

AVA AUTUMN MEETING 2019PROGRAMME BOOK.....



AVA

*Association of Veterinary
Anaesthetists
11-13 September 2019*

*NH Hotel Belfort
Ghent - Belgium*

2019

www.AVA2019.org

Proceedings Main Congress

AVA Autumn meeting

Ghent, Belgium

11 - 13 September 2019

Dear colleagues,

With great pleasure, we invite you to the AVA Autumn Meeting 2019, which will take place in the heart of the beautiful and historic city of Ghent. The congress venue, NH Hotel Ghent Belfort, is located in the city centre, in very close proximity to the Belfry of Ghent, the City Hall, the Saint Bavo's Cathedral and numerous hotels to choose from.

The keynote lectures will be given by specialists from both veterinary and human medicine. The pre-congress day will focus on intensive care of both large and small animals, with lectures on ventilation in the intensive care unit, fluid therapy and surviving sepsis, i.e. topics that are very relevant for veterinary anaesthetists, nurses and general practitioners.

The topics for the main congress days will be 'Opioid free anaesthesia' and 'Cardiorespiratory support'. This will include lectures on opioid free anaesthesia in humans, the use of opioids in veterinary medicine, novel targets for analgesic drugs, protective ventilation in obese human patients, the cardiorespiratory challenges of robotic surgery in humans, etc. We are also very proud to host a Leslie Hall Memorial Lecture, where Prof. Iain Glen will talk about the development of propofol.

The organizing committee is determined to continue the AVA tradition of having excellent social programmes, with a welcome reception at the City Hall of the City of Ghent, a congress dinner (with open-end party!) at the Handelsbeurs of Ghent and, for those interested, a beautiful boat tour through the city centre on Saturday.

Looking forward to welcoming you at the meeting!

The Organising Committee



The AVA would like to thank the Sponsors for their generous support of this event:



HALLOWELL EMC

smiths medical



ALCYON
BELUX



Content

Programme – Main congress	9
Programme oral presentations - Thursday	10
Programme - oral presentations - Friday	11
Our Speakers	12
Keynote Lectures	17
Opioid free anaesthesia in humans - L. De Baerdemaeker	18
Novel targets for pain management - Y. Kushnir	39
Opioids in veterinary medicine - E. Clutton	41
Leslie Hall Memorial Lecture - Iain Glen	43
Cardio-anaesthesia - S. Bouchez	46
Anaesthetic challenges of robotic surgery in man - L. Foubert	61
What can we learn from the last changes in protective lung ventilation in morbidly obese human patients? - J. Mulier	92
Oral presentations	118
Comparison of the PTA (Parasympathetic Tone Activity) and the SPI (Surgical Plethysmographic Index) to assess the analgesia / nociception balance in anaesthetized dog - <u>Cardinali MC</u>, Conde Ruiz CCR, Bernardy AB, Sentenac JS, Junot SJ.	119
Pharmacokinetics of ketamine after intravenous and intranasal administration to dexmedetomidine sedated dogs - <u>Vlerick LV</u>, Devreese MR, Peremans KP, Dockx RD, Croubels SC, Duchateau LD, Polis IP.	120
Influence of pre-anaesthetic clinical examination on anaesthetic case management in dogs and cats - <u>Louro LF</u>, Maddox T, Alderson B.	121
Evaluation of routine pre-anaesthetic haematological and biochemical screening in geriatric cats and dogs - <u>Diaz MdM</u>, Kaartinen J, Allison A	122
A survey of attitudes of Slovenian veterinarians to recognition and treatment of pain in cats and dogs - <u>Tomsič K</u>, Sokolov C, Seliškar A.	123
Feline Grimace Scale for acute pain assessment: real-time versus image scoring and the influence of sedation and surgery - <u>Evangelista MC</u>, Benito J, Monteiro BP, Watanabe R, Doodnaught GM, Pang DJS, Steagal P.	124
The analgesic effects of buprenorphine (Vetergesic or Simbadol) in cats undergoing dental extractions: a randomized, blinded, clinical trial - <u>Watanabe RW</u>, Marcoux JM, Evangelista ME, Dumais YD, Steagall PS.	125
Pain behaviours before and after treatment of oral disease using video assessment: a prospective, blinded, randomized clinical trial - <u>Watanabe RW</u>, Frank DF, Steagall PS.	126
Clinical and anaesthesiologic effects of lidocaine constant rate infusion in neonatal foals during anaesthesia - <u>Lambertini C</u>, Mazzanti A, Romagnoli N.	127
The antinociceptive effect of Magnesium Sulphate administered intravenously in standing horses - <u>La Rosa L</u>, Twele L, Duchateau L, Kästner SBR, Schauvliege S.	128
Recovery quality after romifidine vs detomidine infusion during isoflurane anaesthesia in horses - <u>Alonso BA</u>, Carregaro AC, Cuypers CC, Michielsen AM, Gasthuys FG, Schauvliege SS.	129

Effect of anaesthesia time on the quality of recovery in horses using the same anaesthetic maintenance protocol - <u>Vermedal H</u> , Valverde A, Skelding A, Aguilera R, Tisotti T, Tucker L, Sears W.	130
Retrospective investigation of change in body temperature in anesthetized dogs - <u>Clark-Price SC</u> , Bossert JL, Brunstein KA, Farrow AF, Perregrino A.	131
Evaluation of the anaesthesia gas warmer “Darvall SWT Heated Breathing Circuit” on dogs body temperature undergoing elective ovariectomy - <u>Giannetoni GG</u> , Zilberstein ZL, Laurenza LC.	132
Does catheter insertion site matter? Contamination of cephalic and saphenous vein catheter placement site in anesthetized dogs undergoing dental scaling - <u>Calice I</u> , Ballas P, Vogl C, Ehling-Schulz M, Rocchi A.	133
Electrocardiography-guided placement of central venous catheter in critically ill dogs - <u>Rohwedder L</u> , Böttcher P, Kunz A, Rohwedder T.	134
Identification of the sacrococcygeal epidural space using the nerve stimulator test or the running-drip method in dogs - <u>Martinez-Taboada F</u> , Otero PE, Laredo F, Belda E.	135
The effect of body position and user experience on the ease of anatomical landmark palpation for epidural injection in dogs - Smith RC, Redondo JI, <u>Martinez-Taboada F</u> .	136
A novel parailiac approach for sciatic nerve block in cats – a pilot study - <u>Rodrigo-Mocholi DRM</u> , Martinez-Taboada FMT.	137
Ultrasound-guided parasternal injection in dogs: a cadaveric study - <u>Zublena ZF</u> , Briganti BA, De Gennaro DGC, Corletto CF.	138
Lumbar erector spinae plane (ESP) block in the dog: Anatomical study and assessment of two ultrasound-guided techniques in dog cadavers - <u>Medina Serra RMS</u> , Palacios Jimenez C, Foster A, Plested M, Sanchis Mora SM, Viscasillas J.	139
Ultrasound-guided peribulbar block in the dog: an anatomical cadaveric study - <u>Foster A</u> , Viscasillas J, Sanchis-Mora S, Medina Serra R, Stathopoulou T.	140
Assessment of perioperative pain in intact and gonadectomized dogs undergoing orthopaedic surgery (preliminary results) - <u>Karamichali P</u> , Anagnostou T, Kazakos G, Prassinou N, Savvas I.	141
Systematic Review: Anaesthetic Protocols and Management as Confounders in Rodent Blood Oxygen Level Dependent Functional Magnetic Resonance Imaging (BOLD fMRI) - <u>Steiner AR</u> , Rousseau-Blass F, Schroeter A, Hartnack S, Bettschart-Wolfensberger R.	142
The effect of inhaled albuterol on PaO₂ in anesthetized horses receiving a FiO₂ of 0.5 or > 0.95 - Caldwell FJ, Boone LH, Weatherall KM, Auckburally A, Lascola KM, <u>Clark-Price SC</u> , Hanson RR.	143
Pharmacokinetics of carprofen in pigs - Bošnjak M, Kržan M, Lamprecht Tratar U, Dolenc J, Čemažar M, <u>Seliškar A</u> .	144
Propofol and fentanyl in a porcine model of sepsis. Is it the right choice? - <u>Casoni D</u> , Liu S, Spadavecchia C, Jakob SM.	145
A new photoplethysmographic device for continuous assessment of urethral mucosa perfusion: evaluation in a porcine model - <u>Cardinali MC</u> , Magnin MM, Bonnet-Garin JMBG, Allaouchiche BA, Junot SJ.	146
Evaluation of the ability of minimally-invasive monitoring devices to assess fluid responsiveness in endotoxaemic beagles. - <u>Muehlestein MB</u> , Steblaj B, Joerger FB, Briganti A, Kutter APN.	147
Assessment of immediate and owner perceived recovery following three different premedication drugs in dogs undergoing anaesthesia for radiotherapy - <u>Miller C</u> , Bell AM, Pawson P.	148

