NOT time to return to your hotel before the buses depart.
22:00		First buses return to conference hotels and city centre. Last buses return at midnight.

Programme for Fri 13th March 2020 (Main Congress Day 2)

Staying Alive – You, Your Patient and Your Planet.

O'Reilly Hall: Keynote lectures, trade exhibition, posters, tea/coffee/lunch and AVA AGM

Veterinary Sciences Building, ground floor, rooms 114 and 115: Abstracts

<u>Time</u>	<u>Duration</u>	<u>Topic (speaker)</u>
09.00 – 10.00	60 min	How anaesthesia affects the outcomes for cancer (Buggy)
10.00 – 11.00	60 min	Reducing our carbon footprint (Pierce)
11.00 – 12.00	60 min	Tea/coffee, posters & trade exhibition
12.00 – 13.00	60 min	Why things go wrong in anaesthesia (McMillan)
13.00 – 14.30	90 min	Lunch
13.30 – 14.30	60 min	AVA General Meeting (all AVA members)
14.30 – 15.30	60 min	Abstracts: 114.9 to 114.12 and 115.9 to 115.12
15.30 – 16.00	30 min	Tea/coffee, posters & trade exhibition
16.00 – 17.00	60 min	Abstracts: 114.13 to 114.16 and 115.13 to 115.16
17.10 – 17.20	10 min	Closing Ceremony, presentation of awards, next meeting in Bern.



TE7
Touch Screen Ultrasound System

An ideal partner
for anesthesia
professionals

Simple, Smart, Focused

With TE7's compact touch screen and advanced features, including iNeedle™ visualization, dedicated nerve exam presets, and TEE transducer, the TE7 is an ideal system for nerve block and intraoperative cardiac monitoring. The TE7's intuitive work flow and seamless touch screen, secured with a 10s screen locking feature for easy cleaning even during exams, make scanning efficient for the demanding environment.

- Boot up from standby in 3 seconds
- Seamless touch screen for easy cleaning
- Max three transducer connectors
- Built-in battery and wireless network
- Mobile trolley with retractable power cable
- L14-6Ns with high frequency and resolution for nerves, muscles and vessels
- Excellent nerve and needle imaging
- Dedicated exam presets for Anesthesia
- Middle line mark on linear transducers for out-of-plane approach
- Prospective cine saving for 480s
- Focused applications
- Expeditious operation experience
- Touch screen gesture
- iNeedle: Needle enhance visualization

Advanced design
Intercalane Brachial plexus Median nerve
Peroneal nerve iNeedle

iZoom: Enables accurate viewing of image for users from distance
Intuitive user interface

This system has recently been awarded a national framework tender for Emergency Depts

2014 Shenzhen Mindray Bio-Medical Electronics Co., Ltd. All rights reserved. Specifications subject to changes without prior notice.
P/N: E70-TE7 America: P/N: 2102002P-20151020

Norono Medical Ltd Unit A1 - 4A MaLun Enterprise Park, Belfast, BT36 4GN
www.norono-medical.com www.mindray.com
sales@norono-medical.ie sales@norono-medical.co.uk

mindray
healthcare within reach

Smart

15" touch screen with anti-glare and wide viewing angle

Transducer cable management for cord longevity and ease of use

Built-in battery provides long battery life

Wi-Fi or wireless network

Height adjustable smart trolley

PAJUNK

Sono Needles
Needles for Single Shot
Ultrasound Guided Nerve Blocks



MADE IN GERMANY

Abstracts programme Thurs 12th March. 14.30 to 15.30

Thurs 12th March. Session 1a: 14.30 to 15.30 Veterinary Sciences Building, Ground Floor, Lecture Room 114			
No	Start	Title of Abstract	Presenting author
114.01	14.30	Assessing the efficacy of a laryngeal mask airway in anesthetized free-ranging bighorn sheep (<i>Ovis canadensis</i>) lambs.	Hee
114.02	14.45	Immobilization of captive red kangaroo (<i>Macropus rufus</i>) with medetomidine-ketamine-midazolam or medetomidine-ketamine-butorphanol	Shilo-Benjamini
114.03	15.00	The relationship between food deprivation and blood glucose at induction of anaesthesia in juvenile pigs.	Gregson
114.04	15.15	Accuracy of volumes determined using the Pedi-Lite flow sensor	Raillard
Thurs 12th March. Session 1b: 14.30 to 15.30 Veterinary Sciences Building, Ground Floor, Lecture Room 115			
No	Start	Title of Abstract	Presenting author
115.01	14.30	Retrospective comparison of three loco-regional techniques for pelvic limb surgery in dogs	Ferrero
115.02	14.45	Comparison of blind versus ultrasound-guided intercostal nerve block: a canine cadaveric study	Thomson
115.03	15.00	An investigation of ultrasound and electrical nerve location to predict distance to neuraxial space in dogs.	Gurney
115.04	15.15	Is a wireless ultrasound device useful for performing locoregional anaesthesia in dogs...? A cadaveric study.	Ho
15.30 to 16.00 Tea / Coffee break, Posters and Trade Exhibition O'Reilly Hall			

Abstracts programme Thurs 12th March. 16.00 to 17.00

Thurs 12th March. Session 2a: 16.00 to 17.00 Veterinary Sciences Building, Ground Floor, Lecture Room 114			
No	Start	Title of Abstract	Presenting author
114.05	16.00	CEPEF4 going live	Gozalo-Marcilla
114.06	16.15	Retrospective evaluation of the incidence of post-anesthetic signs of colic with and without the use of hydromorphone	Skrzypczak
114.07	16.30	Effects of inspired oxygen fraction on intra-pulmonary shunt fraction, as measured by F-shunt and alveolar-arterial oxygen gradient, in anesthetized mechanically ventilated Shetland ponies.	Calero Rodriguez
114.08	16.45	Evaluation of conus medullaris and dural sac termination in adult sheep.	Gutiérrez Bautista
Thurs 12th March. Session 2b: 16.00 to 17.00 Veterinary Sciences Building, Ground Floor, Lecture Room 115			
No	Start	Title of Abstract	Presenting author
115.05	16.00	Anaesthesia in feral cats undergoing neutering: effects of three different surgical positions on haemoglobin oxygen saturation and intraocular pressure	Corona
115.06	16.15	The effect of anesthetic induction with propofol, alfaxalone or ketamine on intraocular pressure in cats	Shilo-Benjamini
115.07	16.30	Cardiovascular effects of Acepromazine or Dexmedetomidine with Fentanyl during recovery from Isoflurane Anesthesia in the Cat	Kerr
115.08	16.45	Neuromuscular blockade and cardiovascular effects of cis-atracurium in 11 isoflurane-anaesthetized cats undergoing ophthalmologic surgery	Van Wijnsberghe
17.00 (i.e. immediately after abstracts) Assemble in the foyer of Vet Sciences Building Buses depart for Irish Night at Taylor's Three Rock at 17.15			

Abstracts programme Fri 13th March. 14.30 to 15.30

Fri 13th March. Session 3a: 14.30 to 15.30 Veterinary Sciences Building, Ground Floor, Lecture Room 114			
No	Start	Title of Abstract	Presenting author
114.09	14.30	Accuracy of tidal volume delivery during anesthesia: A bench study testing different large animal ventilators	Floriano
114.10	14.45	Agreement of high definition oscillometry (HDO) at the metatarsal artery with direct arterial blood pressure measurements at different blood pressure ranges in isoflurane anaesthetized horses	Twele
114.11	15.00	The use of a non-invasive 5 electrode EEG wireless helmet in horses: a pilot study on characterizing lateralization of EEG profiles during total intravenous anaesthesia	Touzot-Jourde
114.12	15.15	An enhancement to the time-capnogram	Simpson
Fri 13th March. Session 3b: 14.30 to 15.30 Veterinary Sciences Building, Ground Floor, Lecture Room 115			
No	Start	Title of Abstract	Presenting author
115.09	14.30	Serum inflammatory cytokines in dogs with naturally occurring neuropathic pain treated with gabapentin alone or in combination with meloxicam.	Ruel
115.10	14.45	Systematic review on the measurement properties of grimace scales for pain assessment in non-human mammals: preliminary results	Evangelista
115.11	15.00	Inter-rater reliability of the Feline Grimace Scale before and after dental extractions	Watanabe
115.12	15.15	The analgesic efficacy of intravenous, intramuscular or subcutaneous administration of buprenorphine in dogs undergoing ovariohysterectomy: a randomized, blinded, clinical trial	Ruel
15.30 to 16.00 Tea / Coffee break, Posters and Trade Exhibition O'Reilly Hall			

Abstracts programme Fri 13th March. 16.00 to 17:00

Fri 13th March. Session 4a: 16.00 to 17.00 Veterinary Sciences Building, Ground Floor, Lecture Room 114			
No	Start	Title of Abstract	Presenting author
114.13	16.00	The impact of vatinoxan on microcirculation after intramuscular coadministration with medetomidine in Beagle dogs – a blinded crossover study	Niemann
114.14	16.15	Antinociceptive activity of medetomidine and dexmedetomidine in dogs	Levionnois
114.15	16.30	Investigation of selected respiratory effects of (dex)medetomidine in healthy beagles	Pleyers
114.16	16.45	Cardiopulmonary effects and anaesthetic indices of pentazocine-dexmedetomidine premedicated propofol-isoflurane anaesthetized Nigerian indigenous puppies	Sogebi
Fri 13th March. Session 4b: 16.00 to 17.00 Veterinary Sciences Building, Ground Floor, Lecture Room 115			
No	Start	Title of Abstract	Presenting author
115.13	16.00	Comparison of the cardiovascular and laryngeal abduction effects of carbon dioxide inhalation with two doses of doxapram in dogs	Sakai
115.14	16.15	Intraoperative lung recruitment manoeuvres do not improve early postoperative arterial oxygenation in the anaesthetised healthy dog	Canfrán
115.15	16.30	A prospective investigation on the optimal pre-operative insulin and fasting regimen for diabetic dogs undergoing cataract surgery: preliminary results	Norgate
115.16	16.45	Effects of ketamine or dexmedetomidine continuous rate infusions on propofol total intravenous anaesthesia requirements in healthy dogs undergoing orthopaedic procedures receiving epidural anaesthesia: a randomized clinical trial.	Canfrán
17.10 Closing Ceremony and Distribution of Prizes and Awards. O'Reilly Hall			

Poster Listing

1	Comparison of tracheal, esophageal and rectal temperature in spontaneously and artificially ventilated non-heated dogs Novak L, Rauser P, Burova J, Stankova L, Rado M
2	Incorporation of a 3D-printed feline larynx model as a teaching tool for veterinary students Sakai DM, Skrzypczak HE, Nejamkin P, Clausse M, Bullant C, Genaro A, Clausse A, Del Sole MJ
3	Redefining the recruiting airway pressure based on specific lung elastance in dogs Araos J, Guacci E, Acquafredda C, Di Bella C, Stabile M, Lacitignola L, Grasso S, Crovace A, Staffieri F
4	Ultrasound-guided erector spinae plane (ESP) block in horses: a cadaveric study Bautista Díaz-Delgado O, Louro LF, Rocchigiani G, Verin R, Humphreys W, Senior JM, Campagna I
5	Effect of oral-transmucosal cannabidiol on pain and quality of life in dogs affected by osteoarthritis Brioschi FA, Rabbogliatti V, Gioeni D, Di Cesare F, Valentini Visentin M, Ravasio G
6	Clinical comparison of continuous rate infusion and subcutaneous administration of dexmedetomidine in isoflurane anesthetized horses. Rabbogliatti V, Brioschi F.A, Di Cesare F, Gioeni D, Amari M, Spediacci C, Ravasio G.
7	Clinical assessment of haemodynamic variables measurement using transthoracic echocardiography and oesophageal Doppler monitor in anaesthetized dogs: a preliminary study Sández I, Serrano S, Redondo J.I, Otero P.E.
8	The influence of four different partial intravenous anesthesia techniques on the stress response to surgery in isoflurane-anesthetized horses Masako Fujiyama, Teela Jones, Tanya Duke-Novakovski
9	The clinical utility of a human oscillometric blood pressure monitor in dogs during general anaesthesia Porter SE, Breheny C, Duncan J
10	A comparison of epidural anaesthesia with lidocaine, ropivacaine and lidocaine-ropivacaine in West African Dwarf goats Oguntoye CO, Eyarefe OD, Adewale F, Sogebi EAO, Olaifa AK
11	Prolonged anaesthesia of New Zealand White rabbits Musk GC
12	Effect of repeated disinfection protocols on the mechanical compliance of cuffed polyvinylchloride endotracheal tubes Gatson BJ, Lopez W
13	Attitudes of Spanish-speaking veterinary anaesthesiologists towards the use of Total Intravenous Anaesthesia (TIVA) in dogs: a survey study Bustamante R, Ortiz-Díez G, Canfrán S, Gómez de Segura IA, Aguado D
14	Description of a novel ultrasound guided peribulbar block in horses: a cadaveric study Leigh H, Gozalo-Marcilla M, Esteve V, Gutierrez A, Martin T, Viscasillas J.
15	Pilot study on placement and function of TetraGraph sensor for EMG based monitoring in horses Wiklund M, Nyman GC, Lindh C
16	Comparison of two 2% lidocaine formulations following sciatic nerve blockade in rabbits Otero PE, Zaccagnini A, Sanchez F, Redondo García JJ, Portela DA, Waxam S
17	A comparative pilot study of two different techniques for monitoring neuromuscular blockade in dogs Ferrari D, Sverud J, Nyman G, Ström L, Wiklund M, Lindh C
18	Tracheal extubation complication following surgical repair of a traumatic tracheal laceration in a dog Lucy Miller, Sam Pryke, Ambra Panti & Miguel Gozalo-Marcilla

19	Effects of two different alveolar recruitment manoeuvres in an “open lung” approach during laparoscopy in dogs Di Bella C, Vicenti C, Lacitignola L, Stabile M, Acquafredda C, Grasso S, Crovace AM, Staffieri F
20	Incidence and treatment of postoperative hypoxemia in dogs undergoing general anaesthesia with variable FiO₂ and PEEP Stabile M, Di Bella C, Acquafredda C, De Marzo C, Lacitignola L, Crovace A, Staffieri F
21	Pharmacokinetics after intravenous, intramuscular or subcutaneous administration of buprenorphine in dogs undergoing ovariohysterectomy Steagall PV, Ruel HLM, Yasuda T, Monteiro B, Watanabe R, Evangelista MC, Beaudry F
22	Low doses of medetomidine and ketamine in combination with methadone and alfaxalone prior to general anaesthesia in a tame Lion cub (<i>Panthera leo</i>) Didier C, Junot S, Jourdan G
23	Investigating pre-warming before general anaesthesia with isoflurane in adult Sprague-Dawley rats. Maxime Rufiange, Vivian SY Leung, Keith Simpson, Daniel SJ Pang
24	Laboratory study of the horse (circa 1950-65) used as a model of human lung disease provided foundation knowledge, technology, and skills in support of contemporary equine anaesthesiology Steffey EP
25	A comparison of dexmedetomidine or acepromazine as premedication in brachycephalic dogs undergoing surgery for brachycephalic obstructive airway syndrome (BOAS) Petrucione I, Murison PJ, Flaherty D, Auckburally A

PRIMA 440



High quality compact anaesthesia systems



Compared to many veterinary anaesthesia systems the Prima 440 costs a little bit extra. We believe however that it's a small price to pay for the additional safety and reliability that this system offers. As with all Penlon anaesthesia systems, the UK manufactured Prima 440 is CE marked and meets the current regulatory requirements for human use (ISO 80601-2-13) so you can be sure its safe for use on your patients.

The Prima 440 has all of the features you would expect of a high quality, compact machine of this standard. The system is made from lightweight aluminium with brass fittings and the gas circuit incorporates an overpressure valve for protection. In the event of a total oxygen failure the O2 alarm sounds and the visual indicator turns from green to red, giving you time to react and take appropriate measures. The Prima 440 also incorporates a Selectatec backbar and anti-hypoxic device, making it suitable for use with Nitrous Oxide.

Call **07419 980426** for sales enquiries or to arrange your free trial.

- | | | |
|--------------------------|-----------------------|-------------------------|
| - Made in UK | - O2 Fail Alarm | - Aux O2 and Air Outlet |
| - CE Marked | - Over Pressure Valve | - Selectatec backbar |
| - Tabletop or Rail Mount | - Anti-Hypoxic Device | - O2 Flush (35L/min) |

Firecrest Medical Equipment Ltd are Penlon UK Veterinary distributors.

Tel: 07419 980426 e-mail: admin@firecrestmedical.com www.firecrestmedical.com

Congress Speakers



Kieran Borgeat

BSc BVSc MVetMed CertVC MRCVS DipACVIM DipECVIM-CA Clinical Lead in Cardiology, Langford Vets

Dr. Borgeat worked in general practice for 6-years after graduation, where he became interested in cardiology and gained an initial post-graduate qualification in the subject. In 2011, he undertook a cardiology residency and Masters degree at the Royal Veterinary College in London.

He is an American and European college Diplomate in Cardiology, and an RCVS Recognised Specialist in the subject. He works as Clinical Lead in Cardiology at Langford Vets, University of Bristol, where he treats all species and works alongside two other Diplomates and two residents in training.

Alongside a busy cardiovascular interventional caseload in dogs and horses, he works with the feline centre to treat cats with heart disease. He has published widely on a variety of topics, but has a particular passion for feline cardiomyopathy and congenital heart disease.



Donal Buggy

MSc, MD, FRCPI, FRCA, FFSEM, FCAI, DME

Donal Buggy is UCD Full Professor of Anaesthesiology & Perioperative Medicine and Consultant in Anaesthesiology and Perioperative Medicine at Mater University Hospital, University College Dublin.

As an elected member of Council of the College of Anaesthetists of Ireland, he chaired the CEPD-Education committee and was Convenor of Irish Congress of Anaesthesiology 2015-19.

He is editorial board member of British Journal of Anaesthesia (BJA) and has served an extended term on the ESA Research Committee 2015-19. A clinician scientist in perioperative interventions' on postoperative patient outcomes, he is Chairman of EU COST Action 15204, Euro-Periscope, a collaborative network of researchers in the Europe, investigating the potential influence of anaesthesia and analgesia on cancer outcomes.



Daniel Davies

BVMedSci (Hons), BVM BVS (Hons), DipECVDI, MRCVS.
European Specialist in Veterinary Diagnostic Imaging.
University College Dublin.

After graduating from the University of Nottingham in 2012 Daniel worked for 2 years as a first opinion mixed practice vet in South West Wales. He returned to the University of Nottingham and undertook a 16-month small animal rotating internship based in Pride Veterinary Centre, Derby.

Following 7 months working as an out-of-hours veterinary surgeon in the Midlands of England, in September 2016 Daniel began his residency in Veterinary Diagnostic Imaging at UCD Dublin.

He is a Diplomate of the European College of Veterinary Diagnostic Imaging and is currently a professional doctorate student at University College Dublin.



Íde Delargy

MB BCH, BaO, Dip Obs, MICGP, FRCGP, Substance Misuse
Cert. RCGP

Dr Delargy is GP and is on the Specialist Register of the Medical Council of Ireland. She has been practising as a General Practitioner since 1986 and have been in practice partnerships in both the UK and Ireland. Dr Delargy is a Fellow of the Royal College of General Practitioners in London (FRCGP Lon) and a Member of the Irish College of General Practitioners of Ireland (MICGP). She has contributed to many National expert and policy groups in the area of alcohol and substance misuse.

Her current roles include: GP practice principal in Blackrock, Co Dublin as well as being Director of the Substance Misuse Programme at the Irish College of General Practitioners since 1998. Dr. Delargy is also a national GP Co-ordinator for the HSE Addiction Service and a Medical Director Practitioner Health Matters Programme (formerly the Sick Doctor Scheme) which provides assessment, treatment and support for doctors, dentists and pharmacists who have addiction or mental health problems. She is the medical Director of the PHMP.



Daniel J. Fletcher

PhD, DVM, DACVECC Associate Professor of Emergency and Critical Care Cornell University College of Veterinary Medicine

Dr. Fletcher joined the faculty of the Cornell Veterinary College in 2006. After receiving a BS in Electrical Engineering from Drexel University, a PhD in Bioengineering from the University of California, and a DVM from the University of California, he completed his internship and ECC residency at the University of Pennsylvania.

He is co-chair of the RECOVER Initiative, which published the first evidence-based veterinary CPR guidelines. He is past-president of the American College of Veterinary Emergency and Critical Care and the Associate Chair for Teaching and Clinical Service of the Department of Clinical Sciences at Cornell.

His research interests include disorders of fibrinolysis and the use of immersive simulation in teaching.

He started building simulators for veterinary education in 2009 and developed Open VetSim, an open source veterinary simulation platform. He opened the Tetlow and Roy Park Innovation Lab, an immersive simulation center at Cornell in the fall of 2015.

Blánaid Hayes

MB, MD, FRCPI, FFOM, Consultant Occupational Physician (Beaumont Hospital),

Blánaid has worked as an occupational physician in the health sector for over 2 decades.

She is a Fellow of the Royal College of Physicians of Ireland (FRCPI), former Dean of the Faculty of Occupational Medicine (FFOM) and former president of the Irish Society of Occupational Medicine (ISOM).

She has been involved in training young doctors as specialists for over a decade both as a supervising trainer and as National Specialty Director. She has contributed to the development of national guidelines on MRSA, hand hygiene and blood borne viruses.

Her research interests include doctors' wellbeing, needlestick injury and influenza immunisation in healthcare workers. Her exploration of workplace and personal wellbeing measures in hospital doctors, as well as lifestyle behaviours, has helped to inform policy and curricular developments within medical post-graduate training bodies.





Matthew McMillan

BVM&S, DipECVAA, AFHEA, MRCVS European & RCVS Specialist in Anaesthesia & Analgesia Royal Veterinary College

Matt qualified in 2003 from the R(D)SVS Edinburgh before working in general practice for three years.

After an internship at the RVC he worked as an emergency vet for a year before starting his residency in anaesthesia at the University of Cambridge. He became a diplomate of the ECVAA in 2012.

After his residency he worked at the University of Cambridge first as a clinical anaesthetist and then as the Principle Anaesthetist, and is now working as a clinician at the RVC. Matt's main interests include patient safety, error and clinical decision making, ethics and education.

Matt chaired the AVA subcommittee that developed the Anaesthetic Safety Checklist, he co-authored the book "Error in Veterinary anaesthesia" with Prof John Ludders DipACVAA, has written numerous articles on safety and has published articles on adverse event reporting and safety incidents.



Tom Pierce

FRCP FRCA, Cardiac Anaesthetist at University Hospital Southampton

After completing his undergraduate in medicine in Southampton, Dr. Pierce moved to Derby and Nottingham to undertake SHO general medical training and then SHO training in anaesthesia. Returning to Southampton in the late '80s he completed his registrar anaesthesia training before moving to Groningen in The Netherlands to undertake a fellowship in cardiac anaesthesia.

After senior registrar training, I was appointed to the post of consultant cardiac anaesthetist in 1992.

Following a successful 5 years running the Wessex Final Fellowship course for the FRCA examination Dr. Pierce became an examiner with the Royal College of Anaesthetists in 2006 and in 2013 and he became the inaugural Environmental Advisor to the RCoA.

The years since have been heavily involved developing and subsequently widening the knowledge of the environmental impact of healthcare and clinical care pathways including the relative differences between different anaesthetic agents working towards the inclusion of sustainability within the examination syllabus.



Robert Shiel

MVB ProfCertBiostatistics ProfDipUTL PhD DECVIM-CA (Internal Medicine) University College Dublin

Robert Shiel qualified from University College Dublin (UCD). After several years in small animal practice in the United Kingdom, he returned to UCD to undertake a residency in small animal medicine and obtained the Diploma of the European College of Veterinary Internal Medicine - Companion Animals (Internal Medicine) in 2007.

He completed a PhD at UCD in the area of canine thyroid function in 2011. After four years working as a lecturer at Murdoch University, Western Australia, Robert returned to UCD and is currently an Associate Professor in Small Animal Medicine.

Research interests include small animal endocrinology, neurology, cardiology and genomics. Robert teaches small animal cardio-respiratory medicine in the undergraduate veterinary curriculum.



Antonella Puggioni

DrMedVet, CertDVI, DipECVDI, DipUTL

Dr. Antonella Puggioni graduated cum laude from the Faculty of Veterinary Medicine of Sassari in 1999.

She started her residency in Diagnostic Imaging in UCD Dublin in 2002. Dr. Puggioni was awarded the Certificate in Diagnostic Imaging of the RVC in 2005 and the ECVDI European Diploma in 2006.

Since 2007 Dr. Puggioni has been an Associate Professor and clinical radiologist at UCD University Veterinary Hospital.

She has been invited as speaker in several national and international congresses (SCIVAC Italy and AVEPA Spain), courses and CPD (SCIVAC Italy, XLvet/PVN/VICAS/Kildare vet soc Ireland), and as a visiting Professor at Italian (Faculties of Sassari and Teramo) and Estonian (Eesti Maaulikool Tartu) Universities.

In 2009 Dr. Puggioni was awarded the Professional Diploma in University Teaching and learning by UCDUTL.

Amongst other academic roles she is a resident supervisor and stage coordinator for Stage IV and module coordinator.



Emma Tobin

MVB MVM CVR Dip ECVI

Emma Tobin is a European Specialist in Veterinary Diagnostic Imaging. She works part-time in the UCD Veterinary Hospital as a clinical radiologist and part-time taking referral ultrasound cases in Cork and Dublin.

Her main interests in veterinary diagnostic imaging include abdominal ultrasound in cancer staging, musculoskeletal ultrasound in dogs and echocardiography in all small animals.

Emma enjoys teaching ultrasound to colleagues and is looking forward to this course.



Anaesthesia + Monitoring Solutions

Ease of use, simplicity and safety are vital for you to provide the best patient care, and for every pet owner's peace of mind. Explore our industry-leading anaesthesia and monitoring solutions including products that carry the rich history of the Matrx® and Cardell® technologies, and comprehensive, hands-on, in-clinic training. Let us help you provide a better experience for all.

To learn more, call +44 (0) 1730 815811
or visit midmark.com/AVA.

© 2020 Midmark Corporation Miamisburg, OH USA



Pre-Congress Day Lectures

Lectures 1 & 2: When radiographs talk to the anaesthetist

Antonella Puggioni DrMedVet, CertDVI, DipECVDI, DipUTL, University College Dublin

How to approach a radiograph

It is important to be consistent in the orientation of the radiograph in your PACS system, in order to become familiar with normal anatomy and radiographic appearance of thoracic or abdominal organs.

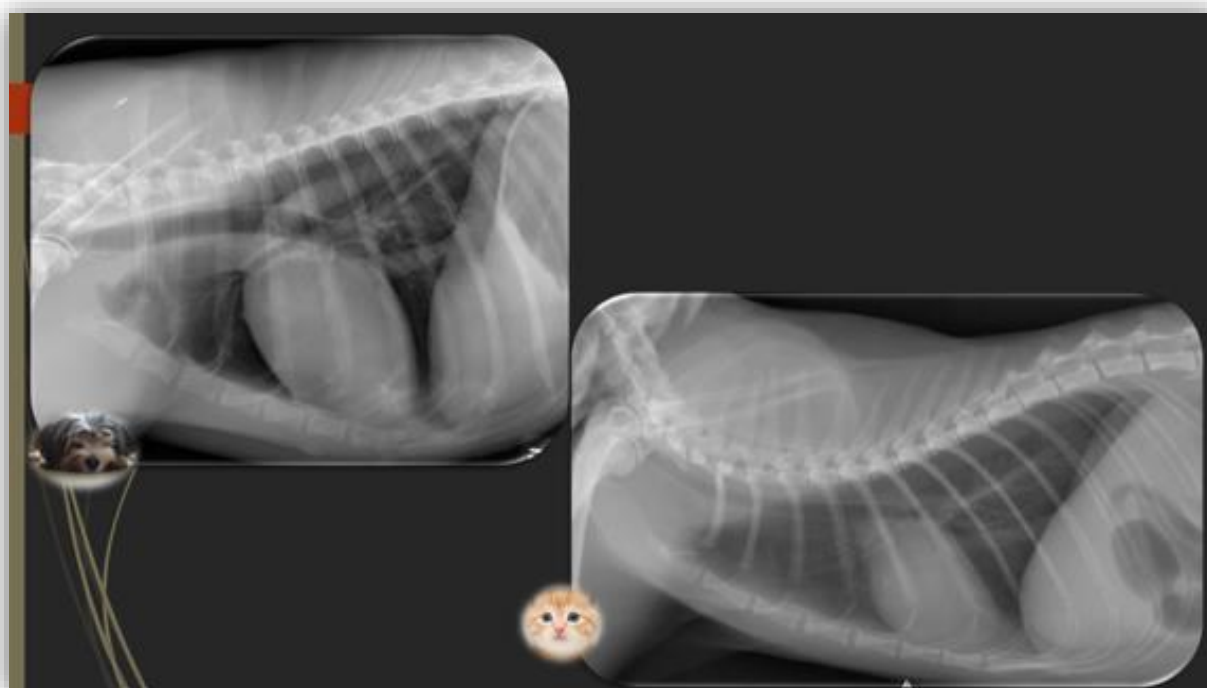
On lateral views the head of the animal is placed always towards the left; for dorsoventral (DV) views of the thorax or ventrodorsal (VD) of the abdomen, the head of the animal is at the top with the left of the animal to your right. We usually take DV for thorax and VD for abdomen.

You can follow a scheme: e.g. from cranial to caudal, dorsal to ventral, periphery to centre to ensure you assess the whole radiograph; or better to go by anatomical units: trachea and bronchi; cardiac silhouette and vessels, lungs, mediastinum/oesophagus etc; thoracic cage: sternum, ribs, column, diaphragm.

What are the main thoracic radiographic differences between dogs and cats?

Dogs: in the lateral views, the vertebral column and sternum are slightly convex towards the periphery. The trachea diverges ventrally from the vertebral column towards the perihilar region. The cardiac silhouette is only mildly oblique and roughly occupies two thirds of the height of the thoracic cavity and three intercostal spaces.

In a right lateral recumbency the two crurae of the diaphragm are parallel, with the dependent one (right) more cranial (the caudal vena cava can be seen merging with the profile). In a left lateral



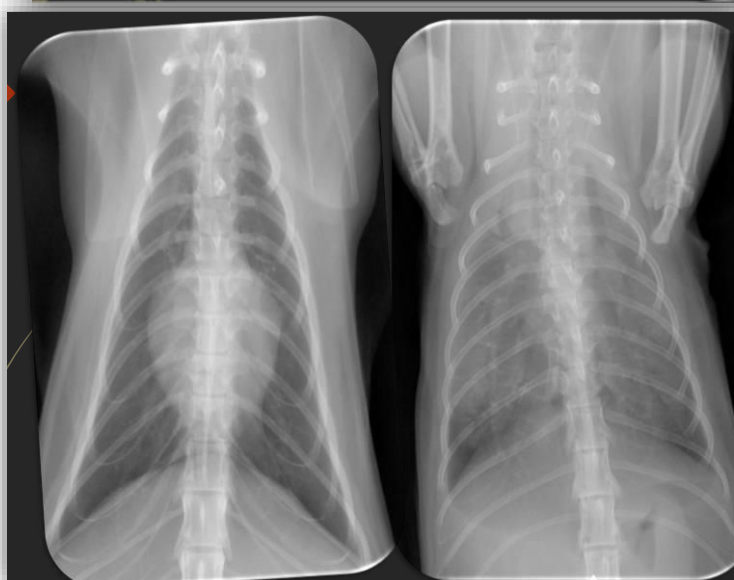
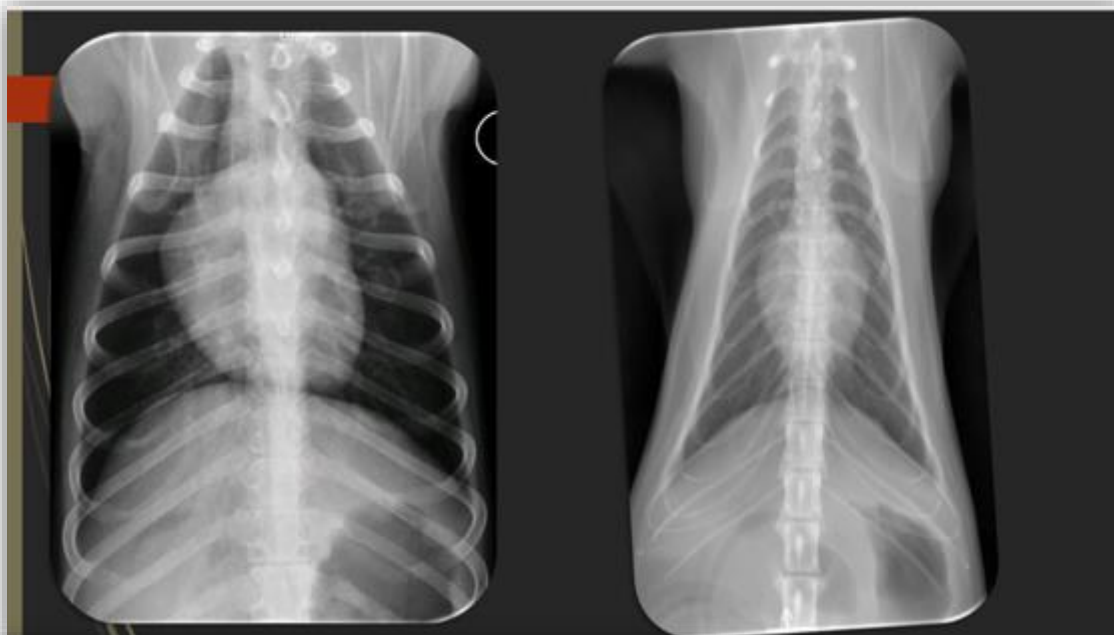
recumbency, the two crurae forms an X or Y, crossing half way. The most cranial one is the dependent one (left) and often gas in the fundus can be seen immediately caudal to it, creating the impression of free gas in the abdomen.

On the dorsoventral (DV) view, mild barrel/convex shape of the thoracic cage, with ribs that emerge almost at a right angle with the vertebral column. Cardiac silhouette mostly central with the apex slightly towards the left; it occupies two thirds of the thoracic width.

Trachea and caudal vena cava run slightly to the right and parallel to the vertebral column. The diaphragm is convex towards the thoracic cavity with a minimal asymmetry towards the right side, which protrudes more (at this level the caudal vena cava enters the right crus).

Cats: Overall the thorax appears slender, thinner and longer. Ribs and spinous processes are thinner. Both in lateral and DV views, the shape is more that of an isosceles triangle compared to a dog, with a very narrow thoracic inlet (especially in lateral views) and walls flaring caudally towards the diaphragm. Characteristic is also the pronounced ventral deviation of the most cranial vertebral column at the thoracic inlet in lateral views and the very straight appearance of the thoracic walls in the DV. In this view, ribs create a more acute angle with the vertebral column compared to dogs.

DV of a dog on the left, DV of a cat on the right

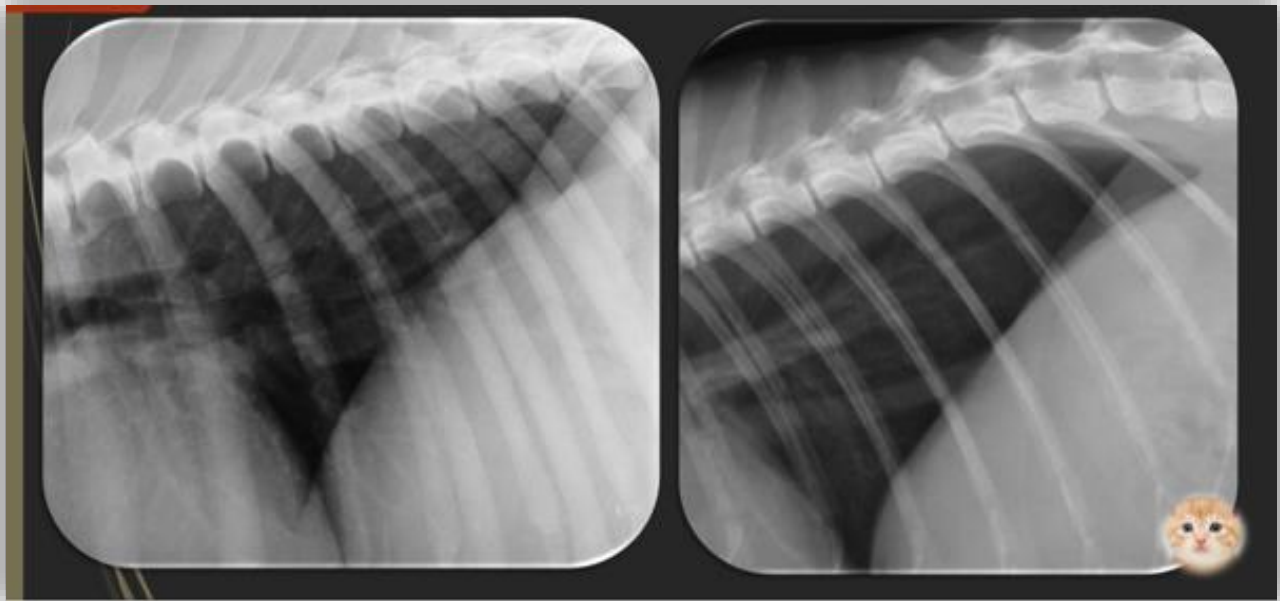


Very important!! If in the DV of a cat the ribs are almost perpendicular to the vertebral column (right image), the thoracic walls are more convex and it overall looks more like a dog's thorax, it's a sign that the cat is in respiratory distress.

The cardiac silhouette is smaller and more slender compared to dogs; it is

often quite oblique in lateral views, and can almost be parallel to the sternum in elderly cats. Due to this, the trachea might have a more pronounced ventral deviation. It should occupy less than three intercostal spaces on a lateral and on the dv is very central, barely protruding laterally on either side of the vertebral column.

The caudal lung fields tend to extend more caudally than in dogs, often reaching T12/T13/L1. The dorsocaudal tips of the lungs deviate slightly from the vertebral column, creating a space usually occupied by a soft tissue/fat opacity. It's important to remember this difference with dogs, as it can

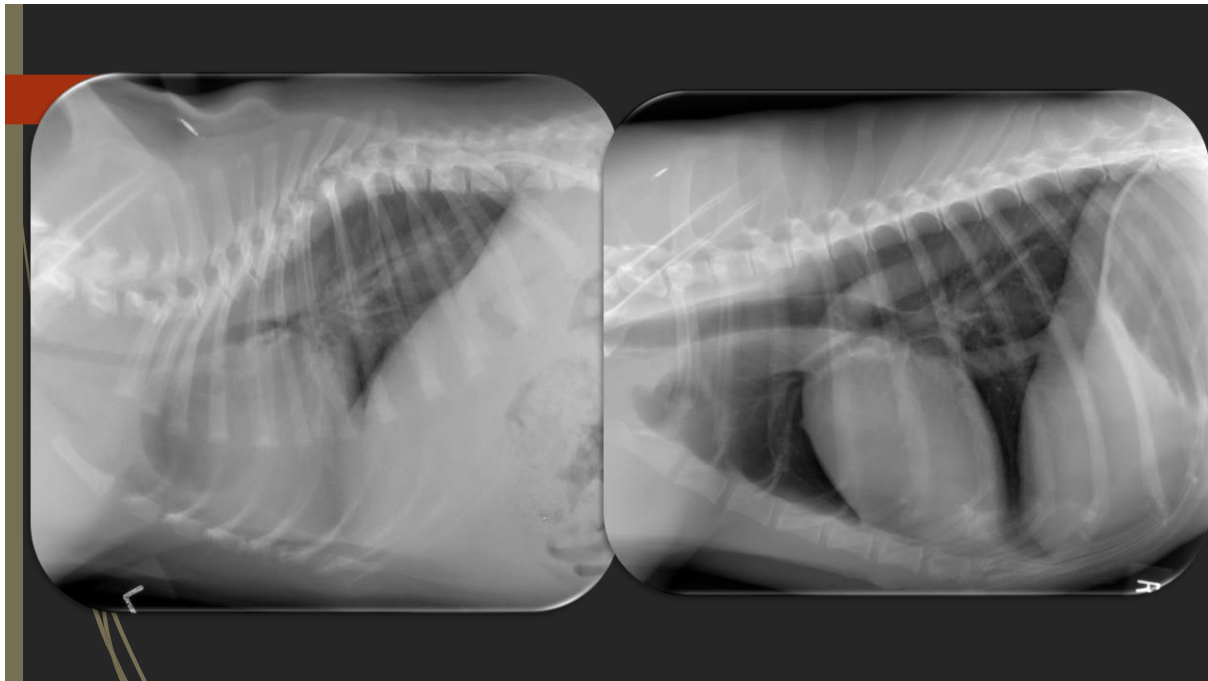


mimic pleural effusion, but it's a normal finding in cats.