Effect of airway management method on the incidence of haemoglobin oxygen desaturation during feline bronchoscopy and bronchoalveolar lavage - Tucker PK, Hibbert A, MacFarlane P.	149
Influence of three oxygen flow rates on oxygen partial pressure and inspired oxygen fraction over time in sixty-nine cats recovering from anaesthesia in an oxygen - Didier C, Polo-Paredes G, Bernard E, Junot S, Verwaerde P, Jourdan G.	150
Poster presentations	152
Ultrasound guided transabdominal plane block in pigs: a cadaveric pilot study - Michielsen A, Rodrigo-Mocholi D, Cornillie P, Gasthuys F, Schauvliege S.	153
Propofol or Alfaxalone? Effects of total intravenous anaesthesia on respiratory function in pigs - Lervik A, Toverud SF, Krontveit R, Haga HA.	155
Influence of the presence or absence of an observer on pain assessment in rabbits submitted to orthopaedic surgery - Pinho RH, Leach MC, Rocha FDL, Armani DJC, Ferreira-Souza G, Dissenhe A, Calciolari K, Minto BW, Luna SPL.	156
Reliability and odds ratio of different evaluators in assessing sedation in horses - Oliveira AR, Gozalo-Marcilla M, Schauvliege S, Ringer SK, Puoli-Filho JNP, Luna SPL.	157
Mandibular nerve block in juvenile Nile crocodile: a cadaveric study - Bianchi C, Adami C, Dirrig, Cuff, D'Ovido, Monticelli P.	158
Effects of local infiltration with ropivacaine and its combination with meloxicam on the isoflurane requirements and cardiovascular response during feline ovariohysterectomy - Carapeba GOL, Nicácio IPGA, Stelle ABF, Bruno TS, Nicácio GM, Costa Jr JS, Cassu RN.	159
Comparison of local and systemic administration of meloxicam for postoperative pain management in cats undergoing ovariohysterectomy - Stelle ABF, Carapeba GOL, Nicácio IPGA, Bruno TS, Nicácio GM, Costa Jr JS, Teixeira Neto FJ, Cassu RN.	160
Anaesthesia management in dogs and cats in Lower Saxony - Kästner S, Goossens L, Samp A.	161
Is BIS a useful monitoring tool during balanced neuroanaesthesia in rabbits? Preliminary results - Casoni D, Petrucci MF, Wanderer S, Spadavecchia C.	162
The Antinociceptive effect of Magnesium Sulphate administered in the epidural space in standing horses - La Rosa L, Twele L, Duchateau L, Kästner SBR, Schauvliege S.	163
Automated tracking of horse behaviour, preliminary data - Auer U, Rother O, Hoffbauer M, Larenza-Menzies P.	164
Efficacy of two epidural techniques in dogs undergoing unilateral perineal hernia repair: preliminary results - Salla K, Lepajoe J, Åhlberg T, Mölsä S, Casoni D.	165
Anaesthetic-related deaths in dogs in Spain: COMPLRED 2016-2019 - Redondo JI.	166
Anaesthetic-related deaths in dogs in Argentina: COMPLRED 2016-2019 - Redondo JI.	167
Reviewing results of an audit of anaesthetic machines and vaporizers in veterinary clinics and hospitals in Spain and Portugal - Redondo JI, Doménech L, Mateu C, Bañeres A, Martínez, Lopes D.	168
The clinical effect of xylazine premedication, ketamine induction and maintenance with isoflurane in oxygen/air mixture in water buffalo calves (Bubalus bubalis) undergoing general anaesthesia for a closed castration	169

surgery - Cerasoli I, Varasano V, Guerri G, Straticò P, De Amiciis I, Vignola G, Petrizzi L.	
Nerve stimulator-guided mid-humeral block of the radial, ulnar, median and musculocutaneous (RUMM block) nerves in Macaca fascicularis with radius and ulna fracture - Lopez-Ramis V, Arenillas Baquero M, García Menéndez E, Álvarez Gómez de Segura I.	170
Use of fentanyl patches for postoperative pain control after kidney embolization in a sheep model -Bonastre C, Rodriguez-Zapater S, Serrano-Casorran C, Fuente S, Lopez-Minguez S, de Gregorio MA.	171
Dexmedetomidine for perioperative management of five dogs submitted to a pheochromocytoma ablation - Lambertini C, Joechler M, Foglia A, Romagnoli N.	172
Comparison of sevoflurane MAC sparing effects of methadone and levomethadone at a 2:1 dose ratio in cats - Thiesfeld N, Kästner SBR, Noll M, Söbbeler FJ, Tünsmeier J.	173

Programme – Main congress

Thursday 12th September (main congress day 1)

8.45 – 9.00	Opening ceremony
9.00 – 9.45	Opioid free anaesthesia in humans (<i>L. De Baerdemaeker</i>)
9.45 – 10.30	Novel targets for pain management (<i>Y. Kushnir</i>)
10.30 – 11.00	Break & exhibition
11.00 – 11.45	Opioids in veterinary medicine (<i>E. Clutton</i>)
11.45 – 13.00	Leslie Hall Memorial Lecture (<i>Iain Glen</i>)
13.00 – 14.30	Lunch & ECVAA General Meeting
14.30 – 15.30	Abstract sessions
15.30 – 16.00	Break & exhibition
16.00 – 17.00	Abstract sessions

Friday 13th September (main congress day 2)

9.00 – 10.00	Cardio-anaesthesia (<i>S. Bouchez</i>)
10.00 – 11.00	Anaesthetic challenges of robotic surgery in man (<i>L. Foubert</i>)
11.00 – 11.45	Break & Exhibition + Poster session
11.45 – 12.45	What can we learn from the last changes in protective lung ventilation in morbidly obese human patients? (<i>J. Mulier</i>)
12.45 – 14.15	Lunch & AVA General Meeting
14.15 – 15.15	Abstract sessions
15.15 – 15.45	Break & exhibition
15.45 – 16.45	Abstract sessions
16.45 – 17.00	Closing ceremony

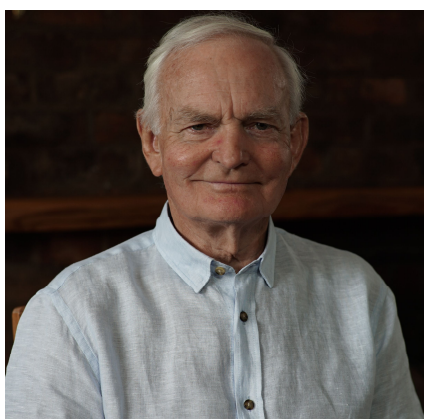
Programme - oral presentations - Thursday