Dog on the left, cat on the right

It is important also to remember differences in thorax shape amongst the various breeds/conformation of dogs. In particular:

- Brachicephalic/chondrodystrophic dogs (French and English Bulldogs; pugs): will have a very foreshortened thoracic cavity, due both to the conformation of the thorax and to the deformity of the vertebral column secondary to the presence of several hemivertebrae. The cardiac silhouette is often difficult to assess properly and it looks larger than normal and in contact with the diaphragm. The trachea is often hypoplastic and markedly reduced in size compared to normal dogs. The mediastinum is very wide due to accumulation of fat in this region; it may mimic a mediastinal mass on DV views.
- Deep-chested dogs (greyhounds/German Shepherds/wolfhounds): the thoracic cavity appears larger, with a more marked ventral deviation of the trachea or a more upright cardiac silhouette. Warning: on the DV in these breeds, very often the skin folds of the extended forelimbs create an artefact that mimics lung lobe retraction and gives the impression of a pneumothorax. Look for small vessel markings, free air should be completely black and radiolucent; if you see a pattern, then it's lung!



Chondrodystrophic dog on the left, normal dog on the right

Radiographic features of some thoracic pathologies

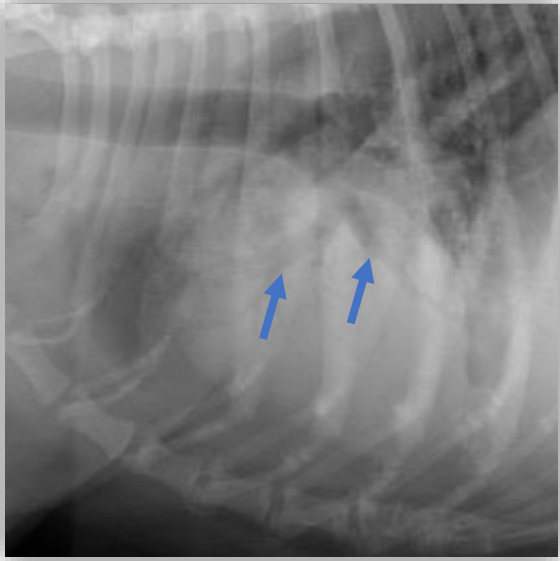
Patterns

One of the main problems when interpreting thoracic radiographs is to differentiate the patterns and especially the interstitial from the alveolar; although sometimes there is a very fine line between these two or the pattern is mixed with components of two or even all three types!

An interstitial pattern is a common finding in elderly dogs or it can be artefactual due to underexposure or presence of large amounts of subcutaneous fat.

The interstitial pattern appears as a reticular web of increased opacity in the background of the lung fields; the typical example is the pattern seen in the interstitial fibrosis of West Highland White Terriers. The alveolar pattern has a more variable radiographic appearance: from fluffy, cotton wool-like focal areas, to complete consolidation of an entire lung lobe and all the degrees in between these two extremes. Typical and pathognomonic features of this pattern are the air bronchogram and the lobar sign; they can be concurrent in the same lung lobe, but they are not always present.

AIR BRONCHOGRAM

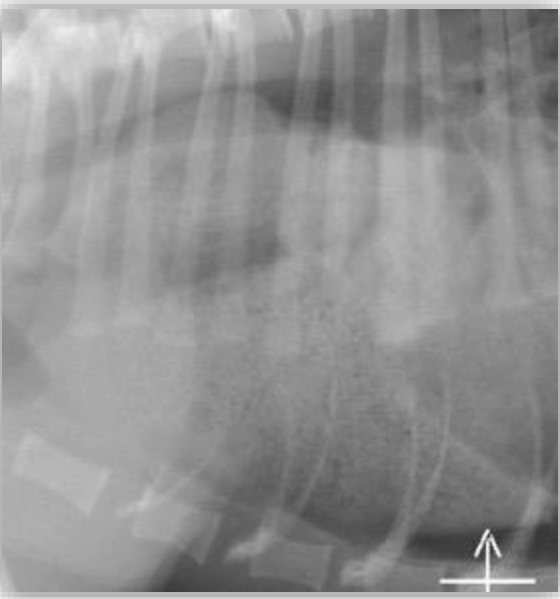


When an air-filled bronchus becomes surrounded by alveoli filled with fluid or cells, it appears as a more noticeable radiolucent bronchus surrounded by fluffy radiopaque areas. Often, over this brighter background, even the smaller branches of the bronchus can be seen clearly.



LOBAR SIGN

When a lung lobe is completely consolidated (due to presence of fluid, cells or atelectasia) one of his borders becomes more visible as a well-defined interface between the radiopaque lobe and the adjacent air-filled normal lobe.



VESICULAR PATTERN

In lung lobe torsion the air trapped in the alveoli appears as several small bubbles scattered throughout the otherwise consolidated lobe.

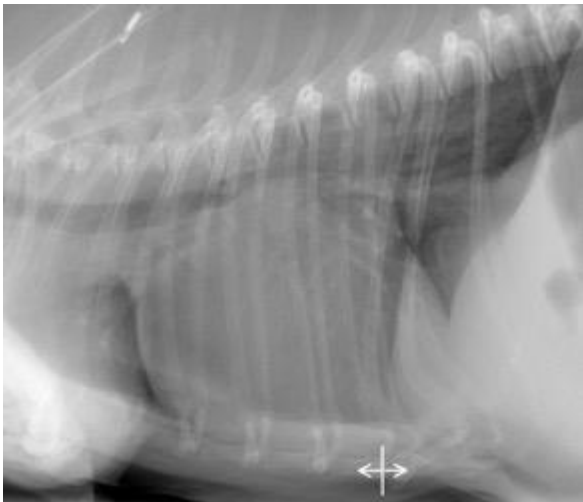
Cardiomegaly

Radiography is not the most reliable technique to assess cardiac size; minimal rotation can cause a great degree of change in the shape and size of the cardiac silhouette and thoracic conformation also plays an important role. However; there are some parameters that can help us make the decision in the many cases.



DORSAL DEVIATION OF THE TRACHEA

In normal animals the trachea diverges from the vertebral column creating a triangle between it, the thoracic inlet and the perihilar region. If the trachea remains parallel to the column or even touches it, the cardiac silhouette is enlarged.



RATIO TO THE THORACIC CAGE

In cases of real cardiomegaly the cardiac silhouette occupies more than 2/3 of the thoracic height on a lateral view and more than 2/3 of the width in a DV. Other parameters include an increase of sternal contact and of number of intercostal spaces occupied.

Mediastinal masses

The trachea can also be deviated dorsally due to the presence of a large cranial mediastinal mass. In these cases, often the tracheal bifurcation is also displaced caudally from its usual position in the 5th intercostal space.



Pneumomediastinum

Free air in the mediastinum highlights structures that are usually not visible, such as the oesophagus, the cranial vena cava or the brachicephalic trunk.



Pneumothorax

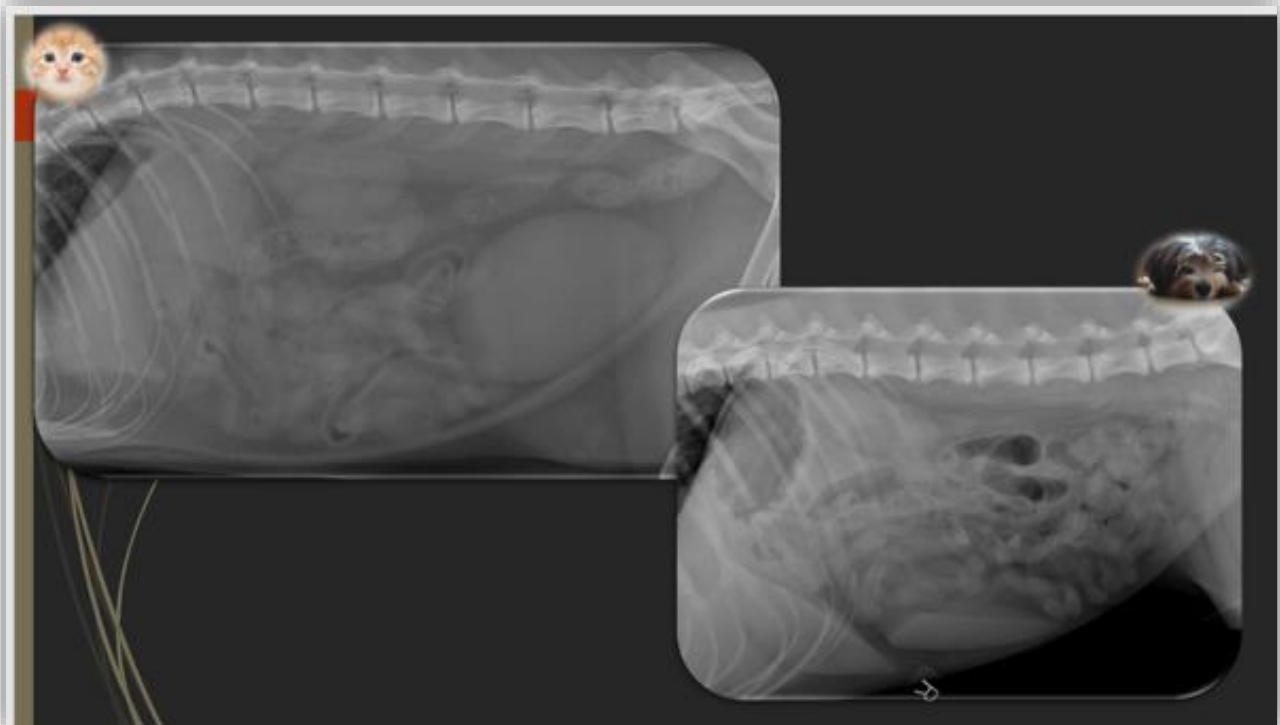
Free air in the pleural space will cause retraction of the lung lobes, which appear smaller, consolidated due to atelectasia and will have sharp margins (unlike presence of pleural effusion which causes rounding and scalloping of the edges). In lateral views usually the cardiac silhouette appears “elevated” from the sternum.



What are the main abdominal radiographic differences between dogs and cats?

In general cats tend to have a larger amount of intraperitoneal fat that creates excellent serosal detail; the organs appear well separated and easily visible. The liver is usually small and well tucked under the costal arch; it's often separated from the ventral wall and diaphragm by a large amount of fat in the falciform ligament. The GIT contains less gas compared to dogs, especially the stomach, which appears often empty and flat against the liver, without the typical gas bubble in the fundus. The small intestine tends to gather in the ventral abdomen in a tight bundle; rather than spread across the abdomen like in dogs. The duodenum has the typical appearance of string of pearls.

The tail of the spleen is seldom visible in the ventral abdomen; whereas sometime the head of the spleen is more visible compared to dogs; this is due to the fact that the right kidney is not as cranial as in dogs, but lies almost at the same level of the left and therefore does not create border effacement with the head of the spleen and the gastric fundus in the dorso-cranial abdomen. The colon can have a more pronounced ventrocranial deviation if there is a large amount of retroperitoneal fat. The bladder is located more cranially in the abdomen compared with dogs, is slightly rounder, with a less pronounced neck, which is not in the pelvic inlet, and a longer, thinner urethra.

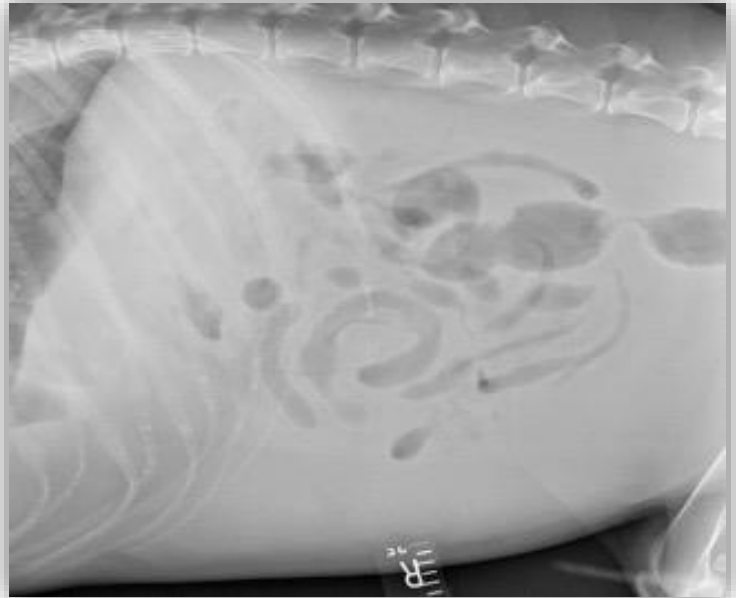


Radiographic features of some abdominal pathologies

Loss of serosal detail in the abdomen can be secondary to:

PRESENCE OF FLUID

The soft tissue opacity is homogeneous and usually only gas filled loops of intestine are visible.



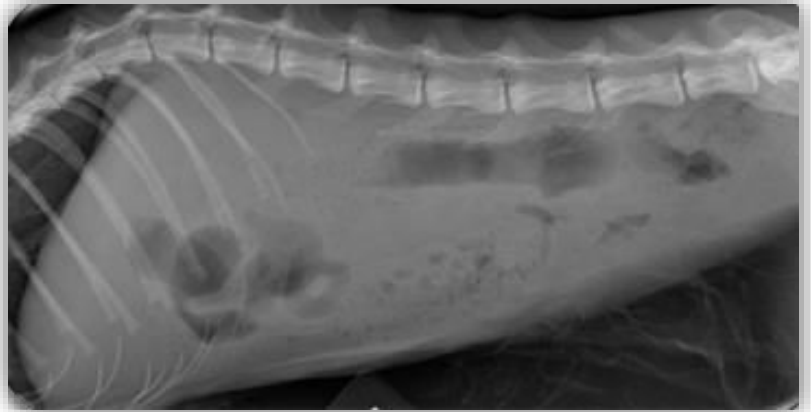
PERITONITIS

Heterogeneous, mottled increased opacity that creates a “ground glass” appearance.



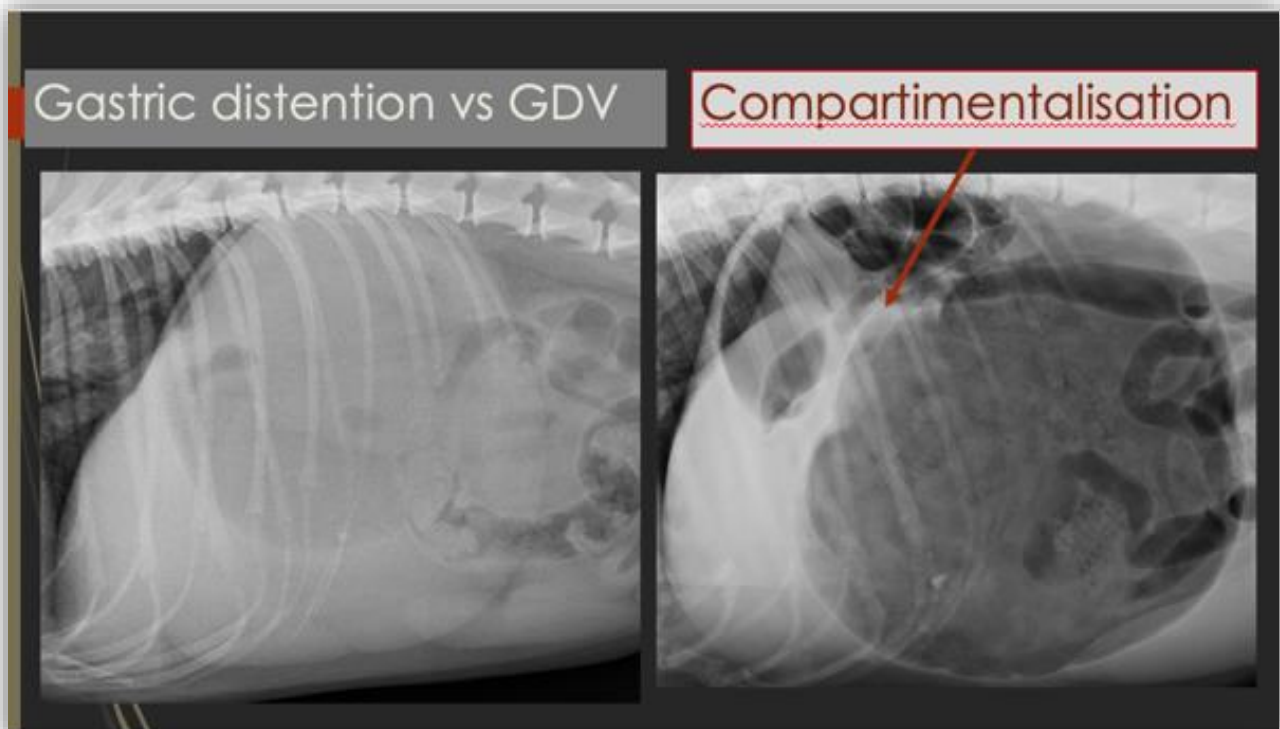
EMACIATION/YOUNG AGE

Lack of fat due to poor body score of young age causes severe loss of serosal detail.



Gastric dilation versus GDV

Gastric dilation due to pyloric obstruction is characterised by a large distention of this viscus mostly due to fluid, plus or minus the presence of a gas bubble. In this condition the position of pylorus and fundus remains the same. In cases of gastric distention and volvulus (GDV), the stomach is characteristically distended by a large amount of gas



and pylorus and fundus change position due to the rotation: the pylorus is displaced dorsally and the fundus ventrally (in a lateral view). The presence of a band of tissue that separates the two distended compartments is called “compartmentalisation”.

Ileus

Functional and mechanical ileus can usually be distinguished radiographically. In both cases the small intestine appears distended and gas filled; however the degree of intestinal distention tends to be usually greater with mechanical ileus. When the ileus is related to an obstruction (FB, intussusception etc) the number of intestinal loops affected depends on the position of the obstruction (more if the lesion is more distal); in some cases only one loop might be affected.



In this case of obstruction due to a lodged conker, only the duodenum (and pylorus) is gas filled and distended to a very large degree, and the stomach is distended with fluid.



In this example the obstruction is more distal and several loops are gas filled and distended. Some normal loops are seen in the ventral abdomen ("two populations")

A typical characteristic of ileus is the "stacked" appearance of some loops that pile up in groups of two or three in a parallel fashion.

Lecture 3: CT and MRI for the Anaesthetist

Daniel Davies BVMedSci (Hons), BVM BVS (Hons), DipECVDI, MRCVS.

University College Dublin

This presentation is an introduction to the basic concepts of computed tomography (CT) and magnetic resonance imaging (MRI) for the anaesthetist. We will cover the basic physics underpinning both of these cross-sectional imaging modalities and provide clinical examples of why these modalities are used for imaging the thorax, skull, vertebral column and spinal cord.

Overview:

There continues to be an explosion in the use of advanced imaging modalities including MRI and CT. As with all imaging modalities, CT and MRI are ideally suited to answer a specific clinical question. With the increased volume of cases requiring diagnostic imaging and the associated need for skilled ultrasonographers, practitioners have instead been turning to three-dimensional imaging due to the increased availability of the modalities.

It is important for the anaesthetist to understand the differences between the modalities. CT utilises ionising radiation to quickly acquire a block of data, which can subsequently be reformatted into different imaging planes. MRI on the other hand uses the magnetisation of the tissues of the body, and the differences in how the tissues respond to changes in magnetic fields to form images. In MRI the images are generally acquired of a particular area of the patient, in a single plane, and require substantially more time compared to CT. Different sequences and planes in MRI are necessary to determine the characteristics of the different tissues and to better define any lesion within the patient. The spatial resolution of CT is excellent compared to MRI, but the contrast resolution of CT is less than that of MRI and so we must weigh up the advantages and disadvantages of each modality.

Physics principles of Computed tomography

CT uses X-ray technology, and is based on Radon's mathematical principle that an object can be produced using an infinite number of projections through that object. A CT scanner consists of the gantry (containing an x-ray tube and x-ray detectors) in addition to the operator's console and computers.

In conventional radiography orthogonal projections are generally obtained in order for the radiologist to generate a mental 3D reconstruction of the patient's anatomical structures. In comparison, with CT thousands of very thin radiographic projections, all orientated at slightly different angles, are obtained of the patient's anatomical region of interest. At all angles, variable X-ray beam absorption (x-ray beam attenuation) occurs within the patient depending on the constituents of the tissue being examined. Using computer algorithms, the CT computer manipulates this data, and generates numerical values based on differences of x-ray attenuation within the examined tissue. A greyscale image can then be produced, with higher contrast resolution compared to conventional radiography, reflecting the different x-ray attenuation values within the patient.

With the advent of 'slip-ring' technology, which allows the CT gantry to rotate uninterrupted without the risk of tangling wires, most modern-day CT scanners employ helical (or spiral) scanning. Helical scanning is possible because of simultaneous advancement of the CT table into the gantry, whilst the X-ray tube is rotating and generating x-ray beams. Compared to the older technique of sequential scanning, helical scanning allows for a large region of anatomy to be examined very quickly.

Similar to conventional radiography, tissues that are dense (such as bone and mineral) will absorb (attenuate) most of the x-ray beam and appear as a shade of white (hyperattenuating) on a CT image. Tissues that are not very dense such as fat and gas absorb (attenuate) less of the x-ray beam, and are more black (hypoattenuating) on the CT image.

After the acquisition of CT data, images can be reconstructed into any 2D plane (typical image planes are transverse, sagittal and dorsal planes), in addition to 3D multiplanar and volume rendered reconstructions.

Physics principles of Magnetic Resonance Imaging

MRI uses the electromagnetic properties of protons (hydrogen nuclei) within the patient to generate an image. Energy transfer to and from these protons can be spatially localised and is used to generate an image. MRI provides far greater contrast resolution compared to CT and other imaging modalities. No ionising radiation is involved in obtaining an MRI study.

Spinning hydrogen atoms generate an external magnetic field, and behave like very little magnets (dipoles). When placed in an external magnetic field (i.e. a powerful MRI magnet), these protons can align themselves with the direction of the external magnetic field.

By using radiofrequency pulses to manipulate the net direction of the magnetic field generated by spinning hydrogen protons within the MRI scanner, an image can be generated that maps the location of hydrogen protons within the body. Different, and sometimes complex, pulse sequences can be used to help clinicians differentiate tissue types based on the chemical composition of tissues. With regard to MRI terminology, tissues that generate a lot of MRI signal on a given sequence are 'hyperintense' (white), and tissues that do not generate a lot of MRI signal are 'hypointense' (dark).

Summary of standard MRI sequences

Sequence	Fat	Water
T1w	Hyperintense	Hypointense
T2w	Hyperintense	Hyperintense
T2w FLAIR	Hyperintense	Hypointense if pure fluid (e.g. CSF) Hyperintense if non pure fluid
STIR	Hypointense	Hyperintense

T2* sequences are predominantly used to help the identification of blood degradation products associated with chronic haemorrhage (over 2-3 days). Ferric / ferrous ions in haemoglobin metabolites distort the local magnetic field and creates a characteristic black (hypointense) susceptibility artefact. This is an extremely sensitive indicator of chronic haemorrhage.

Diffusion weighted sequences are used for the assessment of cytotoxic oedema e.g. such as that associated with cerebellar infarctions.

Paramagnetic contrast media (gadolinium) are used to help identify structures that are well vascularised. They are particularly useful for identifying poorly defined intra-cranial lesions that have disrupted the integrity of the blood brain barrier. On T1w sequences, tissues that uptake paramagnetic contrast media become more hyperintense (more white).

Safety note: The anaesthetist must ALWAYS be aware that MRI machines are very powerful magnets. Bringing ferrous objects such as oxygen cylinders, ferrous metal bowls or ferrous trolleys near the MRI machine could lead to serious injury or death to both humans and veterinary patients, as well as potentially damaging expensive MRI equipment. Staff (or patients!) with medical equipment such as pacemakers and insulin pumps should not go into the veterinary MRI room.

Imaging the thorax:

CT is the cross-sectional imaging modality of choice when it comes to imaging the thorax. CT provides increased spatial resolution compared to conventional radiography, and the modality eliminates the inherent superimposition of the intra- and extra- thoracic structures that are associated with thoracic radiographs. MRI imaging of the thorax is rarely employed in veterinary medicine. Respiratory and cardiac motion degrade MRI image quality, and MRI is poor at examining aerated pulmonary tissue.

CT provides excellent anatomical detail of the musculoskeletal structures, mediastinal structures, pulmonary parenchyma and of intrathoracic vascular anatomy. Angiograms, which are a series of sequential CT studies performed after the intravenous injection of contrast agents, most commonly non-ionic iodinated contrast media, enable enhanced characterisation of vascular anatomy in the both the arterial and venous phases.

Intravenous contrast agents are also helpful in identifying tissue with both increased vascular supply e.g. some neoplastic masses, which appear hyperintense/whiter relative to surrounding tissue post contrast administration. Intravenous contrast media is also helpful in characterising tissue with decreased or no vascular supply e.g. necrotic regions within neoplastic masses and the avascular centre of cystic lesions and abscesses, which appear relatively hypointense/darker compared to surrounding contrast enhancing tissue.

When acquiring CT images to examine the pulmonary parenchyma for the presence of nodules e.g. metastatic pulmonary neoplasia, the induction of apnoea (i.e. scanning static pulmonary parenchyma) reduces the risk of small nodules being missed from the CT images, and reduces motion blur in CT images, thus increase the diagnostic value of the CT examination.

Cross-sectional imaging of the head and vertebral column.

As a general rule, CT is the modality of choice for examining bone / osseous structures due to its inherent high spatial resolution. MRI is the modality of choice for examining soft tissue structures, due to its superior contrast resolution compared to other imaging modalities.

Acquiring a CT series is generally quick, whilst acquiring a full MRI series can be significantly more time consuming and often more expensive. In this presentation we will discuss real and routine clinical examples of the use of both CT and MRI in veterinary practice. It is important to remember that both modalities provide complimentary information, and that one modality does not necessary replace the other.

BURTONS
The Home Of Veterinary Equipment
The Anaesthesia Equipment Experts...



FREE MACHINE COMMISSIONING*

ANAESTHESIA MACHINES FROM JUST £370/ €444

*UK & Ireland Only



ANAESTHESIA CIRCUITS FROM JUST £16/ €19



HUGE RANGE OF ANAESTHESIA ESSENTIALS



FREE CONSULTATION & DESIGN

COMPLETE PIPED GAS SYSTEMS

Designing & manufacturing in the UK since 1981

WWW.BURTONSVETERINARY.COM

SALES: +44 (0)1622 834300 | SERVICE: +44 (0)1622 834350

**Vetronic Services LTD**
Bringing innovation and new ideas to the veterinary profession



Tafonius



Merlin



104	114	77
0.0/45	9/3	100
0.5	16	1.2
8	25.0	1:2.1
2.6		

Ventilation, Capnography, ECG, Blood Pressure, Pulse-Oximetry, Wireless Monitoring, Training Aids, Simulation, Design

Tel: +44 (0)1626 365505
www.vetronic.co.uk
enquiries@vetronic.co.uk

Lecture 4: ECGs for the Anaesthetist

Robert Shiel MVB, ProfCertBiostatistics, ProfDipUTL, PhD, DECVIM-CA (Internal Medicine),
University College Dublin

Review of normal electrical physiology

The heart has a specialised system for generating and conducting electrical impulses to allow ordered contraction of cardiac muscle.

The myocardial specialised conduction system consists of:

- Sinoatrial (SA) node
- Atrioventricular (AV) node
- Bundle of His
- Left and right bundles of Purkinje fibres

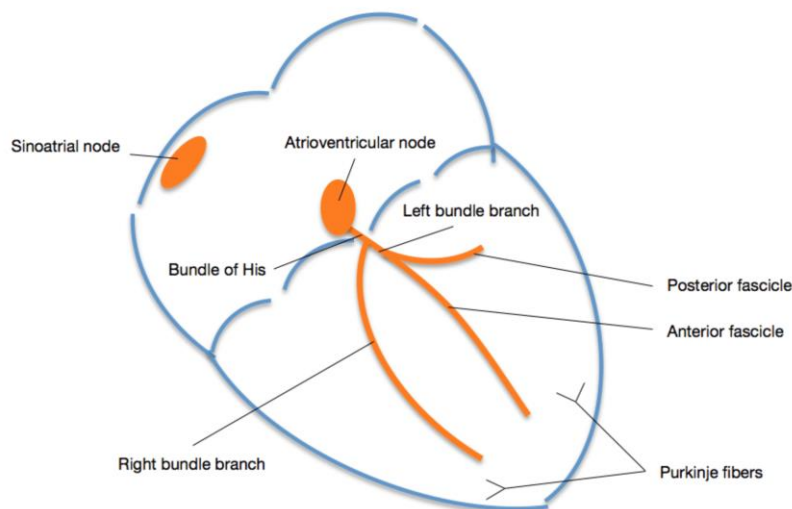


Figure 1: The myocardial conduction system.

<https://rebelem.com/>; <https://creativecommons.org/licenses/by-nc-nd/3.0/legalcode>

Many myocytes have an ability to undergo spontaneous depolarisation; these are known as pacemakers. Each of these anatomical pacemakers can depolarise spontaneously but there is a hierarchy of automaticity with the SA node being most readily (and frequently) excited and therefore most dominant. Hence the SA node governs the intrinsic rate of the healthy heart (a sinus rhythm). The remaining portions of the conducting system are latent pacemakers. This graded automaticity acts as a 'fail-safe' system; if the SA node fails to depolarise, then the next most dominant pacemaker takes over the role of dominant pacemaker.

Rate of depolarisation (dog):

- SA node 60-180/minute
- AV node 40-60/minute
- Purkinje fibres 20-40/minute

Because the lower-order pacemakers have a lower automatic rate of depolarisation, whenever there is a failure of the SA node to generate an impulse, bradycardia usually results.

The impulse is generated at the SA node. The SA node is composed of a small group of specialised myocardial fibres located in the right atrium at the junction of the cranial vena cava and the right atrium.



Depolarisation spreads through both atria and to the AV node. Internodal tracts have been identified in dogs that connect the SA node to the AV node and left atrium (the latter pathway is known as Bachmann's bundle).



The AV node is a specialised group of myocytes situated in the interatrial septum just above the right AV valve. Conduction is slowed through here and must be of sufficient strength to penetrate the AV bundle (bundle of His).



The impulse spreads down through bundle branches before ramifying through the network of Purkinje fibres, and then finally spreads through the ventricular myocardium.

Electrocardiogram:

As cardiac impulses spread through the heart, electrical impulses spread into the tissues surrounding the heart and a small proportion of these spread all the way to the surface of the body. An ECG is a recording of these currents by surface electrodes and is a summation of the direction of the average wavefronts. The main value of an ECG is to determine rhythm and conduction disturbances. Changes consistent with chamber enlargement can also be seen, but there are more sensitive and specific methods available to confirm such changes.

Two limb lead systems are used most commonly in companion animals. Unipolar chest leads are seldom used in veterinary medicine.

Lead I:	potential difference between both forelimbs
Lead II:	potential difference between left hindlimb & right forelimb
Lead III:	potential difference between left hindlimb & left forelimb
Lead aVR:	potential difference between right forelimb & combination of left forelimb & left hindlimb
Lead aVL:	potential difference between left forelimb & combination of right forelimb & left hindlimb
Lead aVF:	potential difference between left hindlimb and combination of both forelimbs

The shape of the P wave / QRS complex is substantially influenced by the distance of the recording lead from the area of electrical activity, the magnitude of the potential difference and the geometry of the advancing wavefront. If the activation wave is parallel to the lead, a large deflection results and conversely, if it is perpendicular, no deflection occurs. For this reason, simultaneous

examination of all leads can be beneficial when interpreting abnormalities because electrical activity may not be captured on all leads. If the wave depolarises towards the positive pole it causes a positive deflection; a wave depolarising in the opposite direction causes a negative deflection.

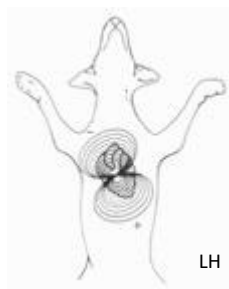


Figure 2: Lead II is most commonly used because the major wavefront of electrical activity is aligned with this lead. This typically produces a positive trace on Lead II.

Complete ECG assessment is best performed conscious and in right lateral recumbency. If another position is necessary, this may alter the mean electrical axis (MEA) and result in changes to complex morphology. As the ECG detects electrical activity, muscle movement, shivering, purring and external electrical activity can cause interference. Breathing, panting and artificial pacemaker activity can also result in interference.

The normal ECG is composed of a P wave, a QRS complex and a T wave. Changes seen on an ECG are the result of net changes (for example the P wave represents depolarisation of the right and left atria).

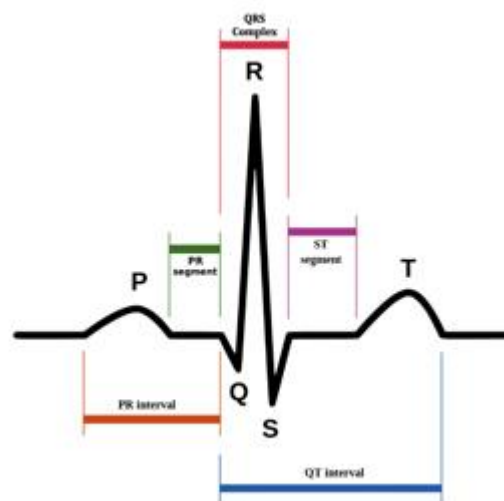


Figure 3: Components of the ECG

<https://commons.wikimedia.org;>

P wave:	Caused by electrical potentials generated as atria depolarise.
PR interval:	Interval between start of atrial depolarisation and start of ventricular depolarisation.
QRS complex:	Represents ventricular depolarisation. Conventionally in lead II first negative deflection = Q wave; first positive deflection = R wave; S wave = negative deflection occurring after the R wave.
ST segment & T wave:	Represent ventricular repolarisation.

Standard measurements on an ECG trace are made using Lead II, most commonly with a sensitivity of 1cm=1mV, and paper speed of 50 mm/s

Mean Electrical Axis (MEA) refers to the average direction that an average wavefront is moving in the heart. It is usually determined by ventricular depolarisation as this is the wavefront that predominates when all wavefronts are averaged. The use of MEA has been superseded by echocardiography to assess chamber enlargement. It can be useful for investigation of conduction disturbances.

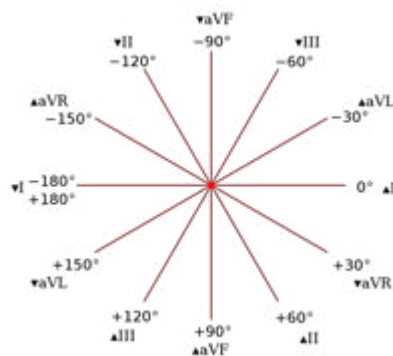


Figure 4: The mean electrical axis (MEA), which can be calculated using the six-lead system.

Causes of arrhythmia:

Arrhythmias can develop due to 1) abnormal impulse formation or 2) abnormal impulse propagation

1. Disorders of impulse formation

- Enhanced normal automaticity.** Areas of the impulse generation of conduction increase their rate of depolarization. Example: sinus tachycardia.
- Depressed normal automaticity.** A decrease in the discharge rate of an autonomic site, for example due to increased parasympathetic nervous system stimulation (i.e. increased vagal tone causing sinus bradycardia), electrolyte disturbances (especially hyperkalaemia) or destruction of the node (e.g. sick sinus syndrome).
- Abnormal automaticity.** Cells that are not normally automatic (e.g. myocardial cells) are made into automatic ones, or those that are automatic but have a very slow rate (Purkinje fibres) depolarise at a faster rate. Examples: supraventricular and ventricular premature complexes; accelerated idioventricular rhythm.

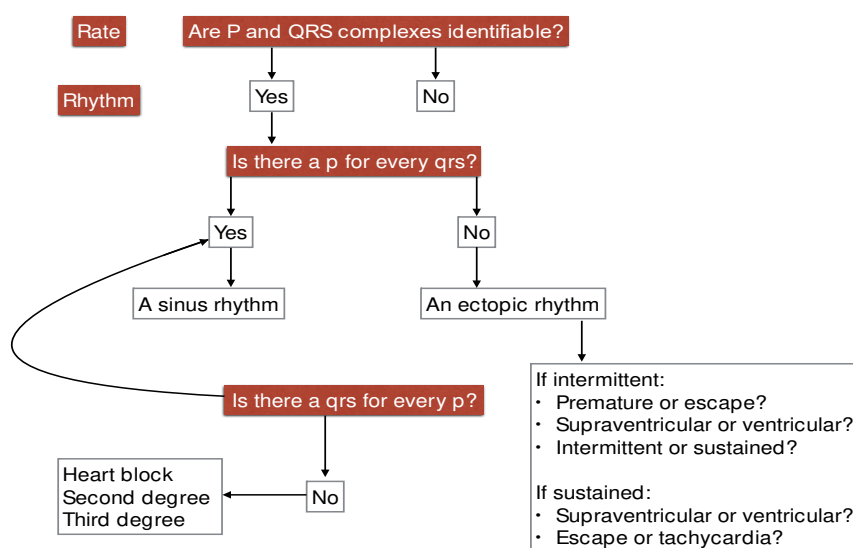
2. Disorders of impulse propagation/conduction

- Conduction delays or blocks can lead to bradyarrhythmias. An example is third degree AV block, where electrical activity from the atria is not conducted through the AV node.
- Conduction abnormalities can also lead to tachyarrhythmias. These are usually due to an extra functional or anatomical circuit so that there are two possible circuits of depolarisation with different conduction velocities and refractory periods. Re-entry occurs as part of this abnormality. An example is when myocardial cells are damaged. Conduction can be slowed through such damaged regions. By the time the depolarisation wave has travelled through the diseased tissue, it reaches normal tissue that is ready to be stimulated again (i.e. repolarised). If this occurs before the new wave descending from SA node has reached this normal tissue, then a premature depolarization occurs. This may be repetitive ('circuit loop') or occur only once.

Interpreting an ECG and the identification of arrhythmias:

As with a radiograph, the first step should be to determine if the ECG recording is of diagnostic quality. If not, it should ideally be discarded and re-recorded. However, in unstable animals, it may be impossible to obtain a “perfect” ECG trace. In such cases, the ECG traces may provide very useful information, but they should be interpreted with caution.

1. Take a few moments to look at the tracing as a whole. Note any obvious abnormalities. Is the ECG of adequate quality?
2. What is the heart rate? Use the tracing set at 50mm/s for this and count the number of complexes over 150 mm (3 seconds) and multiplying by 20. (Note: the margin markers often occur at regular intervals to allow calculation of HR more easily). Do not rely on the instrument-estimated heart rate.
3. Is the heart rhythm regular or irregular? Check the R-R intervals, there should be less than 10 % variation.
4. Now look at the complexes in more detail. Try to identify at least one normal-appearing complex for reference. Identify the P waves (if there are any) and the QRS complexes.
 - Are P and QRS complexes identifiable?
 - Is there a P for every QRS?
 - P without QRS => AV block (2nd or 3rd degree)
 - Is there a QRS for every P?
 - QRS without P => Ectopic beat
 - Site: supraventricular or ventricular?
 - Timing: premature or escape?
 - Persistence: Intermittent or sustained?
 - Are the waveforms normal or abnormal?



5. Now make the measurements of the complex components using lead II. Common changes / abnormalities are listed below.

a. P wave:

Wandering pacemaker: This results from changes in the site of the dominant pacemaker cells within the SA node. It is recognised by variation in the height of the P wave and is common in animals with high vagal tone and sinus arrhythmia. In these cases, the P wave may be positive, negative or difficult to identify. It is not pathological.

Prolongation and sometimes notching of the P wave can be seen in animals with enlargement of the left atrium (termed P mitrale). Note: a slightly prolonged P wave can be a normal finding in giant breed dogs.

Increased amplitude of the P wave can be detected in animals with right atrial enlargement (termed P pulmonale).

Atrioventricular blocks occur when SA impulses are inhibited from conducting normally to the ventricular myocardium.