Thursday 1st session Bourdon 1 (2.30 - 3.30 pm) chairperson: Clara Rigotti
Comparison of the PTA (Parasympathetic Tone Activity) and the SPI (Surgical Plethysmographic Index) to assess the analgesia / nociception balance in anaesthetized dog - <u>Cardinali MC</u> , Conde Ruiz CCR, Bernardy AB, Sentenac JS, Junot SJ.
Pharmacokinetics of ketamine after intravenous and intranasal administration to dexmedetomidine sedated dogs - <u>Vlerick LV</u> , Devreese MR, Peremans KP, Dockx RD, Croubels SC, Duchateau LD, Polis IP.
Influence of pre-anaesthetic clinical examination on anaesthetic case management in dogs and cats - <u>Louro LF</u> , Maddox T, Alderson B.
Evaluation of routine pre-anaesthetic haematological and biochemical screening in geriatric cats and dogs - <u>Diaz MdM</u> , Kaartinen J, Allison A
Thursday 2nd session Bourdon 1 (4.00 - 5.00 pm) chairperson: Stéphane Junot
Assessment of perioperative pain in intact and gonadectomized dogs undergoing orthopaedic surgery (preliminary results) - <u>Karamichali P</u> , Anagnostou T, Kazakos G, Prassinis N, Savvas I.
Feline Grimace Scale for acute pain assessment: real-time versus image scoring and the influence of sedation and surgery - <u>Evangelista MC</u> , Benito J, Monteiro BP, Watanabe R, Doodnaught GM, Pang DJS, Steagal P.
The analgesic effects of buprenorphine (Vetergesic or Simbadol) in cats undergoing dental extractions: a randomized, blinded, clinical trial - <u>Watanabe RW</u> , Marcoux JM, Evangelista ME, Dumais YD, Steagall PS.
Pain behaviours before and after treatment of oral disease using video assessment: a prospective, blinded, randomized clinical trial - <u>Watanabe RW</u> , Frank DF, Steagall PS.
Thursday 1st session Bourdon 2 (2.30 - 3.30 pm) chairperson: Miguel Gozalo Marcilla
Clinical and anaesthesiologic effects of lidocaine constant rate infusion in neonatal foals during anaesthesia - <u>Lambertini C</u> , Mazzanti A, Romagnoli N.
The antinociceptive effect of Magnesium Sulphate administered intravenously in standing horses - <u>La Rosa L</u> , Twele L, Duchateau L, Kästner SBR, Schauvliege S.
Recovery quality after romifidine vs detomidine infusion during isoflurane anaesthesia in horses - <u>Alonso BA</u> , Carregaro AC, Cuypers CC, Michielsen AM, Gasthuys FG, Schauvliege SS.
Effect of anaesthesia time on the quality of recovery in horses using the same anaesthetic maintenance protocol - <u>Vermedal H</u> , Valverde A, Skelding A, Aguilera R, Tisotti T, Tucker L, Sears W.
Thursday 2nd session Bourdon 2 (4.00 - 5.00 pm) chairperson: Jaime Viscasillas
Retrospective investigation of change in body temperature in anesthetized dogs - <u>Clark-Price SC</u> , Bossert JL, Brunstein KA, Farrow AF, Perregrino A.
Evaluation of the anaesthesia gas warmer "Darvall SWT Heated Breathing Circuit" on dogs' body temperature undergoing elective ovariectomy - <u>Giannettoni GG</u> , Zilberstein ZL, Laurenza LC.
Does catheter insertion site matter? Contamination of cephalic and saphenous vein catheter placement site in anesthetized dogs undergoing dental scaling - <u>Calice I</u> , Ballas P, Vogl C, Ehling-Schulz M, Rocchi A.
Electrocardiography-guided placement of central venous catheter in critically ill dogs - <u>Rohwedder L</u> , Böttcher P, Kunz A, Rohwedder T.

Programme - oral presentations - Friday

Friday 1st session Bourdon 1 (2.15 - 3.15 pm) chairperson: Sanne Melis
Identification of the sacrococcygeal epidural space using the nerve stimulator test or the running-drip method in dogs - <u>Martinez-Taboada F</u> , Otero PE, Laredo F, Belda E.
The effect of body position and user experience on the ease of anatomical landmark palpation for epidural injection in dogs - Smith RC, Redondo JI, <u>Martinez-Taboada F</u> .
A novel parailiac approach for sciatic nerve block in cats – a pilot study - <u>Rodrigo-Mocholi DRM</u> , Martinez-Taboada FMT.
Ultrasound-guided parasternal injection in dogs: a cadaveric study - <u>Zublena ZF</u> , Briganti BA, De Gennaro DGC, Corletto CF.
Friday 2nd session Bourdon 1 (3.45 - 4.45 pm) chairperson: Tim Bosmans
Lumbar erector spinae plane (ESP) block in the dog: Anatomical study and assessment of two ultrasound-guided techniques in dog cadavers - <u>Medina Serra RMS</u> , Palacios Jimenez C, Foster A, Plested M, Sanchis Mora SM, Viscasillas J.
Ultrasound-guided peribulbar block in the dog: an anatomical cadaveric study - <u>Foster A</u> , Viscasillas J, Sanchis-Mora S, Medina Serra R, Stathopoulou T.
A survey of attitudes of Slovenian veterinarians to recognition and treatment of pain in cats and dogs - <u>Tomšič K</u> , Sokolov C, Seliškar A.
Systematic Review: Anaesthetic Protocols and Management as Confounders in Rodent Blood Oxygen Level Dependent Functional Magnetic Resonance Imaging (BOLD fMRI) - <u>Steiner AR</u> , Rousseau-Blass F, Schroeter A, Hartnack S, Bettschart-Wolfensberger R.
Friday 1st session Bourdon 2 (2.15 - 3.15 pm) chairperson: Simone Ringer
The effect of inhaled albuterol on PaO ₂ in anesthetized horses receiving a FiO ₂ of 0.5 or > 0.95 - Caldwell FJ, Boone LH, Weatherall KM, Auckburally A, Lascola KM, <u>Clark-Price SC</u> , Hanson RR.
Pharmacokinetics of carprofen in pigs - Bošnjak M, Kržan M, Lamprecht Tratar U, Dolenc J, Čemažar M, <u>Seliškar A</u> .
Propofol and fentanyl in a porcine model of sepsis. Is it the right choice? - <u>Casoni D</u> , Liu S, Spadavecchia C, Jakob SM.
A new photoplethysmographic device for continuous assessment of urethral mucosa perfusion: evaluation in a porcine model - <u>Cardinali MC</u> , Magnin MM, Bonnet-Garin JMBG, Allaouchiche BA, Junot SJ.
Friday 2nd session Bourdon 2 (3.45 - 4.45 pm) chairperson: Chiara De Gennaro
Evaluation of the ability of minimally-invasive monitoring devices to assess fluid responsiveness in endotoxaemic beagles. - <u>Muehlestein MB</u> , Steblaj B, Joerger FB, Briganti A, Kutter APN.
Assessment of immediate and owner perceived recovery following three different premedication drugs in dogs undergoing anaesthesia for radiotherapy - <u>Miller C</u> , Bell AM, Pawson P.
Effect of airway management method on the incidence of haemoglobin oxygen desaturation during feline bronchoscopy and bronchoalveolar lavage - <u>Tucker PK</u> , Hibbert A, MacFarlane P.
Influence of three oxygen flow rates on oxygen partial pressure and inspired oxygen fraction over time in sixty-nine cats recovering from anaesthesia in an oxygen - <u>Didier C</u> , Polo-Paredes G, Bernard E, Junot S, Verwaerde P, Jourdan G.

Our Speakers



John (Iain) Baird Glen

John (Iain) Baird Glen: After graduating Bachelor of Veterinary Medicine in 1963, he spent a year in Kenya doing clinical veterinary work and in 1964 returned to Glasgow University as a House Surgeon in the Small Animal Surgery Department. In 1965 he was appointed Lecturer in the same Department, with a special focus on teaching and research in Anesthesia. He attended classes provided for trainee medical anesthetists at Glasgow Royal Infirmary and was the first veterinarian to be granted a recently introduced Diploma in Veterinary Anesthesia in 1968. His interest in research prompted him to apply for a position as a Research Biologist in the Anesthetics Project Team at ICI Pharmaceuticals Division in Cheshire in 1972.

Most of Iain's career at ICI, which subsequently became Zeneca and latterly AstraZeneca, was involved with the discovery and development of propofol; and in 1982 he was able to combine studies with propofol with earlier work at Glasgow to obtain a doctorate on "Studies on the pharmacology of intravenous anesthetic agents". In 1983, he transferred to the Medical Department within ICI, becoming a Clinical Specialist in Anesthesia, to assist with the propofol clinical trial programme, with a particular focus on clinical pharmacology studies and investigations to exclude known undesirable effects such as that of etomidate on adrenal steroidogenesis. Other projects involved collaboration with equipment manufacturers in the development of syringe pumps suitable for continuous infusion of propofol for maintenance of anesthesia, the organization of scientific meetings and workshops, and a complex programme of clinical studies and regulatory interactions required to achieve the first approval of a target controlled infusion (TCI) system.

Iain retired from AstraZeneca in 2000 but continued to work on anesthetic drug development and TCI topics as an independent consultant until 2014.

Awards received.

Honorary Membership of the Association of Anaesthetists of Great Britain and Ireland (1999)

Honorary Membership of the UK Society for Intravenous Anaesthesia (2000)

Fellowship of the Royal College of Anaesthetists (by Election) (2002)

Honorary Membership of the Association of Veterinary Anaesthetists (2009)

Frontiers Lectureship, US Society for Ambulatory Anesthesia (SAMBA) 2012

Honorary Membership of the Scottish Society of Anaesthetists (2014)

Lasker~DeBaakey Clinical Medical Research Award (2018)



Luc de Baerdemaeker

Luc de Baerdemaeker started working on the department as anaesthesiologist for orthopaedic surgery and traumatology with a built up of a broad experience in loco regional anaesthesia. Made a short stay in neuro anaesthesia, cardiac anaesthesia and thoracovascular surgery. Current activity is in abdominal surgery and liver transplantation for adults and children. Research subjects were on cerebral blood flow, applied total intravenous anaesthesia and applied modern inhalation anaesthesia. Main study group was morbidly obese patients and this resulted in June 2008 in the public defence of a thesis on the optimisation of anaesthetic and analgesic drug administration in obese patients. (Promoters Prof. Dr. M Struys and Prof. Dr. E. Mortier)

Elected in 2008 as Secretary of the newly founded European Society for the Perioperative Care of the Obese Patient (ESPCOP), elected as secretary of the International Society for the perioperative care of the obese in 2011.

Appointed as guest professor at University of Ghent Belgium since octobere 2010, full professorship in 2012.

Currently President of the European Society for the Perioperative Care of the Obese Patient (ESPCOP).



Yishai Kushnir

Yishai Kushnir graduated from The Koret School of Veterinary Medicine, The Hebrew University of Jerusalem, Israel, in 2006. After an internship in small animal medicine at the Hebrew University of Jerusalem Veterinary Teaching Hospital, he continued to work as an anesthetist in the department of anesthesia and pain management at the hospital. In 2016, he completed his residency in veterinary anesthesia and obtained a diplomate of the American College of Veterinary Anesthesia and Analgesia (ACVAA).

Parallel to his work as an anesthetist, Dr. Kushnir is involved in research on local anesthesia and the physiology of pain and is a PhD candidate in the department of neurophysiology at the Hebrew University of Jerusalem's Faculty of Medicine. He is a member of the International Association for the Study of Pain (IASP) and of the Israel Pain Association.



Stefaan Bouchez

Stefaan Bouchez:

- Staff member cardiac anesthesiology. (Ghent University Hospital, Belgium)
 - ° Adult and Pediatric Cardiac Anesthesia
 - ° Perioperative Echocardiography and Lung Ultrasound
 - ° Simulation-based training in anesthesia and echo(cardio)graphy
 - ° Pulmonary reversibility testing (department of cardiology)
 - ° Anesthesia for LVAD and ECMO
 - ° Experimental animal research on 'Pharmacological induced arrhythmias'
 - ° Docent Electrocardiography : Biomedical Sciences (Ghent University)
 - ° EACVI/EACTA TOE certification committee: European Board Exam for Transoesophageal Echocardiography
 - ° Instructor Echography (Lung, Gastric & Cardiac) ESA, EACTA, SARB.

Certification

- NBE Board Certification of Echocardiography (US)
- FASE (Fellow of the American Society of Echocardiography)
- Instructor ATLS (Advanced Trauma and Life Support)
- CEURF (Lung Ultrasound certification by Prof. Lichtenstein Pars, France)

Active memberships :

- EACTA: European Association of Cardiothoracic Anaesthesiology
- Former National representative for Belgium 2012-2016
- Active member of the EACTA Echo-subcommittee
- Active member of the EACTA LVAD/Transplant
- Officer / faculty of EACTA-Echo Congress
 - ESA : European Society of Anesthesia
 - BVAR /SARB : Belgian Association of Anesthesiology
 - NVA Dutch Association of Anesthesiology
 - ESC European Society of Cardiology
 - EACVI European Association of Cardiovascular Imaging
 - ASE American Society of Echocardiography



Eddie Clutton

Professor Richard Eddie Clutton is currently the Clinical Director of the Wellcome Trust Critical Care Laboratory for Large Animals.

He graduated in 1981 from the University of Liverpool, Faculty of Veterinary Science and obtained a PhD in 1983 from the same faculty. From 1983 to 1989, he was working as Professor of Veterinary Anaesthesiology, at the Veterinary Medicine College of the University of Virginia in Blacksburg, VA, USA, before becoming a senior lecturer of Veterinary Anaesthesia at the Royal (Dick) School of Veterinary Studies, Edinburgh. There, he was awarded Personal Chair of Veterinary Anaesthesiology in 2007. He is a member of the Royal College of Anaesthetists and is a European Veterinary Specialist in Veterinary Anaesthesia and Analgesia.

Being the author or co-author of more than 130 peer-reviewed publications in the field of veterinary anaesthesia he largely contributed to our current knowledge and understanding of pain prevention and treatment in domestic and laboratory animals as well as in zoo and wildlife fauna. He focussed his work on improving animal welfare and ethics in the veterinary practice and in experimental laboratory settings and contributed to the establishment of guidelines widely accepted in this field.



Jan Mulier

Jan Mulier graduated as MD from KU Leuven University (Belgium), where he obtained a PhD in 1984. He worked as anaesthetist at University of California, San Francisco and as a researcher in the Engineering Department Circulatory Dynamics of the University of Pennsylvania and at the Minneapolis Medical Research Foundation, Minneapolis. Since 1995, he is the Head of the Department of Anaesthesiology at the AZ Sint-Jan Brugge-Oostende. He has a special interest in bariatric anaesthesiology and as well as opioid free anaesthesia; obesity and OSAS; protective lung ventilation; abdominal compliance; SIP block; anti-inflammatory anaesthesia; cognitive function.



Luc Foubert

Luc Foubert is a Staff Anaesthesiologist at the Departement of Anaesthesia and Intensive Care Medicine of the OLV Hospital in Aalst, Belgium. He has a special interest in Critical Care Medicine, Intensive Care Medicine, Electrocardiography, Anaesthesiology for Cardiac and Cardiovascular Surgery, Heart Valve Diseases, Transoesophageal Echocardiography, Cardiopulmonary Bypass, ECG, Glucose control.

DORMAZZOLAM

The first veterinary licensed midazolam
for optimal anaesthetic conditions every time

With its rapid onset of action, midazolam enhances muscle relaxation, delivering improved surgical conditions when compared to using ketamine alone. Midazolam also reduces the need for ketamine 'top ups' without adversely affecting recovery quality.¹

PART OF DECHRA'S EXTENSIVE EQUINE ANAESTHESIA SOLUTIONS RANGE

Dechra Veterinary Products / Pettelaarpark 38 / 5216 PD 's-Hertogenbosch / The Netherlands
www.dechra.com
©Dechra Veterinary Products A/S April 2019

¹ Allison, A; Robinson, R; Jolliffe, C. and Taylor, P. (2018) 'Evaluation of the use of midazolam as a co-induction agent with ketamine for anaesthesia in sedated ponies undergoing field castration' Equine Vet. J. 50; pp. 321-326

DORMAZOLAM[®]
midazolam

TRUE INNOVATION IN EQUINE ANAESTHESIA

Keynote Lectures

Opioid free anaesthesia in humans
(*L. De Baerdemaeker*)

Opioid free anesthesia (OFA) in humans

Luc De Baerdemaeker

Since their introduction decades ago, the opioids have become a basic component in balanced anesthesia techniques for all sorts of procedures and have been prescribed increasingly for the analgesic treatment of not only postoperative pain but also various types of chronic pain disorders.

Opioid receptors are not only located in the central nervous system. Opioids have neurotoxic effects and immune suppressive effects. Increasing evidence from the literature indicates that perioperative use of opioid can be associated with exposure to adverse effects, substance abuse and poor surgical outcomes.