- **First degree** block: prolonged PR interval
- **Second degree** block: intermittent AV conduction with one or more unconduted P waves
 - **Mobitz type I:** Progressive prolongation of the PR interval occurs prior to the unconduted P wave.
 - **Mobitz type II:** The PR interval has a fixed duration.
 - The distinction between Mobitz type I and II is made because Mobitz type II cases are more likely to progress to third degree AV block.
 - Severity described as a ratio of P:QRS complexes i.e. 2:1 AV block means two P waves for every one QRS complex.
- **Third degree** block: complete AV block with no AV conduction and independent and asynchronous P waves and QRS complexes (each occurring at their own rate).

b. QRS wave:

Low amplitude QRS complexes can occur in animals in which there is more resistance to electrical conduction between the heart and the electrodes e.g. large breed dogs, obese dogs and in animals with pericardial effusion. The use of the filter will also reduce the amplitude of complexes.

Left ventricular enlargement is characterised by tall R waves. Prolonged QRS duration, or a shift in the MEA to the left, may also be observed

Right ventricular enlargement is characterised by deep S waves. Prolonged QRS duration, or a shift in the MEA to the right, may also be observed

Notching on the R wave can be a feature of several cardiac diseases and the significance is sometimes debatable. It can be a feature of myocardial infarction or fibrosis or interventricular conduction defects. A slight notch on the upstroke of the R wave can be seen in some animals with ventricular pre-excitation (see later).

Occasionally conduction disturbances in the left or right bundle branches are observed. Each QRS complex will have an associated P wave (unless there is a concurrent arrhythmia such as atrial

fibrillation), but the QRS duration will be prolonged due to slower conduction through ventricular muscle on the affected side. **Left bundle branch blocks (LBBB)** are characterised by positive QRS complexes in leads I, II, III and aVF, whilst **right bundle branch blocks (RBBB)** are characterised by deep S waves in leads I, II, III and aVF.

Left anterior fascicular block (LAFB), common in cats with cardiomyopathy, is characterised by tall r-waves in lead I and aVL, and deep S waves in leads II, III and aVF.

Supraventricular ectopic beats are characterized by a normal appearing QRS complex (all conduction is transmitted through the AV node) but they do not have an associated P wave

Ventricular ectopic beats are wide and bizarre (due to slower depolarisation through myocardial cells rather than the specialised conducting pathways) and have no associated P wave.

Ventricular ectopic complexes originating in the left ventricle have a negative deflection followed by a positive deflection in lead II. Ventricular ectopic complexes originating in the right ventricle have a positive deflection followed by a negative deflection in lead II.

c. ST segment:

ST segment elevation can be seen in animals with pericarditis or severe myocardial ischaemia or infarction. ST segment depression can be seen in animals with endomyocardial ischaemia, potassium imbalances or digitalis toxicity.

d. T wave:

The morphology of the T wave in animals is highly variable, and in contrast to humans, the diagnostic value of T wave “changes” is minimal. However, tall T waves can be seen in animals with hyperkalaemia (usually narrowed or spiked) or myocardial hypoxia.

Recognition of selected arrhythmias:

Supraventricular arrhythmias:

Atrial or supraventricular premature complexes (APC or SVPC) occur when an ectopic focus within the atria leads to a premature depolarisation. The ectopic P-wave may or may not be visible and is followed by a normal QRS complex.

SVPCs should not be confused with junctional escape beats. Junctional escape beats occur due to emergence of a latent pacemaker at this site due to a lack of sinus rhythm. They are characterised by the presence of a normal or relatively normal QRS complex that follows a pause. This escape process can be sustained as a **junctional escape rhythm**, which results in a sustained supraventricular rhythm at a rate of approximately 40-60 bpm.

Supraventricular tachycardias are broadly defined as tachycardias originating from the SA node, atrial myocardium, AV node/junction or veins entering the atria. In all cases, the QRS complexes are predominantly normal in appearance because depolarisation of the ventricles still occurs via the normal conducting system (bundle of His, Purkinje fibres).

- **Sinus tachycardia** is identified by the presence of a fast sinus rhythm (P for every QRS; QRS for every P).

- **Supraventricular tachycardias** may be ectopic in origin (i.e. originate outside of the SA node). In such cases, P waves are not present, but the QRS complexes are of normal morphology.
 - **Atrial flutter** is characterised by rapid and regular waves of atrial depolarisations (flutter or F-waves) without a rest phase between them, resulting in a saw-tooth appearance. The R-R interval is often irregular because some atrial impulses are blocked.
 - **Atrial fibrillation** is characterised by the absence of p-waves or F-waves, and the presence of irregular R-R intervals. There is often subtle variation in R wave height.

Absence of atrial depolarisation can result in **atrial standstill**. This is characterised by an absence of P waves. In some animals, P-waves can be small, and it is therefore important to ensure the ECG is of adequate quality, and to check more than one lead. In affected animals, bradycardia occurs because of emergence of a latent pacemaker (atrial (outside the SA node), junctional or ventricular), resulting in a slow ectopic escape rhythm.

Sick sinus syndrome occurs when the SA node is unstable, with both periods of failure of SA depolarisation resulting in bradycardia, and periods of premature depolarisations and supraventricular tachycardia (a.k.a. “brady-tachy syndrome”).

Conduction through the AV node normally results in a pause prior to ventricular depolarisation (represented by the PR interval) to allow for complete atrial depolarisation to precede ventricular depolarisation, ensuring ordered contraction of these chambers. **Ventricular pre-excitation syndrome** occurs when an abnormal accessory pathway bypasses the normal AV node. This is associated with a short PR interval and possible slurring of the QRS complex (delta wave) if the pathway terminates in ventricular tissue. Paroxysmal re-entry tachycardia can be seen if the pathway allows conduction from the ventricles to the atria.

Ventricular arrhythmias:

Ventricular premature complexes (VPC) occur when an ectopic focus within the ventricles leads to a premature depolarisation. It is typically characterised by a wide and bizarre QRS complex because normal rapid ventricular conduction pathways are bypassed, resulting in slower propagation of the impulse through ventricular tissue. Compensatory pauses are common following a VPC, before the next complex occurs. This pause occurs because the VPC results in a failure of the next regular sinus complex to be conducted (due to the refractory period), and therefore ventricular depolarisation will not occur until the following complex. The shape of the VPC depends upon the site of origin and pathway of depolarisation. Unifocal VPCs have identical morphologies. Right-sided VPCs are typically positive followed by a negative deflection, while left-sided VPCs are negative followed by a positive deflection. Multifocal VPCs occur from more than one ventricular site or pathway and have variable morphology. Their presence can suggest more global ventricular disease. Two consecutive VPCs are termed a **couplet**. Three or more consecutive VPCs are termed a **salvo** or run. When every second or third beat is a VPC, the term **bigeminy** or **trigeminy** is used, respectively. **R-on-T phenomenon** occurs when a VPC occurs within the T wave of the preceding complex. This is a sign of ventricular instability and can predispose to the development of ventricular tachycardia.

Ventricular premature complexes should not be confused with **ventricular escape beats**. Ventricular escape beats occur due to emergence of a latent pacemaker due to a lack of stimulation from above. They are characterised by the presence of a wide and bizarre QRS complex that follows a pause. This escape process can be sustained as a **ventricular escape rhythm**, which results in a sustained ventricular rhythm at a rate of approximately 20-40 bpm.

Fusion beats can occur when a sinus and ventricular complex collide. These can be variable in shape depending upon the complex responsible for the majority of ventricular depolarisation.

Ventricular tachycardia (VT) occurs when multiple ventricular premature complexes are sustained. The rate is usually > 100 bpm, and can be much faster. No P waves are evident, complexes are wide and bizarre, and rhythm is often regular, especially if the complexes are uniform. Paroxysmal ventricular tachycardia is used to describe 'bursts' of ventricular tachycardia. **Ventricular fibrillation** is characterised by irregular, chaotic complexes due to a lack of organised ventricular depolarisation. There are no discernible P-QRS-T waves and a wavy, undulating baseline. It can be characterised as coarse (large wavelets) or fine (small wavelets).

Torsade de Pointes (TdP) is a ventricular arrhythmia that arises because of prolongation of the QT interval. It is characterized by rapid, irregular QRS complexes, which appear to be twisting around the electrocardiogram baseline; a finding that is caused by the ever-changing geometry of a re-entry circuit. The rhythm immediately prior to TdP is slow with prolonged QT interval. The onset of TdP usually coincides with an R on T phenomenon. The ensuing rapid rhythm has QRS complexes that are more regular than VF but continuously change in amplitude, as if twisting around the baseline. It is often self-limiting, but if persistent, can lead to VF.

Ventricular tachycardia should not be confused with **accelerated idioventricular rhythm (AIVR)**. AIVR is a typically benign arrhythmia that is often inappropriately treated. AIVR results when the rate of an ectopic ventricular pacemaker exceeds that of the sinus node, but when the rate is not markedly elevated (usually approximately 60-100 bpm). AIVR is often associated with increased vagal tone and decreased sympathetic tone. In this situation, whenever the sinus rate slows, the ectopic pacemaker emerges and captures the heartbeat. The proposed mechanism is enhanced automaticity of a ventricular pacemaker, although abnormal automaticity of an ectopic pacemaker can also occur.



B. BRAUN
SHARING EXPERTISE

B. BRAUN VETCARE
COME AND SAY HELLO
ON STAND 17

B. Braun Medical Ltd | VetCare | Thorncliffe Park | Sheffield | S35 2PW
Tel: 0114 225 9000 | Fax: 0114 225 9111 | www.bbraun-vetcare.co.uk

Lecture 5 Cardiac ultrasound for the anaesthetist

Kieran Borgeat BSc BVSc MVetMed CertVC MRCVS DipACVIM DipECVIM-CA (Cardiology)

Clinical Lead in Cardiology, Langford Vets, University of Bristol

cardio@langfordvets.co.uk @kborgeat

(twitter) / @cardio_vetbristol (Instagram)

Introduction

Echocardiography provides the only method of assessing cardiac structure and function non-invasively in real time. Cardiac MRI is often hailed as the gold-standard in cardiac imaging, but cine loops are produced by taking frames from several consecutive cardiac cycles and assembling them into a movie (therefore not real time), in a patient where anaesthesia is required to facilitate imaging (therefore altering function and loading conditions). So, the lowly ultrasound probe can find a new lease of life.

Transthoracic echocardiography (henceforth referred to as simply “echo”) has become widely practised over the last decade in first opinion and referral practice. Transoesophageal echocardiography (TOE) is becoming more accessible, and using a TOE probe on a portable machine allows its use in the theatre setting – potentially by an anaesthetist – with a view to assessing haemodynamics or even guiding a cardiac interventional procedure. This lecture aims to review the various advantages of echocardiography from an anaesthetic point of view, and introduce the various standard views, providing examples of how real-time imaging of the heart can aid in practical decision making.

What diseases are common?

Mitral valve disease (MVD) – primary degenerative disease of the mitral valve (others commonly affected but rarely clinically relevant). Mitral regurgitation is the primary problem, which reduces cardiac output and leads to renin-angiotensin-aldosterone system (RAAS) activation – ultimately leads to volume overload and myocardial remodelling (fibrosis, eccentric hypertrophy, electrical alterations, etc). Long pre-clinical phase prior to murmur identification (mitral prolapse and thickening on echo) followed by variable time frame prior to onset of clinical signs of heart failure – over half of affected dogs do not develop signs during their natural lifespan. First onset signs often left-sided congestive heart failure (pulmonary oedema causing tachypnoea or dyspnoea; stage C). Middle-aged to older small breed dogs are most commonly affected and 100% of dogs with clinically significant MVD have a heart murmur; usually grade III or louder, localised to the left apex. Louder murmurs are associated with worse disease. This disease accounts for 75% of canine heart disease in practice. Advanced cases (stage D) can be associated with pulmonary hypertension, which will limit right heart output and potentially lead to bi-ventricular failure.

Dilated cardiomyopathy (DCM) – primary problem with force transduction leads to progressive systolic dysfunction. This drops cardiac output and triggers the RAAS, leading to eccentric hypertrophy (“dilation”), fibrosis, electrical abnormalities etc. Pre-clinical phase variable in duration, and most affected dogs do not have a heart murmur until the heart dilates enough for the mitral anulus to stretch and allow valve regurgitation. Murmurs are usually low-grade and left apical. Arrhythmias are common – atrial fibrillation in Newfoundland and Irish Wolfhound breeds, ventricular tachycardia in Doberman, Boxer and Great Dane. Syncope or even sudden cardiac death may be first sign of a

problem, but affected dogs living long enough develop left-sided heart failure. DCM makes up around 15% of heart disease diagnosed in dogs.

Arrhythmogenic right ventricular cardiomyopathy (ARVC) – primary fibro-fatty infiltration of the right or both ventricles. Think of it as a variant of DCM. Boxer dogs and the English Bulldog are most commonly affected. In Boxers, it is not really clear where ARVC ends and DCM begins. Diagnosis rests upon demonstrating >100 VPCs on 24h Holter ECG, but systolic dysfunction common on echo. Can be clinically silent until syncope, heart failure or sudden death, heart murmurs relatively uncommon.

Congenital heart diseases – most common congenital disorders seen in dogs in Europe are pulmonic stenosis, subaortic stenosis and patent ductus arteriosus (PDA). If working in a referral centre with a cardiologist or keen surgeon, anaesthetising these dogs is likely to take place as a route to treatment (e.g. transvascular occlusion or ligation of a PDA) rather than for other procedures, but since dogs with subaortic stenosis often live into middle- or old-age without any specific treatment, they are often anaesthetised for non-cardiac procedures. Since these diseases should be diagnosed as puppies, approaching them has the added complexity of the patients being juvenile. Make up less than 5% of all cases identified in practice.

Hypertrophic cardiomyopathy (HCM) – primary problem with force transduction leads to alterations in connective tissue matrix (fibrosis) and compensatory concentric hypertrophy (“thickening”) of the myocardium, affecting predominantly the left ventricle. 60% or more of cases seen in cats are concurrently diagnosed with dynamic left ventricular outflow tract obstruction, adding a layer of consideration. 30% of cats with HCM develop clinical signs in their lifetime, so many cases seem affected by a benign, clinically silent disease. In the unfortunate cases, reduced LV cavity size and poor relaxation leads to reduced filling and therefore reduced cardiac output, activating the RAAS. Resultant increases in filling pressure cause left-sided congestive heart failure in cats (manifest as pulmonary oedema, alone or accompanied by pleural effusion if the right heart is impacted also). Left atrial dilation and reduced left atrial function go hand in hand, and cause intracardiac thrombosis in a small proportion of affected cats.; this can lead to arterial thromboembolism (ATE). Murmurs in cats have a relatively low positive predictive value in cats (less than 50% at best), but louder murmurs (grade III and above) and those detected in older cats – especially males – are more worthy of investigation. That being said, a fair number of cats with no murmur may also have HCM, which complicates screening pre-anaesthesia. NT-proBNP may be used as a “pre-screening” tool in cats with murmurs – if it is abnormal, perform an echo. The finding of an arrhythmia or gallop sound in cats always merits echocardiography, irrespective of history and murmur findings.

What degree of detail is required on echo pre-anaesthesia?

The bottom-line from a pre-anaesthetic echo should not be the diagnosis or staging of disease, but an assessment of risk. Who cares if the cat has HCM or some other variant cardiomyopathy (restrictive cardiomyopathy, etc)? What matters is the risk of developing or worsening pulmonary oedema, causing hypoxaemia, or systemic hypotension causing hypoperfusion.

Four major players should be considered in terms of risk assessment:

1. Left atrial volume loading (diameter and function): left atrial size and function can be used as a surrogate marker of risk of pulmonary oedema

2. Systolic function: left ventricular systolic function can be assessed quantitatively (ejection fraction, fractional shortening, systolic diameter and strain measurements) or qualitatively ("it looks weak"), as an indicator of why a patient may become hypotensive during anaesthesia and whether inotropic support should be considered in addition to vasopressors
3. Arrhythmias: simultaneous ECG should be performed during even a brief echo, to identify any previously unknown rhythm abnormalities, especially ventricular arrhythmias which may worsen during catecholamine release associated with pain or a stressful induction or recovery.
4. Context of history and physical exam findings: always should be integrated into the imaging findings. For example, a Boxer dog with a normal echo but a history of frequent syncope episodes is still likely to have undetected arrhythmias, despite a normal ECG during the scan.

When might a pre-anaesthetic echo be indicated and what question/s are we looking to answer?

Mitral valve disease patients

- Incidental murmur in an older-small breed dog: is the left atrium dilated?
- Known pre-clinical MVD: is the left atrium large, is there evidence of pulmonary oedema (B-lines)?
- Known MVD previous heart failure: is there evidence of active pulmonary oedema or complicating factors such as significant arrhythmias or pulmonary hypertension?

Dilated cardiomyopathy patients

- Asymptomatic patient being screened because of close family history / age+breed: is systolic function normal, is the left atrial size normal?
- Known DCM: quantify systolic function – has it deteriorated? Is there evidence of active pulmonary oedema? Are there significant arrhythmias (may require a 24h Holter rather than merely ECG during echo)?

Hypertrophic cardiomyopathy patients

- Incidental murmur in a cat: is there LV hypertrophy, is the left atrium enlarged, is LV outflow tract obstruction present?
- Known pre-clinical HCM: is the left atrium dilated, is the left ventricular function normal, is there an intra-cardiac thrombus?
- Known HCM with previous heart failure: what is left ventricular systolic function, is there an intra-cardiac thrombus?

No known primary cardiac disease and not considered high-risk for primary cardiac disease

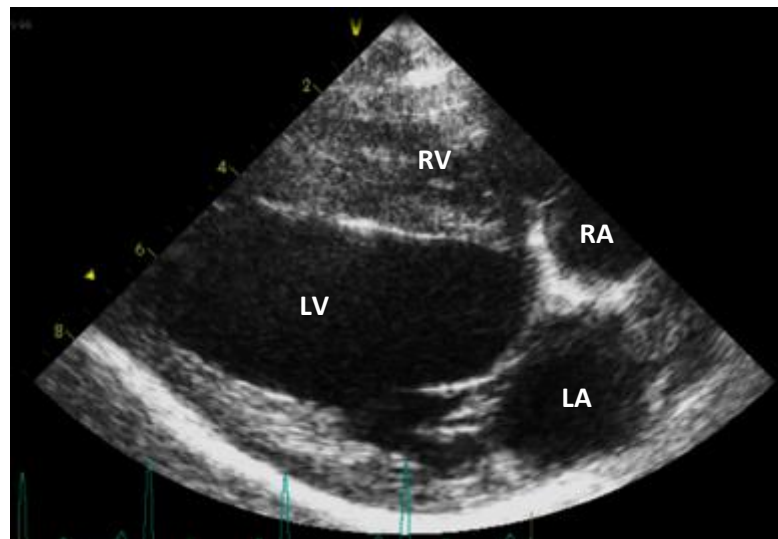
- Volume status: echo can be used to assess tolerance of higher fluid rates or further boluses (especially cats), e.g. acute kidney injury, ureteric obstruction, chronic anaemias (which commonly develop cardiac remodelling owing to RAAS activation). Also, may be used to see if

obviously behind on fluids – does the left heart appear relatively small (sometimes with thick-looking walls; “pseudo-hypertrophy”).

- Systolic function: septic patients or those with SIRS may develop transient systolic dysfunction, which may need specific attention during anaesthesia for, say, exploratory coeliotomy. In addition, patients with systemic hypotension, non-responsive to fluid therapy and pressors, may have systolic dysfunction as a limiting factor.
 - This can be an especially useful aspect of TOE in theatre, where the anaesthetist can check both volume status and systolic function using a focussed examination without moving the patient or altering their position – even works during open-chest surgery.

Standard echocardiographic views

Right parasternal long axis 4 chamber

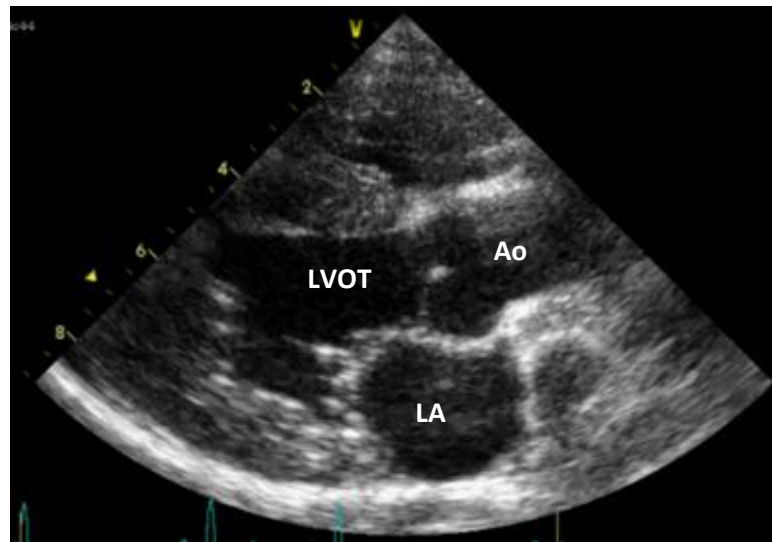


Good overview of all 4 chambers

Left ventricular (LV) and left atrial (LA) diameter measurements

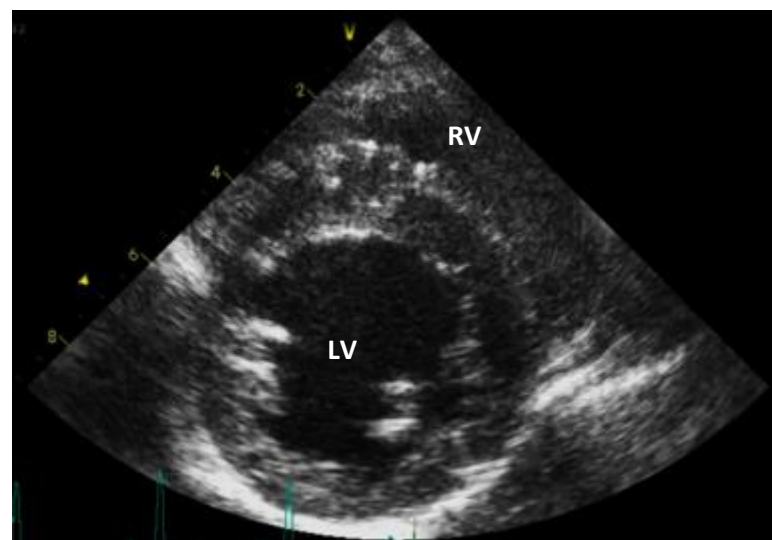
Mitral valve morphology and motion – is prolapse present?

Right parasternal long axis 5 chamber



LV outflow tract abnormalities (sub-aortic stenosis, systolic anterior motion in HCM) and LV wall thickness

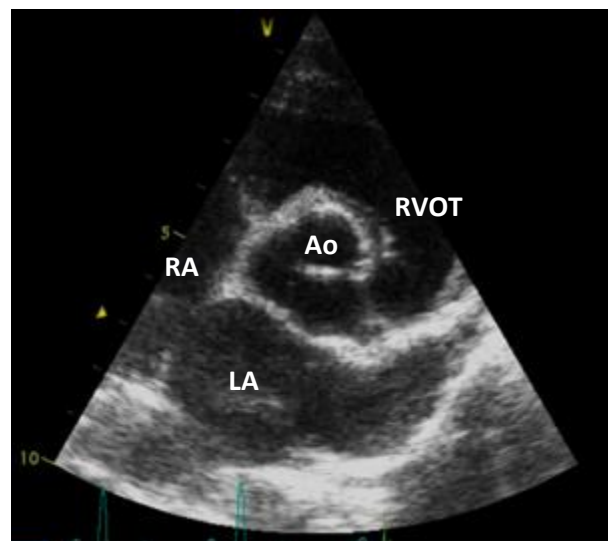
Right parasternal short axis at papillary muscle level



LV dimensions and systolic function (sometimes using M-mode)

Septal morphology – relationship of LV pressure to RV pressure

Right parasternal short axis at the aortic valve level ("LA:Ao view")



Assessment of LA size compared to aortic root, to account for differences in body size: normal LA:Ao is <1.5 ; over 1.6 is considered abnormal

NEW *Wow!* **ROBUST BORDETELLA PROTECTION WITH EASY ORAL DELIVERY**



Be amazed by **NEW VERSICAN PLUS Bb ORAL** - Easy for vets, kind to the dog and less stressful for the owner. Vaccination reduces disease. Together let's build a healthier dog population.

EUROPE'S 1ST ORAL COMPANION ANIMAL VACCINE

VERSICAN[®] Plus Bb Oral
CHANGING THE FACE OF VACCINATION

zoetis

For further information please see the product's SPC or contact Zoetis Ireland, Unit 10, Cherrywood Business Park, Co. Dublin • Telephone 01 256 9800 • www.zoetis.ie • Legal category POM • Use medicines responsibly (www.apha.ie) • ZTC 20/03/01 (JAN2020) • MM-08017

Lecture 6: A-FAST & T-FAST for the Anaesthetist

Emma Tobin MVB MVM CVR DipECVDI

University College Dublin

AFAST (Abdominal Focused Assessment with Sonography for Trauma) and TFAST (Thoracic Focused Assessment with Sonography for Trauma) are designed for use in the trauma or emergency medicine room, they are not intended to be complete ultrasound examinations. There are several potential limitations such as skill level of the sonographer, the quality of the ultrasound machine, and the fact that the scans are often performed in the trauma room along with bright lights, painful or stressed patients etc. It is advisable to stick to a strict routine to minimise these limitations and maximise ultrasound exam results.

PATIENT PREPARATION, POSITIONING, AND SCAN FACTORS

Patient preparation: Either quickly clip little squares for the particular views or wet the coat with isopropyl alcohol and then use ultrasound coupling gel.

If the patient is stable then place them in left lateral recumbency (easier to find right kidney and apparently faster) for the AFAST examination. TFAST is performed in sternal recumbency or by alternating left and right lateral recumbency. Dyspnoeic patients should be provided with supplemental oxygen and should be scanned in sternal recumbency. AFAST and TFAST examinations should never be prioritized over immediate life-saving therapy.

It is important to understand the basic buttons on your ultrasound machine. These include depth, gain (level of image brightness) and the focal zone. Optimise the image quickly by using these buttons. If the room is bright it may be necessary to increase the gain. Terminology is key too, anechoic means “no echoes” typically fluid (transudate, modified transudate, and some types of exudate). Hyperechoic means bright / white (mineral or gas are the brightest structures) and hypoechoic is dark grey (different tissues etc).

AFAST TECHNIQUE

The technique for performing the AFAST examination is described in detail elsewhere.¹⁻³ Four acoustic “windows” are assessed in a complete AFAST examination. At each window, orientate the image so that the machine company logo is on the left of the screen, indicating that the transducer marker (or “notch”) is pointing cranially, along the long axis of the patient. Then rotate the transducer 90° so that the notch points toward the patient’s right side. This results in the right side of the dog or cat being oriented toward the left-hand side of the ultrasound image on the screen, as viewing a ventro-dorsal radiograph of the abdomen.

Diaphragmatic–Hepatic Window

Place transducer below the xiphiisternum. Angle cranially. Increase the depth to visualise the diaphragm- lung interface and the liver. Image depth and focus should be optimized such that the diaphragm is located in the far field of the image display.

Fan the ultrasound beam to the patient's left and right, following the contour of the diaphragm, while maintaining a sagittal imaging plane along the long axis of the patient. In a normal patient, the liver and diaphragm remain in direct contact. If peritoneal effusion is present at this window, it may appear as anechoic material between the liver and diaphragm or between liver lobes.

A complete assessment at the DH window includes an assessment of the gallbladder and transdiaphragmatic visualization of the pericardium.

Gallbladder Assessment

The gallbladder is positioned to the right of midline between the right medial and quadrate lobes of the liver in the dog and within the right medial lobe in the cat. In normal dogs and cats, the gallbladder appears as a thin-walled, ovoid to rounded structure containing anechoic material. In a typical small to medium-size dog, the gallbladder can easily be found from the original xiphisternum position by fanning the probe toward the patient's right.

Subtle abnormalities of the gallbladder may not be readily apparent during the AFAST examination; however, the combined presence of a large volume of organized, nonmobile gallbladder contents, anechoic surrounding fluid, and hyperechoic adjacent fat (representing steatitis) should raise concern for gallbladder leakage, rupture and peritonitis.

Pericardial Assessment

The DH window provides a good acoustic window to the heart. In cats and small and medium-size dogs, minimal adjustment of imaging parameters (depth and focus) will be necessary to visualize the apical portion of the heart. If readily apparent, pericardial effusion can be seen as anechoic material surrounding the cardiac apex, bordered by a thin, echogenic interface representing the pericardium. Using this window alone, it may not be possible to differentiate between pericardial and pleural effusion; thus, a complete TFAST examination is warranted in dogs or cats when pleural or pericardial effusion is present.

Splenorenal Window

If the patient is positioned in left lateral recumbency, the splenorenal (SR) window will be located within the dependent flank. The window is defined as the interface between the homogenous echotexture of the spleen and the ovoid, typical mixed-echogenicity appearance of the kidney. The normal kidney has a hyperechoic outer cortex and a relatively hypoechoic inner medulla. Because both the spleen and the left kidney are mobile, they may not be found immediately adjacent, and small intestine or mesenteric fat may be present in the space between.

For many operators, examining the dependent flank is challenging, but external anatomic landmarks can be helpful.

- Compose a long axis image by placing the probe in the dependent (left) flank caudal to the 13th rib and ventral to the lumbar muscles.
- While maintaining a long axis image, fan dorsomedially to search for the left kidney.
- With the kidney centered, fan lateral and cranial to identify the spleen.

Anechoic material adjacent to renal or splenic parenchyma, between loops of small intestine, or within mesenteric fat represents peritoneal effusion. Small volumes of fluid located immediately adjacent to the kidney may be difficult to distinguish as peritoneal or retroperitoneal.

Cystocolic Window

The primary landmarks used to orient the cystocolic (CC) window are the urinary bladder and the ventral surface of the descending colon. To generate this window, place the probe caudally along midline with the marker oriented cranially to create an image along the long axis of the patient. The body of the urinary bladder is mobile and typically falls to the dependent flank, so it may not be readily apparent on initial probe placement. Too much pressure on the probe can collapse or displace a small volume urinary bladder and make identification challenging.

The normal urinary bladder appears as an ovoid structure containing anechoic material, surrounded by a thin echogenic wall with 3 discernible layers. The colon generally contains gas, which generates dirty distal acoustic shadowing and reverberation artifacts originating at the luminal mucosal surface, and/or feces, which is often associated with clean distal acoustic shadowing. These artifacts will interfere with image generation of structures deep to the colon.

If moderate peritoneal effusion is identified at this window, exercise caution when interpreting the appearance of the urinary bladder wall. When a curvilinear interface is bounded on either side by anechoic fluid (e.g., urine within the urinary bladder lumen and peritoneal effusion outside), refraction artifact (also known as *edge shadowing*, *pseudo-urinary bladder rupture*, or *edge dropout artifact*) may occur at the tangential interface with the ultrasound beam, giving the appearance of a discontinuous urinary bladder wall. The appearance of effusion in the CC window should not be confused with a true rupture of the urinary bladder, in which the urinary bladder will be collapsed.

Hepatorenal Window

The hepatorenal (HR) window can be challenging to obtain, especially in large dogs. The right kidney is located within the renal fossa of the caudate process of the caudate lobe of the liver in dogs; in cats, it is typically separated from the caudate lobe of the liver by retroperitoneal fat. Relative to the left kidney, the right kidney is generally in a more cranial and lateral position.

To obtain the HR window, place the probe caudal to the right 13th rib, ventral to the lumbar hypaxial musculature, and fan dorsomedially to search for the interface of the right kidney with the liver. The relatively cranial position of the right kidney generally makes it necessary to angle the probe cranially before fanning. In large-breed or deep-chested dogs, a dorsolateral, 11th or 12th intercostal space approach may be necessary to visualize the right kidney. In the HR window, anechoic material between the hepatic parenchyma and the kidney represents a retroperitoneal or peritoneal effusion

TFAST TECHNIQUE

The TFAST examination involves assessment of both hemithoraces for pleural space disease (presence of gas or effusion) and pericardial effusion. With training and/or experience, the examination can include focused echocardiography as well as assessment of the peripheral pulmonary parenchyma for peripheral or diffuse lung diseases. Once the patient is stabilized, the lungs should be completely evaluated by obtaining 3-view thoracic radiographs.

In echocardiography, the machine logo marker is positioned on the right of the screen so that cranial on the dog or cat is to the viewer's right. This is opposite from abdominal ultrasonography. In the

following description, the probe and the machine logo positions are the same as those used for an abdominal scan.

Assessing for Pleural Space Disease

A primary goal of the TFAST examination is to assess for the presence of gas within the left and/or right pleural spaces. The probe position for identifying gas within the pleural space has been described as the *chest tube site*: dorsolateral along the thoracic wall, with the transducer notch pointing cranially (cranial is on the left side of the screen), within the 7th to 9th intercostal spaces, bilaterally.⁴

From this position, the interface between the pulmonary (visceral) pleural surface with the costal (parietal) pleural surface is identified. In a normal individual, the rhythmic to-and-fro motion at this interface constitutes a *glide sign*. The absence of a glide sign is indicative of gas within the pleural space. If pneumothorax is identified in a dyspneic patient, therapeutic thoracocentesis is indicated. When normally inflated, the pulmonary parenchyma cannot be visualized using ultrasound.

Thoracic (pleural and pericardial) effusions have identical ultrasound characteristics to peritoneal effusions. In the presence of sufficient thoracic effusion, pulmonary atelectasis occurs and the collapsed lung parenchyma may be visualized as well-defined, triangular echogenic structures floating within the effusion. Thus, thoracic effusion can improve the acoustic window to the pulmonary parenchyma as well as the heart.

Assessment of the Pulmonary Parenchyma Using Vet BLUE

The primary goal of the veterinary bedside lung ultrasound exam (Vet BLUE) is to identify diseased pulmonary parenchyma. Diseased lung tissue often involves additional fluid or cells within the interstitial and/or alveolar spaces (i.e., wet lung), resulting in increased penetration of the ultrasound beam beyond the visceral pleural surface. Vet BLUE exploits this phenomenon by utilizing the ultrasound findings associated with wet lung as an indicator for pulmonary disease. This examination is useful when critical patient status prevents thoracic radiography.

Differential diagnostic considerations for wet lung must take into account the distribution of affected lung tissue as well as the specific patient context. For example, identifying wet lung caudodorsally in an electrocuted patient or a patient with a history of seizures could indicate noncardiogenic pulmonary edema, while wet lung at the site of blunt trauma may indicate pulmonary contusion or hemorrhage. The distribution of pulmonary changes is best assessed using survey thoracic radiographs, which should be used subsequent to Vet BLUE to evaluate the entire lung fields, pleural space, extrathoracic structures, cardiovascular structures, and mediastinum.

Vet BLUE assessment of the pulmonary parenchyma involves the bilateral evaluation of 4 windows: the caudodorsal lung lobe region, the middle lung lobe region, the perihilar lung lobe region, and the cranial lung lobe region. At each position, the transducer is oriented cranially so that the company logo on the image is to the viewer's left, between ribs, such that the pulmonary–pleural interface in association with the adjacent rib shadows resembles a partially submerged alligator with eyes peering above the water (referred to as the gator sign).

Horizontally oriented hyperechoic A-lines are equidistant lines caused by reverberation artifacts of the lung margin, or reverberation artifact from the normal pulmonary–pleural interface. The presence of A-lines in conjunction with a normal glide sign indicate normal, dry lung.

Wet lung is indicated by the presence of B-lines, which are hyperechoic lines running perpendicular to A-lines that oscillate with respiration. These lines are sometimes referred to as ultrasound lung rockets or ring-down artifact.

Assessing for Pericardial Effusion and Tamponade

The probe position for identifying pericardial effusion has been described as the pericardial site: ventrolateral along the thoracic wall, within the 5th to 6th intercostal spaces, bilaterally.⁴ Pericardial effusion appears as anechoic or echogenic material surrounding the ventricular and/or atrial free walls, bordered by a thin curvilinear echogenic structure representing the pericardium.

If a large volume of effusion (accumulated over a long time) or a small volume of effusion (accumulated over a short time but creating elevated intrapericardial pressure) is present within the pericardial sac, cardiac tamponade might be present. Tamponade is characterized by collapse or inward motion of the right ventricular and right atrial free wall throughout the cardiac cycle, particularly during early diastole, when pericardial pressures exceed intracardiac pressures. If pericardial effusion is identified in a hemodynamically unstable patient (e.g., cardiac tamponade), ultrasound-guided pericardiocentesis is indicated. Scant pericardial effusion may not be immediately life threatening but always warrants further investigation.

INTERPRETATIONS OF FLUID

Cavitary effusions are often found adjacent to viscera and appear anechoic, although the cellular, lipid, or protein content can increase fluid echogenicity. Ultrasound alone cannot reliably determine the constitution or etiology of effusions. Echogenic material in the fluid does not equate with an exudate; anechoic fluid or echogenic fluid can be a transudate, modified transudate, or exudate. Cavitary effusions in small animals vary in etiology. When a cavitary effusion is identified and sampling is clinically indicated, standard procedures for paracentesis should be used as long as there are no contraindications to sampling (i.e., thrombocytopenia or coagulopathy of any form).

1. Lisciandro GR. Abdominal and thoracic focused assessment with sonography for trauma, triage, and monitoring in small animals. *J Vet Emerg Crit Care* 2011;21(2):104-122.

2. Boysen SR, Lisciandro GR. The use of ultrasound for dogs and cats in the emergency room. *Vet Clin N Am Small Anim Pract* 2013;43(4):773-797.

3 Boysen SR, Rozanski EA, Tidwell AS, et al. Evaluation of a focused assessment with sonography for trauma protocol to detect free abdominal fluid in dogs involved in motor vehicle accidents. *JAVMA* 2004;225(8):1198-1204. doi:10.2460/javma.2004.225.1198.

4 Lisciandro GR, Lagutchik MS, Mann KA, et al. Evaluation of a thoracic focused assessment with sonography for trauma (TFAST) protocol to detect pneumothorax and concurrent thoracic injury in 145 traumatized dogs. *J Vet Emerg Crit Care* 2008;18(3):258-269.

Keynote lectures

CPR: Basic Life Support (BLS) / Advanced Life Support (ALS)

Daniel J. Fletcher, PhD, DVM, DACVECC; djf42@cornell.edu

Cornell University College of Veterinary Medicine, Ithaca, NY

Veterinary protocols for cardiopulmonary resuscitation (CPR) have been largely adapted from those promoted by the American Heart Association for people. The Reassessment Campaign on Veterinary Resuscitation (RECOVER) recently completed a systematic review of the literature relevant to veterinary CPR and developed the first evidence-based, consensus CPR guidelines for small animals (<http://www.acvecc-recover.org>). This web site contains thorough worksheets documenting the literature supporting the recommendations contained in this document. A complete overview of the methods used, the evidence base upon which the clinical guidelines are based, and a complete description of all of the clinical guidelines are available in the June 2012 special issue of the Journal of Veterinary Emergency and Critical Care.¹ A summary of the consensus guidelines is presented here, and the CPR algorithm derived from that process is presented in Figure 1.

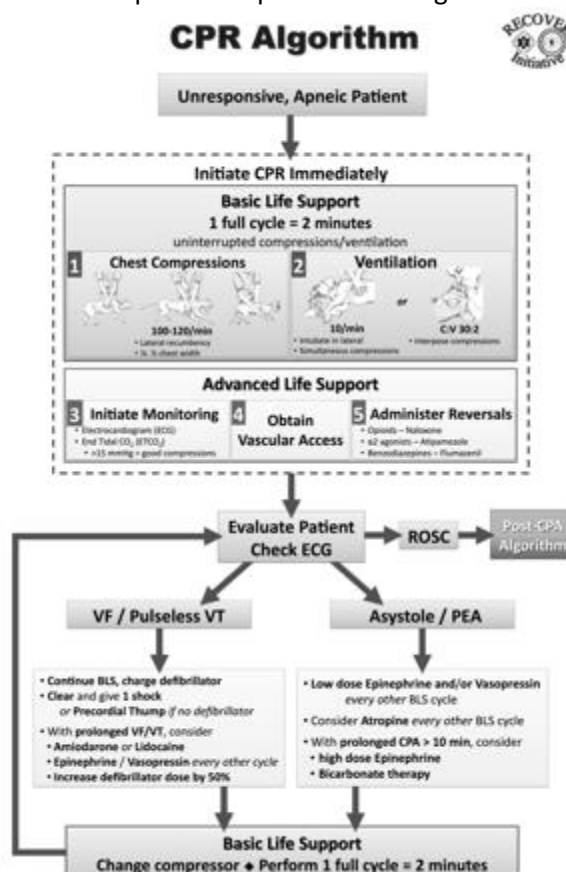


Figure 1: RECOVER CPR algorithm*

Diagnosis of Cardiopulmonary Arrest (CPA)

CPA is an important differential diagnosis for any acutely unresponsive patient. It is a clinical diagnosis based on the presence of unconsciousness, lack of breathing and absence of a palpable pulse. Regardless of the clinician's index of suspicion for CPA in an individual patient, a rapid assessment focused on ruling out CPA should be undertaken immediately in any unresponsive patient. A standardized approach based on evaluation of Airway, Breathing, and Circulation (ABC) will quickly identify the condition and allow immediate intervention should the diagnosis be made. Because the

benefits of starting CPR immediately in a patient with CPA far outweigh the risks of performing CPR on an unresponsive patient not in CPA, the clinician should not delay starting CPR in any patient in which there is a suspicion of CPA.