In this presentation, some of the neurophysiological basis of opioid-free anesthesia (OFA) will be briefly reviewed. The rationale supporting its use in perioperative medicine will be explored.

Additionally, OFA has gained popularity with the introduction of enhance recovery after surgery (ERAS) protocols. In ERAS protocols, opioid sparing/avoiding techniques are advised.

OFA is challenging and our current paradigms are under attack. Will safe and stable anesthesia be possible without opioids? Do we need to have monitoring that can measure intraoperative nociception to guide our use of non-opioid multimodal anesthesia?

Finally, an example of a practical OFA mixture will be briefly presented.

Opioid free anaesthesia in humans

Prof. Dr. Luc De Baerdemaeker, MD, PhD, DEAA
Department of Anaesthesia
University Hospital
Ghent University, Belgium

AVA meeting 2019 Ghent

© 2008 Universitair Ziekenhuis Gent

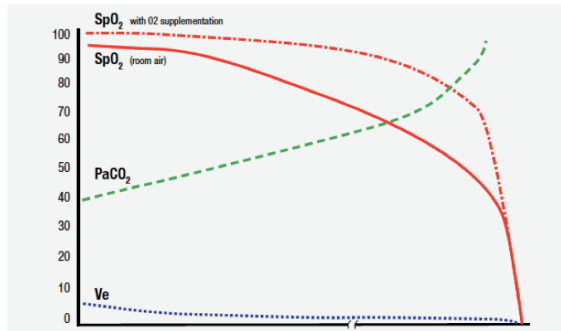
1

Why a presentation on Opioid Free Anesthesia in humans in a meeting for veterinary anaesthetists?

- **Opioids do carry risks:**
 - Opioid Induced Hyperalgesia (OIH) and Differential Tolerance
 - negative effects on the immune system
 - gastrointestinal side effects (PONV, motility, ...)
 - respiratory depression
 - **“dead in bed” events** in OSA patients can occur, due to opioid / sedative administration (type 2 events) or sleep apnea arousal failure (type 3 event)

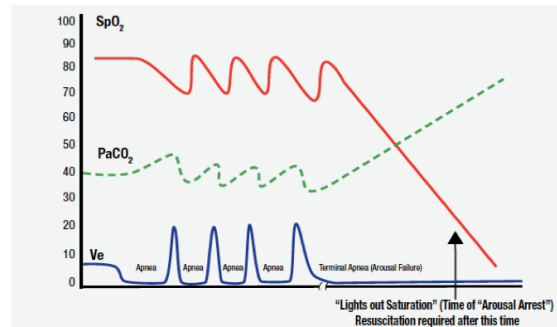
TYPE 2 pattern UHD:
PROGRESSIVE UNIDIRECTIONAL
HYPOVENTILATION (CO_2 NARCOSIS)
+ Progressive rise in PaCO_2 (and Et CO_2)

- fall in SpO_2 over 15 minutes to many hours
- often due to overdosing of narcotics or sedatives



TYPE 3 pattern UHD:
SENTINEL RAPID AIRFLOW/ SpO_2
REDUCTIONS FOLLOWED BY
PRECIPITOUS SpO_2 FALL

- A state of “arousal dependent survival” that occurs only during sleep.
- Arousal Failure allows precipitous hypoxemia during apnea causing terminal arousal arrest.



Why are opioids so successful?



- **Opioids blocks ascending nociceptive stimuli,**
 - thereby reducing the concentration of hypnotics (inhaled or IV anesthetics) required to induce
 - unconsciousness, immobility and hemodynamic stability
 - “Mac sparing effect of opioids”
 - Balanced anesthesia: **Hypnotics with opioids.**
- **We have used opioids NOT to “treat intraoperative pain”,**
 - but to facilitate the hemodynamic stability?
 - To reduce the cardiac output without reduction in the coronary perfusion.
 - To block the respiration and facilitate the ventilation.
- **But at high dose: “Higher chance of awareness”**
 - Lee M, Pain Physician 2011;14: 145
 - Balanced anesthesia: **The opioids with hypnotics**

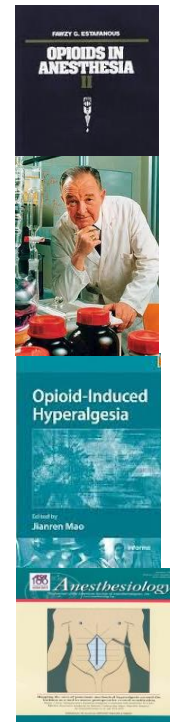
Why avoiding opioids?

1. Side effects :

Resp depression,
obstructive breathing,
pruritis,
nausea & vomiting,
ileus, constipation,
urinary retention,
muscle stiffness,
addiction,
impaired peripheral perfusion ...

Mulier IFSO 2014

5

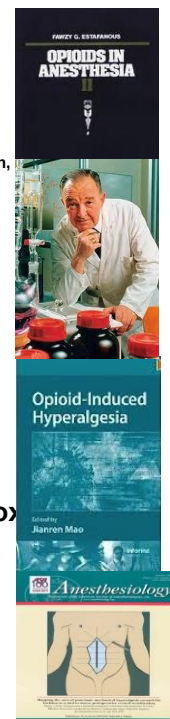


Why avoiding opioids?

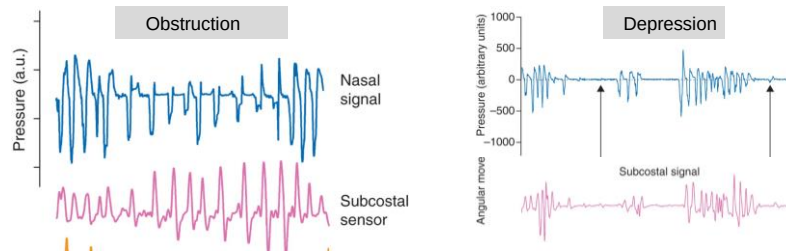
1. **Side effects:**
Resp depression, obstructive breathing, pruritis, nausea & vomiting, ileus, constipation, urinary retention, muscle stiffness, addiction, impaired peripheral perfusion ...
2. **Opioids alone can not treat all pain problems.**
Add non opioid analgesics and additives to reduce side effects.
Pain 2008;137:441
3. **Opioid induced immunosuppression**
Possible Negative impact on cancer outcome
Curr Pharm Des. 2012;18:6034
4. **Opioid-induced neurotoxicity.**
Clear in neonates. Quid cognitive dysfunction in elderly?
Anesth Analg 2002;94:1229
5. **Acute tolerance and addiction.**
Withdrawal syndrome after stopping PCIA with opioids.
6. **Opioid-induced hyperalgesia post operative. "Opioid Paradox"**
Agitation, crying in PACU after longduration TIVA for plastic surgery.
Curr Opin Anaesthesiol 2005;18:540
7. **Chronic postsurgical pain syndrome lasting for months.**
High incidence if questioned: 10 % to 40% after laparotomy.
Lancet 2006;367:1618

Mulier IFSO 2014

6



Characterization of breathing patterns during patient-controlled opioid analgesia



- In undisturbed subjects receiving patient-controlled analgesia after surgery, abnormal breathing patterns are extremely common.
- Cyclical airway obstruction and respiratory depression are associated with a different pattern of chest wall movement.
 - *Drummond Br. J. Anaesth. August 21, 2013*

Differential Opioid Tolerance and Opioid Induced Hyperalgesia are two different things

Hayhurst et al. Anesthesiology 2016;124(2)

Different targets of opioid drugs do not develop tolerance at the same speed and the same degree!

- Fastest and most pronounced for analgesic actions
- Less for respiratory depressant effects
- Least for peripheral effects e.g. GI motility

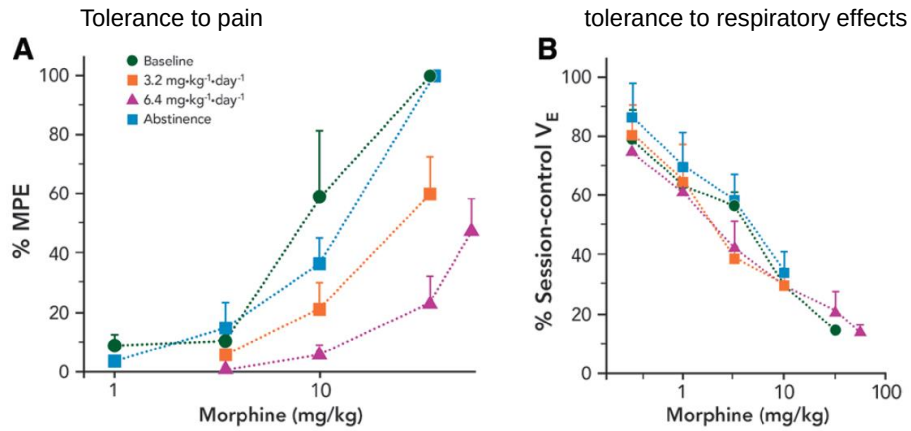
Implications:

patients on very high doses of opioid analgesics preoperatively **may not be protected** from adverse events such as respiratory depression by tolerance development.

At the contrary: this group is at particular risk!!

Differential Opioid Tolerance

Hayhurst et al. *Anesthesiology* 2016;124(2)

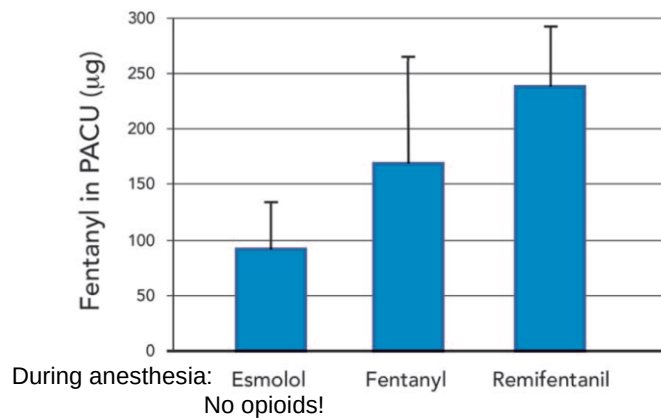


reversible tolerance to the analgesic effects (A)

no tolerance to the respiratory effects(B)

Opioid Induced Hyperalgesia

Hayhurst et al. *Anesthesiology* 2016, 124(2)



Collard et al. *AA*2007;105:1255-62

Tolerance to remifentanil develops rapidly

Albertin et al. *Minerva* 2006;72:915-24

➤ Propofol-remifentanil BIS guided 40-50

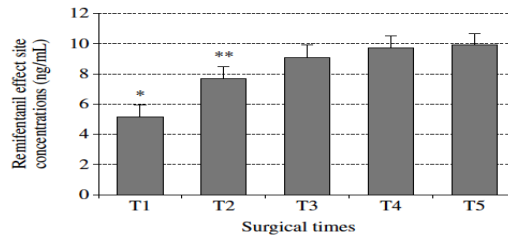


Figure 1.—Remifentanil effect site concentrations required to maintain cardiovascular homeostasis during different surgical intervals time: skin incision-opening of peritoneum (T1), bowel resection (T2), colecisto-jejunal anastomosis (T3), ileum-jejunal anastomosis (T4), closing of peritoneum (T5).

Does Fentanyl Lead to Opioid-induced Hyperalgesia in Healthy (Crazy) Volunteers?

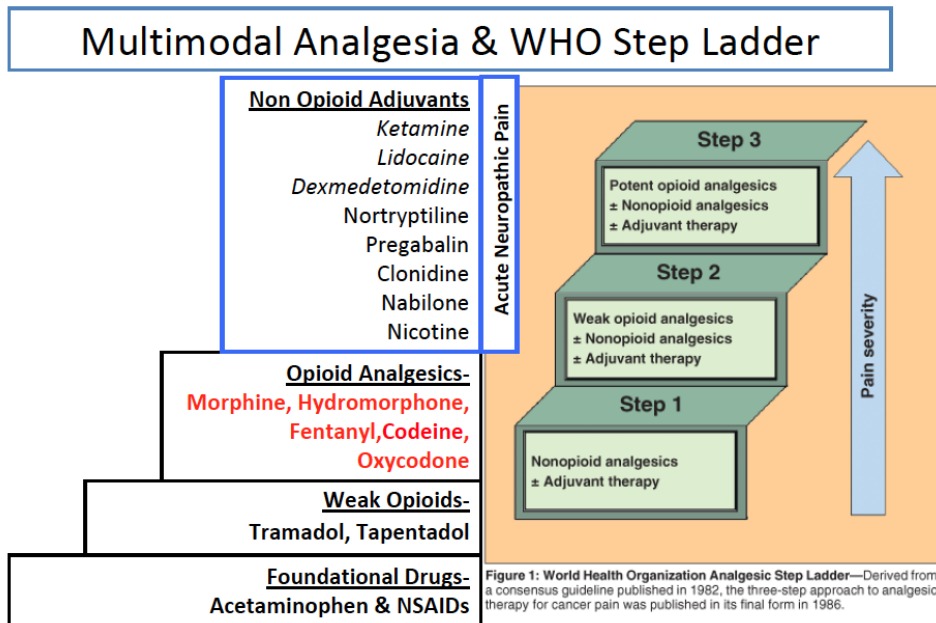
Mauermann et al (*Anesthesiology* 2016; 124:00-00)

n=11 low-dose (1 µg/kg) vs n=10 high-dose (10 µg/kg) fentanyl

- High-dose (10 µg/kg) fentanyl infusion can increase cold pressor test pain threshold and tolerance 4.5 to 6.5 h after infusion
- High-dose fentanyl infusion can increase the area of hyperalgesia caused by electrical burn



Fig. 2. Picture of intradermal electrical stimulation model with grid (A), for hyperalgesia assessment with a von Frey filament (B), and allodynia assessment with a cotton swab (C).



The First Two Steps- Safety & Efficacy

Step 1

- **Acetaminophen** (max 4g/day)
- $\pm$ NSAIDs- « *First On/ Last Off* »
- Sole drugs for mild nociceptive and inflammatory pain
- Well tolerated and 30-50% « opioid » sparing

Step 2

- **Tramadol** (50-100mg q4-6h. Daily Max. 400mg)
- Inherent Multimodal- Opioid, Adrenergic and Serotonergic
- Efficacious for mild to mod. *mixed* pain
- Appropriate models 30% « opioid sparing »
- N&V, ?Serotonin Syndrome
- **Tapentadol** (2x potent, devoid of serotonin activity)

Morphine + ketamine + DHBP

✓ « Ketamine plus » PCA- Ratio Ket: Morphine (1:1)

Indications-

1. Trauma- burns, crush & rib fractures
 2. Opioid tolerance & dependance, substance abuse
 3. Neuropathic pain- neuro (spine), ischemia, sickle
 4. GI Sx, ERAS-Laparoscopic & Converted
 5. Sensitive to or side effects-**Obese**/ OSA & Elderly.
- [Other PCA Additives- *Ondansetron* (1:10), *Naloxone* (1:100)]

Enhanced Recovery After Surgery (ERAS)

Or fast-track programs

- ✓ multiple evidence-based perioperative interventions
- ✓ to standardize and optimize patient care

GOAL: to minimize morbidity

RESULT: reduced hospital Length Of Stay (**hLOS**)

ERAS protocols: Enhanced Recovery After Surgery

Basse et al. Annals of surgery 2000; 232: 51-57

Ljungqvist et al. BJS 2003; 90: 400-406

Basse et al. Annals of surgery 2005; 241: 416-23

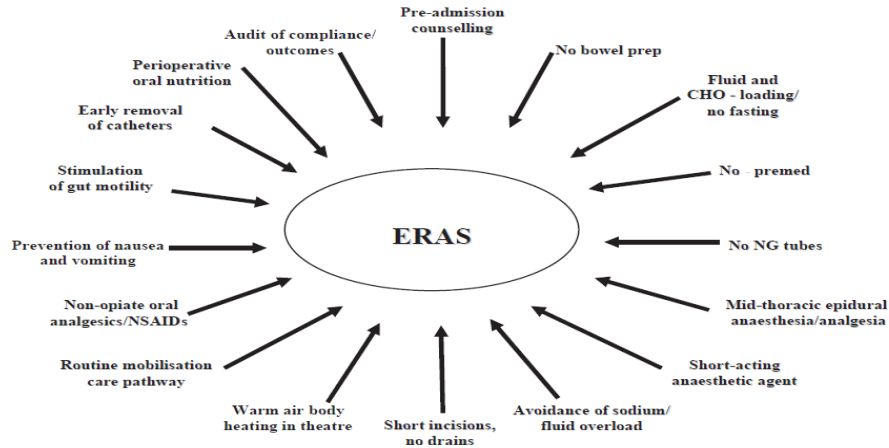


Figure 1 Main elements of the ERAS protocol.

from: Fearon et al. Clinical nutrition 2005;24:466-77

Opioid-overdose crisis in USA (Fentanyl-overdose crisis?)