If CPA cannot be definitively ruled out, CPR should be initiated immediately rather than further diagnostic assessment. This is important as (1) several studies in human medicine have shown that pulse palpation is an insensitive test for diagnosis of CPA, and this may also be the case in dogs and cats, and (2) a large body of literature supports the notion that even short delays in initiating CPR in pulseless patients reduce the likelihood of successful resuscitation. Therefore, the ABC assessment should take no more than 10-15 seconds to complete.

Preparedness

Delays in initiation of CPR for patients with cardiopulmonary arrest (CPA) consistently result in poor outcomes, making it crucial that veterinary practices are well prepared for early recognition of CPA. Studies in human medicine have shown that a combination of didactic CPR training and opportunities to practice psychomotor skills is more effective than either technique alone. Training is recommended for all veterinary personnel who may be called upon to assist in a crisis, including both technicians and veterinarians. Until structured training programs are available in veterinary medicine, practice owners must devise accessible training programs for their staff. Refresher training and drills at least every 6 months have been shown to improve performance in human medicine, and structured assessment and feedback after training maximizes effectiveness.

A fully stocked crash cart routinely audited for content should be available. Because the incidence of CPA in many practices is low, systems should be in place to ensure regular restocking of the crash cart. CPR algorithm charts and emergency drug dosing charts improve adherence to guidelines and individual performance during CPR. They should be available in a central location in the practice and reviewed with any staff that may be called upon to acquire drugs for Advanced Life Support efforts.

Following all CPR attempts, debriefing sessions during which team performance is discussed and critically evaluated should be held. The team leader should facilitate the discussion, but all team members should be encouraged to participate and offer their insights.

Basic Life Support (BLS)

Basic Life Support (BLS) should be initiated as quickly as possible following diagnosis of CPA using the Circulation, Airway, Breathing (CAB) concept. Circulation should be addressed first, as ventilation will be ineffective if there is no cardiac output, and evidence suggests that outcome worsens as delay to the initiation of chest compressions increases.

Circulation - Chest Compressions:

Patients with CPA have no forward blood flow out of the heart and no delivery of oxygen to the tissues. An immediate consequence is the exhaustion of cellular energy stores, cell depolarization and thus loss of organ function. This quickly results in increasing severity of ischemic organ injury and sets the stage for escalating reperfusion injury upon reinstitution of tissue blood flow. The initial goals of chest compressions are to provide (1) pulmonary blood flow for oxygen uptake and CO₂ elimination, and (2) tissue perfusion for oxygen delivery to restore cellular metabolic activity. Experimental evidence suggests that even well-executed external chest compressions produce at best 30% of normal cardiac output, making proper technique critical. Chest compressions should be started as

soon as possible after diagnosis or suspicion of CPA. Delay in the start of high-quality chest compressions reduces the likelihood of return of spontaneous circulation (ROSC).

Chest compressions should be done with the dog or cat in lateral recumbency with a compression depth of 1/3-1/2 the width of the chest at a rate of 100-120 compressions per minute regardless of size or species. Use of aids to ensure correct compression rate, such as a metronome or a song with the correct tempo (e.g., "Staying Alive") is recommended. Leaning on the chest between compressions must be avoided to allow full elastic recoil. Chest compressions should be delivered without interruption in cycles of 2 minutes, and a new compressor should take over after each cycle to reduce the effect of rescuer fatigue. Any interruption in compressions should be as short as possible, as it takes approximately 60 seconds of continuous chest compressions before coronary perfusion pressure (CPP) reaches its maximum. CPP in turn is a critical determinant of myocardial blood flow and the likelihood of ROSC.

The physiology of blood flow generation is fundamentally different during CPR compared to spontaneous circulation. Two distinct theories exist to explain how chest compressions lead to systemic blood flow. The cardiac pump theory is based on the concept that the left and right ventricles are directly compressed, increasing the pressure in the ventricles, opening the pulmonic and aortic valves and providing blood flow to the lungs and the tissues respectively. Recoil of the chest between compressions due to the elastic properties of the rib cage creates negative pressure within the chest, improving filling of the ventricles before the next compression. The thoracic pump theory is based on the concept that external chest compressions raise overall intrathoracic pressure, forcing blood from intrathoracic vessels into the systemic circulation, with the heart acting as a passive conduit.

Given the chest wall stiffness in medium and large dogs, blood flow generated by the thoracic pump mechanism likely predominates in these patients. Therefore, it is recommended that the chest be compressed over the highest point on the lateral thoracic wall with the patient in lateral recumbency (i.e., the widest part of the chest). In contrast, in very keel chested dogs (e.g., Doberman Pinschers, sight hounds), it is reasonable to do chest compressions directly over the heart as the cardiac pump mechanism likely predominates. In markedly barrel-chested dogs (e.g., English Bulldogs), compressions over the sternum with the patient in dorsal recumbency may be more effective in eliciting the thoracic pump mechanism than lateral chest compressions. In these and other large dogs with low chest compliance, considerable compression force is necessary for CPR to be effective. The compressor should maintain locked elbows with one hand on top of the other, and the shoulders should be directly above the hands. This allows compressions to be done using the core muscles rather than the biceps and triceps, reducing fatigue and maintaining optimal compression force. If the patient is on a table and the elbows cannot be locked, a stool should be used or the patient should be placed on the floor.

Most cats and small dogs tend to have higher thoracic compliance and narrower chests than larger dogs, making the cardiac pump mechanism achievable in these patients; therefore, chest compressions should be done directly over the heart. Compressions may be performed using the same two-handed technique as described above for large dogs, or may be done using a single-handed technique where the compressing hand is wrapped around the sternum and compressions are achieved from both sides of the chest by squeezing. Circumferential compressions of the chest using both hands may also be considered.

Airway and Breathing – Ventilation

If an endotracheal tube and laryngoscope are available, the patient should be intubated as soon as possible. Both dogs and cats can be intubated in lateral recumbency, so chest compressions should continue during endotracheal tube placement. If an endotracheal tube is not readily available, mouth to snout ventilation will provide improved oxygenation and CO₂ removal. The patient's mouth should be held closed firmly with one hand. The neck is extended to align the snout with the spine, opening the airway as completely as possible. The rescuer makes a seal over the patient's nares with his/her mouth and blows firmly into the nares to inflate the chest. The chest should be visually inspected during the procedure and the breath continued until a normal chest excursion is accomplished. An inspiratory time of approximately 1 second should be targeted.

In non-intubated patients ventilated using the mouth to snout technique, ventilation cannot be performed simultaneously with chest compressions. Therefore, 30 chest compressions should be delivered, immediately followed by two breaths. Alternating compressions and ventilations should be continued for 2-minute cycles, and the rescuers rotated every cycle to prevent fatigue. Chest compressions and ventilations should be performed simultaneously in intubated patients because the inflated cuff of the endotracheal tube allows alveolar ventilation during a chest compression and interruptions in chest compressions are minimized. Intubated patients should be ventilated at a rate of 10 breaths per minute with an inspiratory time of approximately 1 second. If a spirometer is available, a tidal volume of approximately 10 ml/kg should be targeted. This low minute ventilation is adequate during CPR since pulmonary blood flow is reduced. Care should be taken not to hyperventilate the patient, as low arterial CO₂ tension leads to cerebral vasoconstriction, decreasing oxygen delivery to the brain.

Advanced Life Support (ALS)

Once BLS procedures have been implemented, the CPR team should initiate Advanced Life Support (ALS), which includes monitoring, drug therapy, and electrical defibrillation. Drug therapy is preferably administered by the intravenous or intraosseous route. Therefore, placement of a peripheral or central intravenous or intraosseous catheter is recommended, but should not interfere with continuation of BLS.

Monitoring

Many commonly employed monitoring devices are of limited use during CPR due to their susceptibility to motion artifact and the likelihood that decreased perfusion will compromise accurate readings. Low yield monitoring devices include pulse oximeter and indirect blood pressure monitors, including Doppler and oscillometric devices. The two most useful monitoring devices during CPR are the electrocardiogram (ECG) and end tidal CO₂ monitor (ETCO₂).

Although the ECG is highly susceptible to motion artifact and is of limited use during ongoing chest compressions, an accurate rhythm diagnosis is essential to guide drug and defibrillation therapy. The goal of ECG monitoring during CPR is to diagnose which of the four most common arrest rhythms are present: (1) asystole, (2) pulseless electrical activity (PEA), (3) ventricular fibrillation (VF), or (4) pulseless ventricular tachycardia (pulseless VT). Rhythms 1 and 2 are the "non-shockable" arrest rhythms and rhythms 3 and 4 are the "shockable" arrest rhythms. The ECG should be quickly evaluated while compressors are being rotated between 2-minute cycles of CPR, the rhythm diagnosis should be

called out to the group by the team leader, and differing opinions on the diagnosis should be solicited. Discussion about the rhythm diagnosis should not prevent rapid resumption of chest compressions. Figure 2 shows an ECG algorithm that can be used during CPR to diagnose the arrest rhythm.

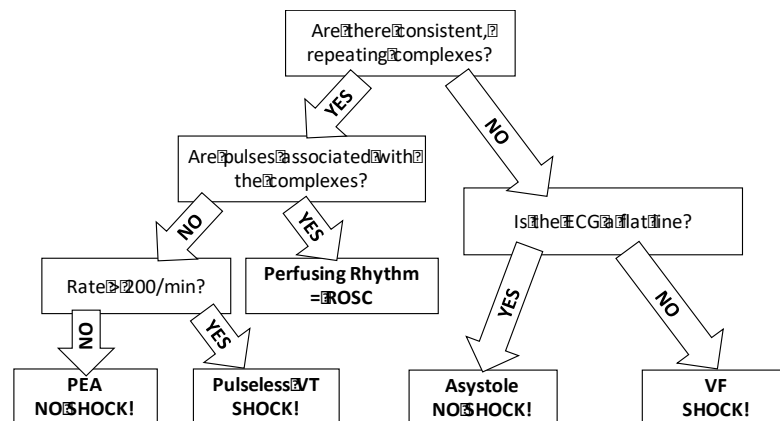


Figure 2: Arrest rhythm diagnosis algorithm

ETCO₂ data can be used in multiple ways during CPR, and regardless of the technology used is highly resistant to motion artifact. The presence of measurable CO₂ by ETCO₂ monitoring is supportive of (but not definitive for) correct placement of the endotracheal (ET) tube. Because ETCO₂ is proportional to pulmonary blood flow, it can also be used as a measure of chest compression efficacy under conditions of constant quality of ventilation. Upon return of spontaneous circulation (ROSC), ETCO₂ dramatically increases due to the rapid increase in circulation, and therefore is a valuable early indicator of ROSC during CPR.

Drug Therapy

Depending on the arrest rhythm, the use of vasopressors, parasympatholytics, and/or anti-arrhythmics may be indicated in dogs and cats with CPA. In addition, in some cases the use of reversal agents, intravenous fluids, and alkalinizing drugs may be indicated. Strict adherence to evidence-based CPR algorithms is recommended to increase the quality of CPR, the likelihood of ROSC and the chance of survival to hospital discharge.

For non-shockable arrest rhythms, vasopressors are recommended to increase peripheral vasoconstriction. Because cardiac output is low even during optimal external chest compressions, shunting of blood away from the periphery and towards the core (e.g., the heart, lungs, and brain) is essential to maintain perfusion to these vital organs. Epinephrine causes peripheral vasoconstriction via stimulation of α_1 receptors. It is a nonspecific catecholamine that also acts on β_1 and β_2 receptors, but the α_1 effects have been shown to be the most beneficial during CPR. Initially low doses (0.01 mg/kg IV/IO every other cycle of CPR) are recommended, but after prolonged CPR, a higher dose (0.1 mg/kg IV/IO every other cycle of CPR) may be considered. Epinephrine may also be administered via ET tube (0.02 mg/kg low dose; 0.2 mg/kg high dose) by feeding a long catheter through the ET tube and diluting the epinephrine 1:1 with isotonic saline.

Vasopressin is an alternative vasopressor that exerts its vasoconstrictive effects via activation of peripheral V1 receptors. It may be used interchangeably with epinephrine during CPR at a dose of 0.8 U/kg IV/IO every other cycle of CPR. Potential benefits of vasopressin include continued efficacy

in acidic environments in which α_1 receptors may become unresponsive to epinephrine and lack of β_1 effects (positive inotropy and positive chronotropy), which may cause increased myocardial oxygen consumption and worsened myocardial ischemia upon ROSC. Vasopressin may be administered via ET tube using the technique described above.

Atropine is an anti-cholinergic, parasympatholytic drug that has been extensively studied in CPR. Although only a few studies have shown a beneficial effect, there is limited evidence of a detrimental effect, and atropine at a dose of 0.04 mg/kg IV/IO may be considered during CPR in dogs and cats, and is reasonable in all dogs and cats with asystole or PEA associated with increased vagal tone. Atropine may also be administered via ET tube (0.08 mg/kg).

Although non-perfusing VF/ventricular tachycardia (VT) should be treated as early as possible with electrical defibrillation, patients with VF refractory to defibrillation may benefit from treatment with amiodarone at a dose of 2.5-5 mg/kg IV/IO. This drug has been associated with anaphylactic reactions and hypotension in dogs, so patients should be closely monitored for signs of peripheral vasodilation, wheals, or hives once ROSC is achieved. Treatment with diphenhydramine (2 mg/kg IM) and/or anti-inflammatory corticosteroids (0.1 mg/kg dexamethasone sodium phosphate IV) is warranted should these signs be noted.

If amiodarone is not available, patients with VF refractory to electrical defibrillation may benefit from lidocaine 2 mg/kg slow IV/IO push. Although this drug has been shown to increase the defibrillation threshold in dogs in one study, benefit was evident in others.

Although specific evidence of efficacy is not available, the use of reversal agents in dogs and cats in which reversible anesthetic/analgesic drugs were recently administered may be considered. Naloxone (0.01 mg/kg IV/IO) may be used to reverse opioids, flumazenil (0.01 mg/kg IV/IO) for benzodiazepines, and atipamezole (0.1 mg/kg IV/IO) or yohimbine (0.1 mg/kg IV/IO) for α_2 agonists.

The routine use of IV fluids in euvoletic or hypervolemic patients are not recommended during CPR, but is reasonable in patients with documented or suspected hypovolemia. In euvoletic or hypervolemic patients, fluids administered IV serve solely to increase right atrial pressure, which results in decreased perfusion of the brain and heart and should be avoided. However, in hypovolemic patients, IV fluids will help to restore adequate circulating volume, and will increase the efficacy of chest compressions and improve perfusion.

The routine use of high-dose corticosteroids during CPR in dogs and cats is not recommended. Although one retrospective study showed an association between administration of corticosteroids and increased rate of ROSC in dogs and cats, the type and dose of steroids administered were highly variable and the study design did not allow determination of a cause and effect relationship (Hofmeister et al, 2009). Other studies have shown no benefit or harm from the use of steroids during CPR. Non-CPR studies have demonstrated that single high doses of corticosteroids in dogs frequently lead to gastrointestinal ulceration and bleeding, which could also cause other ill effects such as bacterial translocation. Because the documented risks of high-dose steroids far outweigh the potential benefit shown in one study, the use of steroids is not recommended in patients with CPA.

Electrical Defibrillation

Early electrical defibrillation in patients with shockable rhythms (VF and pulseless VT) has been associated with increased ROSC and survival to discharge in numerous studies, and is superior to anti-arrhythmic medical therapy. The goal of defibrillation is to stop the ventricular myocardial cells from contracting by driving them all simultaneously into a refractory period, allowing the pacemakers

to take over and drive coordinated contractions of the heart. If the duration of the shockable rhythm is known or suspected to be of duration of 4 minutes or less, chest compressions should be continued until the defibrillator is charged and the patient should then be defibrillated immediately. If the duration of VF is known or suspected to be more than 4 minutes, one full cycle of CPR should be done before defibrillating to allow the myocardial cells to generate enough energy substrate to restore a normal membrane potential, thereby increasing the likelihood of success.

Defibrillators may be either monophasic (delivering a current in one direction across the paddles) or biphasic (delivering a current in one direction, the reversing and delivering a current in the opposite direction). The use of biphasic defibrillators is recommended over monophasic defibrillators because a lower current (and hence less myocardial injury) is required to successfully defibrillate the patient. For monophasic defibrillators, an initial dose of 4-6 J/kg should be used, while biphasic defibrillation should start at 2-4 J/kg. The second dose may be increased by 50%, but subsequent doses should not be further increased.

After defibrillation, chest compressions should be resumed immediately and a full 2-minute cycle of CPR administered before reassessing the ECG and determining if the patient is still in VF and should be defibrillated again. Brief assessment of the ECG immediately after defibrillation to determine if a perfusing rhythm has resulted is reasonable, but should minimally delay resumption of chest compressions.

Prognosis

There is limited data in the veterinary literature regarding prognosis for patients receiving CPR after cardiopulmonary arrest. Although overall survival rates have been reported to be quite low, the underlying cause of the arrest may contribute significantly. Patients that experience CPA as a consequence of severe, untreatable or progressive chronic diseases are less likely to experience good outcomes. However, peri-anesthetic CPA carries a better prognosis for survival to discharge (as high as 47% in one recent retrospective veterinary study), and aggressive, prolonged CPR attempts in these cases are reasonable. Adherence to these evidence-based CPR guidelines may help improve survival in these cases.

REFERENCES

- *Fletcher DJ, Boller M, Brainard BM, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 7: Clinical guidelines. *J Vet Emerg Crit Care (San Antonio)*. 2012;22 Suppl 1S102–31.
- Hopper K, Epstein SE, Fletcher DJ, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 3: Basic life support. *J Vet Emerg Crit Care (San Antonio)*. 2012;22 Suppl 1S26–43.
- Rozanski E a, Rush JE, Buckley GJ, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 4: Advanced life support. *J Vet Emerg Crit Care (San Antonio)*. 2012;22 Suppl 1S44–64.
- Brainard BM, Boller M, Fletcher DJ. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 5: Monitoring. *J Vet Emerg Crit Care (San Antonio)*. 2012;22 Suppl 1S65–84.
- McMichael M, Herring J, Fletcher DJ, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 2: Preparedness and prevention. *J Vet Emerg Crit Care (San Antonio)*. 2012;22 Suppl 1S13–25.

Wellbeing and burnout prevention in clinicians.

Dr Blánaid Hayes, MB, FRCPI, FFOM, MD,

Consultant Occupational Physicians, Hon. Clinical Associate Professor (RCSI),

Mental health is a growing concern in healthcare, for both veterinary and human healthcare professionals. Indeed, research suggests that veterinarians report higher levels of distress, burnout and suicidal ideation than other healthcare occupations and the general public.

Globally, healthcare worker psychological distress is a major occupational hazard and burnout is commonly reported. While its distinctiveness as a clinical entity is the subject of much debate, what is clear is that its prevalence in certain healthcare professionals is rising. It is increasingly being recognised as a product of demanding and dysfunctional workplaces rather than evidence of individual vulnerability and lack of resilience. It has an impact not only upon the individual but also on others both inside and outside of work. It is a barrier to the provision of good clinical care. The evolving literature on burnout makes a compelling case for improving the workplace and conditions of employment, rather than merely building the resilience of the individual worker.

The findings of a national survey of personal and workplace wellbeing in hospital doctors will be presented and explored, with comparison of correlating factors between specialties including anaesthesiologists. Nearly one third of hospital doctors in Ireland met the criteria for burnout.

Just as health is not merely the absence of disease, so wellbeing cannot be seen as simply the absence of burnout or distress. Contemporary approaches to worker wellbeing have moved beyond simply preventing injury or illness, and/ or employee health promotion to the concept of Total Worker Health[®] which integrates occupational safety and health protection with health promotion, to prevent worker injury and illness and to advance health and wellbeing.

In conclusion therefore, healthcare workplaces need to place as much emphasis on caring for workers as they purport to do for clients / service users. Indeed, it can be argued that caring for the carers will inevitably result in high quality patient care.

Can anaesthetic technique during cancer surgery influence risk of recurrence?

Professor Donal Buggy, MSc, MD, FRCPI, FRCA, FFSEM, FCAI, DME

Mater Misericordiae University Hospital, Dublin

This lecture will summarise the rationale for the hypothesis that anaesthetic technique during cancer surgery of curative intent might potentially influence risk of recurrence. It will trace the development of this research question from the first retrospective analysis, through experimental research to a decade-long prospective, randomised, controlled clinical trial which was published recently. It will outline future directions in this field, including the emergence of a new clinical subspecialty of Onco-Anaesthesiology.

most-care Up

The only cardiac output monitor offering beat-to-beat real time information, highlighting the slightest haemodynamic variations.

The intuitive, customisable interface and quick set up provides a rapid and comprehensive overview of patients' haemodynamic status.



Visit us
at stand

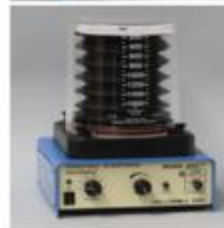
7

vygonvet

VYGON
Value Life

HALLOWELL EMC

Providing Veterinary Anesthesia and Respiratory Support
Products for the World's Creatures Since 1988



Anesthesia Workstation: Rats, Rabbits, Reptiles, Avian, Kittens
Model 2002 Pro: Interchangeable Bellows 0-1600 mL Kittens to Large Dogs, Foals
Tafonius: Large Animal Ventilator: Horses, Cows, Lions, Bears

We Also Provide:

- ✓ Accessories Including Stands, IV Poles, Baskets and more
- ✓ Heated Hard Pads for Patient Warming
- ✓ Medical Gas Fittings, Hoses, Peep Valves & Wyes
- ✓ Vacuum Scavenging Systems
- ✓ Parts, Service & Accessories



www.hallowell.com
info@hallowell.com

(413) 445-4263

ACE Veterinary Supplies Ltd



Specialist suppliers of Anaesthetic
Consumables to the Veterinary
Market.

With over 25 years experience in the anaesthesia industry,
we are committed to providing the widest range of veteri-
nary anaesthesia consumables at the best possible prices...

- Avian Tubes
- All Types of Endotracheal Tubes & Connectors
- Anaesthesia Circuits
- Airway Management
- Veterinary Laryngoscopes
- Tracheostomy Tubes
- Veterinary Warming Blankets
- Oxygen Therapy Equipment
- Monitoring Accessories
- Anaesthetic Scavenging
- Suction Equipment
- Syringe Labels
- ECG Pads
- Induction Chambers

Next day delivery on orders placed before 4:30pm.

sales@acevetsupplies.co.uk

01491 527027

www.acevetsupplies.co.uk



Expanding your range of **CHOICE**

Providing **EXPERTISE** with over
30 years experience

RELIABILITY & Exceptional
customer service

Visit Stand #5 to find out more information on our
product range including v-gel and MILA.



MILA
INTERNATIONAL, INC.
Medical Instrumentation for Animals



www.dugganvet.ie

Why things go wrong in anaesthesia

Dr Matthew McMillan

BVM&S, DipECVAA, AFHEA, MRCVS European & RCVS Specialist in Anaesthesia & Analgesia

Royal Veterinary College, London

As anaesthetists, we work in a dynamic, complex, uncertain, high-technology, accident-prone environment where many different professional groups, often with conflicting priorities, have to work together to solve non-linear, complex and constantly adapting problems.

As individuals we are fallible; our performance and actions are influenced not only by our knowledge, technical skills and experience but also by external “systems” factors, and internal factors such as affective state and non-technical skills including decision-making, situational awareness and task management. In addition, we must work and communicate as part of a team. Consequently, once a certain degree of competence and expertise has been met, overall success or failure does not just depend on an individual’s actions and decisions, but rather on the system that individual works in, the team’s performance and interactions between people.

In this lecture I will use a systems-based approach to consider different factors influencing performance and outcome in anaesthesia, and indicate what information can be gained from current research. I will primarily focus on the role of the individual and team within the system.

Background

Anaesthesia is traditionally taught as a battle for balance between pharmacodynamics and the surgical or diagnostic procedure on one side versus the disease process and physiology on the other. Based on this premise improving technology, pharmaceuticals, and individual technical skills and knowledge have been the focus for improving performance and outcome. This approach has brought us a very long way, great leaps have been made in our specialty. However, now it may fall short as it fails to consider the fallible, complex, dynamic and messy nature of our work which is performed as part of a system composed of a multitude of interacting imperfect parts.

How can we as anaesthetists keep a patient safe within the systems we work in?

The systems approach

The systems approach to patient safety considers the individual as one part of a healthcare delivery system. The patient, including their disease process, forms the epicentre of this system and is affected by the task (procedure) being performed, as well as the decisions and actions of individual clinicians performing the task and interacting with any technology required to perform the task. However, in modern healthcare individual clinicians also work as part of a team, and therefore team performance and cohesion affect the functioning of the entire system and adds further complexity. Additionally, the team works and performs a task in a given environment, such as the operating theatre, which forms part of a larger organisation delivering the health care; both local environment and organisation significantly influence the team and therefore the individual, task and the patient.

The use of a systems-based approach to incident analysis is therefore thought to more effectively permit identification of factors contributing to patient outcome throughout all levels of a system

without simply apportioning blame to individuals at the frontline. Identification of such contributing factors could help us learn from mistakes and allow changes to be designed at a system level to prevent similar incidents occurring in the future.

Each levels within a system is discussed further in subsequent sections.

Background literature from human medicine: How realistic is this systems-based approach?

Data in the tables below demonstrates some contributing factors thought to be involved in fatalities, safety incidents and diagnostic error in human anaesthesia. Although a lack of knowledge was found to be important in a number of cases, it was not the frequent factor identified. These studies were performed before the organised systems approach was widely used to analyse incident report data but demonstrate the potential for factors outside of knowledge and technical skills being involved.

Factor	Relative frequency
Failure to apply knowledge	75%
Lack of due care	30%
Failure of organisation	25%
Lack of experience	24%
Lack of knowledge	15%
Drug effect	10%
Equipment failure	1.7%

Table 1. Factors contributing to anaesthetic deaths, Buck et al 1987 (National Confidential Enquiry into Peri-Operative Deaths)

Factor	Relative frequency
Error of judgement	16%
Failure to check equipment	13%
Fault of technique	13%
Inattention	12%
Haste	12%
Inexperience	12%
Communication failure	9%
Failure of equipment	9%
Inadequate pre-anaesthetic assessment	7%
Monitor failure	6%
Inadequate pre-anaesthetic preparation	4%
Unfamiliarity with environment/equipment	4%
Lack of skilled assistance or supervision	3%
Fatigue	3%
Drug labelling error	3%
Inadequate facilities	2%

Table 2. Factors contributing to safety incidents, Williamson et al, 1993 (Australian Incident Monitoring System)

When one widens the search in the human medicine literature, the overall finding that dominates is that not only individual factors but system factors contribute to incidents.

Factor	Relative frequency
System-related factors and individual cognitive factors	46%
Individual cognitive factors only	28%
System-related factors only	19%
No factors identified	7%

Table 3. The categories of factors contributing to diagnostic error in 100 internal medicine patients, Graber, 2005.

Currently, a systems-based approach to improve standard of care is recommended in the **Guidelines for Safety and Quality in Anaesthesia Practice in the European Union: Section and Board of Anaesthesiology, European Union of Medical Specialists.**

ORGANISATIONAL FACTORS

The organisation supplies the framework of the system in which healthcare is delivered by providing and managing the equipment, facilities, and individuals who make up the hospital staff, furthering their training and education and influencing the physical and social environment. In addition, the organisation establishes workflow models through scheduling and setting expectations, influencing what happens in the operating theatre by imposing external pressures and distractions on individuals and teams.

In our study using a systems-based analysis of 174 anaesthetic safety incidents, organisational factors were identified as potentially contributing to conditions in 54% of cases (McMillan & Lehnus 2018). Within these cases, 143 organisational contributing factors were identified, with the most common being staffing level (37%), poor scheduling (22.4%) and culture and priorities (19.6%).

More recently, we analysed 30 morbidity and mortality reports using a systems-based approach and modified critical incident technique (data not yet published). Organisational factors were identified in 26 (87%) of reports.

These results suggest the organisation has considerable potential to influence our both our performance and outcome for the patient.

ENVIRONMENTAL FACTORS

The operating theatre is perhaps the most dynamic, complex, highly technical and time pressured environment in healthcare. Both the physical conditions, including ambient temperature, noise levels, layout and design, and social atmosphere can influence system performance.

For example, one commonly discussed subject is the optimal operating room ambient temperature. If temperatures are too cold, the animal risks significant hypothermia and those not wearing surgical gowns may become distracted from their tasks through discomfort. If the temperature is too warm the surgeon may become uncomfortably hot and unable function properly.

Social atmosphere may appear trivial in a professional workplace but “joy” in work, heavily influenced by social atmosphere, is considered an important factor in clinician Burn-out. Burn-out in clinicians, defined by emotional exhaustion, depersonalisation and a lack of sense of personal accomplishment is a considerable influence on performance and is associated with negative patient outcomes (Hall et al. 2016).

One of the biggest factors contributing to errors in the operating theatre are distractions, be that through equipment alarms and electronic beeps, other team members, telephone calls, pages, clinical queries from colleagues and personal electronic devices. Distractions have been demonstrated to affect a clinician's ability to perform a task effectively in an allotted time, if distractions occur in a critical period (induction of anaesthesia or an important part of the surgery) this may lead to patient harm.

In our investigations, environmental factors were identified in 7.9% of safety incidents and 53% of M&M reports, with distractions playing the biggest role in both.

TEAM FACTORS

Operating theatre teams are considered "action teams" as they function under dynamic, complex, uncertain and time-pressured conditions over which they only have partial control. They also function as multi-team systems made up of smaller sub-teams, each with their own tasks performed independently while striving towards a common goal. A major benefit of a multi-team system is the diversity of expertise provided by the team when approaching a complex problem. In this context, inter-team performance is thought to be more important than intra-team performance (how anaesthetists interact with surgeons is more important than how they interact amongst themselves).

Teamwork involves interpersonal relations, socialisation, motivational tendencies, values, beliefs, and perceptions all of which affect team cohesion, psychological safety and efficacy. Significant influence comes from **leader behaviour** (inclusiveness, encouraging input from others), **mutual trust** and a **supportive culture**. Team members who feel included, safe and trusted are more likely to engage in behaviours that improve team function (requesting help when needed, communicating information and seeking feedback). **Team cognition**, the manner in which members acquire, store, distribute and retrieve knowledge critical for effective performance, is vital for team performance as it permits team members to anticipate and execute actions as a coherent unit rather than as individuals

Example: Leadership

A highly skilled and knowledgeable clinician gets stressed during a crisis. Although their personal performance was effective, they made correct decisions and took correct actions, their behaviour (micromanaging, unwillingness to delegate tasks, communication skills) means other team members did not function as well as they could (reduced communication, had less confidence performing tasks, did not speak up).

There are a number of factors that influence effective teamwork in the operating theatre: we can all think of clinicians who are skilled individuals but fail to work well in a team. Perceptions of team strength, priorities and values can vary between surgeons, anaesthetists, and nurses, and be counterproductive for effective communication. The often-ad hoc composition of teams introduces further obstacles to effective teamwork.

One of the factors hindering effective teamwork in the operating theatre is **tribalism**. In this context, the term "tribe" is used to describe each of the different professions working together, including surgeon, anaesthetist, nurse. Tribes are defined by their differences and often carry stereotypical labels. They may be associated with derogatory perceptions in the eyes of other tribes, bringing into question whether the other "tribe's" motivation is in the best interest of the patient (Cooper, 2019).

Anaesthetists derogatory perceptions of surgeons	Surgeons derogatory perceptions of anaesthetists
• Egotistical and single minded • Goal orientated: care more about procedure than patient • Often not being forthcoming to patients and families about the likelihood of success and magnitude of difficulty in recovery after surgery • Failure to understand/recognise: ○ How long they take to do things ○ Degree of post-operative pain ○ Non-surgical aspects of healthcare ○ Adverse effects their actions may have on the patient (degree of blood loss, trauma to the patient, interference with homeostasis etc) ○ adequately considering a patient's other health conditions • Discourage speaking up by others about safety concerns • They view themselves as in charge and patients as their property	• Obstructive ○ Cause delays ○ Order unnecessary tests ○ More concerned with finishing day on time than getting through an operating list ○ Unreasonable eagerness to cancel a procedure based on unjustified concerns ○ Unwillingness to change anaesthetic technique to aid surgical technical considerations • Over-estimate post-operative pain • Failure to understand: ○ how long they take doing things ○ surgical techniques ○ need to maintain schedule ○ owner–surgeon relationship • Failure to communicate important changes in vital signs to the entire team • Always believe they advocate for the patient despite having spent little time with it and not having spoken to the owner • Fail to get consent for any of the procedures they perform

Table 4. Some negative tribal perceptions held by anaesthetists and surgeons (based upon work by Cooper and on personal communication between myself, surgeons and other anaesthetists)

The truth is anaesthetists and surgeons have different roles, values and motivations for what they consider to be the patient's best interest, often learnt based on previous success their "tribe" has had. However, the urge for tribalism to prevail must be set aside as the ever more complex systems we work in give rise to an increasing requirement for effective teamwork in order to provide high standard patient care.

Communication is vitally important for effective teamwork and is perhaps the main area where problems occur. Effective, efficient communication consists of a clear, concise, understandable and audible message from a transmitter which is delivered to an attentive, undistracted receiver. To ensure the message has been received and understood feedback is also an important factor. Reasons for ineffective transmission include natural reluctance to interrupt, fear of embarrassment or outright retribution, beliefs about not being listened to, concern about being misjudged, or simply not knowing what to say or how to say it (particularly important when complex problems are being communicated). The main reason for ineffective receiving is distraction leading to altered attention.

From our investigations, team factors were identified as potentially contributing to 62.1% of safety incidents and 83% of M&Ms. Failure to provide adequate supervision and communication issues were found to be the most common contributing factors in both.

INDIVIDUAL FACTORS

Importantly, the systems approach does not absolve the individual from all responsibility or accountability: it does not shift blame higher up the system to the team, environment or organisation, or down to the task, technology or patient. Rather, each part of the system has responsibilities to contribute to achieving effective and efficient healthcare without causing unnecessarily harm. Thus, the systems approach signifies a shift in perspective, not accountability.

Individuals must recognise their role within the system, as well as effects they and other system components have on their decisions and actions. Importantly, it is often an individual's actions and decisions that identify an incident, solve problems and intervene thus mitigating effects on a patient. The individual therefore has huge potential for improving safety through problem solving, determination, innovation, imagination, communication and teamwork, and therefore these factors represent individual responsibilities.

Decision-Making

As scientists we are trained to problem solve by identifying certainty, predictability and linear causality (cause-effect). For anaesthetists this approach will often work, and causation may be obvious: an animal is pale, tachycardic and hypotensive and the suction bottle is full of blood and therefore has haemorrhagic hypovolaemia which can be treated by blood transfusion.

A "this + this = this" reductionist approach can serve us well, but there are situations when things are more complex and causation is unclear. Instead of considering the body a linear cause and effect model based on general rules we have constructed to explain its function and reactions to insults, it may be more representative to consider normal homeostasis as a complex system with great biological variability that relies on multiple interacting physiological networks (in series, in parallel, additive, synergistic or antagonistic). Adding to this complex system the variable effects and side effects of anaesthetic and analgesic agents, and the presence of multiple insults simultaneously, the degree of uncertainty is understandably huge.

In addition to the inherent uncertainty when dealing with biological systems, the individual clinician must deal with poorly defined limits and process a multitude of data from often incomplete measurements obtained from fallible technological devices that demand attention in a time critical situation. The volume of such data is expanding exponentially as the profession moves from using human senses to relying on complex electronics generating dynamic numbers and waveforms.

Studies suggest the human mind can deal with 4-5 variables simultaneously and the addition of further variables generates confusion, dissociating information and making it harder to interpret. In an attempt to deal with such "information overload", the brain groups data such as physiological and patient characteristics into clusters through logic and principles anchored in an individual's experience and knowledge. We therefore simplify what we observe and fit it into a pattern and synthesise a story for our data. As our ability to generate information has outstripped our ability to interpret it effectively, it is not surprising that individuals may make incorrect decisions.

Once the data from monitoring devices has been integrated and a first decision made, further decisions about whether or not, or indeed how, to intervene are required. Such decisions may depend on further factors such as familiarity, treatment availability, side effects, cost etc. In many situations we make the best guess based on knowledge and experience and provide symptomatic treatment, failing to treat the underlying cause. In all likelihood we get away with such application of

a linear solution to a non-linear problem because the resilience of physiology comes to our aide. When it cannot, the wrong decision may harm the patient.

The decision-making process

Simplistically, decision-making can fall into two main types. **Type 1 intuitive** decision-making and **type 2 analytical** decision-making (in psychology termed dual process reasoning).

Intuitive decision-making relies on **pattern recognition** over logic and statistics. It is fast, efficient and depends on direct use of knowledge and experience. This is commonly used in time pressurised situations where risks and cues may be unquantifiable and uncertain in the face of high stakes. Such situations are common in anaesthesia. In the right circumstances and in a well-trained, experienced individual such reasoning can yield accurate and fast decisions, but it is easily influenced by biases and mental short cuts (heuristics) and is thus prone to significant error.

Analytical decision-making relies on quantifiable data and cues, using logic and statistics to come to a conclusion. It is more time-consuming than intuitive thinking, and therefore can be problematic to apply in the high-risk anaesthesia environment. Despite being more rational, analytical thinking is still vulnerable to bias and error: a theoretical linear model or dogma followed for complex problem solving may not be entirely accurate for a given situation, it is one we choose to make, and if information is incomplete or of questionable reliability, we are required to make assumptions and use pattern recognition to fill in gaps.

Anaesthetists are likely to spend most of the time employing intuitive decision-making and then use analytical thinking when it is required. Indeed, the more complex decisions require several steps which may require both modes of thinking.

Cognitive influences: Heuristics and bias

There are a large number of biases and heuristics that influence decisions and may play an important role in contributing to errors and safety incidents. Work by Crosskerry (in emergency medicine) and Stiegler (in anaesthesia) has defined several cognitive biases and heuristics commonly affecting medical decision-making. It should be noted that these heuristics and bias are not cleanly defined but often overlap. In addition, multiple heuristics and biases are often present in a single decision.