Prince

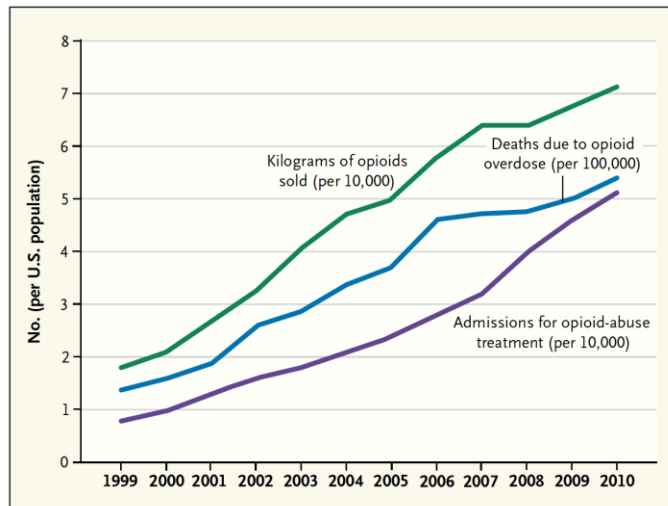


Dolores O'Riordan
The Cranberries



Medication-Assisted Therapies — Tackling the Opioid-Overdose Epidemic

Nora D. Volkow, NEJM 370;22 may 29, 2014



A key driver of the overdose epidemic is underlying substance-use disorder.

Opioid Sales, Admissions for Opioid-Abuse Treatment, and Deaths Due to Opioid Overdose in the United States, 1999–2010.

Rates and risk factors for prolonged opioid use after major surgery:

Clarke et al. BMJ 2014;348:g1251

- 49.2% (n=19 256) discharged with an opioid prescription
- 3.1% (n=1229) continued to receive opioids for more than 90 days after surgery.
- patient related factors
 - ✓ younger age,
 - ✓ lower household income,
 - ✓ specific comorbidities (diabetes, heart failure, pulmonary disease),
 - ✓ use of specific drugs preoperatively (benzodiazepines, selective serotonin reuptake inhibitors, angiotensin converting enzyme inhibitors).

Rates and risk factors for prolonged opioid use after major surgery:

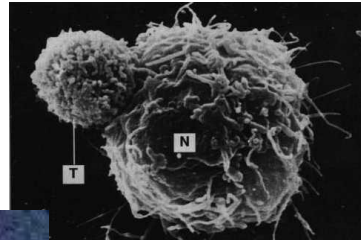
- The type of surgical procedure was also highly associated with prolonged opioid use.
- ✓ both open and minimally invasive thoracic procedures (odds ratio 2.58, 95% CI 2.03 -3.28)
- ✓ Open and minimally invasive major gynaecological procedures were associated with significantly lower risks (OR 0.73 CI95% 0.55 -0.98 and OR 0.45 CI 95% 0.33-0.62,respectively).

OPRM1 A118G Gene Variant and Postoperative Opioid Requirement

In Cheol Hwang,(Anesthesiology 2014; 121:825-34)

- Interpatient variability in responses to opioids is governed by genetic and environmental factors
- The A118G single nucleotide polymorphism of the μ -opioid receptor has been implicated in these differences
- carriers of the G-allele were observed to exhibit higher opioid analgesic requirements
- ✓ These genetic effects were strongest in Asian patients,
- ✓ Morphine users
- ✓ those receiving surgery to a viscus

Lymphocyte type Natural Killer (N) attacking a Tumor cell (T)



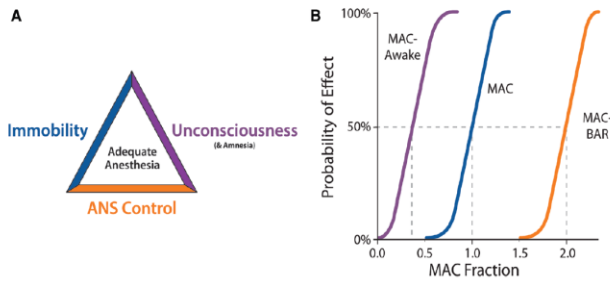
23

Three perioperative factors for shifting the balance toward cancer progression:

- ◊ **Surgery:** release of tumorcells, depresses cytotoxic T-cell and NK cell function, reduces antiangiogenic factors, increases proangiogenic factors, release of growth factors
- ◊ **Anaesthesia:** decreases function of neutrophil, macrophage, dendritic cell, T-cell, NK-cell
- ◊ **Opioids:** inhibits humoral and cellular immune functions, morphine is proangiogenic.

Unconsciousness, immobility and ANS control

Egan et al. AA2018,127(5):1104-6



at least a 2-drug process

1. an inhaled agent or propofol
2. an agent to control ANS responses to surgical stimulation.

Opioids as second drug

OFA = opioid free anaesthesia

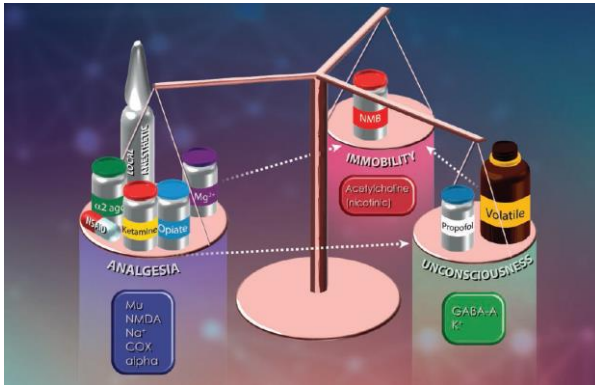
*It's another form of anaesthesia Jim,
but not as we know it!*



is "MOCA = minimal use of opioids to control analgesia" a better name?

MULTIMODAL ANESTHESIA: Theory and practice

Emmery Brown. AA2018;127(5):1246-58



- Multiple agents summate to produce full depth of anaesthesia
- Reduced drug doses decreases chances of side effects of each agent
- Targets spinal and supraspinal sites of nociception
- Decreases reliance on post-op opiates

Why avoid opioids in humans at risk for opioid induced side effects ?

Being fully awake, pain free and without respiratory depression is very important in morbidly obese patients.

Recommendations from SASM on OSAS

- ➔ Reduce/Avoid opioids in OSAS and morbid obese patients

Recommendations from ERAS

- ➔ Avoid opioids to improve bowel function and enhance recovery after surgery

How to avoid opioids?