Bias or heuristic	Definition	Example
Affect	The tendency for decisions to be influenced by emotion such as anger or regret	A supervising anaesthetist is angry about how the monitoring and anaesthetic machine has been left when they help move an animal into the operating theatre, deciding to divert attention from the animal to the monitoring
Anchoring	Focus is fixated on a single aspect of the case at the expense of understanding the whole situation e.g. considering alternative information and explanations	An anaesthetist is pre-occupied with ventilation parameters and does not notice a cardiovascular crisis

Bias or heuristic	Definition	Example
Authority	The tendency to attribute greater accuracy to the opinion of an authority figure whatever the content	A resident takes the advice of a senior despite that senior not having the full case details and it going against their judgement
Availability	Decisions are made based on the resemblance of the situation to another memorable experience in the false belief that because they are memorable, they occur more frequently	An anaesthetist considers bradycardia in a greyhound to be secondary to a vago-vagal reflex due to sudden postural change which they have experienced before and initially misses hyperkalaemia
Bias blind	The belief an individual may have that they are less susceptible to bias than others	Appears most commonly in highly intelligent, educated and experienced individuals who do not believe they are fallible to bias
Commission	The obligation towards beneficence. The tendency towards action rather than inaction	Before performing an anaesthetic on a healthy young animal for an elective procedure the anaesthetist orders a full blood panel "just in case" despite the dog have no clinical or historical signs of any problem
Confirmation	The tendency to look for evidence that supports a decision and overlook evidence which refutes it, even if the latter is more persuasive	Repeatedly cycling of an arterial pressure cuff, changing cuff sizes, and locations, because the low reading was not believed
Diagnostic momentum	Once an assumptive diagnosis has been made it gathers momentum and becomes definitive even if it is incorrect	An elderly large and overweight dog is presented collapsed and unresponsive. A neurologist diagnoses a forebrain lesion and asks for an MRI. The anaesthetist puts the dull heart sounds down to it being fat. In fact, the dog has a pericardial effusion and the neurological signs are secondary to poor perfusion
Familiarity	Decisions are based on the familiarity of that decision to the individual	An anaesthetist chooses a treatment with lower efficacy that has been shown to lead to poorer outcomes because they are used to using it compared to the alternative

Bias or heuristic	Definition	Example
Feedback	If significant time elapses between an action and consequence and there is a lack of outcome reporting, the absence of feedback is seen as positive feedback	An anaesthetist believes they have never had a case of prolonged locoregional anaesthesia because nothing has been fed back to them. They do occur but are not reported because they are self-limiting
Framing effect	The way the problem is framed as either positive or negative profoundly influences decisions	An animal presented as being aggressive, after surgery its behaviour is attributed its "aggression" whereas it is in fact painful
Hindsight	Knowing the outcome effects the perception of past events	Common when reviewing cases especially if a complication occurred: "you should have done x", "that was always going to happen"
Need for closure	The tendency to draw a conclusion when the result is not definite because of external or internal pressure	During investigation of an anaesthetic fatality a conclusion is drawn and recommendations made to demonstrate actions have been taken, even though the contributing factors had not been properly considered and other issues may have been more significantly involved
Omission	The obligation towards non-maleficence. The tendency towards inaction rather than action	A bolus of fluids is not administered to a cat with HCM through concerns over fluid overload even though there is a high indication of hypovolaemia
Outcome	The tendency to view decisions as correct or incorrect based on the overall outcome, even when the outcome was not associated with the decision	An anaesthetist doesn't prepare for a difficult airway in brachycephalic dogs because they have always managed well in the past without a problem
Overconfidence	The tendency to believe we know more than we actually do. May lead to decisions being made on incomplete data, opinion and intuition	A failure of an anaesthetist to ask for help when they were struggling to manage a situation because they felt "they would work it out eventually"
Premature closure	The tendency to accept a diagnosis or conclusion before it has been verified	An anaesthetist puts a decrease in oscillometric blood pressure down to "machine error" rather than checking

Bias or heuristic	Definition	Example
Reactance	The tendency to do something against the rules or to do the opposite of what is suggested by another	A surgeon suggests an anaesthetic technique to the anaesthetist because they have seen it successfully used elsewhere. The anaesthetist chooses a different technique without considering the benefits of the surgeon's suggestions
Representativeness	The tendency to make a decision based upon a situations resemblance to pre-existing or "classical" models or dogma even if the situation is different. Often it is a classic presentation rare condition diagnosed when in fact it is a rare presentation of a common condition	A large breed overweight dog is anaesthetised and after it is positioned in theatre starts to become hyperthermic, hypertensive and tachycardic under anaesthesia at 1.3 MAC ET'isoflurane. The dog then develops muscle fasciculations. Malignant hyperthermia is diagnosed. In fact, the hyperthermia was mild 39.2C and the dog was light due to pain from osteoarthritis. PET'CO2 had not increased at a stable minute volume
Search satisficing	The tendency to call off investigations once something has been found	A trauma case is presented for orthopaedic surgery because of severe fractures. A bladder rupture was present but not identified as the search for additional injuries was not continued
Self-serving	The tendency to claim more responsibility for successes than failures	When an animal survives a crisis, it is put down to the skill of the anaesthetist, if it had died it would have been "one of those things"
Semmelweis (Cognitive dissonance)	The tendency to reject new evidence or knowledge because it contradicts established norms, beliefs, paradigms and dogma	An anaesthetist continues to use an old technique despite another being available which has evidence that it is safer when a problem is identified it is put down to one of those things

Bias or heuristic	Definition	Example
Sunk cost	The tendency that the more is invested in a course of action the less likely it is for that course of action to be questioned and alternatives be considered	An animal has significant haemorrhage from a ruptured abdominal mass, it receives multiple transfusions to stabilise it but continues to bleed. Rather than take it into theatre stabilisation is continued until it develops coagulopathy. The mass was resected but the animal continued to bleed and died after surgery
Unpacking principle	Failure to elicit all relevant information in establishing a differential diagnosis list leads to significant possibilities being missed	An anaesthetist sees the potassium in a cat with urethral obstruction is normal but does not go on to check the acid:base status. Once anaesthetised and no longer able to respiratory compensate the cat's pH lowers and it becomes hyperkalaemic. The subtle initial signs are missed because the actual status of the cat had not been properly assessed
Visceral	The tendency for negative or positive feelings about a patient influencing our decisions	An anaesthetist does not consider the reasonable concerns of a colleague because they are pessimist and panic easily
Zebra retreat	The tendency to hesitate to pursue a diagnosis because the condition is rare despite it being a strong possibility	An anaesthetist finds other reasons for increasing hypercarbia and does not consider malignant hyperthermia

Table 5. Cognitive biases and heuristics and their definitions based on work by Crosskerry and Stiegler.

Situational awareness

The success of either mode of decision-making depends significantly on situational awareness. Situational awareness is a non-technical skill that requires the appropriate gathering of information based upon what is understood to be happening at that particular point in time (perception). It also includes understanding what the information means (comprehension) and being able to anticipate what might happen next (projection). In anaesthesia situational awareness is a dynamic vigilance and awareness of the situation based on all the elements which influence the system: the patient, the monitoring and equipment (including alarms and displays), the procedure, colleagues and the team, time, and understanding what they mean as a whole and thinking about what may happen in the future.

Situational awareness can be thought of being affected by ten different dimensions:

1. Familiarity of the situation
2. Focussing of attention
3. Information quantity
4. Information quality
5. Concentration of attention
6. Complexity of the situation
7. Variability of the situation
8. Instability of the situation
9. Arousal
10. Spare mental capacity

Errors in situational awareness can occur in each of the perception, comprehension and projection phases. Anaesthetists may not collect and consider all of the available data, they may have the available data and not understand and process it properly or they may have all the data, understand the current situation but inaccurately or incompletely predict the future consequences of the situation.

Investigation of 200 safety incidents in human anaesthesia identified situational awareness error in 81.5 % [Schultz et al. 2016]. Errors occurred on the levels of perception (38.0 %) and comprehension (31.5 %) and projection (12.0 %).

Evidence in Veterinary Anaesthesia

Investigation of decision-making in our investigation of 30 M&M reports identified 111 **cognitive biases** falling into 18 bias categories [using the work of Steigler et al, and Crosskerry as reference].

- Anchoring (18)
- Overconfidence (14)
- Authority (11)
- Unpacking principle (10)
- Diagnostic momentum (10)
- Framing (5)
- Sunk cost (5)
- Visceral (5)
- Premature closure (4)
- Commission (4)
- Confirmation (4)
- Availability (3)
- Feedback (3)
- Omission (3)

During M&M conference discussion of these cases amongst colleagues (other trainees and specialist anaesthetists), 32 biases were identified amongst those analysing the case in question, including: Hindsight bias, outcome bias, search satisficing and overconfidence

Interestingly, issues with situational awareness occurred in 22 (73%) of the 30 M&Ms analysed and in 21 (84%) of the 25 M&M where an issue with decision making was identified. In our previous study. This highlights the link between situational awareness and decision making.

It is important to recognise that both issues with knowledge and experience were also noted. However, in the systems-based approach the organisation and team as well as the individual are responsible for recognising deficits and therefore should provide appropriate supervision, training and education as well as encouraging the individual to feel free to ask for help.

On a more positive note negative outcome was believed to have been limited by anaesthetist intervention in 63.8% safety incidents. Factors such as problem solving, innovation, communication, teamwork and planning and preparation were all felt to have mitigated the degree of morbidity in our investigation of M&Ms.

TASK & TECHNOLOGY FACTORS

The tasks we are performing in veterinary anaesthesia becoming more complex and the technology we utilise is improving rapidly. With this will come greater potential for things to go wrong and for new unforeseen complications to occur. With new techniques and technology come new policies and protocols to be followed and checks that need to be performed. As these become more numerous and complicated the potential for a step in the process to be neglected increases. In addition, in order to perform these tasks, we put our faith in technology but it too can fail or give false readings or having a low signal to noise ratio. Recognising the potential for these issues remains important in maintaining safety within the system.

Task and technology factors were found in 46% of safety incidents and 70% of M&Ms.

ANIMAL & OWNER FACTORS

As our ability to treat conditions increases so does the complexity of the animals we have to deal with as patients. Animals are living longer and developing with more and more co-morbidities and animals with conditions which were once incurable or unmanageable are now being treated successfully. In addition, owner's expectations of what is possible to achieve and the amount of money which is available to be spent on treating their animal also has a role to play in the system.

Although animal and owner factors were only identified in 20.7% of safety incidents they were identified as a risk factor for developing Major and Catastrophic incidents. To highlight this, they were identified in 90% of investigated M&Ms.

CONCLUSION

In conclusion, things go wrong in anaesthesia for a multitude of reasons that are not limited to the animal and its condition, the procedure and anaesthetic being performed, the technology and equipment being used and an individual's knowledge and skills.

Recently an excellent anaesthetist was defined beyond their knowledge as having the following attributes (Larsson et al. 2013):

- Is structured, responsible and has a focussed way of approaching tasks
- Communicates clearly and informatively
- Is humble to the complexity of anaesthesia and its inherent uncertainty
- Admits their own fallibility
- Is patient-centred
- Is fluent in practical work without losing overview
- Is calm and clear in critical situations, being able to change to a strong leadership when necessary
- Is socially competent

So potentially part of being an excellent anaesthetist is understanding where we fit into the system and the factors that influence our decisions and actions beyond our knowledge and experience. Achieving this may help us improve outcomes for our patients and help us move forward as a specialty.

REFERENCES

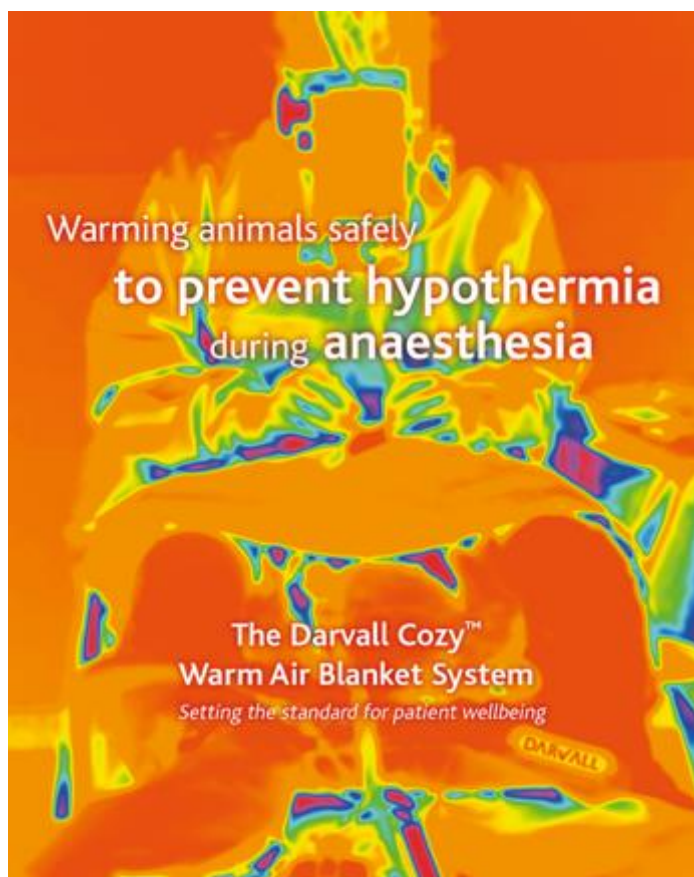
- Buck et al. (1987) *The report of a Confidential Enquiry into Perioperative Deaths*. London Nuffield Provincial Hospitals/Kings Fund Publishing Office
- Cooper (2018) *Critical role of the surgeon-anesthesiologist relationship for patient safety*. *Anesthesiol* 129(3):402-405
- Crosskerry (2003) *The importance of cognitive errors in diagnosis and strategies to minimize them*. *Acad Med* 78(8):775-780
- Crosskerry (2013) *From mindless to mindful practice – Cognitive bias and clinical decision making*. *N Engl J Med* 368(26): 2445-2448
- Dekker & Leveson (2015) *The systems approach to medicine: controversy and misconceptions*. *BMJ Qual Saf* 24:7-9
- Flin et al (2010) *Anaesthetists non-technical skills*. *Brit J Anaesth* 105(1):38-44
- Graber et al (2005) *Diagnostic error in internal medicine*. *Arch Int Med* 165(13): 1493-1499
- Hall et al (2016) *Healthcare staff wellbeing, burnout and patient safety: a systematic review*. *PLOS One* 11(7): e0159015
- Larsson & Holmstrom (2013) *How excellent anaesthetists perform in the operating theatre: a qualitative study on non-technical skills*. *Brit J Anaesth* 110(1):115-121
- Leveson et al (2016) *A systems approach to analyzing and preventing hospital adverse events*. *J Patient Saf* 00:00-00
- McMillan & Lehnus (2018) *Systems analysis of voluntary reported anaesthetic safety incidents occurring in a university teaching hospital*. *Vet Anaesth Analg* 45: 3-12
- Peden et al (2017) *Quality, safety and outcomes in anaesthesia: what's to be done? An international perspective*. *Brit J Anaesth* 119(S1):i5-i14
- Rosenman et al (2018) *Changing systems through effective teams: a role for simulation*. *Acad Emerg Med* 25: 128-143
- Saposnik et al. (2016) *Cognitive biases associated with medical decisions: a systematic review*. *BMC Medical Informatics & Decision Making* 16:138
- Schultz et al. (2013) *Situation awareness in anesthesia: concept and research*. *Anesthesiol* 118(3): 729-742
- Schultz et al. (2016) *Situation awareness errors in anesthesia and critical care in 200 cases of a critical incident reporting system*. *BMC Anesthesiology* 16(4)
- Smith et al. (2011) *Defining excellence in anaesthesia: the role of personal qualities and practice environment*. *Brit J Anaesth* 106(1) 38-43

Stiegler et al. (2012) *Cognitive errors detected in anaesthesiology: a literature review and pilot study.* *Brit J Anaesth* 108(2): 229-235

Stiegler & Tung (2014) *Cognitive processes in anesthesiology decision making.* *Anesthesiol* 120(1): 204-217

Weller & Boyd (2014) *Making a difference through improving teamwork in the operating room: a systematic review of the evidence on what works.* *Current Anesthesiology Reports* 4(2):77-83

Williamson (1993) *Human failure: an analysis of 2000 incident reports.* *Anaesth Intens Care* 21(5): 678-683



Darvall Veterinary Customer Support
www.darvallvet.com
www.aasmedical.com

AAS
ADVANCED
ANESTHESIA
SPECIALISTS
DARVALL



Carus Animal Health
are pleased to support the
AVA Spring meeting Dublin 2020

Contact us: info@carusanimalhealth.com

Website: www.carusanimalhealth.com/

<https://www.facebook.com/pages/Carus-Animal-Health-Ltd/>

https://twitter.com/carus_ah

Reducing our carbon footprint

Dr JMT Pierce

Environmental Advisor Royal College of Anaesthetists, London

Cardiac Anaesthetist at University Hospital Southampton

The impending environmental consequences of the continued rise in atmospheric CO₂ and other greenhouse gases (GHG) is impetus enough for all of us to address seriously the carbon footprint of both our personal and professional lives.

The Greenhouse Gas Protocol ascribes emissions into one of three Scopes. Scope 1 results from the CO₂ generated from combusting fuel to heat premises, propel practice owned vehicles and the use of anaesthetic gases. Scope 2 relates to the consumption of purchased electricity generated off the practice site but used on the site and Scope 3 are all indirect emissions generated within the value chain of the physical structure of the practice and the clinical veterinary practice that do not fit into Scopes 1 and 2 such as drug and equipment procurement and waste management.

The presentation will cover the science of GHGs as well as the terms in use to describe the atmospheric effects and the way in which individual anaesthetists can measure the impact of their inhalational agent use by the use of a freely available smart phone app.

However, unlike human anaesthetic practice, the use of inhaled agents with significant GHG effects (desflurane and nitrous oxide) is unusual. As such the low hanging fruit have already been gathered. Within veterinary practice therefore the relative impact of building energy use and staff transport is greater than in human practice.

In order to quantify this impact and to allow international comparisons, I have produced an interactive Excel® sheet that calculates the CO₂equivalence (CO₂e) of a veterinary procedure according to its duration and this will be made available to all delegates. It is hoped that this will allow the identification of “carbon hotspots” in practice and encourage efforts to reduce one’s veterinary carbon footprint.

Abstracts

114.01

Assessing the efficacy of a laryngeal mask airway in anesthetized free-ranging bighorn sheep (*Ovis canadensis*) lambs

Hee O¹, Windeyer MC², Ruckstuhl K³, Neuhaus P³, Caulkett N¹

¹Department of Veterinary Clinical and Diagnostic Sciences, University of Calgary Faculty of Veterinary Medicine, Calgary, AB, Canada

²Department of Production Animal Health, University of Calgary Faculty of Veterinary Medicine, Calgary, AB, Canada

³Department of Biological Sciences, University of Calgary, Calgary, AB, Canada

Chemical immobilization of wildlife often induces hypoxemia and respiratory depression (Fahlman 2014). Laryngeal mask airways (LMA) have shown promise as an efficient method of airway protection during anesthesia (Engbers *et al.* 2017, Armstrong *et al.* 2018).

Nineteen free-ranging bighorn sheep (*Ovis canadensis*) lambs were immobilized using an intramuscular combination of medetomidine ($0.14 \pm 0.021 \text{ mg kg}^{-1}$), azaperone ($0.19 \pm 0.028 \text{ mg kg}^{-1}$), and alfaxalone ($0.47 \pm 0.070 \text{ mg kg}^{-1}$) via remote injection. Upon recumbency, arterial blood gas parameters, minute ventilation (V_E), tidal volume, and respiratory rate were measured without a LMA via face mask, then repeated post-LMA placement. V_E and tidal volume were measured using a spirometer. Medetomidine was reversed with intramuscular atipamezole at five times the medetomidine dose upon completion of procedures. Pre- and post-LMA measurements were compared using a t-test or a Wilcoxon signed-rank test based on normality of the data.

The LMA provided a patent airway in all lambs with a significant ($p < 0.05$) increase in V_E (baseline $V_E = 540 \pm 74.9 \text{ mL kg}^{-1} \text{ minute}^{-1}$, post-LMA $V_E = 619 \pm 82.9 \text{ mL kg}^{-1} \text{ minute}^{-1}$) but did not significantly improve PaO_2 (baseline $\text{PaO}_2 = 45.2 \pm 8.36 \text{ mmHg}$, post-LMA $\text{PaO}_2 = 47.5 \pm 8.70 \text{ mmHg}$) or PaCO_2 (baseline $\text{PaCO}_2 = 49.4 \pm 4.41 \text{ mmHg}$, post-LMA $\text{PaCO}_2 = 51.9 \pm 4.95 \text{ mmHg}$).

We conclude that this device is a viable option for airway protection in free-ranging bighorn sheep. Further studies are required to assess the utility of this device in other wildlife species under field conditions.

References:

- Armstrong, L., Caulkett, N., Boysen, S., *et al.* (2018) Assessing the efficacy of ventilation of anesthetized neonatal calves using a laryngeal mask airway or mask resuscitator. *Front. Vet. Sci.* 5:292.
- Engbers, S., Larkin, A., Rousset, N., *et al.* (2017). Comparison of a supraglottic airway device (v-gel[®]) with blind orotracheal intubation in rabbits. *Front. Vet. Sci.* 4:49.
- Fahlman, Å. (2014) Oxygen Therapy. In: West, G., Heard, D., & Caulkett, N. (eds.). *Zoo animal and wildlife immobilization and anesthesia*. 2nd ed. Ames (IA): John Wiley & Sons, Inc. p. 69-81.

114.02

Immobilization of captive red kangaroo (*Macropus rufus*) with medetomidine-ketamine-midazolam or medetomidine-ketamine-butorphanol

Shilo-Benjamini Y¹, Dray AG¹, Kafri A² and Lapid R³

¹ Koret School of Veterinary Medicine, The Hebrew University of Jerusalem

² Gan-Garoo, Nir-David

³ Hai-Park, Kiryat-Motzkin

Objectives of this clinical study were to compare immobilization and recovery with medetomidine-ketamine-midazolam (MKM) versus medetomidine-ketamine-butorphanol (MKB) in captive red kangaroo (*Macropus rufus*).

Twenty kangaroos were randomly administered medetomidine ($65 \pm 4 \mu\text{g kg}^{-1}$), ketamine ($2.2 \pm 0.4 \text{ mg kg}^{-1}$) and midazolam ($0.12 \pm 0.04 \text{ mg kg}^{-1}$) ($n = 10$) or medetomidine ($70 \pm 15 \mu\text{g kg}^{-1}$), ketamine ($2.3 \pm 0.5 \text{ mg kg}^{-1}$) and butorphanol ($0.23 \pm 0.05 \text{ mg kg}^{-1}$) ($n = 10$) IM. Induction, immobilization, and recovery times were recorded. Vital signs, blood pressure and SpO₂ were monitored every five minutes. Quality of induction, immobilization, and recovery were scored (scale 1-5; 1 = poor, 5 = excellent). A masked observer performed all measurements. For recovery, atipamezole was administered IM to both groups, and flumazenil (MKM) and naltrexone (MKB) were administered IV. Mann-Whitney U-test was used for analysis, with p -value < 0.05 .

Mean induction time was significantly shorter in MKB ($7:26 \pm 4:22$) versus MKM ($11:54 \pm 4:50$ minutes). Median induction quality in both groups was 5 (2-5). Median immobilization quality was 5 (3-5) in MKM and 4 (3-5) in MKB. Mean SpO₂ was significantly higher in MKM ($92 \pm 4\%$) versus MKB ($84 \pm 10\%$). Following antagonist's administration, recovery time and quality were $17:40 \pm 08:33$ minutes and 4 (3-5) in MKM, and $14:28 \pm 05:27$ minutes and 5 (2-5) in MKB.

Both protocols provided smooth induction and good immobilization and recovery. The MKB is recommended for short induction, however, MKM should be considered if oxygen is not available.

114.03

The relationship between food deprivation and blood glucose at induction of anaesthesia in juvenile pigs

Rachael Gregson¹, Stephen Greenhalgh¹, Eddie Clutton¹

¹Wellcome Trust Critical Care Laboratory for Large Animals, University of Edinburgh, Roslin, Midlothian, UK

Restricting food for 4 – 48 hours is recommended before general anaesthesia in pigs (Bradbury and Clutton, 2016). However, prolonged deprivation is stressful and may have adverse physiological effects including hypoglycaemia.

In this retrospective observational study, 28 juvenile [age 8 (5 – 11) weeks] female Landrace-cross pigs [18.5 (10 – 34) kg] were anaesthetised for an unrelated, experimental study. Time from food withdrawal until anaesthesia induction was recorded. Blood glucose (BG) was measured (AlphaTRAK, Zoetis) at induction of anaesthesia (isoflurane in oxygen), 10 minutes after pre-anaesthetic medication with intramuscular morphine (0.3 mg kg⁻¹), medetomidine (7 µg kg⁻¹), midazolam (0.3 mg kg⁻¹) and alfaxalone (2 mg kg⁻¹).

Hypoglycaemia [BG < 4.7 mmol L⁻¹ (Constable, 2017)] at induction was recorded in 1/16 (6%) pigs with food withhold < 4 hours, 3/8 (38%) pigs with food withhold 4-8 hours, and 4/4 (100%) pigs with food withhold > 8 hours (Fisher's Exact Test, two-sided, test statistic 12.9, $p < 0.001$). Median food withhold was 3.4 (0 – 19) hours. There was a strong correlation between duration of food withhold and BG at induction (Pearson, $r = -0.73$, 95% CI -0.87 – -0.49, $p < 0.0001$). Other than hypoglycaemia, no adverse events (vomiting, regurgitation, oral debris at tracheal intubation) were observed.

Duration of food deprivation is strongly correlated with BG at induction in female, juvenile pigs anaesthetised as described. Withholding food > 4 hours may lead to an unacceptably high incidence of hypoglycaemia at induction. Food withhold < 4 hours does not appear to be associated with additional adverse effects.

References

Bradbury AG, Clutton RE (2016) Review of Practices Reported for Preoperative Food and Water Restriction of Laboratory Pigs (*Sus scrota*). *Journal of the American Association for Laboratory Animal Science* 55, 35-40.

Constable P, Hinchcliff K, Done S et al. (2017) *Veterinary Medicine: a textbook of the diseases of cattle, horses, sheep, pigs and goats*. (11 edn), Elsevier, Edinburgh

114.04

Pedi-lite flow sensor vs. calibration syringe

Raillard ^{MR1}, Levionnois ^{OL2}, Auckburally ^{AA3}, Borland ^{KB4}, Garcia de Carellan Mateo ^{AG5}, Macfarlane ^{PDM6}, Merlin ^{TM7}, Steblaj ^{BS8}, Mosing ^{MM9}

¹The University of Sydney, Australia. ²University of Bern, Switzerland. ³SCVS, UK. ⁴Anderson Moores, UK. ⁵Hospital Veterinario de la UCV, Spain. ⁶University of Bristol, UK. ⁷Eastcott Referrals, UK. ⁸University of Zürich, Switzerland. ⁹Murdoch University, Australia

Using the Pedi-lite, spirometry modules measure the differential between dynamic and static pressures to calculate gas flows. Values of VT are integrated from the linearized-corrected signal. The manufacturer claims accuracy is $\pm 6\%$ or ± 4 mL (largest volume) (Datex-Ohmeda 2005).

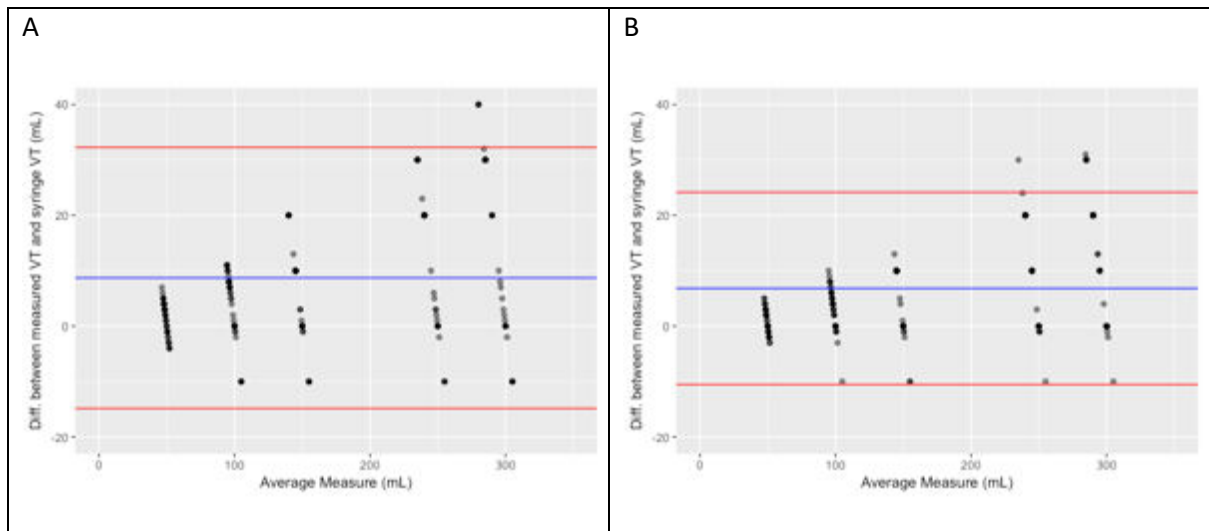
Forty-two monitors at 8 centres were tested with certified calibration syringes. Monitors' last maintenance date was recorded when available. Monitors were switched on for over 10 minutes, paediatric sensors selected, and syringes connected to the patient end of the sensor. The calibration procedure was standardized (written and video instructions). Five volumes (50, 100, 150, 250, 300 mL) were pumped in and out 3 times. Both "inspired" (VTi) and "expired" (VTe) values were recorded (630 measurements each). Wilcoxon signed-rank test was used to compare VTi and VTe. Number of measurements out of $\pm 6\%$ (or ± 4 mL) and $\pm 10\%$ of the volumes set on the syringes were recorded. Monitors were defined "uncalibrated" if VTi and VTe consistently differed by more than 6% from 100 mL, as described in the product manual¹. Bland-Altman plots were generated (Figure).

The VTi was $0.85 \pm 3.5\%$ lower than VTe ($p < 0.001$). For VTi and VTe, 52.4% (330) and 34.9% (220) were out of $\pm 6\%$ (or ± 4 mL), respectively. For VTi and VTe, 11.6% (73) and 2.7% (17) were out of $\pm 10\%$, respectively. Seven monitors were "uncalibrated", 6/7 serviced 0-2 months earlier.

Caution is recommended when interpreting VT values using Pedi-lite.

References

Datex-Ohmeda (2005). 1.4 Patient spirometry specifications. Compact airway modules. In: S/5 TM E-Modules, Technical Manual.



Pedi-lite or calibration syringes: V_{Ti} (A) and V_{Te} (B)

114.05

CEPEF4 going live

Gozalo-Marcilla M¹, Redondo JI², Johnston M³, Taylor PM⁴, Bettschart-Wolfensberger R⁵

¹The University of Edinburgh, UK. ²University of Valencia, CEU, Spain. ³Managing Director – Vetstream, UK. ⁴Topcat Metrology, UK. ⁵University of Zurich, Switzerland

The Confidential Enquiry into Perioperative Equine Fatalities (CEPEF-2) was the largest observational study of equine anaesthetic mortality (Johnston et al. 2002). Equine anaesthesia has evolved in the last 17 years, but fatalities still occur (Dugdale & Taylor 2016); an update is now appropriate.

In this era of digital globalization new technology provides better tools for simple and immediate worldwide data collection. Based on similar methodology to a study in small animals which has collected data from more than 30,000 dogs and cats (<https://complred.wordpress.com/2018/11>), we aimed to develop a pdf format questionnaire for equine anaesthesia that can be filled in using a mobile phone, a tablet or a computer. The form will be completed for all anaesthetic cases, regardless of the reason for anaesthesia (therapeutic/diagnostic). It will include general anaesthesia (inhalational or injectable) and standing sedation. The form will be sent automatically to CEPEF4@gmail.com at the end of anaesthesia. Data will be collected from at least 40,000 cases.

The proposed questionnaire will obtain information on all features of anaesthesia which might be associated with anaesthetic morbidity and mortality. The sections include details about the institution, the personnel, the horse, the surgical or diagnostic procedure, the anaesthetic and ancillary drugs administered, and the protocol used for induction, maintenance and recovery for both standing sedation and general anaesthesia. Any fatality occurring within 7 days of sedation/anaesthesia and its likely cause is recorded. See further information in <https://cepef4.wordpress.com/>.

CEPEF4 should update knowledge and understanding of the factors associated with equine anaesthetic morbidity and mortality.

References

Dugdale AH, Taylor PM (2016) *Equine anaesthesia-associated mortality: where are we now?* *Vet Anaesth Analg* 43, 242 – 255.

Johnston GM, Eastment JK, Wood J, Taylor PM (2002) *The confidential enquiry into perioperative equine fatalities (CEPEF): mortality results of Phases 1 and 2.* *Vet Anaesth Analg* 29, 159 – 170.

114.06

Retrospective evaluation of the incidence of post-anesthetic signs of colic with and without the use of hydromorphone

Skrzypczak HE¹, Reed RA², Barletta M², Quandt JE¹, Sakai DM¹

¹University of Georgia, Department of Small Animal Medicine and Surgery, USA

²University of Georgia, Department of Large Animal Medicine, USA

Opioid use delays gastrointestinal transit time and is minimally administered peri-anesthetically in horses due to the concern for post-anesthetic colic. The purpose of this study was to determine if hydromorphone increased the risk of post-anesthetic colic.

Four hundred and nine anesthetic and clinical records of horses presenting for various procedures from July 2018 to September 2019 were reviewed. Post-anesthetic signs of colic (PASC) including pawing, pacing, flank watching, rolling, and flehmen response were recorded up to 48 hours after the anesthetic event. A binary logistic model was used to examine the association between development of colic signs and administration of peri-anesthetic hydromorphone. Colic or non-colic surgery, and duration of anesthetic event were also evaluated.

Overall, 25 horses (6.1%) developed PASC within 48 hours of general anesthesia. The incidence of PASC with and without hydromorphone was not different [7.9% ($n = 12/152$) vs. 5.1% ($n = 13/257$)] ($p = 0.25$). Horses undergoing colic surgery had a greater incidence of PASC (OR = 13.7) than non-colic surgery [26.7% ($n = 16/60$) vs. 2.6% ($n = 9/349$)] ($p < 0.001$). No animals administered hydromorphone required surgical intervention for PASC. The incidence of PASC in anesthetic events lasting longer than 2 hours was greater (OR = 4.1) than in shorter anesthetic events [9.6% ($n = 20/209$) vs. 2.5% ($n = 5/200$)] ($p = 0.006$).

This retrospective analysis did not identify an association between hydromorphone and an increase in PASC. Colic surgery and duration of anesthetic were associated with an increased risk of PASC.

114.07

Effects of inspired oxygen fraction on intra-pulmonary shunt fraction, as measured by F-shunt and alveolar-arterial oxygen gradient, in anesthetized mechanically ventilated Shetland ponies

Abraham Calero Rodriguez, Janny C. de Grauw and Johannes P.A.M. van Loon

Department of Equine Sciences, Faculty of Veterinary Medicine, Utrecht University, 3584 CM Utrecht, The Netherlands.

Impaired oxygenation due to atelectasis is a common complication in equine anesthesia. A reduced fraction of inspired oxygen (FiO_2) has been used in other species to limit the development of atelectasis.

Twenty-three adult Shetland ponies were anesthetized for a total of 32 anesthetic procedures. Ponies were premedicated intravenously with detomidine (0.01 mg kg^{-1}) and morphine (0.1 mg kg^{-1}) or butorphanol (0.02 mg kg^{-1}). Induction was performed with intravenous ketamine (2.2 mg kg^{-1}) and midazolam (0.07 mg kg^{-1}). Ponies were randomized to maintenance of anesthesia with isoflurane in oxygen (FiO_2 95%) or a mixture of oxygen and medical air (FiO_2 65%), and a constant rate infusion of detomidine ($0.01 \text{ mg kg}^{-1} \text{ hour}^{-1}$). Animals were mechanically ventilated to maintain PaCO_2 between 35 and 45 mmHg. The F-Shunt equation, the alveolar-arterial oxygen gradient (P (A-a) O_2) and the difference between PaCO_2 and end tidal carbon dioxide ($\text{PaCO}_2 - \text{F}_\text{E}'\text{CO}_2$) were calculated every 30 minutes. Data were analyzed using mixed model analysis.

In the FiO_2 95%-group F-shunt and P (A-a) O_2 decreased over time and were always lower than in the FiO_2 65%-group. Significant differences were found at 60 and 90 minutes after induction for F-shunt (19.39 ± 8.3 and 18.63 ± 9.5 for FiO_2 65% versus 13.21 ± 4.3 and 11.72 ± 3.5 for FiO_2 95%) and at 90 minutes after induction for P(A-a) O_2 (234.95 ± 132.4 mmHg versus 149.82 ± 52.3 mmHg)

Our findings do not support beneficial effects of a reduced FiO_2 in preventing absorption atelectasis in anesthetized Shetland ponies.

114.08

Evaluation of conus medullaris and dural sac termination in adult sheep

Gutiérrez Bautista AJ, Redondo García JI, García Roselló M, Esteve Bernet V, Viscasillas Monteagudo J, Hernández Magallana EZ, Martínez Albiñana A, García Vitoria C

CEU Cardenal Herrera University (Valencia), Spain

There is little information on where the conus medullaris (CM) and the dural sac (DS) end in sheep. The aim of this study is to describe that anatomy.

Forty adult Merino-mixed sheep weighing 42.9 kg (± 10.4 kg) were anaesthetised for lumbo-sacral CT myelography, following a standard anaesthetic protocol for ruminants. Animals were placed in sternal recumbency and the lumbo-sacral area was clipped and aseptically prepared for intrathecal injection. Tuohy needle was inserted and advanced until the cerebrospinal fluid was observed. Then, 0.4 ml kg⁻¹ iodinated contrast media was injected and CT scan was performed. The following data were retrieved from the CT images: The vertebrae where the end of the CM was located and the end of the DS. The end of the DS was categorised as “cranial to the lumbo-sacral space” (CRAI-s), “sacral area” (SACR) and “caudal to sacro-coccygeal space” (CAUs-c).

Conus medullaris:

First Sacral vertebrae	Second Sacral vertebrae	Not assessed	Total
14	14	12	40

Dural sac:

CRAI-s	SACR	CAUs-c	Not assessed	Total
0	2	31	7	40

12/40 cases in the conus evaluation and 7/40 in the dural sac exam were excluded for several reasons such as poor image quality, accidental epidural injection or difficult injection/multiple attempts.

Care should be taken when lumbo-sacral injection is performed in this type of sheep because the CM ends caudally to this space. DS is still present caudal to the sacro-coccygeal space; therefore, it should be taken into account when an epidural injection is carried out in this location.

References

Khan, Z., Munro, E., Shaw, D., Faller, K.M. (2019) Variation in the position of the conus medullaris and dural sac in adult dogs. *Vet Rec* 185, 20.

Mageed, M., Berner, D., Julke, H., Hohaus, C., Brehm, W., Gerlach, K. (2013) Morphometrical dimensions of the sheep thoracolumbar vertebrae as seen on digitised CT images. *Lab Anim Res*, 29, 138-47.

114.09

Accuracy of tidal volume delivery during anesthesia: A bench study testing different large animal ventilators

Florian DE, Hopster KH, Driessen BD

Department of Clinical Studies–New Bolton Center, School of Veterinary Medicine, University of Pennsylvania, USA

Mechanical ventilation, though commonly employed in horses to treat lung collapse and gas exchange disturbances, may also cause various complications if tidal volume (V_T) delivery is inaccurate. Therefore, we determined the accuracy of V_T delivery among commonly used large animal anesthesia ventilators (pneumatic ventilators: Draeger AVE, Surgivet DHV-1000, Mallard Medical 2800 & 2800C; piston ventilator: Tafonius-Junior).

With each of the tested ventilators five different V_T (1.0, 2.5, 4.0, 5.5 and 7.0 liters) were delivered 10 times via a breathing circuit into a calibration syringe under conditions of different driving gas flow rates (DFR) ($\sim 100, 150, 200 \text{ liter min}^{-1}$) and fresh gas flow (FGF) rates (leak-flow rate, 3, 5, 7 liters min^{-1}). Accuracy of V_T delivery was evaluated employing a thermal mass flow/volume meter. Volume difference (ΔV_T) between preset and delivered V_T were expressed as % of preset V_T . Dependence of ΔV_T on V_T , DFR and FGF was calculated using the Pearson product moment correlation ($p < 0.05$).

All ventilators exhibited a variable ΔV_T ranging from 1.2 - 22.2% with delivered V_T always less than preset V_T . The volume error was related to FGF ($r^2 = 0.62$, $p < 0.001$) and DFR ($r^2 = 0.69$, $p = 0.003$), as well as to preset V_T ($r^2 = 0.58$, $p < 0.001$).

The piston-driven ventilator performed with significantly greater accuracy in V_T delivery than pneumatically powered ventilators that commonly surpassed the clinically tolerated volume error threshold of 10 %. Thus, close monitoring of V_T is warranted when using these types of anesthetic ventilators.

114.10

Agreement of high definition oscillometry (HDO) at the metatarsal artery with direct arterial blood pressure measurements at different blood pressure ranges in isoflurane anaesthetized horses

L. Twele¹, S. Neudeck¹, J. Reiners³, M. Noll², J. Delarocque¹, N. Verhaar¹, J. Tünsmeier², S. Kästner²

¹Clinic for Horses, University of Veterinary Medicine Hannover, Foundation, Hannover, Germany

²Small Animal Clinic, University of Veterinary Medicine Hannover, Foundation, Hannover, Germany

³Kleintierzentrum Duisburg-Asterlagen, Duisburg-Asterlagen, Germany

The metatarsal artery (MA) is easily accessible during anaesthesia, allowing placement of a blood pressure cuff around the metatarsus. This study aimed to determine agreement of invasive blood pressure measurement (IBP) in the MA and facial artery (FA) with non-invasive blood pressure (NIBP) measurement at the MA at different blood pressure ranges.

For a terminal surgical study, horses (n = 11) received a standardized anaesthetic protocol and were positioned in dorsal recumbency. Blood pressure was measured noninvasively by HDO, randomly over the left or right MA and invasively in the contralateral MA and FA. Lactated-ringers solution and dobutamine were infused to achieve normotension (MAP 61 - 119 mmHg). After completion of the surgical study, hypotension (MAP $\leq$ 60 mmHg) was induced by increasing isoflurane concentrations and cessation of infusions. Hypertension (MAP $\geq$ 120 mmHg) was induced by dobutamine and norepinephrine. Blood pressures obtained by HDO were corrected to heart level. Data were analysed by Bland-Altman analysis.

In total, 152 paired measurements were analysed. Agreement between IBP in FA and MA was good, whereas overall agreement between IBP measurement at FA and MA in comparison to HDO was low (figure 1). At low, normal and high blood pressures HDO slightly overestimated, underestimated and markedly underestimated IBP, respectively.

In dorsally recumbent horses, NIBP measurement over the MA by HDO does not seem to be a reliable alternative to IBP measurement at critical blood pressures.

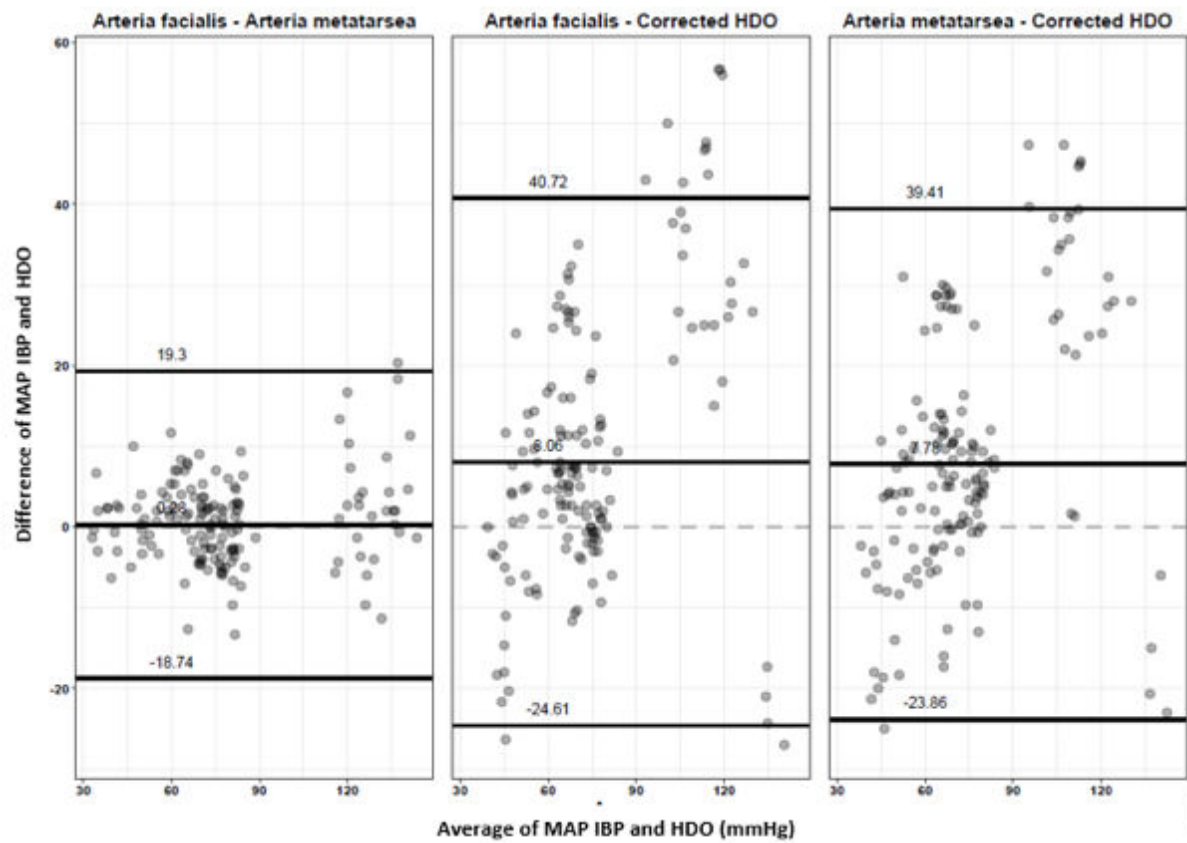


Figure 1: Bland-Altman plots of MAP. Bold lines = mean bias, limits of agreement; dashed line = identity.

114.11

The use of a non-invasive 5 electrode EEG wireless helmet in horses: a pilot study on characterizing lateralization of EEG profiles during total intravenous anaesthesia

Gwenola Touzot-Jourde¹, Amélie Daéffler², Martine Hausberger³, Hugo Cousillas³

¹RMeS Regenerative Medecine et Squeleton UMR_1229 INSERM/ Nantes/Oniris, National College of Veterinary Medicine, Food Science and Engineering, Site de la Chantrerie Route de Gachet, Nantes France

²Oniris, National College of Veterinary Medicine, Food Science and Engineering, Site de la Chantrerie Route de Gachet, Nantes France

³EthoS Ethologie Animale et Humaine UMR 6552 CNRS/Université de Rennes 1, Rennes Cedex France

Several EEG monitors with algorithms for humans have failed to assess anaesthetic depth in horses (Haga et al. 2002, Tünsmeier et al. 2016). The study aimed to describe the feasibility of using a transcutaneous electrode EEG helmet in horses and analyse lateralized brain activity during anaesthesia and early recovery.

Four horses wearing the helmet were anaesthetised with diazepam and ketamine after an acepromazine-romifidine premedication. Anaesthesia was maintained with a continuous infusion of romifidine, ketamine and guaifenesin for 40 to 50 minutes. Anaesthetic depth was numerically scored using common clinical signs. Raw EEG signals were analysed by calculating proportions of delta, theta + alpha (T+A) and beta + gamma (B+G) waves for left and right hemispheres. A Friedman test was used to compare proportions ($P < 0.05$).

Delta waves were predominant during stable planes of anaesthesia ($> 95\%$). Analysis after delta wave removal showed equivalent remaining wave proportions in both hemispheres for horses 1 and 2 ($T+A > 80\%$, $B+G < 20\%$). Horses 3 and 4 right T+A and B+G wave proportions (50-60% and 40-50% respectively) were different from the left hemisphere and horses 1 and 2 ($P < 0.05$) and corresponded to lighter and less stable planes of anaesthesia. Increased proportion of B+G waves ($> 50\%$) predicted early signs of recovery (nystagmus, blinking, ear movement) by 1 to 8 minutes.

Delta waves were predominant during anaesthesia. Variations of T+A and B+G wave proportions showed possible lateralization of brain activity during anaesthesia and may indicate early changes of depth in horses.

References

Haga HA, Dolvik NI (2002) Evaluation of the bispectral index as an indicator of degree of central nervous system depression in isoflurane-anesthetized horses. *Am J Vet Res.* 63:438-42.

Tünsmeier J, Hopster K, Kästner SB (2016) Clinical Use of a Multivariate Electroencephalogram (Narcotrend) for Assessment of Anesthetic Depth in Horses during Isoflurane-Xylazine Anesthesia. *Front Vet Sci.* 3:25. doi: 10.3389/fvets.2016.00025.

114.12

An enhancement to the time-capnogram

Keith Simpson. Vetronic Services LTD, Newton Abbot, Devon, UK

Interpretation of the time-capnogram can be enhanced by including the direction of airflow. A new method has been devised to explicitly indicate inspiration, expiration and pause phases.

A time-capnogram shows a plot of carbon dioxide concentration against time. It is generally accepted that a rise in CO₂ concentration indicates expiration and a fall in CO₂ concentration indicates inspiration. However, rising or maintained CO₂ values may also indicate rebreathing during inspiration.

For a patient on a circuit with significant apparatus dead space, inspiration begins some time before the CO₂ value is seen to fall. In addition, a patient on a circle system with an expiratory pause may show a prolonged and maintained high level of CO₂ between the end of expiration and the beginning of inspiration. In both cases the act and degree of rebreathing are hidden from the observer. The vital component that distinguishes expired CO₂ from inspired CO₂ is the direction of airflow. By including an indicator of air flow direction on the time-capnogram, rebreathing is highlighted. When these air direction measurements are coupled with a time-capnogram, expiration can be shown in white, inspiration in blue and pauses in yellow. This feature, known as Colour Coded Capnography (CCC), clearly indicates dead-space rebreathing, inadequate gas flow in a non-rebreathing circuit and the presence of respiratory pauses.

The technique is equally applicable to mainstream and sidestream analysers.

114.13

The impact of vatinoxan on microcirculation after intramuscular coadministration with medetomidine in Beagle dogs – a blinded crossover study

L Niemann¹, M L Wieser¹, F B Joerger¹, S Hartnack², A P N Kutter¹, B Steblaj¹

¹Section of Anaesthesiology, Department of Clinical Diagnostics and Services, ²Section of Epidemiology, Vetsuisse Faculty, University of Zurich, Switzerland

Macrovascular side effects of medetomidine in dogs are attenuated by the peripheral α_2 -antagonist vatinoxan (formerly called MK-467). The objective of this study was to characterize effects of medetomidine on microcirculation without (group MED) or with vatinoxan (group MVX).

Eight healthy beagle dogs were used in this randomized crossover, blinded, experimental study. Each dog received 1 mg m⁻² medetomidine IM with or without 20 mg m⁻² vatinoxan IM into the gluteal muscle immediately after baseline measurement with a washout period of seven days. A side-stream dark-field (SDF) camera (USB3 MicroScan Microvision Medical, Amsterdam, NL) was used to assess buccal mucosal microcirculation. Videos were recorded at baseline and 10, 20, 30, 40, 60, 90 and 120 minutes after treatment administration. Linear mixed effects models were used to assess if microvascular parameters were significantly associated with treatment, baseline and sequence.

Significant effects of treatment and baseline were found. The estimated effect of MED against MVX was -1.98% (-3.53% to -0.42% (confidence interval)) for proportion of perfused vessels (PPV), -0.33 (-0.43 to -0.22) for microvascular flow index (MFI), and 0.13 (0.05 to 0.22) for heterogeneity index (HI). The interquartile range for baseline measurements was (91.39% – 98.42%) for PPV, (2.75 – 3) for MFI and (0 – 0.36) for HI. There were no significant changes seen for perfused DeBacker density, perfused DeBacker density < 20 μ m and PPV < 20 μ m between treatments.

These results suggest that MVX had significantly less effect on microcirculation than MED.

This GCP study was financed by Vetcare Finland Oy. The sponsors had no influence on data recording, analysis and interpretation.

114:14

Antinociceptive activity of medetomidine and dexmedetomidine in dogs

Joëlle Siegenthaler¹, Tekla Pleyers¹, Mathieu Raillard^{1,2}, Claudia Spadavecchia¹, Olivier Levionnois¹

¹Division of Anaesthesiology and Pain Therapy, Department of Clinical Veterinary Sciences, Vetsuisse Faculty, University of Berne, Switzerland (for all authors at the time of the trial)

²School of Veterinary Science, Faculty of Science, The University of Sydney, Australia (actual institution)

A prospective, block randomized, masked trial was performed on eight beagles to compare the antinociceptive activity of dexmedetomidine and medetomidine and their reversal by atipamezole.

Each dog participated in two sessions separated by 10 days to receive 0.02 mg kg⁻¹ intravenous (IV) medetomidine (MED) or 0.01 mg kg⁻¹ IV dexmedetomidine (DEX), followed 45 minutes later by 0.1 mg kg⁻¹ intramuscular atipamezole (ATI) or saline (CONT). The nociceptive withdrawal reflex (NWR) threshold (mA) was continuously measured using electrical stimulation and electromyographic recording (Diez et al. 2019). Sedation was scored at baseline (unmedicated) and then every 10 minutes (Wagner et al. 2017). The median (range) of all data were calculated and analyzed using a Wilcoxon signed rank test or a two-way ANOVA for repeated measures.

The NWR threshold increased within minutes for both drugs (4.7 (3.8–5.6) times its baseline, MED *versus* DEX: $p = 0.311$) and slowly decreased back to baseline. The duration required for the NWR threshold to decrease to 1.5 times its baseline was shorter for ATI [83 (50–121) minutes] compared to CONT [116 (71–158) minutes] ($p = 0.343$). Sedation scores did not differ between treatments (MED *versus* DEX, $p = 0.67$). Duration of sedation was longer for MED/CONT [155 (133–193) minutes] than for DEX/CONT [115 (88–135) minutes] ($p = 0.057$).

Sedation appeared longer-lasting after medetomidine. Sedation and antinociceptive efficacy were similar for dexmedetomidine and medetomidine. Antinociception did not outlast sedation, and atipamezole was able to reverse rapidly both sedation and antinociception.

References

Diez Bernal S, Studer N, Thormann W et al. (2019) Pharmacokinetic-pharmacodynamic modelling of the antinociceptive effect of a romifidine infusion in standing horses. *Vet Anaesth Analg* Epub ahead of print.

Wagner MC, Hecker KG, Pang DSJ (2017) Sedation levels in dogs: a validation study. *BMC Vet Res* 13, 110.

114:15

Investigation of selected respiratory effects of (dex)medetomidine in healthy beagles

Pleyers TF, Siegenthaler J, Levionnois OL, Spadavecchia C, Raillard M

Department of Anaesthesiology and Pain Therapy, Vetsuisse Faculty, University of Bern, Switzerland

Effects of alpha-2 adrenoreceptor agonists on respiratory mechanics are unclear. In dogs, thoracic impedance changes correlate with V_T changes. Effects of IV dexmedetomidine (Dex, 10 $\mu\text{g kg}^{-1}$) or medetomidine (Med, 20 $\mu\text{g kg}^{-1}$) on selected respiratory variables using EIT (electrical impedance tomography) were investigated in 8 healthy beagles.

In this prospective, randomized, blinded, cross-over study, dogs received the two treatments at 10 days interval. Dogs were breathing room air, had an EIT belt around the chest and were kept in right lateral recumbency. Changes in thoracic impedance (ΔZ) in arbitrary units (AU) and f_R in movements per minute (mpm) were recorded for 120 seconds before (T0) and 10 minutes after the administration of (dex)medetomidine (T10). Minute ΔZ ($\dot{\Delta Z}$) was calculated multiplying median ΔZ by f_R . Two-way ANOVA for repeated measures were used to investigate overall drug (Dex vs Med) or treatment (T0 vs T10) effects.

There was no difference between drugs. Some dogs developed a respiratory pattern characterised by clusters of breaths followed by short periods of apnoea; f_R decreased [T0: 26 (22 - 29) mpm, T10: 13 (10 - 21) mpm, $p = 0.003$] and ΔZ increased [T0: 1.133 (0.856 - 1.599) AU, T10: 1.650 (1.273 - 2.813) AU, $p = 0.007$] but $\dot{\Delta Z}$ did not change [T0: 30.375 (23.411 - 32.445) AU minute⁻¹, T10: 30.581 (22.487 - 35.091) AU minute⁻¹].

In healthy beagles, it is likely that (dex)medetomidine cause a reduction in f_R and an increase in V_T without impacting on minute ventilation.

References

Adler A, Amyot R, Guardo R et al. (1997) Monitoring changes in lung air and liquid volumes with electrical impedance tomography. J App Physiol 83, 1762-1767.

Lamont LA, Burton SA, Caines D et al. (2012) Effects of 2 different infusion rates of medetomidine on sedation score, cardiopulmonary parameters, and serum levels of medetomidine in healthy dogs. Can J Vet Res 76, 308-316.

Lerche P, Muir WW (2004) Effect of medetomidine on breathing and inspiratory neuromuscular drive in conscious dogs. Am J Vet Res 65, 720-724.

114:16

Cardiopulmonary effects and anaesthetic indices of pentazocine-dexmedetomidine premedicated propofol-isoflurane anaesthetized Nigerian indigenous puppies

Sogebi EAO¹, Popoola, AP¹ Oguntoye CO², Oyenekan, OI¹

¹Department of Veterinary Medicine and Surgery, Federal University of Agriculture, Abeokuta, Nigeria

²Department of Veterinary Surgery and Radiology, University of Ibadan, Ibadan, Nigeria

Pain is the most salient aspect of veterinary surgery for patients throughout the perioperative period.

This study evaluated the effects of dexmedetomidine-pentazocine as premedicants on the quality of induction; duration and quality of anaesthesia, analgesia and recovery; and cardiopulmonary parameters in propofol-isoflurane anaesthetized Nigerian indigenous puppies.

In a prospective cross-over blinded study with one week 'washout' period, six puppies, aged 3 – 5 months and weighing 6 – 7 kg, received 0.01 mg kg⁻¹ dexmedetomidine (treatment D) or a combination of 0.01 mg kg⁻¹ dexmedetomidine and 2 mg kg⁻¹ pentazocine (treatment DP) intramuscularly as premedicants. Induction was achieved with intravenous propofol at 4 mg kg⁻¹. After tracheal intubation anaesthesia was maintained for one hour with 0.8% isoflurane in 2 L min⁻¹ oxygen. Atipamizole was administered as reversal.

Blood glucose and cardiopulmonary parameters were measured at baseline; thereafter the cardiopulmonary parameters were recorded every 5 minutes. Blood glucose level was assessed 15 minutes after drug administration while analgesia was assessed using the pin prick method (Dehkordi et al., 2012) with 15-minute intervals. Data were expressed as mean ± SD and subjected to one-way ANOVA. $P \leq 0.05$ was considered significant.

Cardiopulmonary parameters and blood glucose levels did not significantly differ between treatments. The quality of induction and analgesia was better with treatment DP. Anaesthesia and recovery times were significantly longer in DP 57.25 ± 2.60 and 12.41 ± 0.20 minutes respectively, than in treatment D 53.2 ± 2.52 , 9.32 ± 0.13 . Dexmedetomidine-pentazocine combination provided better analgesia.

References

Dehkordi SH, Bigham-Sadegh A, Gerami R. 2012. Evaluation of anti-nociceptive effect of epidural tramadol, tramadol-lidocaine and lidocaine in goats. *Vet. Anaesth Analg* 39(1): 106-10

115:01

Retrospective comparison between three loco-regional blocks for pelvic limb surgery in dogs

Ferrero C¹, Borland K¹, Rioja E²

¹Anderson Moores Veterinary Specialists, Winchester, UK

²Optivet Referrals, UK

Loco-regional nerve blocks are commonly performed for pelvic-limb surgery. The objectives of the study were to compare the efficacy and duration of three loco-regional blocks in dogs undergoing elective orthopaedic surgery.

A total of 221 hospital records were reviewed. Dogs were grouped according to the loco-regional block received: pre-iliac femoral and sciatic nerve block guided by electrostimulation (group PS; $n = 56$), saphenous and sciatic nerve block guided by ultrasound (group SS, $n = 79$) or lumbosacral epidural (group EPI; $n = 86$). Bupivacaine 0.5% or ropivacaine 0.75% was used, EPI group had morphine in addition. Analysed data included: time until first postoperative methadone and the pain score (short form composite Glasgow pain scale) at that time, intraoperative rescue analgesia, intraoperative hypotension and comments regarding walking and urination. Kruskal Wallis tests and Mann Whitney tests were performed. $P < 0.05$ was considered significant. Median (minimum-maximum) are reported.

Dogs in EPI required less intraoperative rescue analgesia than PS and SS (all groups 0, 0 - 1) ($P = 0.04$). The time to first postoperative methadone was not significantly different between groups (EPI: 510 minutes, 110 - 1337; PS: 430 minutes, 140 - 1030; SS: 458 minutes, 135 - 1094). In EPI, 11% did not require methadone overnight, 13% in PS and 15% in SS (not significantly different). Significantly more dogs in EPI had hypotension intraoperatively and urinary retention postoperatively.

A lumbosacral epidural resulted in superior intraoperative analgesia and a higher incidence of intraoperative hypotension and postoperative urinary retention.

References

Bartel et al (2016) Comparison of bupivacaine and dexmedetomidine femoral and sciatic nerve blocks with bupivacaine and buprenorphine epidural injection for stifle arthroplasty in dogs. *Vet Anaesth and Anal* 43, 435-443.

Boscan P. et al (2010) Fluid balance, glomerular filtration rate, and urine output in dogs anaesthetized for an orthopaedic surgical procedure. *Am J Vet Res* 71, 501-507.

Campoy L. et al (2010) Ultrasound-guided approach for axillary brachial plexus, femoral nerve and sciatic nerve blocks in dogs, *Vet Anaesth Analg* 37, 144-153.

115:02

Comparison of blind versus ultrasound-guided intercostal nerve block: a canine cadaveric study

Alexander Thomson¹, Diego A. Portela¹, Marta Romano¹, Pablo E. Otero²

¹Department of Comparative Diagnostic and Population Medicine, University of Florida College of Veterinary Medicine, Gainesville FL USA

²Universidad de Buenos Aires, Facultad de Ciencias Veterinarias, Cátedra de Anestesiología y Algología, Buenos Aires, Argentina

This study aims to compare the success rate of intercostal nerve injections (ICi) using blind or ultrasound-guided technique in canine cadavers.

Twelve adult mid-sized canine cadavers were used. Two cadavers were dissected to identify ultrasound landmarks and develop an ultrasound-guided technique. The remaining ten cadavers were randomly assigned to receive blind (n = 5) or ultrasound-guided (n = 5) injections of the 3rd to the 9th intercostal nerves bilaterally with 0.03 mL kg⁻¹ of colorant solution per injection. For each cadaver, a practitioner in training performed the blocks on one hemithorax, while an experienced practitioner performed the blocks on the opposite hemithorax. Injections were considered successful if ≥ 1 cm of the target nerve was stained with colorant upon dissection.

A total of 70 blind and 70 ultrasound-guided ICi were performed. The endpoint for successful ultrasound-guided injection was identified as displacement of the parietal pleura without visible intramuscular distribution of the injected solution. Success rates of the blind and ultrasound-guided techniques were 57.1% and 91.4%, respectively ($p < 0.0001$). The length of intercostal nerve staining was 3.12 ± 1.2 cm and 3.64 ± 1.0 cm using the blind and ultrasound-guided technique, respectively ($p = 0.02$). No significant differences were observed between the two practitioners for blind ($p = 0.33$) and ultrasound-guided technique ($p = 0.67$).

Ultrasound guidance improves the accuracy of intercostal nerve injections when compared to blind technique, independently of the level of expertise in regional anesthesia.

All experimental procedures were reviewed and approved by the Institutional Animal Care and Use Committee of the University of Florida. Cadavers were obtained from dogs euthanized for reasons unrelated to the study.

115:03

An investigation of ultrasound and electrical nerve location to predict distance to neuraxial space in dogs.

MA Gurney

Anderson Moores Veterinary Specialists, Winchester, UK

Distance to neuraxial space has been assessed ultrasonographically in humans (Seligman et al 2017). Body condition score (BCS) and body mass (BM) predict distance to neuraxial space in dogs (Gurney et al 2018).

Dogs (n = 40) positioned in sternal recumbency underwent ultrasound (5-13MHz) (US) of the epidural space prior to lumbosacral epidural placement confirmed with nerve location (ENL). Following injection and prior to removal of the needle a single operator pinched the needle at the level of the skin. Once removed distance from skin to needle tip was measured with a standard ruler. Distance from skin to ligamentum flavum (US focal point) was then measured from three transverse ultrasound images and mean distance calculated. Variables recorded included BM, BCS, age, gender and breed. Data was used to revise the pilot study formula (Gurney et al 2018). Absolute difference was compared between the two sets of measurements using paired t-tests and compared to length calculated by the formula. Agreement between predicted and operator-measured needle length was assessed using Bland-Altman limits of agreement.

Needle length can be predicted from the revised formula $14.1 + (2.22 \times \text{BCS}) + (0.63 \times \text{BM})$. Predicted length did not differ significantly from ENL guidance but differed significantly from US measurements 4 [1-8mm]. For US compared to ENL Bland-Altman limits of agreement were -15 to +6 mm for the absolute differences and -40% to +16% for the percentage differences.

Reasons for variation in US-estimated distance to neuraxial space requires further examination.

References

Gurney MA, Leece EA & Bradbrook CA (2018). A pilot examination of association between body condition score, body mass and needle length for successful epidural placement in dogs. *Vet Anaesth Analg* 45 A25 (abstract).

Seligman KM, Weiniger CF, Cravalho B (2017). The Accuracy of a Handheld Ultrasound Device for Neuraxial Depth and Landmark Assessment: A Prospective Cohort Trial. *Anesthesia & Analgesia* Jun 126(6) doi: 10.1213/ANE.0000000000002407.

115:04

Is a wireless ultrasound device useful for performing locoregional anaesthesia in dogs? A cadaveric study.

Andrew Foster¹, Nicola TZ Ho¹, Sandra Sanchis-Mora¹, Ludovic Pelligand¹ & Jaime Viscasillas^{1,2}

¹ Department of Clinical Sciences and Services, Royal Veterinary College, University of London, AL9 7TA, Hatfield, United Kingdom

² Departamento de Medicina y Cirugía Animal, Facultad de Veterinaria, Universidad CEU Cardenal Herrera, Valencia, Spain

Wireless ultrasound devices designed for point-of-care imaging may be suitable for locoregional techniques in veterinary species. This study aims to assess a wireless ultrasound device for performing locoregional anaesthesia techniques in dogs.

Six beagle cadavers weighing 8.67 kg (5 – 12.7 kg) were used. Brachial plexus (subscalenic approach, Portela et al. 2018) and sciatic nerve (Viscasillas et al. 2013) blocks were performed bilaterally using 0.4 and 0.1 ml kg⁻¹ methylene blue dye respectively. Each operator (one experienced in ultrasound-guided locoregional techniques, the other minimally-experienced) was randomly assigned to a block, side of patient and probe type, ensuring equal distribution for each operator. Ease of probe use, ease of nerve identification and perceived injection success were recorded using Likert scales for all blocks. Cadavers were dissected to confirm adequate staining of the brachial plexus and sciatic nerve - methylene blue dye covering >50% of the nerve circumference (Marhofer et al. 2014).

Using the wireless probe 9/12 blocks were successful, compared to 11/12 with conventional ultrasound. Using univariate binary logistic regression, no significance was found for the effect of weight, operator, type or side of block, ultrasound device used, perceived injection success, ease of probe use and ease of nerve identification, on block success.

The wireless ultrasound device used could represent a cost-effective and accurate tool for providing ultrasound-guided brachial plexus and sciatic nerve blocks in dogs. A prospective study is necessary to confirm this finding in clinical cases.

	Brachial plexus successful	Sciatic successful	Total
Wireless	3/6	6/6	9/12
Standard	5/6	6/6	11/12

References

- Marhofer D, Karmakar MK, Zeitlinger M, et al. (2014) Does circumferential spread of local anaesthetic improve the success of peripheral nerve block? *Br J Anaesth* 113, 177–185.
- Portela DA, Verdier N, Otero PE. (2018) Regional anesthetic techniques for the thoracic limb and thorax in small animals: A review of the literature and technique description. *Vet J.* 241, 8-19.
- Viscasillas J, Benigni L, Brodbelt D, et al. (2013) Use of needle enhancing software to improve injection technique amongst inexperienced anaesthetists performing ultrasound-guided peripheral nerves blocks in dogs. *Vet Anaesth Analg.* 40, 83-90.

115:05

Anaesthesia in feral cats undergoing neutering: effects of three different surgical positions on haemoglobin oxygen saturation and intraocular pressure

Daniele Corona DVM^{1*}, Elisabeth Ranninger DVM¹, Fabiola Binja Joerger Dr. med. vet.¹, Elisabeth Goldinger Dr. med. vet.^{2,3}, Aurelian Stefan DVM⁴, Paul Torgerson Prof. Dr. med. vet. PhD, VetMB, Dipl. ECVPH⁵, Regula Bettschart-Wolfensberger Prof. Dr. med. vet. PhD, Dipl. ECVA¹

¹Department of Clinical Diagnostics and Services, Section of Anaesthesiology, Vetsuisse Faculty University of Zurich, Switzerland

²Tezet Tiermedizinisches Zentrum AG, Müllheim, Switzerland

³NetAp Network for Animal Protection, Switzerland

⁴Center of Hope Veterinary Hospital, Pitesca, Ilfov, Romanian

⁵Section of Epidemiology, Vetsuisse Faculty, University of Zurich, Switzerland

Female cats' neutering is performed in Trendelenburg, dorsal or lateral position. Effects of surgical position on SpO₂ and intraocular pressure (IOP) in anaesthetised cats were evaluated.

244 feral Romanian female cats were randomly allocated to Trendelenburg (TB = 82), dorsal (D = 76) and flank (F = 86) groups. Anaesthesia was induced with medetomidine (30 – 50 µg kg⁻¹), ketamine (7 – 10 mg kg⁻¹) and butorphanol (0.4 mg kg⁻¹) IM. Following preparation, after one minute in lateral recumbency (LR), baseline measurements (T0) were recorded: SpO₂, PR, IOP, and repeated after one minute in surgical position (T1), at end of surgery (T End) and after another 5 minutes in LR (T +5). During surgery SpO₂ and PR were recorded every minute.

To determine effect of group and time a generalised additive mixed model was used.

There was no difference between groups regarding duration of surgery, SpO₂ or PR but SpO₂ increased with time (Fig 1). IOP was significantly higher in TB end of surgery (mean 31 ± 6 mmHg, individual max. 48 mmHg), versus D+F (17 ± 4 mmHg) but normalised after 5 minutes in LR.

Cats' positioning during neutering has no influence on SpO₂ or PR. IOP is elevated in TB. Incidence of SpO₂ < 90 % was high, oxygen supplementation is advocated.

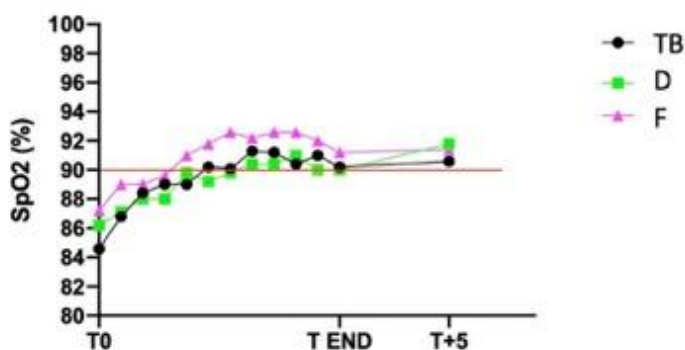


Fig 1: Mean SpO₂ over time for each group

T0 = Baseline; T0 – T End = SpO₂ at 1 min intervals during surgery, T End = End of surgery;

T +5 = 5 min after T End

115:06

The effect of anesthetic induction with propofol, alfaxalone or ketamine on intraocular pressure in cats

Shilo-Benjamini Y, Peer O, Abu Ahmad W and Ofri R

Koret School of Veterinary Medicine, The Hebrew University of Jerusalem

Induction may produce intraocular pressure (IOP) spikes, which can be harmful in eyes predisposed to perforation or glaucoma. Our objective was to compare the effect of propofol, alfaxalone and ketamine on feline IOP.

Forty-three ophthalmologically-normal cats scheduled to undergo general anesthesia were recruited in a blinded, randomized clinical trial. Cats were not sedated prior to induction. Following baseline IOP measurements using applanation tonometry, cats were induced with propofol ($n = 15$), alfaxalone ($n = 14$) or ketamine ($n = 14$) administered IV to effect. Then, 0.3 mg kg^{-1} midazolam was administered IV and cats were intubated. The IOP was re-measured following each intervention. Data was analyzed using One-way ANOVA and repeated measures mixed design with post hoc analysis. P -value < 0.05 was considered significant.

Mean $\pm$ SEM at baseline was not different between treatments (propofol 18 ± 0.6 , alfaxalone 18 ± 0.7 , ketamine 17 ± 0.5 mmHg). Following induction, IOP increased significantly compared with baseline in the propofol (20 ± 0.7 mmHg), but not in the alfaxalone (19 ± 0.8 mmHg) or ketamine (16 ± 0.7 mmHg) treatments. Midazolam administration resulted in significant decrease from the previous measurement in the propofol (19 ± 0.7 mmHg) and alfaxalone (16 ± 0.7 mmHg) treatments, but not in the ketamine treatment (16 ± 0.8 mmHg). Intubation resulted in further decrease in the alfaxalone group (15 ± 0.9 mmHg).

In conclusion, propofol should be used with caution in patients predisposed to perforation or glaucoma, as any increase in IOP should be avoided.

115.07

Cardiovascular effects of acepromazine or dexmedetomidine with fentanyl during recovery from isoflurane anaesthesia in the cat

Keating SCJ¹, Kerr CL²

¹Department of Veterinary Clinical Medicine, College of Veterinary Medicine, University of Illinois, USA

²Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Canada

The effects of dexmedetomidine or acepromazine with fentanyl administration during anaesthesia recovery in cats have not been reported. In a randomized cross over study, six mature male cats (4.74 ± 0.46 kg) received dexmedetomidine ($2.5 \mu\text{g kg}^{-1}$) (Dex) or acepromazine (0.05 mg kg^{-1}) (Ace) IV. Anaesthesia was induced with propofol and maintained with isoflurane after intubation. Arterial and cardiac thermodilution catheters were placed. Cats then received fentanyl ($5 \mu\text{g kg}^{-1}$) followed by an infusion ($5 \mu\text{g kg}^{-1} \text{ hr}^{-1}$) IV. At 120 minutes after initiating fentanyl administration, isoflurane was discontinued, and the treatment was administered. Cardiovascular data were obtained during isoflurane anaesthesia (BL) and at 5 to 15-minute intervals for 30 minutes following treatment administration with the concurrent fentanyl infusion. Data were analysed using ANOVA for repeated measures with Tukey's analysis ($P < 0.05$). Select results [mean (SD)] are shown in Table 1.

The effects of acepromazine and dexmedetomidine administration during recovery from isoflurane anaesthesia in healthy cats receiving fentanyl differed, however, both treatments resulted in cardiovascular variables remaining within acceptable limits.

Table 1.

		Time (minutes)			
		BL	5	15	30
HR (beats min^{-1})	Dex	158 (43)	108 (22) [†]	111 (21) [†]	132 (60)
	Ace	158 (45)	212 (58)	221 (21)	208 (21)
MAP (mmHg)	Dex	78 (13)	168 (22) [†]	143 (23) [†]	130 (7) [†]
	Ace	72 (13)	96 (19)	90 (10)	90 (10)
Cardiac Index ($\text{mL kg}^{-1} \text{ min}^{-1}$)	Dex	126 (21)	69 (13) [†]	75 (14) [†]	89 (16) [†]
	Ace	122 (28)	156 (25)	158 (20)	151 (14)

[†]Significant difference between treatments ($p < 0.05$)

115:08

Neuromuscular blockade and cardiovascular effects of cis-atracurium in 11 isoflurane-anaesthetized cats undergoing ophthalmologic surgery

Van Wijnsberghe ASVW, Ida KI, Dmitrovic PD, Limpens VL, Tutunaru AT, Sandersen CS

University of Liège, Belgium

This case series describes the neuromuscular blockade (NMB) and the cardiovascular effects following 0.15 mg kg⁻¹ IV cis-atracurium administration in eleven isoflurane-anaesthetized cats undergoing ophthalmologic surgery.

Anaesthetic records were assessed retrospectively. Neuromuscular function was assessed by a calibrated train-of-four (TOF) monitor with surface electrodes placed over the tibial plateau for stimulation of the peroneal nerve (every 15 seconds), and recording electrode was placed over the dorsal aspect of the paw. HR was assessed using ECG. SAP was monitored with Doppler, and in two cases with oscillometry.

Cats were 73 ± 53 months old and weighed 4 ± 1 kg. Duration of anaesthesia and surgery were 144 ± 27 and 94 ± 24 minutes, respectively. Anaesthetic and analgesic drugs included methadone, fentanyl, pethidine, buprenorphine, medetomidine, midazolam, alfaxalone, propofol, ketamine, lidocaine, and meloxicam. Lowest TOF count was 0 in four cats, 4 in five cats, while in 2 cats TOF-ratio was 31 and 35%. The onset time was observed at 2.45 ± 1.75 minutes after cis-atracurium administration and the duration of action was 20.4 ± 10.1 minutes. The HR was 101 ± 16 beats minute⁻¹ and SAP was 89 ± 13 mmHg before cis-atracurium administration. The mean HR increased by 0%, 10%, 7%, 18%, and 21%, and SAP increased by 2.2%, 15%, 15%, 17%, and 15% at 1, 5, 10, 15, and 20 minutes after cis-atracurium administration, respectively.

Cis-atracurium at the present dose did not consistently induce a TOF-count of 0 in all cats. The actual dose should be titrated to effect.

References

Bastilla et al. (1996) Comparative Pharmacology of Cisatracurium (51W89), Atracurium, and Five Isomers in Cats. Anesthesiology 85,169-177.

Auer U, Mosing M (2006) A clinical study of the effects of rocuronium in isoflurane-anaesthetized cats. Vet Anaesth Analg 33,224-228.

Suzuki et al. (2003) Comparative fading responses induced by mivacurium, cisatracurium, and d-tubocurarine in the evoked muscular compound action potentials of the cat. J Anesth, 17:98-103.

115:09

Serum inflammatory cytokines in dogs with naturally occurring neuropathic pain treated with gabapentin alone or in combination with meloxicam

Ruel HLM¹, Auger JP², Beauchamp G¹, Segura M¹, Steagall PV¹

¹Faculty of Veterinary Medicine, Université de Montréal, Saint-Hyacinthe, QC, Canada

²Department of Internal Medicine 3, University of Erlangen-Nuremberg, Erlangen, Germany

This study aimed to evaluate the effects of placebo, gabapentin or gabapentin-meloxicam on serum concentrations of inflammatory/anti-inflammatory cytokines in dogs with neuropathic pain (NeuP) and to compare those with healthy controls.

Twenty-eight client-owned dogs with naturally occurring NeuP (6.7 ± 3.0 years; 26.9 ± 18.8 kg) were included in a prospective, randomized, clinical trial. After neurological examination and magnetic resonance imaging, dogs with NeuP were allocated to one of two treatments: gabapentin/placebo/gabapentin-meloxicam or gabapentin-meloxicam/placebo/gabapentin for 21 days; each treatment lasted 7 days and resting was recommended throughout the study. Serum concentrations of GM-CSF, IFN- γ , IL-2, IL-6, IL-7, IL-8, IL-15, IP-10, KC-like, IL-10, IL-18, CCL2, and TNF- α were determined using a pre-mixed Milliplex 13-plex canine magnetic bead panel at initial presentation and at days 7, 14, 21 in dogs with NeuP, and in sixteen healthy controls (4.8 ± 2.1 years; 32.0 ± 16.7 kg) at a single visit. Linear models or Wilcoxon and Friedman tests were used for analysis ($p < 0.05$).

Serum cytokines concentrations did not differ between controls and dogs with NeuP at initial presentation. In dogs with NeuP, IL-15 and TNF- α levels were both lower after gabapentin-meloxicam ($p = 0.016$ and $p = 0.002$, respectively) and placebo ($p = 0.012$ and $p = 0.014$) than after gabapentin. Concentrations were not significantly different between gabapentin-meloxicam and placebo.

Gabapentin-meloxicam and placebo reduced the concentrations of some important pro-inflammatory cytokines in dogs with NeuP. Changes after placebo could be attributed to resting or a carry-over effect after the first week of treatment.

115.10

Systematic review on the measurement properties of grimace scales for pain assessment in non-human mammals: preliminary results

Marina C. Evangelista¹, Beatriz P. Monteiro¹, Paulo V. Steagall¹

¹Faculty of Veterinary Medicine, Université de Montréal, Saint-Hyacinthe, QC, Canada

The aim of this systematic review was to provide evidence relating to the measurement properties (validity and reliability) of grimace scales for pain assessment in non-human mammals.

The protocol was registered at SyRF (Systematic Review Facility) and seven databases were searched for references. Studies reporting the development and/or validation of grimace scales, and the assessment of psychometric properties of these instruments were included. Those reporting the use of grimace scales to measure constructs other than pain, and trials comparing treatments using these instruments as outcome measurements were excluded. Initial data extraction was performed according to the Consensus-based standards for selection of health measurement instruments methodology (COSMIN) (Prinsen et al. 2018).

A total of 894 studies were screened; 86 were assessed for eligibility and 41 were included for data extraction. Twelve scales for eight species were identified (mice, rats, rabbits, horses, cats, piglets, sheep/lambs and ferrets). Two scales have been reported for horses, sheep and piglets. Median (range) of items or action units was 5 (2-10). Construct validity was reported for all scales. Criterion validity was reported for all scales, except for one scale in piglets and one in lambs. Inter-rater reliability was moderate for one scale in piglets and one in horses, good for the scales in mice, rats, sheep and ferrets and excellent for the other scale in horses, sheep and piglets.

Grimace scales showed considerable variability regarding their validity and reliability. Risk of bias and quality assessment of these studies are currently being performed by two independent reviewers.

Reference

Prinsen CAC, Mokkink LB, Bouter LM et al. (2018) COSMIN guideline for systematic reviews of patient-reported outcome measures. Qual Life Res 27(5):1147-1157.

115.11

Inter-rater reliability of the Feline Grimace Scale before and after dental extractions

Watanabe R¹, Doodnaught GM², Evangelista MC², Monteiro BP², Ruel HLM², Steagall PV²

¹Faculty of Veterinary Medicine, Université de Montréal, Canada

²College of Veterinary Medicine, University of Illinois, USA

This study aimed to evaluate the inter-rater reliability of the Feline Grimace Scale (FGS) in cats before and after dental extractions and effects of the caregiver's presence on the FGS scores.

Twenty-four cats (6 ± 3.3 years old; 4.9 ± 1.7 kg) with or without oral disease were included in a prospective, blinded, randomized, clinical study (Watanabe et al. 2019). They underwent oral examination/radiographs/treatment under general anesthesia (acepromazine-hydromorphone-propofol-isoflurane-meloxicam-local anesthetic blocks at day 1) and were discharged at day 6. Images were captured from videos obtained with or without the caregiver's presence 6 hours postoperatively on day 1 and day 6, and before and after rescue analgesia. The images were independently evaluated by four blinded raters using the FGS [five action units (AU): ear position, orbital tightening, muzzle tension, whiskers change and head position; score 0-2 for each]. Inter-rater reliability and effects of the caregiver's presence were analyzed with intraclass correlation coefficient [single measures (95% confidence interval)] and Wilcoxon signed-rank test, respectively ($p < 0.05$).

A total of 91 images were included. The FGS scores showed good inter-rater reliability [0.84 (0.77-0.89)]. Reliability was good for eyes [0.76 (0.65-0.84)] and moderate for ears [0.68 (0.55-0.78)], muzzle [0.56 (0.43-0.69)], whiskers [0.64 (0.50-0.76)] and head position [0.74 (0.63-0.82)]. The FGS scores (%) were not different with [7.5 (0-32.5)] or without [8.8 (0-52.5)] the caregivers' presence ($p = 0.12$).

Overall, the FGS is a reliable tool for pain assessment in cats undergoing dental extractions. The caregiver's presence did not affect the FGS scores.

Reference

Watanabe R, Frank D, Steagall P. (2019) Pain behaviors before and after treatment of oral disease in cats using video assessment: a prospective, blinded, randomized clinical trial. Association of Veterinary Anaesthetists Autumn meeting, Ghent, U.K, 11-13 September.

115.12

The analgesic efficacy of intravenous, intramuscular or subcutaneous administration of buprenorphine in dogs undergoing ovariohysterectomy: a randomized, blinded, clinical trial

Steagall PV, Ruel HLM, Yasuda T, Monteiro B, Watanabe R, Evangelista MC, Beaudry F

Université de Montréal, Canada

This study aimed to evaluate the analgesic efficacy of IV, IM or SC buprenorphine (Simbadol, 1.8 mg mL⁻¹) in combination with carprofen in dogs undergoing ovariohysterectomy.

Twenty-four dogs were included in a randomized, prospective, blinded, clinical trial. Buprenorphine (0.02 mg kg⁻¹) was administered intravenously, intramuscularly or subcutaneously (n = 8/group) 0.5 hour before general anesthesia with propofol-isoflurane. Carprofen (4.4 mg kg⁻¹ SC) was administered after anesthetic induction and before ovariohysterectomy. Pain and sedation were scored using the Glasgow composite measure pain scale-short form (CMPS-SF) and a dynamic interactive visual analog scale up to 24 hours after extubation. If CMPS-SF scores were $\geq 5/20$, dogs were administered morphine (0.5 mg kg⁻¹ IV). Statistical analysis was performed using linear mixed models and Fisher's exact test ($p < 0.05$).

Sedation scores (cm) were not significantly different among treatments, except at 0.5 hour postoperatively when scores were higher in IM [4 (2-10)] than SC [2 (0-6)]. Pain scores were significantly higher than baseline after IV (0.5-2 hours), IM (0.5-3 hours) and SC (0.5-4 hours) but not among groups. Prevalence of rescue analgesia was significantly higher in SC (7/8 dogs) than IV (2/8) but not different between IV and IM (3/8) or IM and SC. The frequency of rescue analgesia was not significantly different among groups (IV = 2, IM = 4 and SC = 9).

The route of administration influences the analgesic efficacy of buprenorphine in dogs. At the doses administered, the IV and IM routes are preferred for postoperative analgesia.

115:13

Comparison of the cardiovascular and laryngeal abduction effects of carbon dioxide inhalation with two doses of doxapram

Sakai DM¹, Howard SL², Reed RA², Barletta M¹, Quandt JE¹, Kleine SA¹

¹Department of Small Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, USA

²Department of Large Animal Medicine, College of Veterinary Medicine, University of Georgia, USA

General anesthesia depresses vocal fold abduction during laryngeal examination. Respiratory stimulants improve the quality of the examination although can have detrimental cardiovascular effects.

Inhalation of 10% carbon dioxide in oxygen delivered over 90 seconds (iCO₂) was compared with intravenous doxapram at 0.55 mg kg⁻¹ (L-Dox) and 2.20 mg/kg (H-Dox) for effects on heart rate (HR), mean arterial blood pressure (MABP), and inspiratory normalized glottic gap area (iNGGA) on six propofol-anesthetized hounds. Each treatment, tested in triplicate with 15 minutes intervals, was performed with one washout out. Mixed-effect models with Bonferroni correction evaluated the effects.

The HR was lower in the iCO₂ group than both doxapram groups (both $P < 0.008$). The HR increased in L-Dox and H-Dox in a dose-dependent, non-cumulative, and transient manner ($18 \pm 10\%$ and $39 \pm 20\%$, respectively; $P = 0.016$). All treatments increased MABP over time ($P < 0.001$). The effect of iCO₂ ($18 \pm 10\%$) on MABP was less than L-Dox ($36 \pm 23\%$) and H-Dox ($41 \pm 30\%$, both $P < 0.001$). The effect of each dose of doxapram on MABP was cumulative ($P < 0.001$). Overall, respiratory stimulation increased iNGGA from 0.220 ± 0.077 to 0.315 ± 0.069 ($P < 0.001$). The iNGGA on treatments iCO₂ (0.289 ± 0.071) and L-Dox (0.302 ± 0.069) were lower than H-Dox (0.351 ± 0.036 ; both $P < 0.013$).

The iCO₂ had less cardiovascular effect than both doses of doxapram. H-Dox is more effective in increasing iNGGA but has greater effect on HR and MABP.

115:14

Intraoperative lung recruitment manoeuvres do not improve early postoperative arterial oxygenation in the anaesthetised healthy dog

Virginia García-Sanz¹, Delia Aguado¹, Ignacio A Gómez de Segura¹, Susana Canfrán¹

¹ Department of Animal Medicine and Surgery, Veterinary Teaching Hospital, Veterinary Faculty, Complutense University of Madrid, Avda. Puerta de Hierro s/n, 28040 Madrid, Spain

The aim of the study was to compare the effect of intraoperative stepwise lung recruitment manoeuvres (RMs), followed by individualised positive end-expiratory pressure (PEEP), to spontaneous ventilation (SV) and controlled mechanical ventilation (CMV) without RM or PEEP on arterial oxygenation in the early postoperative period in healthy clinical dogs.

Thirty-two client-owned dogs undergoing general anaesthesia in dorsal recumbency were included in a prospective, randomised, non-blinded, clinical study. Dogs were ventilated intraoperatively with one of the following ventilatory strategies ($\text{FiO}_2 = 0.5$): SV, CMV without RM or PEEP, and CMV with an individualised PEEP following a single RM (RM1), or two RMs (RM2, the second RM repeated at the end of surgery) (García-Sanz et al. 2019). Arterial blood gas analyses were performed at 5, 10, 15, 30 and 60 minutes after tracheal extubation while breathing room air. Data were compared using the Kruskal-Wallis test ($p < 0.05$).

The PaO_2 was not significantly different between groups at any time point (Table 1).

In conclusion, intraoperative RMs followed by individualised PEEP did not improve early postoperative arterial oxygenation compared to SV or CMV without RM or PEEP in healthy dogs.

	Group	Time after tracheal extubation [minutes; median (minimum-maximum)]				
		5	10	15	30	60
PaO_2 (mmHg)	SV	95.1 (78.1-104.0)	90.8 (81.1-99.0)	89.1 (76.3-100.0)	92.2 (79.6-101.0)	96.0 (79.7-102.0)
	CMV	93.8 (88.3-104.0)	92.3 (88.2-108.0)	89.9 (86.4-98.8)	88.4 (82.3-92.6)	91.2 (84.6-103.0)
	RM1	96.9 (86.6-115.0)	91.5 (84.9-110.0)	89.5 (80.8-106.0)	86.9 (80.5-104.0)	87.0 (77.9-103.0)
	RM2	89.1 (87.6-102.0)	88.7 (82.8-96.3)	86.6 (78.8-102.0)	82.6 (78.3-90.2)	85.5 (81.3-90.0)

References

García-Sanz V, Aguado D, Gómez de Segura IA et al. (2019) Comparative effects of open-lung positive end-expiratory pressure (PEEP) and fixed PEEP on respiratory system compliance in the isoflurane anaesthetised healthy dog. *Res Vet Sci* 127, 91-98.

Acknowledgements

The authors thank Radiometer for equipment support and providing blood gas analysis material. The authors acknowledge technical support provided by the Clinical Biopathology Service, Veterinary Teaching Hospital, Complutense University of Madrid, Spain. One of the authors (VGS) was the recipient of a scholarship from the Complutense University of Madrid (PhD program UCM CT27/16-CT28/16).

115:15

A non-randomised prospective investigation on the optimal pre-operative insulin and fasting regimen for diabetic dogs undergoing cataract surgery: preliminary results

Norgate DJ

The Royal Veterinary College, UK

Current recommendations regarding the anaesthetic management of diabetic dogs are inconclusive or limited to clinician-dependent protocols. The aim of this study was to compare two protocols regarding their effects on perioperative complications and blood glucose (BG) stability.

Twenty-three diabetic dogs anaesthetised for phacoemulsification were enrolled. Dogs in group AM (n=10) were fasted overnight, received 50% of their usual insulin morning dose and underwent surgery between 9.30 and 10.30 am. Dogs in group PM (n=13) received 75% of their regular food with their full insulin morning dose, were fasted for 6 hours and underwent surgery between 1.00 and 2.00 pm. Preoperative serum fructosamine and diabetic clinical score, baseline BG before premedication, perioperative BG every 30 minutes and blood electrolyte concentrations if BG was > 20 mmol L⁻¹ were measured. Data were analysed with one-way repeated measures ANOVA, Holm-Sidak method, and Fisher exact test.

Baseline BG concentrations were not significantly different between groups AM (19.42 ± 7.8 mmol L⁻¹) and PM (13.0 ± 7.9 mmol L⁻¹). In group AM, BG remained unchanged, while in group PM it was significantly increased, compared to baseline, at 120 (15.4 ± 8.5 mmol L⁻¹), 150 (19.2 ± 9.5 mmol L⁻¹) and 180 (17.7 ± 10.6 mmol L⁻¹) minutes after induction and at extubation (17.0 ± 8.9 mmol L⁻¹). The incidence of complications was not significantly different between groups.

Anaesthetising diabetic dogs in the morning after overnight fasting and half the usual insulin dose may enhance short-term BG stability compared with 6-hour-fasting following a full usual insulin dose.

115.16

Effects of ketamine or dexmedetomidine continuous rate infusions on propofol total intravenous anaesthesia requirements in healthy dogs undergoing orthopaedic procedures receiving epidural anaesthesia: a randomized clinical trial.

Bustamante R, Canfrán S, Gómez de Segura IA, Aguado D

Department of Animal Medicine and Surgery, Veterinary Teaching Hospital, Veterinary Faculty, Complutense University of Madrid, Madrid, Spain

Balanced anaesthesia with propofol total intravenous anaesthesia (TIVA) in dogs is advisable. This study aimed to evaluate the effects of ketamine or dexmedetomidine constant rate infusions (CRIs) on intraoperative propofol TIVA requirements and recovery quality in healthy dogs undergoing orthopaedic surgery receiving epidural anaesthesia.

In a blinded, randomized, clinical trial, 39 dogs were premedicated IM with dexmedetomidine ($4 \mu\text{g kg}^{-1}$) and methadone (0.3 mg kg^{-1}). Anaesthesia was induced (dose-effect) and maintained with propofol ($18 \text{ mg kg}^{-1} \text{ hour}^{-1}$), adjusted thereafter to maintain a suitable anaesthetic depth. Dogs also received either IV saline (P; loading dose 1 mL kg^{-1} , CRI $1 \text{ mL kg}^{-1} \text{ hour}^{-1}$), ketamine (PK; 1.5 mg kg^{-1} , CRI $1.5 \text{ mg kg}^{-1} \text{ hour}^{-1}$), or dexmedetomidine (PD; $1 \mu\text{g kg}^{-1}$, CRI $1 \mu\text{g kg}^{-1} \text{ hour}^{-1}$), and epidural bupivacaine (1 mg kg^{-1}) and morphine (0.1 mg kg^{-1}). Anaesthetic recovery quality was assessed through a 0 (very calm) to 4 (extreme excitement) scale. ANOVA, Kruskal-Wallis, or Chi squared tests were used as appropriate ($p < 0.05$).

Averaged propofol infusion rates were similar: 14.3 ± 3.5 , 14.0 ± 5.0 and $14.1 \pm 4.3 \text{ mg kg}^{-1} \text{ hour}^{-1}$ for groups P, PK and PD respectively. Controlled ventilation ($\text{Pe}'\text{CO}_2 > 55 \text{ mmHg}$) was more frequently required in group PK (12 dogs) compared to both P and PD (7 dogs group⁻¹). Recovery quality scores were similar: 0-1 in 11 dogs group⁻¹.

Ketamine or dexmedetomidine CRIs, at the studied doses, did not reduce propofol TIVA requirements or provide additional clinical advantages in dogs undergoing orthopaedic surgery with epidural anaesthesia.

Acknowledgements

One of the authors (RB) was the recipient of a scholarship from the Complutense University of Madrid (PhD program UCM CT45/15 - CT46/15).

Posters 1-25

Poster 1

Comparison of tracheal, esophageal and rectal temperature in spontaneously and artificially ventilated non-heated dogs

Novak L, Rauser P, Burova J, Stankova L, Rado M

Small Animal Clinic, Faculty of Veterinary Medicine, University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic

We assumed that hypothermia occurs faster in artificial ventilation compared to spontaneous breathing.

Twenty-seven non-heated dogs were breathing spontaneously (SPO, n = 17) or artificially (ART, n = 10, FGF 50 mL kg⁻¹, FiO₂ 0.6, PIP 10 cmH₂O, PEEP 2 cmH₂O). Cardiorespiratory variables, tracheal, esophageal and rectal temperatures were measured after connecting to circle re-breathing system (T0) and subsequently in ten minutes intervals for sixty minutes (T10 – T60). The room temperature was 21 ± 1 °C. Dunnet and Tukey tests were used.

Temperature (mean ± SD)		T0 (°C)	T10	T20	T30	T40	T50	T60
Tracheal	SPO	37.4 ± 0.4	37.4 ± 0.6	37.3 ± 0.6	37.0 ± 0.5	36.7 ± 0.6*	36.5 ± 0.6*	36.3 ± 0.5*
	ART	37.6 ± 0.5	37.6 ± 0.6	37.2 ± 0.6	37.0 ± 0.7	36.8 ± 0.7*	36.6 ± 0.7*	36.5 ± 0.7*
Esophageal	SPO	38.7 ± 0.5	38.8 ± 0.5	38.5 ± 0.4	38.1 ± 0.5	37.8 ± 0.5*	37.6 ± 0.6*	37.4 ± 0.6*
	ART	38.9 ± 0.3	38.8 ± 0.4	38.5 ± 0.4	38.2 ± 0.5*	37.9 ± 0.6*	37.7 ± 0.6*	37.5 ± 0.7*
Rectal	SPO	38.5 ± 0.4	38.4 ± 0.4	38.4 ± 0.5	38.1 ± 0.5	37.8 ± 0.7*	37.6 ± 0.7*	37.4 ± 0.8*
	ART	38.7 ± 0.5	38.6 ± 0.6	38.4 ± 0.6	38.2 ± 0.6	38.0 ± 0.6	37.8 ± 0.8*	37.6 ± 0.7*

* significantly lower compared to T0

No significant differences were detected in measured temperatures between spontaneous breathing and artificial ventilation.

Supported by the Ministry of Education, Youth and Sports of the Czech Republic (Research Project IGA VFU No. 106/2020/FVL).

Poster 2

Incorporation of a 3D-printed feline larynx model as a teaching tool for veterinary students

Sakai DM¹, Skrzypczak HE¹, Nejamkin P², Clausse M², Bullant C³, Genaro A⁴, Clausse A³, Del Sole MJ²

¹Department of Small Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, USA

²Hospital Escuela de Pequeños Animales, Universidad Nacional del Centro de la Provincia de Buenos Aires, Argentina

³Instituto de Plasmas Densos, Universidad Nacional del Centro de la Provincia de Buenos Aires, Argentina

⁴Instituto de Profesorado de Arte Tandil, Universidad Nacional del Centro de la Provincia de Buenos Aires, Argentina

Endotracheal intubation (EI) in cats is associated with risk of mortality (Brodgelt *et al.*, 2007). This can be decreased with simulation-based training. We evaluated the implementation of a low-cost feline larynx model (LaryngoCUBE 2019) as a training device for veterinary students.

The students received either standard training (ST, n = 22) or trained with a larynx model the day prior to anesthesia (MT, n = 16). Veterinary students practiced EI in cats sedated with dexmedetomidine and hydromorphone and anesthetized with propofol. They attempted EI and evaluated the difficulty with a visual analogue score (VAS; 0 cm = very easy and 10 cm = extremely difficult). Up to three attempts were permitted. For successful EI, we measured the time and number of attempts. Fisher's exact and Mann-Whitney tests compared groups with alpha at 5%.

The VAS [median (minimum – maximum)] on the ST and MT were 4.5 (0.0 – 10.0) cm and 3.0 (0.2 – 10.0) cm, respectively (p = 0.029). The failure rate was 27% on the ST and 25% on the MT (p = 1.000). The EI time on ST [58 (18 – 160) seconds] was longer, but not statistically different from MT [29 (13 – 120) seconds; p = 0.101]. The number of attempts on ST [2 (1 – 3)] was higher than MT [1 (1 – 3), p = 0.005].

Students that practiced with a larynx model found that EI was easier, took less attempts for EI, and tended to be faster. However, EI success rate in MT was not improved.

References

Brodgelt, D. C. *et al.* (2007) Risk factors for anaesthetic-related death in cats: results from the confidential enquiry into perioperative small animal fatalities (CEPSAF). *Br J Anaesth*, 99:617–23.

LaryngoCUBE 2019, Hospital Escuela De Pequeños Animales website, viewed 9 December 2019, <www.vet.unicen.edu.ar/HEPA/investigacion/LaryngoCUBE>.

Poster 3

Redefining the recruiting airway pressure based on specific lung elastance in dogs

Araos J¹, Guacci E², Acquafredda C², Di Bella C², Stabile M², Lacitignola L², Grasso S², Crovace A², Staffieri F²

¹Department of Clinical Sciences, Section of Anesthesiology and pain medicine, Cornell University, College of Veterinary Medicine, Ithaca, NY, USA

²Section of Veterinary Clinics and Animal Production, D.E.O.T., University of Bari, Bari, Italy

Specific lung elastance (SLE) is the transpulmonary pressure (PTP) at which lung volume doubles functional residual capacity and is unknown in dogs. Recruiting airway pressure (RAP) aims at reaching total lung capacity at PTP 1.5 times the SLE. Aim of this study was to determine the SLE in dogs and evaluate CT-scan characteristics of lungs at an SLE-based RAP.

In 28 mechanically ventilated clinical dogs of different breeds undergoing thoracic CT, esophageal pressure was monitored. SLE was estimated as $PTP / (V_t/EELV)$, where EELV corresponds to end-expiratory lung volume, as determined by CT-scan (Chiumello et al. 2008). Ratio of lung and respiratory system elastances (EI/Ers) was also determined. In the second part of the study 7 dogs underwent full thoracic CT-scan at end-expiration (EE) and at end-inspiration (EI) for clinical reasons, with a RAP calculated as $1.5 * SLE/(EI/Ers)$ using the mean SLE, EI/Ers previously determined (Caironi et al. 2011). Lung aeration was determined at EE and EI. Data were analyzed by one-way ANOVA ($p < 0.05$).

The SLE and EI/Ers were 8.8 ± 3.0 cmH₂O and 0.46 ± 0.06 . Accordingly, the target RAP used for the EI-CT was 29.3 cmH₂O. At EI compared to EE, percentage of hypoaerated (3.5 ± 0.9 vs 12.2 ± 9.5) and nonaerated tissue was lower (0.5 ± 0.2 vs 1.1 ± 0.6) while hyperaerated tissue was higher (19.2 ± 15.6 vs 0.5 ± 0.3).

A RAP of approximately 30 cmH₂O is effective in reducing poorly and nonaerated lung tissue in dogs.

References

Caironi P, Langer T, Carlesso E et al. (2011) Time to generate ventilator-induced lung injury among mammals with healthy lungs: a unifying hypothesis. *Intensive Care Med* 37, 1913-1920.
Chiumello D, Carlesso E, Cadringher P et al. (2008) Lung stress and strain during mechanical ventilation for acute respiratory distress syndrome. *Am J Respir Crit Care Med* 178, 346-355.

Poster 4

Ultrasound-guided erector spinae plane (ESP) block in horses: a cadaveric study

Bautista Díaz-Delgado O¹, Louro LF¹, Rocchigiani G², Verin R², Humphreys W¹, Senior JM³, Campagna J⁴

¹Department of Small Animal Clinical Science. University of Liverpool

²Institute of Ageing and Chronic Disease. Veterinary Pathology. University of Liverpool.

³Department of Equine Clinical Science. University of Liverpool.

⁴Department of Small Animal Clinical Science & Equine Clinical Science. University of Liverpool.

This study aimed to describe the distribution of dye and spinal nerve involvement after a simulated ESP block as it could potentially be performed to diagnose and treat kissing spines.

In 10 fresh dead horses ($549.5 \pm 58\text{kg}$), 0.2 ml kg^{-1} of a 50:1 lidocaine 2%: yellow permanent tissue marking dye solution was injected bilaterally ($n=20$ injections) into the plane between the 16th thoracic transverse process and the erector spinae muscles using a 20G 18cm long spinal needle. An in-plane ultrasound-guided technique with a linear transducer orientated longitudinally was used.

Dissection was performed. The extent of dye spread was documented in cephalocaudal and lateral directions as were thoracic and abdominal cavity and possible epidural space contamination for all injections. For twelve injections, further dissection was performed to evaluate if staining of the ventral (VR) and dorsal (DR) rami of the spinal nerves and sympathetic chain (SC) occurred.

The thoracolumbar fascia was stained in 17/20 injections. Three injections terminated intramuscularly. No evidence of dye was found in the thoracic and abdominal cavity nor on the SC. Epidural migration was observed in 4/20 of the injections. Multi-segmental staining of the DR and VR was observed.

ESP block may prove beneficial to desensitize structures innervated by the DR and VR of the thoracic spinal nerves. Further investigation is needed to evaluate complications due to epidural contamination.

Poster 5

Effect of oral-transmucosal cannabidiol on pain and quality of life in dogs affected by osteoarthritis

Brioschi FA¹, Rabbogliatti V², Gioeni D², Di Cesare F³, Valentini Visentin M¹, Ravasio G¹

¹ Department of Veterinary Medicine, Università degli Studi di Milano, Milan, Italy.

² Department of Veterinary Medicine, Centro Clinico Veterinario e Zootecnico Sperimentale, Università degli Studi di Milano, Milan, Italy.

³ Department of Health, Animal Science and Food Safety, Università degli Studi di Milano, Milan, Italy.

The aim of this study was to evaluate the analgesic efficacy of oral-transmucosal (OTM) cannabidiol in dogs affected by osteoarthritis-related chronic pain.

Dogs received oral firocoxib (standard down-titration) and gabapentin (10 mg kg⁻¹ every 12 hours) and were randomly divided into 2 groups. Dogs in group CBD (n = 6) received OTM cannabidiol oil (2 mg kg⁻¹ every 12 hours), while in group C (n = 6) cannabidiol was not administered. Treatments lasted three months. Pain Severity Score (PSS), Pain Interference Score (PIS) and Quality of Life (QoL) were evaluated by owners with Canine Brief Pain Inventory before treatment initiation (T0) and one (T1), two (T2), four (T3) and twelve (T4) weeks thereafter. Data were analysed using Shapiro-Wilk test and Student's t-test.

Baseline scores for PSS, PIS and QoL were similar among groups. PSS was significantly lower in CBD than in C group at T1 (3.8 ± 1.1 versus 6.0 ± 1.6), T2 (3.7 ± 0.9 versus 5.5 ± 1.7) and T4 (3.3 ± 1.3 versus 5.5 ± 1.7). PIS was significantly lower in CBD than in C group at T1 (2.9 ± 1.1 versus 6.7 ± 1.2), T2 (3.1 ± 1.1 versus 6.5 ± 1.1), T3 (3.0 ± 1.2 versus 5.4 ± 1.6) and T4 (3.7 ± 1.4 versus 6.3 ± 1.2). QoL was significantly higher in CBD group at T1 (3.5 ± 0.5 versus 2.1 ± 0.7).

Despite both groups' improvement, OTM cannabidiol enhanced pain relief and quality of life in osteoarthritic dogs submitted to multimodal pharmacological treatment.

Poster 6

Clinical comparison of continuous rate infusion and subcutaneous administration of dexmedetomidine in isoflurane anesthetized horses.

Rabbogliatti V.¹, Brioschi F.A.², Di Cesare F.³, Gioeni D.¹, Amari M.², Spediacci C.², Ravasio G.².

¹ Department of Veterinary Medicine, Centro Clinico Veterinario e Zootecnico Sperimentale, Università degli Studi di Milano, Italy

² Department of Veterinary Medicine, Università degli Studi di Milano, Milan, Italy

³ Department of Health, Animal Science and Food Safety, Università degli Studi di Milano, Milan, Italy

In humans, dexmedetomidine is efficiently absorbed following subcutaneous administration (Tobias 2008; Uusalo et al. 2018).

The aim of the study is to compare dexmedetomidine administered by continuous rate infusion (CRI) or SC on cardiopulmonary function and recovery during equine general anaesthesia.

Horses received acepromazine 0.03 mg kg⁻¹ and detomidine 10 µg kg⁻¹ IV. Anaesthesia was induced by intravenous diazepam/ketamine and maintained with isoflurane in 60% oxygen by mechanical ventilation. Seven horses each randomly received IV dexmedetomidine CRI 1 µg kg⁻¹ hour⁻¹ (CRI group) or 2 µg kg⁻¹ by SC (SC group). Dobutamine was administered IV. Physiological parameters, end-tidal gas concentrations and arterial blood gases were measured. Recovery was assessed using Young and Taylor's scale.

Data normal distribution was tested with Kolmogorov-Smirnoff test. Student's *t* test or Mann-Whitney and ANOVA were applied. Significance $p \leq 0.05$.

No difference in anaesthesia time (minutes) (CRI 139 ± 9.7; SC 144 ± 16.2), recovery score (CRI 1.8 ± 1.2; SC 1.5 ± 0.5), extubation time (minutes) (CRI 11.5 ± 5.0; SC 9.7 ± 2.6), to attain sternal (minutes) (CRI 41.5 ± 12.2; SC 49.7 ± 6.0) and standing (minutes) (CRI 50.7 ± 14.6; SC 57.2 ± 6.0) were detected. There was significant difference in urine output (mL Kg⁻¹ hour⁻¹) (CRI 6.4 ± 1.8; SC 9.9 ml ± 3.8) and dobutamine rate (µg kg⁻¹ min⁻¹) (CRI 0.89 ± 0.35 SC 0.56 ± 0.18).

Dexmedetomidine administered either by CRI or SC at indicated dosages, showed similar effect and proved to be useful for balanced equine isoflurane anaesthesia.

References

Tobias JD, (2008) Subcutaneous dexmedetomidine infusions to treat or prevent drug withdrawal in infants and children *J Opioid Manag.* 2008 Jul-Aug;4(4):187-91.

Uusalo P, Al-Ramahi D, Tilli I, et al. (2018) Subcutaneously administered dexmedetomidine is efficiently absorbed and is associated with attenuated cardiovascular effects in healthy volunteers, *Eur J Clin Pharmacol.* 74(8):1047-1054.

Poster 7

Clinical assessment of haemodynamic variables measurement using transthoracic echocardiography and oesophageal Doppler monitor in anaesthetized dogs: a preliminary study

Sáñdez I.¹, Serrano S.¹, Redondo J.I.², Otero P.E.³

¹Hospital Veterinario Vetsia. Leganés. Madrid (España)

²Universidad CEU Cardenal Herrera. Facultad de Veterinaria. C/Tirant Lo Blanch 7. 46115. Alfara del Patriarca. Valencia (España)

³Universidad de Buenos Aires, Facultad de Ciencias Veterinarias. Cátedra de Anestesiología y Algología, Buenos Aires (Argentina)

Doppler measurement of aortic flow velocity has been used as a non-invasive index of left ventricle performance.

The aim of this study was to assess the agreement of aortic velocity integral time (VTi), peak velocity (PVa) and minute distance (MDa) obtained with trans-thoracic echocardiography (TTE) and trans-oesophageal Doppler CardioQ-ODM (ED) in anaesthetized dogs. The hypothesis was that the ED will be an acceptable alternative technique to TTE.

Fourteen mixed breed dogs undergoing general anaesthesia for diagnostic or therapeutic procedures were enrolled in the study. Anaesthetic protocol was: preanaesthesia with dexmedetomidine (2-3 $\mu\text{g kg}^{-1}$ IM) and methadone (0.2-0.3 mg kg^{-1} IM), induction with propofol (2-3 mg kg^{-1} IV) and maintenance with isoflurane in O_2 . In order to obtain ETT variables, a SonoSite Micromaxx ultrasound device with a cardiac ultrasound probe (5-2 MHz) was used. With the animal positioned in dorsal recumbency, the probe was placed in the subcostal window. To obtain ED variables, an oesophageal Doppler CardioQ-ODM probe was used.

Agreement between methods was determined using their paired data employing the Bland-Altman method with single observation per individual where the true value is non-constant. The absolute differences between methods and the 95% limits of agreement [95% LOA] between the two methods were established.

Mean differences (ED minus TTE measurements) and 95% LOA were: VTi: -0.19 [-3.32 – 2.95] cm; PVa: 10.83 [-20.50 - 42.16] m sec^{-1} ; MDa: -3.6 [-222.92 - 215.72] m sec^{-2} .

In conclusion, no differences between both methods were found in normovolaemic anaesthetized dogs without valvular disease, in dorsal recumbency.

Reference

Sohn S, Kim HS, Han JJ (2002) Doppler flow velocity measurement to assess changes in inotropy and afterload: a study in healthy dogs. *Echocardiography* Apr;19(3):207-13.

Poster 8

The influence of four different partial intravenous anesthesia techniques on the stress response to surgery in isoflurane-anesthetized horses

Masako Fujiyama BVSc¹, Teela Jones DVM, MSc¹, Tanya Duke-Novakovski BVetMed, MSc¹

¹Departments of Small Animal Clinical Sciences and Veterinary Biomedical Sciences, Western College of Veterinary Medicine, 52 Campus Dr, Saskatoon, SK, Canada S7N 5B4

Stress response occurs during anesthesia and surgery, inducing neurohormonal changes. Stress response to elective surgeries in isoflurane-anesthetized horses using four different protocols was evaluated.

Fifty-one horses anesthetized with isoflurane were assigned to one of four groups. Group D ($n = 13$) received dexmedetomidine ($1 \mu\text{g kg}^{-1} \text{ hour}^{-1}$); group DB ($n = 13$) received dexmedetomidine ($1 \mu\text{g kg}^{-1} \text{ hour}^{-1}$) with butorphanol (0.05 mg kg^{-1}); group DR ($n = 13$) received dexmedetomidine ($1 \mu\text{g kg}^{-1} \text{ hour}^{-1}$) with remifentanyl ($3 \mu\text{g kg}^{-1} \text{ hour}^{-1}$); group MK ($n = 12$) received morphine (0.15 mg kg^{-1} and $0.1 \text{ mg kg}^{-1} \text{ hour}^{-1}$) with ketamine ($0.6 \text{ mg kg}^{-1} \text{ hour}^{-1}$). Romifidine (0.025 mg kg^{-1}) was given for recovery. Serum was collected before anesthesia (baseline), 10 minutes after induction, every 30 minutes during surgery, and 1 hour after standing. Linear mixed models compared cortisol, insulin, glucose, and non-esterified fatty acids (NEFA) concentrations between groups and to baseline within groups. Kruskal-Wallis test compared recovery quality (subjective); significance $p < 0.05$.

Group MK had significantly higher cortisol during surgery than group D (143.9 ± 73 ; 104.8 ± 48 ; [30 minutes]; 196.5 ± 102 ; 107.2 ± 38 [60 minutes]), respectively ($p = 0.008$). Group D had significantly higher cortisol post-operatively than during surgery. Insulin was significantly higher in group D than group DB post-operatively. In all groups, glucose was significantly higher during surgery than baseline or after induction, NEFA, recovery score and anesthesia time were not significantly different, and insulin significantly increased post-operatively compared to baseline.

No clinical difference was observed between groups.

Poster 9

The clinical utility of a human oscillometric blood pressure monitor in dogs during general anaesthesia

Porter SE, Breheny C, Duncan J
The University of Edinburgh, UK

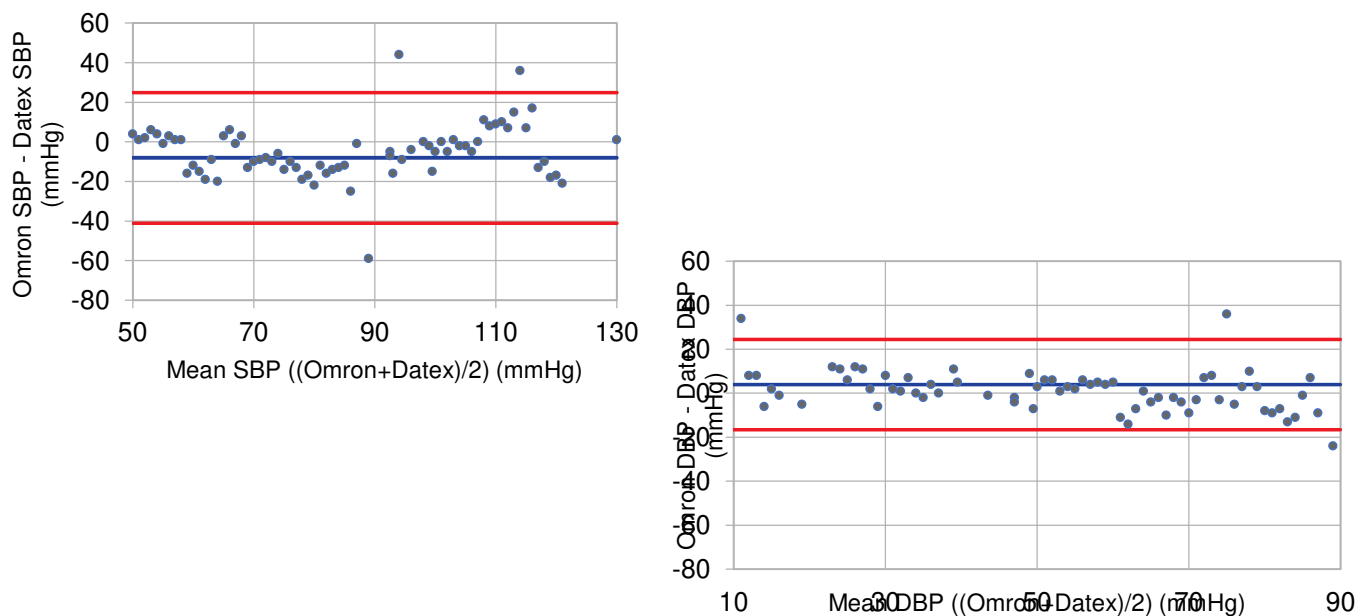
The aim of this study was to determine the agreement between an affordable human oscillometric blood pressure monitor (Omron M2 Basic) and an oscillometric monitor (Datex-Ohmeda S/5) used commonly in our small animal hospital in dogs during general anaesthesia.

A prospective, observational clinical study was undertaken. Seventeen dogs aged 73 ± 43 months (mean $\pm$ SD) weighing 25 ± 10 kg (mean $\pm$ SD) were anaesthetised for different procedures with varying anaesthetic protocols. Each dog had up to 10 measurement pairs of systolic blood pressure (SBP), diastolic blood pressure (DBP), and PR recorded using the two monitors on contralateral limbs. Pearson's correlation coefficient was calculated, and a Bland-Altman plot was used to assess agreement (Bland and Altman 2007).

Out of a total of 153 measurement pairs, the Omron failed in 34 measurements (22%). Pearson's correlation coefficient ($P < 0.001$) showed a strong positive correlation for PR (0.95) and moderate correlation for SBP (0.46) and DBP (0.69). The Bland-Altman plot for SBP had a mean difference (bias) of -8.1 mmHg and 95% limits of agreement (LoA) of ± 33 mmHg. For DBP, the bias was 3.9 mmHg and the LoA was ± 21 mmHg.

Systolic BP, more useful clinically, showed poorer agreement than DBP. Pulse rate had excellent correlation, which is a good starting point. More work is needed to determine the Omron monitor's clinical utility, such as including abnormal blood pressure ranges.

Figures. Bland-Altman plots of Omron and Datex SBP and DBP measurements. Blue line = bias, red lines = LoA.



References

Bland, JM, Altman, DG. (2007) Agreement Between Methods of Measurement with Multiple Observations Per Individual. *Journal of Biopharmaceutical Statistics* 17, 571-582.

Poster 10

A comparison of epidural anaesthesia with lidocaine, ropivacaine and lidocaine-ropivacaine in West African Dwarf goats

Oguntoye CO¹, Eyarefe OD¹, Adewale F¹, Sogebi EAO², Olaifa AK¹

¹Department of Veterinary Surgery and Radiology, University of Ibadan, Ibadan, Nigeria

²Department of Veterinary Medicine and Surgery, Federal University of Agriculture, Abeokuta, Nigeria

Combinations of local anaesthetic drugs have been used to produce epidural anaesthesia with possible advantages over single drugs.

In a prospective crossover study, four goats received epidural injections of lidocaine (2 mg kg⁻¹), ropivacaine (1 mg kg⁻¹) and their combination (1 mg kg⁻¹; 0.5 mg kg⁻¹), respectively. Goats were manually restrained, and a skin bleb was made over the lumbosacral junction with 1 ml lidocaine following identification and aseptic preparation to achieve painless epidural puncture. Vital parameters were measured before treatment, then every ten minutes until recovery. Onset and duration of analgesia, duration of recumbency, and time to stand were recorded. Analgesia was assessed by serial skin pinpricks of areas caudal to the umbilicus. Student t-test was used for comparison and ANOVA used for repeated measures ($p \leq 0.05$).

There were no significant differences in the goats' vital parameters between the three treatments. Onset of analgesia was significantly longer with lidocaine-ropivacaine (6.25 ± 2.22 minutes) than with ropivacaine (3.50 ± 1.73 minutes) and lidocaine (3.00 ± 1.63 minutes). Duration of analgesia was longer with lidocaine-ropivacaine (168.50 ± 45.53 minutes) than with lidocaine (98.00 ± 26.65 minutes), but shorter than with ropivacaine (229.25 ± 33.54 minutes). Respective values for duration of recumbency and time to standing were intermediate with lidocaine-ropivacaine (137.00 ± 57.87 ; 200.50 ± 37.17 minutes); longest with ropivacaine (167.00 ± 55.94 ; 281.25 ± 23.77 minutes) and shortest with lidocaine (80.75 ± 28.27 ; 130.50 ± 24.72 minutes).

In conclusion, epidural ropivacaine appears best suited for long surgical procedures.

Poster 11

Prolonged anaesthesia of New Zealand White rabbits

Musk GC

University of Western Australia, Australia

The aim of this opportunistic study was to document physiological changes during prolonged anaesthesia of rabbits.

Eight male New Zealand White rabbits were anaesthetised twice for a pharmacokinetic study with a two week wash out period between each anaesthetic. The rabbits were anaesthetised with isoflurane in 100% oxygen via a facemask and then an endotracheal tube through a non-rebreathing system. The rabbits breathed spontaneously during anaesthesia. A circulating warm air blanket was used to prevent hypothermia. Multiple variables were monitored: haemoglobin saturation, pulse rate, rectal temperature, non-invasive blood pressure, respiratory rate, and expired CO₂. Arterial blood gas samples were collected intermittently to measure PaCO₂, PaO₂, blood glucose concentration and haematocrit. Data were compared by repeated measures one-way ANOVA.

The rabbits weighed 3.1 ± 0.2 kg and were anaesthetised for 271 ± 21 minutes. During anaesthesia haemoglobin saturation, pulse rate, rectal temperature, blood pressure and respiratory rate were stable. There was no change during anaesthesia in selected measured variables (Table 1). Recovery from anaesthesia was uneventful.

Selected variables	Baseline	+ 2 hours	+ 4 hours	p value
Expired CO ₂ (mmHg)	33 ± 4.9	31.3 ± 4.7	29.6 ± 5.8	0.287
PaCO ₂ (mmHg)	40.5 ± 2.7	37.8 ± 3.3	38 ± 3.4	0.055
PaO ₂ (mmHg)	343.4 ± 66.7	357.6 ± 68.2	350.2 ± 78.1	0.378
Blood Glucose (mmol/L)	9.8 ± 1.0	9.0 ± 1.3	10.2 ± 1.3	0.029
Haematocrit	0.38 ± 0.04	0.36 ± 0.02	0.36 ± 0.02	0.331

Prolonged anaesthesia in rabbits did not cause hypercapnia, hypoxaemia, hypoglycaemia or anaemia.

Poster 12

Effect of repeated disinfection protocols on the mechanical compliance of cuffed polyvinylchloride endotracheal tubes

Gatson BJ, Lopez W

University of Florida, College of Veterinary Medicine, USA

Commonly used disinfectants may change the physical characteristics of polyvinylchlorides (PVC) that comprise endotracheal tubes (ETTs), possibly altering cuff compliance after repeated exposure. Fifty-five sterilized PVC cuffed 8.0 ID ETTs from one manufacturer were used. Each ETT was randomly subjected to: no repurposing (Control, n = 5), 30-minute immersion in 0.05% chlorhexidine solution repeated 1 to 5 times (CH, n = 5 each time), or ethylene oxide treatment repeated 1 to 5 times (EO, n = 5 each time). Using a calibrated transducer, peak intra-cuff pressure (Pcuff) was measured for each 1 mL of air added to the cuff through a tested leak-tight port from 1 to 40 mL. After 40 mL, air was removed and Pcuff measurements were repeated for 3 total inflations. Repeated measures ANOVAs were performed and $p < 0.05$ was considered significant. The Pcuff at each cuff volume was compared between controls and CH (1-5) or EO (1-5) per inflation group. The Pcuff significantly decreased in CH3 compared to CH1 and control groups for cuff volumes above 22 mL for the second inflation ($p < 0.05$) and above 17 mL for the third inflation ($p < 0.05$). Changes in Pcuff were insignificant between EO1-5 and controls for each inflation group. The Pcuff significantly decreased ($p < 0.0001$) in each treatment group with increasing repetitive inflations. Repeated CH disinfection, but not EO, increased ETT cuff compliance only at high inflation volumes. No matter the disinfectant, repetitive high-volume ETT cuff inflation may loosen plastic bonding, thus increasing compliance.

Poster 13

Attitudes of Spanish-speaking veterinary anaesthesiologists towards the use of Total Intravenous Anaesthesia (TIVA) in dogs: a survey study

Bustamante R, Ortiz-Díez G, Canfrán S, Gómez de Segura IA, Aguado D

Department of Animal Medicine and Surgery, Veterinary Teaching Hospital, Veterinary Faculty, Complutense University of Madrid, Madrid, Spain

Use of total intravenous anaesthesia (TIVA) in veterinary medicine remains limited compared to volatile anaesthesia. This study aimed to evaluate attitudes of Spanish-speaking veterinary anaesthesiologists towards TIVA use in dogs.

A questionnaire was distributed among veterinary anaesthesia associations from Spain and Latin America, including questions regarding TIVA use, drugs employed, reasons for not using TIVA, opinion on TIVA compared to inhalational anaesthesia and preferred alternatives to isoflurane. Descriptive statistics and logistic regression analysis were performed.

A total of 300 responses were analysed and 92% of respondents had ever used TIVA (24% rarely, 36% sometimes, and 40% very frequently). Most of the respondents used propofol (98%). The main reasons for not using TIVA were a lack of user confidence (92%), unavailability of infusion pumps (32%), established anaesthetic protocol (32%), and technical difficulty (20%). Among the respondents using TIVA very often or always: a higher proportion of respondents considered TIVA easy to use (OR = 5.2; CI95:1.7-16.6; $p = 0.004$); also more respondents considered TIVA is neither more expensive (OR = 2.1; CI95:1.0-4.3; $p = 0.034$) nor more difficult to perform (OR = 2.5; CI95:1.3-4.9; $p = 0.006$) or to manage the equipment (OR = 3.3; CI95:1.4-7.8; $p = 0.008$) than inhalation anaesthesia. Considering a potential isoflurane shortage, respondents chose sevoflurane (59%) as the preferred alternative, followed by TIVA (47%).

Use of TIVA is widespread among Spanish-speaking veterinary anaesthesiologists and their attitudes towards it are moderately positive; however, it is not their first choice for isoflurane substitute.

Acknowledgements

One of the authors (RB) was the recipient of a scholarship from the Complutense University of Madrid (PhD program UCM CT45/15 - CT46/15). The authors acknowledge people who participated in the survey.

Poster 14

Description of a novel ultrasound guided peribulbar block in horses: a cadaveric study

Leigh H¹, Gonzalo Marcilla M¹, Esteve V², Gutierrez A², Martin T², Viscasillas J².

¹University of Edinburgh, ²Universidad Cardenal Herrera, CEU

Ultrasound guided (USG) peribulbar block (PB), described in dogs (Viscasillas et al., 2019) but not horses; may have application in facial and ocular surgery due to reduced risk of complications versus retrobulbar block (RB) (Shilo-Benjamini, 2019).

Landmarks for USG PB block were described in two equine cadaver heads. A micro-convex ultrasound probe was placed over the orbital fossa. The cone was visualized and needle advanced in-plane just before entering the cone; computed tomography (CT) imaging confirmed peribulbar contrast. Subsequently ten equine cadaver heads were randomised to two operators naïve to the USG PB, but with similar experience with ultrasonography and conventional “blind” RB. Both techniques were demonstrated once to the operators, after which they performed five USG PB and five RB each, unassisted. Contrast location and spread was evaluated by CT. Success was defined for USG PB as contrast inside the peribulbar space, and for RB as contrast inside the intraconal space. Success rate was 10/10 for USG PB, and 0/10 for RB. Of the retrobulbar injections, eight resulted in peribulbar contrast, and two in the masseter muscle. No difference was found in success between operators ($p < 0.05$).

The USG PB had a high success rate, the blind technique being unreliable. Clinically, the failed retrobulbar injections that were peribulbar may have still worked however more volume is needed in this space for adequate blockade (Shilo-Benjamini, 2019). The US technique was easily learnt and no potential complications were found. Further studies are needed to evaluate clinical use.

References

- Shilo-Benjamini, Y. (2019). A review of ophthalmic local and regional anesthesia in dogs and cats. *Veterinary Anaesthesia and Analgesia*, 46(1), pp.14–27.
- Viscasillas, J., Everson, R., Mapletoft, E.K. and Dawson, C. (2019). Ultrasound-guided posterior extraconal block in the dog: anatomical study in cadavers. *Veterinary Anaesthesia and Analgesia*, 46(2), pp.246–250.

Poster 15

Pilot study on placement and function of TetraGraph sensor for EMG based monitoring in horses

Wiklund M¹, Nyman GC¹, Lindh C²

¹Swedish University of Agricultural Sciences, Sweden

²Senzime, Sweden

Monitoring neuromuscular function is critical when neuromuscular blocking agents (NMBA) are used during anaesthesia. An electromyography (EMG) based neuromuscular sensor (TetraGraph) using train of four (TOF), has been developed for humans.

The aim of this study was to examine if the sensor works when placed on a hind limb. The sensor, which includes electrodes for both stimulation and monitoring, was evaluated on eight horses, six ponies and two Standardbred trotters, who were anaesthetized in another study. No NMBA were used. After review of the anatomy the superficial peroneal nerve on the lateral aspect of the hind limb proximal to the hock was selected for sensor placement. Anatomical landmarks and a peripheral nerve stimulator (PNS) (Stimpod NMS 410) were used. The sensor was evaluated on different types of skin preparation (clipped/not clipped).

Placement of the sensor was possible on all horses, with readings of a TOF ratio ~100%. The hair had to be removed (clipped) on all ponies to establish contact between the sensor and the skin. The use of anatomical landmarks for positioning of the sensor was successful in two horses, while the use of a PNS to locate the actual nerve was needed to correctly place the sensor in the remaining horses.

The TetraGraph sensor for EMG based monitoring was successfully placed on an equine hind limb and it was possible to record a TOF ratio. Next step is to evaluate the function of the equipment during NMB and surgery.

Poster 16

Comparison of two 2% lidocaine formulations following sciatic nerve blockade in rabbits

Pablo E. Otero, Prof, MV, PhD ¹, Andrea Zaccagnini MV ¹, Fernanda Sanchez MV ¹, José I Redondo García Prof. MV, PhD ², MV ¹, Diego A. Portela, MV, PhD ³, Samanta Waxam MV, PhD ^{1,4}

¹ Universidad de Buenos Aires. Facultad de Ciencias Veterinarias. Cátedra de Anestesiología y Algología, Buenos Aires, Argentina

² Servicio de Anestesia Hospital Clínico Veterinario Universidad CEU Cardenal Herrera, Valencia, Spain

³ Department of Comparative, Diagnostic, and Population Medicine College of Veterinary Medicine University of Florida, Gainesville (FL), USA

⁴ Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET), Argentina

Different formulations of local anesthetics are used to perform peripheral nerve blocks to optimize latency and duration of effect. The aim of this study was to assess two different formulations of lidocaine following ultrasound-guided sciatic nerve blockade in rabbits.

Eight New Zealand rabbits, weighing 3.0 ± 0.7 kg were anesthetized (midazolam 2 mg kg^{-1} IM, and isoflurane via face mask). An ultrasound-guided lateral sciatic nerve block was performed with 0.1 mL kg^{-1} of either a lidocaine 2% solution or a lidocaine 2% gel formulation, randomly assigned to the left or right hindlimb. The blockade was assessed in each hindlimb by evaluating the withdrawal reflex in every toe. A nociceptive stimulus was applied every 60 seconds over the distal phalanx of each toe with a hemostatic clamp by closing it to the first ratchet for 1 second. Latency was defined as the time from administration to the first lack of response to the nociceptive stimulus. Duration of effect was defined as the time from latency to the moment the withdrawal reflex is recovered in all toes. Normality was assessed by means of a Shapiro-Wilk test. The results were compared by means of a paired T-test.

Both latency and duration of action were significantly longer after the gel formulation administration (latency: 5 ± 1.93 and 9.75 ± 3.45 minutes, duration of action: 49.25 ± 11.23 and 79 ± 23.84 minutes, for solution and gel formulations, respectively).

Lidocaine gel formulations may be useful to enhance the duration of action of peripheral nerves blockades.

Funding: UBACyT 20020160100040BA

Poster 17

A comparative pilot study of two different techniques for monitoring neuromuscular blockade in dogs

Ferrari D¹, Sverud J¹, Nyman G¹, Ström L¹, Wiklund M¹, Lindh C²

¹Swedish University of Agricultural Sciences, Sweden

²Senzime, Sweden

Tetragraph, a new human neuromuscular blockade (NMB) electromyography (EMG) monitor, was compared to Stimpod NMS 410, an acceleromyography (AMG)-based device in a pilot study analysing both the applicability and the reliability of Tetragraph in dogs.

A pre-study was performed on two beagles to identify correct positioning of sensors in regard to anatomical landmarks; the peroneus communis nerve was localized with percutaneous electric guidance pen. The adhesive sensor of Tetragraph was applied on clipped skin so that the stimulating electrode was localized on the nerve. The recording sensors were placed on the tibialis cranialis muscle and over its insertion. Six anesthetised beagles placed in dorsal recumbency received an IV bolus of 0.4 mg kg⁻¹ Rocuronium, followed by an infusion at 0.2 mg kg⁻¹ hour⁻¹ during mechanical ventilation. Tetragraph and Stimpod NMS 410 were placed on a randomly chosen hindlimb. Neuromuscular blockade was measured simultaneously with the two devices and recorded every minute for one hour.

Application of Tetragraph on patients was fast and simple, exclusive of the time necessary for hair clipping. Results were analysed with a paired t-test and showed in Table 1.

The time for T2-T4 recovery was significantly shorter when measured with AMG compared to the Tetragraph, but no significant difference in time for train of four ratio >0,90 was evidenced.

Table 1

	T2 recovery in min	T4 recovery in min	TOF ratio >0.90 in min
AMG	14.33 ± 3.61	17.00 ± 4.51	27.50 ± 5.09
EMG	16.66 ± 3.38	19.50 ± 4.55	29.67 ± 4.68

Poster 18

Tracheal extubation complication following surgical repair of a traumatic tracheal laceration in a dog

Lucy Miller, Sam Pryke, Ambra Panti & Miguel Gozalo-Marcilla

Royal (Dick) School of Veterinary Studies, The University of Edinburgh

Endotracheal tube (ETT) transfixation is a reported complication of tracheal extubation in humans (Hartley & Vaughan 1993) and while other causative human errors are documented in the veterinary literature (Boveri & Brearley 2015), this differential requires consideration.

A four-year-ten-month-old female entire Yorkshire terrier crossbreed weighing 3.7 kg presented for investigation of diffuse subcutaneous emphysema secondary to cervical trauma. Following intravenous premedication (methadone 0.2 mg kg⁻¹ and dexmedetomidine 2.0 µg kg⁻¹), general anaesthesia (GA) was induced with 5.5 mg kg⁻¹ propofol intravenously. The trachea was intubated with a cuffed 6 mm ETT and GA was maintained with isoflurane vaporised in oxygen, delivered via a Jackson Rees modified Ayre's T-piece. Computed tomography revealed tracheal collapse, pneumomediastinum and pneumothorax. Surgical exploration of the ventral neck identified a 10 cm tracheal laceration requiring suture apposition. In recovery, tracheal extubation was not possible and observation of blood within the deflated pilot balloon led to suspicion of cuff transfixation.

Suture removal under GA enabled free ETT movement and the laceration was resutured with the ETT tip positioned at the proximal trachea, preventing its entry into the surgical field. Unsuccessful attempts to readvance the ETT into the trachea suggested that the laceration had initially allowed enhanced luminal expansion. Consequently, the trachea was intubated with a cuffed 4.5 mm ETT prior to uneventful recovery.

This case demonstrates that to reduce the risk of human error to animals undergoing GA for tracheal surgery, anatomical defect extent and location must be a considered factor in airway management.

References

Boveri S, Brearley JC (2015) *All in a tangle: A mishap with an oesophagostomy tube in an intubated cat.* *Vet Anaesth Analg* 42, 227-229.

Hartley M, Vaughan RS (1993) *Problems associated with Tracheal Extubation.* *British Journal of Anaesthesia* 71, 561-568.

Poster 19

Effects of two different alveolar recruitment manoeuvres in an “open lung” approach during laparoscopy in dogs

Di Bella C¹, Vicenti C¹, Lacitignola L¹, Stabile M¹, Acquafredda C¹, Grasso S², Crovace AM¹, Staffieri F¹

¹Section of Veterinary Clinics and Animal Production, D.E.O.T., University of Bari “Aldo Moro”, Bari, Italy

²Section of Anesthesia and Intensive Care, D.E.O.T., University of Bari “Aldo Moro”, Bari, Italy

The aim was to compare sustained inflation (ARMi) and stepwise (ARMc) alveolar recruitment manoeuvres (ARM) during laparoscopy in dogs.

Twenty dogs were anesthetised with methadone IM, propofol IV and inhaled isoflurane. Baseline ventilatory settings (BVS) were: V_T 15 mL kg⁻¹; *inspiratory pause* 25%; *I:E ratio* 1:2; FiO_2 1; *fr* to maintain $Fe'CO_2$ 45-55 mmHg. Parameters were evaluated 10 minutes after pneumoperitoneum (PP10) and 10 minutes after ARM (ARM10). ARMi was achieved maintaining an inspiratory pressure of 40 cmH₂O for 20 seconds. Thereafter, BVS plus 5 cmH₂O of PEEP was applied (Di Bella et al. 2018). The ARMc consisted in a stepwise increase of PEEP by 5 cmH₂O, reaching 40 cmH₂O maintaining a driving pressure of 10 cmH₂O. Optimal PEEP was set based on best compliance during decremental phase (Maisch et al. 2008). Statistical analysis was performed with ANOVA test ($p < 0.05$).

At ARM10, in ARMi, PaO_2/FiO_2 (450.9 ± 70.61 mmHg) and indexed static compliance ($C_{statind}$, 1.89 ± 0.59 mL cmH₂O⁻¹ kg⁻¹) were higher than PP10 (359.81 ± 67.22 mmHg; 1.09 ± 0.26 mL cmH₂O⁻¹ kg⁻¹ respectively). Instead, Fshunt decreased ($2.31 \pm 2.2\%$) compared to PP10 ($7.61 \pm 2.84\%$). In ARMc, at ARM10 PaO_2/FiO_2 (521.32 ± 66.2 mmHg), $C_{statind}$ (1.76 ± 0.4 mL cmH₂O⁻¹ kg⁻¹) and Fshunt ($3.91 \pm 3.7\%$) improved compared to PP10 (431.22 ± 55.1 mmHg; 1.38 ± 0.2 mL cmH₂O⁻¹ kg⁻¹; $12.12 \pm 3.96\%$ respectively). Differences between the two groups were not detected.

The application of both ARMs can be useful to manage the respiratory alterations induced by pneumoperitoneum in dogs.

References

Di Bella C, Lacitignola L, Grasso S, et al. (2018) An alveolar recruiting maneuver followed by positive end-expiratory pressure improves lung function in healthy dogs undergoing laparoscopy. *Vet Anaesth Analg* 45, 618-629.

Maisch S, Reissmann H, Fuellekrug B, et al. (2008) Compliance and Dead Space Fraction Indicate an Optimal Level of Positive End-Expiratory Pressure After Recruitment in Anesthetized Patients. *Critical Care and Trauma* 106, 175 – 81.

Poster 20

Incidence and treatment of postoperative hypoxemia in dogs undergoing general anaesthesia with variable FiO₂ and PEEP

Stabile M, Di Bella C, Acquafredda C, De Marzo C, Lacitignola L, Crovace A, Staffieri F

Section of Veterinary Clinics and Animal Production, D.E.O.T., University of Bari “Aldo Moro”, Bari, Italy

This study aimed to evaluate the incidence of postoperative hypoxaemia (PH) and compare its treatment with face mask O₂ supplementation and 5 cmH₂O continuous positive airway pressure (CPAP) (Staffieri et al. 2014) in dogs.

ASA I/II dogs were randomized for receiving spontaneous or mechanical ventilation with or without PEEP, and an FiO₂ of 0.4 or > 0.8 during general anaesthesia. Pulse oximetry at room air was monitored every 15 minutes for one hour after extubation (EXT). Dogs that showed “hypoxaemia” (SpO₂ < 95%) at EXT were randomly treated with either CPAP or O₂ by face mask. Of the 290 dogs included in the study at EXT, 125 (43.1%) were hypoxaemic of which 69 were treated with CPAP and 56 with O₂. T-test and odds ratios for occurrence of PH were used for analysis (P < 0.05).

Hypoxaemic dogs had a significantly lower SpO₂ (P < 0.05) at EXT (91.4 ± 3.2 % vs 96.9 ± 1.3%), and 15 (92.1 ± 2.6% vs 97.2 ± 1.4%) and 30 (94.5 ± 3.4% vs 97.2 ± 1.6%) minutes later. Spontaneous breathing no PEEP, dorsal recumbency, BCS ≥ 4/5 and FiO₂ > 0.8 were associated with PH (odds ratio: 1.94, 6.68, 2.29, 40.7 and 9.4 respectively). Duration of hypoxaemia was shorter in dogs treated with CPAP compared to O₂ (16.1 ± 11.1 Vs 24.4 ± 11.1 minutes).

PEEP, mechanical ventilation and low FiO₂ may reduce the occurrence of PH in dogs. Treatment with CPAP reduced the time to return to normoxaemia.

Reference

Staffieri F, Crovace A, De Monte V, et al. (2014) Noninvasive continuous positive airway pressure delivered using a pediatric helmet in dogs recovering from general anesthesia. *J Vet Emerg Crit Care* 24, 578 – 85.

Poster 21

Pharmacokinetics after intravenous, intramuscular or subcutaneous administration of buprenorphine in dogs undergoing ovariohysterectomy

Steagall PV, Ruel HLM, Yasuda T, Monteiro B, Watanabe R, Evangelista MC, Beaudry F

Faculty of Veterinary Medicine, Université de Montréal, Saint-Hyacinthe, QC, Canada

This study aimed to describe the pharmacokinetics of buprenorphine using three routes of administration in dogs undergoing ovariohysterectomy.

Twenty-four healthy dogs were included in a randomized, prospective, blinded, clinical trial. Buprenorphine (0.02 mg kg^{-1} ; Simbadol, 1.8 mg mL^{-1}) was administered intravenously, intramuscularly or subcutaneously ($n = 8/\text{group}$) 30 minutes before general anesthesia (propofol-isoflurane-carprofen) and ovariohysterectomy. Blood sampling was performed before (time 0) and at 2, 5, 10, 15, 30, 60, 120, 240, 360, 540 and 720 minutes after drug administration. Plasma buprenorphine and norbuprenorphine concentrations were analyzed using a validated method by liquid chromatography mass spectrometry. Pharmacokinetics of buprenorphine was described using a non-compartmental model (PK Solver 2.0).

Norbuprenorphine was not detected. Concentrations of buprenorphine were quantifiable up to 720 minutes for all routes and dogs, and with large inter-subject variability especially in SC group. For IV, IM and SC administration, clearance was 1.29 , 1.65 and $1.40 \text{ L kg}^{-1} \text{ hour}^{-1}$; volume of distribution was 6.8 , 14.2 and 40.1 L kg^{-1} ; the elimination half-life was 3.7 , 5.7 , 22 hours, and the area under the plasma concentration-time curved extrapolated to infinity was 15.7 , 12.4 and $16.4 \text{ ng mL}^{-1} \text{ hour}^{-1}$, respectively. Bioavailability for IM and SC was 62.6% and 40% , respectively. Maximum plasma concentrations of buprenorphine were 6.2 and 1.3 ng mL^{-1} at 0.14 and 0.33 hours after IM and SC administration, respectively.

At the dose administered, SC administration of buprenorphine might fail to provide clinical analgesia due to erratic drug absorption.

Poster 22

Low doses of medetomidine and ketamine in combination with methadone and alfaxalone prior to general anaesthesia in a tame Lion cub (*Panthera leo*)

Didier C¹, Junot S², Jourdan G¹

¹ UP Anesthésie-Réanimation, Département des Sciences Cliniques (CHUVAC), Ecole Nationale Vétérinaire de Toulouse, Université Toulouse-Midi-Pyrénées, Toulouse, France

²Service d'anesthésie, VetAgro Sup - Campus Vétérinaire de Lyon, Université de Lyon, Marcy- L'Étoile, France

A seven-month-old lion cub (*Panthera leo*) was anaesthetized for full body computed tomography, blood sampling and echocardiography.

The lion was tame and sociable. History included generalized lameness and severe pain. Spontaneous fractures and generalized osteopaenia were suspected. Due to its father's sudden death from suspected primary cardiac arrest, a congenital cardiac disease was also considered. A complete cardio-pulmonary examination could not be performed prior to anaesthesia. Heart rate and *f*R were 92 and 16 bpm, respectively.

Moderate sedation was achieved within 15 minutes with medetomidine (0.01 mg kg⁻¹), methadone (0.3 mg kg⁻¹) and ketamine (1.5 mg kg⁻¹) IM. After additional alfaxalone (1 mg kg⁻¹) IM, preoxygenation and cephalic vein catheterization were performed prior to propofol administration (2 mg kg⁻¹ IV) for intubation. Maintenance of anaesthesia with isoflurane (vaporizer setting 0.8-2%) in 100% oxygen lasted for 2 hours and was uneventful. Physiological variables including invasive arterial pressure were continuously recorded every 5 minutes (Table 1). Recovery was smooth and achieved in 5 minutes. The owner reported no complications after discharge.

In conclusion, lower doses of medetomidine and ketamine than previously described in wild lions, combined with methadone and alfaxalone, resulted in an effective and safe sedation prior to general anaesthesia in this tame young lion.

HR (bpm)	<i>f</i> R (bpm)	SAP(mmHg) MAP(mmHg) DAP (mmHg)	SpO2 (%)	PE'CO ₂ (kPa)
68 ± 7	10 ± 1	107,8 ± 12,8 72,9 ± 9,0 56,3 ± 9,2	97 ± 2	5,6 ± 0,7

Table 1. Physiological variables (mean ± SD) during 2-hour anaesthetic in a lion.

Poster 23

Investigating pre-warming before general anaesthesia with isoflurane in adult Sprague-Dawley rats.

Maxime Rufiange¹, Vivian SY Leung¹, Keith Simpson², Daniel SJ Pang^{1,3}

¹Department of Clinical Sciences, Faculty of Veterinary Medicine, Université de Montréal, Saint-Hyacinthe, QC, Canada

²Vetronic Services Ltd, Abbotskerwell, England

³Department of Veterinary Clinical and Diagnostic Sciences, Faculty of Veterinary Medicine, University of Calgary, Calgary, AB, Canada

Induction of general anaesthesia causes warm blood to redistribute from the core to periphery, a major contributor to hypothermia. Pre-warming (PW), raising skin temperature before anaesthesia, reduces the periphery-core temperature gradient.

A prospective, crossover study (10 female and 7 male Sprague-Dawley rats, protocol ID 18-Rech-1947) compared: 1. PW1% (increasing core temperature 1% over baseline within the induction chamber using an in-line, controllable, electrically heated device), 2. PW40 (increasing core temperature to 40°C) and 3. NPW (no pre-warming). The PW1% group was performed first to ensure tolerance of PW (observed for pawing, digging, abnormal posture), followed by randomisation to remaining two treatments, with at least 5 days washout. Temperatures were recorded by implanted abdominal telemetry capsules. After achieving target temperature, anaesthesia was induced and maintained with isoflurane (induction chamber, then face mask) until core temperature was approximately 34°C. Time to onset of hypothermia (defined as mean core temperature – 2SD) was assessed with 1-way ANOVA (Tukey post-hoc) ($p < 0.05$). Data are mean $\pm$ SD [95%CI of mean difference].

No escape behaviours were observed. Pre-warming delayed onset of hypothermia: PW1% [12.4 $\pm$ 4.0 minutes] versus PW40 [19.3 $\pm$ 6.5 minutes, $p = 0.004$ (95%CI -12.0 to -2.2)], PW40 versus NPW [7.1 $\pm$ 2.7 minutes, $p < 0.0001$ (95%CI 8.1 to 16.0)] and PW1% versus NPW [$p = 0.003$, 95%CI 1.8 to 8.7]. Pre-warming to 1% above baseline core temperature or to 40°C provides short-term protection against hypothermia associated with general anaesthesia. Longer periods of anaesthesia would require additional heating support.

Poster 24

Laboratory study of the horse (circa 1950-65) used as a model of human lung disease provided foundation knowledge, technology, and skills in support of contemporary equine anaesthesiology

Steffey EP

Did you know that some important early advances in equine anaesthesia were based on the horse serving as an animal model for human lung disease research? The story begins in the early 1950's when a group of U.S. Naval physicians, motivated to confirm their hypothesized aetiology of human pulmonary emphysema initiated collaborative efforts with W.S. Tyler, DVM, PhD, Department of Anatomy at the School of Veterinary Medicine, University of California, Davis (and subsequently his PhD trainee, J.R. Gillespie, DVM, PhD). The physicians postulated that emphysema was due to a decrease in bronchial artery blood flow, the nutrient supplier to alveoli. Following cadaver study of subgross lung anatomy of 10 animal species the horse was identified as the most appropriate animal model for further laboratory investigation. For continued study including necessary cannulation of a bronchial artery development of general anaesthetic and surgical protocols for equine thoracotomy, post-operative recovery and long-term care was necessary. Given the historical time period these investigations were performed including available anaesthetic and surgical knowledge, skills and technology (both broadly and especially equine focus), and that more than 100 thoracotomies were ultimately performed, the magnitude of effort was astounding. While ultimately results of this laboratory study did not support (or deny) the original hypothesis these efforts meaningfully extended contemporary knowledge of: comparative circulatory and pulmonary anatomy¹ and physiology^{2,3} and contributed scientifically-based, foundation knowledge^{4,5}, skills⁶ and technology⁷ in support of the evolution of anaesthesiology as an emerging, organized clinical specialty within veterinary medicine.

(Some examples of published results are highlighted above: ¹ Am Anat 108:149, 1961; ² Am J Vet Res 25:1712, 1964; ³ Am J Physiol 207:1067, 1964. ⁴ Am J Vet Res 29:305, 1968. ⁵ Br J Anaesth 40:560, 1968. ⁶ Am J Vet Res 24:766, 1963. ⁷ J Am Vet Med Assoc 143:272, 1963.)

Poster 25

A comparison of dexmedetomidine or acepromazine as premedication in brachycephalic dogs undergoing surgery for brachycephalic obstructive airway syndrome (BOAS)

Petrucione I¹, Murison PJ¹, Flaherty D², Auckburally A²

¹University of Glasgow School of Veterinary Medicine, Glasgow, UK

²Southern Counties Veterinary Specialists, Ringwood, UK

Perioperative complications are common in brachycephalic dogs undergoing BOAS correction (Poncet et al. 2006). The influence of dexmedetomidine or acepromazine premedication was compared.

Forty dogs randomly allocated received acepromazine 20 µg kg⁻¹ (GroupAce) or dexmedetomidine 2 µg kg⁻¹ (GroupDex), with methadone 0.3 mg kg⁻¹ IM before propofol induction and sevoflurane maintenance of anaesthesia. Scores were allocated for quality of sedation (0-18), induction (0-6) and recovery (0-5). Propofol dose and time to extubation were recorded. Airway obstruction, O₂ supplementation by mask, additional dexmedetomidine or regurgitation were recorded after sedation, extubation +30 and +60 minutes. Data were compared using Chi-squared or Mann-Whitney U tests.

GroupAce dogs were less sedated (6 ± 5 c.f. 3 ± 4 ; $p = 0.02$) and required more propofol (4.5 ± 2.3 , c.f. 2.4 ± 1.8 mg kg⁻¹; $p = 0.018$). Induction scores (GroupAce: 0.4 ± 0.6 ; GroupDex: 0.6 ± 1.2 ; $p = 0.989$), recovery scores (GroupAce: 1 ± 1.2 ; GroupDex: 1.5 ± 1.9 ; $p = 0.738$) and anaesthesia duration (GroupAce: 95 ± 29 ; GroupDex: 108 ± 52 minutes; $p = 0.758$) were similar between groups. Time to extubation was longer in GroupAce (13 ± 7 c.f. 7 ± 3 minutes; $p = 0.005$).

	After-sedation		Extubation+30		Extubation+60	
Group	Ace	Dex	Ace	Dex	Ace	Dex
Airway obstruction	0	0	1	0	0	0
O ₂ supplementation by mask	0	0	5	4	6	4
Additional dexmedetomidine	0	0	1	2	3	0
Regurgitation	2	3	0	1	0	0

Complications were similar in acepromazine or dexmedetomidine premedicated brachycephalic dogs.

Reference

Poncet CM, Dupre GP, Freiche VG, Bouvy BM. Long-term results of upper respiratory syndrome surgery and gastrointestinal tract medical treatment in 51 Brachycephalic dogs. J Small Anim Pract 2006; 47 (3): 137-142.

Sponsors and Exhibitors

AVA Dublin 2020 wish to acknowledge our sponsors and exhibitors for the Spring Meeting.

PLATINUM SPONSOR



GOLD SPONSORS



SILVER SPONSORS



BRONZE SPONSORS



OTHER SPONSORS AND EXHIBITORS



Further information on our Sponsors

PLATINUM SPONSOR



www.chanellegroup.com

Chanelle Pharma specialises in the development, production, marketing and distribution of generic animal pharmaceutical products. The company has over 1700 animal health licenses registered in the EU and 500 animal health licenses registered in the rest of the world – the largest number of registered veterinary licenses of any company in Europe. We have a rapidly growing customer base in over 80 countries worldwide, with key markets in EU, Australia, New Zealand, Japan, South Africa and the Middle East.

At the forefront to Chanelle Pharma is our dedication to Research & Development. We have four Research & Development facilities, three located in Ireland and one in Jordan. Chanelle Pharma brings on average 15 new products to market each year. Chanelle Pharma is headquartered in Loughrea, Co Galway, Ireland.

GOLD SPONSORS



www.midmarkanimalhealth.com

Midmark anesthesia machines (formerly Matrx®) are a long-time favorite of veterinary professionals around the world for inhalation anesthesia delivery. For over 50 years, each machine has been carefully manufactured to provide you with years of safe, simple and controllable inhalation anesthesia delivery.

State-of-the-art Midmark diagnostic and multiparameter monitors provide the gold standard in efficient, accurate patient monitoring. Our family of total monitoring solutions features Cardell® BP technology, pet-specific algorithms and unique, pet friendly features that make it easier to get reliable, precise readings, even in small companion animals. Designing better care.™



www.zoetis.ie

Zoetis is a global animal health company dedicated to supporting its customers and their businesses in ever better ways. Building on 60 years of experience, we deliver quality medicines and vaccines, support and education. We are working every day to better understand and address the real-world challenges faced by those who raise and care for animals in ways they find truly relevant.

Our name, Zoetis (zō-EH-tis), has its root in zo, familiar in words such as zoo and zoology and derived from zoetic, meaning “pertaining to life”. It signals our company’s dedication to supporting the veterinarians and livestock producers everywhere who raise and care for the farm and companion animals on which we all depend.

SILVER SPONSORS



www.acevetsupplies.co.uk

Specialist suppliers of anaesthesia consumables for the Veterinary industry. Concentrating purely on anaesthetic products, they stock a variety of items that would be difficult to find at your general wholesale provider. This includes a vast range of ET Tubes from Avian through to Large Animal, Circuits, Filters, Veterinary Laryngoscopes, Tracheostomy Tubes and an array of monitoring leads for most makes of patient monitoring. ACE have access to many worldwide anaesthesia suppliers and are happy to order in non-stock items.

Tel: 01491 527027; Email: sales@acevetsupplies.co.uk



www.aasmedical.co.uk

Advanced Anaesthesia Specialists UK Limited. (AAS), is an international innovator in the design and manufacture of solutions for longstanding problems in veterinary anaesthesia and critical care.

AAS has developed the Darvall brand of veterinary anaesthesia equipment and supplies including warming blankets, zero dead space breathing masks, veterinary laryngoscopes, and heated breathing circuits.

Darvall veterinary products represent the highest quality in veterinary anaesthesia equipment and supplies for veterinarians, veterinary anaesthetists, and research scientists. AAS also provides technical services, expertise, and continuing education for veterinarians around the world.

Founded by Dr. Colin Dunlop (formerly Head of Veterinary Anaesthesia at Colorado State University) the Advanced Anaesthesia Specialists team have extensive backgrounds in veterinary anaesthesia, engineering, animal safety, and technical services



LEADING VETERINARY INNOVATION

www.carusanimalhealth.com

Carus Animal Health identifies emerging trends in healthcare and technology to better meet the needs of animals, vets, farmers and pet owners. The company seeks out innovative technologies and products that can be developed / re-purposed for the treatment and care of companion animals, farm animals and for use in aquaculture. It identifies unique / niche vet application areas that remain unsupported in the animal health setting and explores & develops life science technologies to meet unmet needs. The company looks to partner with academic institutions, animal health organisations, pharmaceutical companies, scientists, small enterprises and early or pre-clinical stage companies.

SILVER SPONSORS Continued



www.dechra.com

Dechra Veterinary Products specialise in the sales, marketing and technical support of our branded veterinary products to the veterinary profession from general practitioner to specialist vets. Operating directly in twelve European countries and the USA and Australia, Dechra are also committed to working with partners to distribute our products in over 40 other key markets throughout the world. Some of our key anaesthesia and analgesia products include; Comfortan, Fentadon, Alfaxan, Sedator, Atipam and Equipalazone. We have recently launched exciting products including Intra-Epicaine, Dormazolam and Tralieve.

As experts in companion animal and equine anaesthesia and analgesia, we are committed to supporting best practice anaesthesia, providing a comprehensive product range alongside an unprecedented level of technical support. We are proud to support and work alongside the AVA wherever possible, improving the lives of animals and vets across the world.



www.firecrestmedical.com

Firecrest specialize in the supply of cost-effective anaesthesia and patient monitoring solutions to veterinary practices and clinics. We offer highly portable monitors for transportation as well those for general purpose and theatre use.

Firecrest are UK veterinary dealers for Penlon, a multi-award winning, UK based company which has been producing world class anaesthesia products for over 75 years. The Prima 440 is a portable anaesthesia machine, which due to its compact size and safety features, is ideally suited to veterinary use. Also available from Firecrest is the 10-year maintenance free, Sigma-Delta vaporizer, giving you peace-of-mind whilst saving you money!



www.norsomedical.com

Norso Medical Limited, A local supplier of medical equipment ranging from Patient Monitors, Ultrasound and Pre-Hospital Monitoring strive to bring state of the art products to areas such as Anesthesia, ICU, General Wards and Pre-Hospital Transport.

Accredited with ISO 9001:2015, Norso Medical understand the needs of clinical and technical clients and supply a high standard of sales, service and aftersales care with our dedicated clinical trainers, highly knowledgeable technical staff and customer services team.

Norso Medical Limited is the sole exclusive sales/service agent for Mindray Patient Monitors and Ultrasound, Masimo Co Oximetry in Ireland. These products are innovative and world leading in their respective Clinical areas.

BRONZE SPONSORS



www.burtonsveterinary.com

The Burtons family and company have been manufacturing, distributing and servicing equipment for the veterinary community for nearly 40 years. Our full range covers everything from anaesthesia to X-ray and is largely made in-house, in the UK. Established for three generations, the Burtons ethos is to give honest expert advice and excellent customer service to all.



Your Safety Partner in IV Therapy.

We offer an extensive range of innovative products that meet the highest quality standards offering best value and improved clinical outcomes within the veterinary market place.



www.dugganvet.ie/productsvet/

Duggan Veterinary Supplies Ltd. are a veterinary pharmaceutical and instrumentation company, based in Tipperary. Duggan Veterinary Supplies Ltd. Have been supplying animal health products to the veterinary industry for over 30 years.



www.hallowell.com

Hallowell EMC provides ventilatory support for animals of all sizes from rats to horses and more! Our full product line includes parts, accessories, and service for your HEMC ventilators. Stop by and see the difference our thirty-plus years of industry experience can make for your practice!



www.pajunk.com

PAJUNK® SonoSystems utilise the market leading innovative and unique 'Cornerstone' reflective technology throughout the SonoPlex, SonoTap & TuohySono range of systems. Along with the unique E-Cath with Catheter over Needle technique, SonoCurl Catheters for Continuous Paravertebral Blocks. A comprehensive and complete range of products for guidance under Ultrasound.



www.vetronic.co.uk

Vetronic Services is a unique company which designs, manufactures and supports monitoring and ventilation equipment for the veterinary market. The company is based in Devon, England and was established in 1992 by Keith Simpson BVSc MRCVS MIET.

To contact us please use: Tel: 01626365505
enquiries@vetronic.co.uk



www.vygonvet.co.uk

Vygon, a world leader in the manufacture of Single Use Medical Devices is also a major supplier of single-use veterinary consumables. Since its creation in 1962, continuous technological and market research, dedication to customer satisfaction and adherence to stringent standards are the key factors in Vygon's growth.