- ➔ **Direct sympathetic block central - peripheral**
 - ➔ Clonidine, Dexmedetomidine, Beta- blockers
- ➔ **Indirect block of sympathetic effects**
 - ➔ Nicardipine, lidocaine, Mg sulfate, inhalation vapor, NO₂
- ➔ **Multimodal analgesia (non opioids) loading dose preoperative to be active when waking up.**
 - ➔ low dose ketamine, dexmedetomidine, lidocaine, diclofenac, paracetamol, gabapentoids
- ➔ **Neuraxial block + locoregional anaesthesia with higher sympathetic nerve block.**

29

Lidocaine IV OBES SURG (2014) 24:212–218

- 1.5 mg/kg bolus
- followed by a 2 mg/kg/h infusion until the end of the surgical procedure,
- continue at 1.33mg/kg/u until discharge from PACU or for another 23hrs and STOP.
- calculated on IBW

Alpha-2 agonists:

- Indications:
 - Premedication
 - Opiate sparing
 - Additives for regional anesthesia
 - Effect on chronic (postoperative) pain

Clonidine, 150 – 300 µg at induction
Dexmedetomidine loading dose 0,5 to 1 µg/kg IBW
followed by 0,1 to 0.2 µg/kg IBW/h

Even postoperative if necessary
Dexmedetomidine 0,1 – 0,2 µg/kg IBW/h

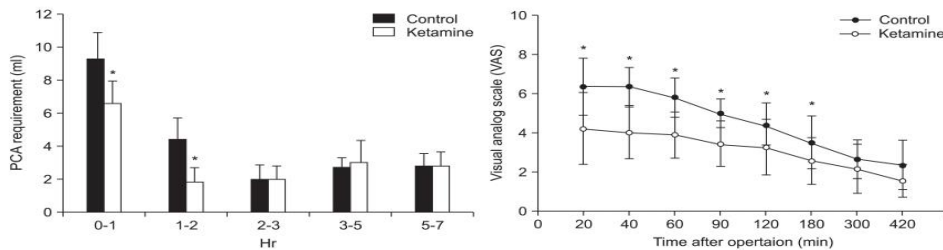
Side effects & complications

- **Bradycardia (dex)**
- **Hypotension (clonidine)**
- Orthostatism, AV-block, arrhythmias
- Constipation, dizziness, dry eye/nose
- Hallucinations, confusion, decrease libido
- Neurotoxicity?
- Antidote: atepamizole not available for human use

Ketamine reduces opioid induced hyperalgesia

Effects of intraoperative low dose ketamine on remifentanyl-induced hyperalgesia in gynecologic surgery with sevoflurane anesthesia. *Boo Hwi Hong et al. Korean J Anesthesiol. 2011; 61: 238.*
Same dose of remifentanyl with ketamine 25 mg vs without ketamine

Ketamine 0,3 mg/kg followed by 3 ug/kg/min AFTER YOUR PROPOFOL!
Ketamine 0,125 to 0,25 mg/kg IBW followed by 0,125 to 0,25 mg/kg IBW/h



Magnesium and Central Nervous System



- **MgSulfate 40 mg/kg IBW followed by 10 mg/kg IBW/hr**
- **Interaction with NMBA: potentiation, give at start of surgery!**
- Tramer, Schneider, Marti, Rifat- *Anesthesiology* 1996: pre-op MgSO₄ and post-op infusion lowered Morphine requirements
- Lysakowski et al *AA* 2007;104:1532-9: Mg did not alter pain intensity or analgesic requirements but significantly reduced postoperative shivering

Intraoperative glucocorticoid

Gan et al. Anesth Analg 2014;118:85–113)

- Analgesic (rest, mobilisation)
- Antihyperalgesic
- Prevention of acute pain chronification?
- Prevention of PONV
- Reduction of postoperative fatigue
- Side effects? (infection, woundhealing, hyperglycemia)
- DM2 is not a reason to withhold this medication (4mg)

➤ **Dose ? 5-10mg or 0.1mg/kg IBW**

Disadvantages of N ₂ O	Advantages of N ₂ O
PONV	Analgesic properties
Expansion of air spaces	Dose reduction of other drugs
Myocardial ischemia Elevated homocysteine levels	Long standing safety record
Increased risk of hypoxia ⁶²	Possible lower risk of awareness
Increased ICP	Second gas and concentrating effect
29 vol% CO ₂ /N ₂ O supports combustion ⁶³	Prevention of acute and Chronic pain
Pulmonary atelectasis ⁶⁴	Short acting/ low blood/gas solubility
Increases pulmonary artery pressure	Increases sympathetic activity

Is the abandonment of N₂O premature?

- p_aO₂ is higher when using oxygen/nitrous oxide compared to oxygen/air mixture due to the concentrating effect *Peyton et al. 2006*
- Hypoxic events are hardly influenced by “diffusion anoxia” and should be attributed to pulmonary atelectasis and other co-morbidities
Duggan et al 2005
- >2hrs 67% N₂O: contamination with 29 vol% of nitrous oxide, a fraction that becomes hazardous with regard to explosion risk
Diemunsch et al 2002
- CO₂/N₂O embolism, no negative impact of nitrous oxide on the haemodynamic consequences of this type of embolism
Diemunsch et al 2006

Summary

- Opioids in humans should be used with extreme caution
- must be avoided wherever analgesic demands can be met with other (multi)modalities
- ERAS protocols: use short acting opioids or at least minimize the use of long acting opioids in morbidly obese patients
- Optimization and individualization is important!
- Multimodal anesthesia and analgesia and opioid free techniques: in all patients?

Novel targets for pain management
(*Y. Kushnir*)

Novel Target for Pain Management

Yishai Kushnir

Pain is a serious concern in the 21st century as a welfare problem and has important economic implications. More than a century of pain research has provided many insights into the mechanisms of pain, the way it is formed, transmitted, modulated and perceived. However, the treatment of pain is still largely reliant on opioids and anti-inflammatory agents. The relative inefficacy of these treatments for neuropathic and chronic pain, especially in light of the opioid crisis, has emphasized the need for therapies, which specifically target nociceptors and provide analgesia with minimal adverse effects. This has led to a search for novel targets for treatment based on the mechanisms demonstrated by basic science. These targets include nociceptive specific receptors, which are involved in transduction of pain from a mechanical thermal or chemical insult to an electrical signal, such the transient receptor potential vanilloid 1 (TRPV1). Another area for intervention may be the mechanisms involved in transforming the initial electrical current into an action potential at the spike initiation zone. The inflammatory process, which potentiates nociceptors involves a large number of compounds and offers several potential targets, which may modulate pain and its response to other analgesics. Platelet derived growth factor (PDGF) is one of the elements in inflammatory soup, and has a role in pain and potentially in the development of opioid tolerance. However, pain is more complex than the nociceptive input and this poses a problem for pain research in bridging the gap between the research bench and the bedside. Thus, we turn to nature to find other compounds including cannabinoids, animal toxins and spontaneous mutations in humans which may shine a light on new mechanism and potential treatments for pain in the future.

Opioids in veterinary medicine
(*E. Clutton*)

Opioids in Veterinary Medicine

R. Eddie Clutton

Human beings have used opioids for millennia in order to alter states of consciousness, to promote euphoria and to suppress pain. Such "benefits" were not initially - nor universally - afforded to animals because *their* capacity to experience human emotions and suffer pain is a relatively recent "discovery". However, even when the evidence that higher vertebrates could suffer pain became incontrovertible - and that opioids *could* effectively manage that pain - the use of these drugs in animals was limited for several, usually unsound reasons. This changed as veterinary anaesthesia developed into a clinical specialty, the use of opioids in animals became more commonplace and their clinical advantages appreciated.

In one form or another, opioid drugs have played an important role in medical anaesthetics despite well-recognized side-effects, e.g., respiratory depression, nausea, vomiting, dizziness and constipation. However, there is increasing concern with their capacity to cause confusion and postoperative delirium, *increased* postoperative pain, immunodepression, hyperalgesia and chronic postoperative pain. Most importantly, it is recognised that opioid tolerance to analgesia can occur after a single dose, and there is growing concern over an ongoing international opioid abuse epidemic, which in many cases originates from the use of opioid drugs to manage acute postoperative pain. Medical postoperative pain management is currently moving away from perioperative opioid use.

Veterinary medicine has a poor record in following unsound medical trends (neophilia) whilst ignoring the more compelling (ethics in intensive care). This presentation will make the case for preserving - even extending - the use of opioids in animal anaesthesia.

Leslie Hall Memorial Lecture:

“From test tube to TIVA: Some milestones in the development of propofol”

(Iain Glen)

THE LESLEY HALL MEMORIAL LECTURE

From test tube to TIVA: Some milestones in the development of propofol

John (Iain) B Glen

Serendipity rather than prospective chemical design was responsible for the unexpected discovery of anaesthetic activity in mice with 2,6-diethylphenol in 1973. Thereafter, the systematic evaluation of the anaesthetic properties of about 300 chemically related di-alkylphenols, in laboratory animals, led to my selection of 2,6-diisopropylphenol (propofol) as a candidate for clinical trials [1,2]. This agent was an oil, thus poorly soluble in water, so laboratory studies and early clinical trials, which began in 1977, were done with a formulation containing the surfactant Cremophor EL. At this time this surfactant material was also used in preparations of alphaxalone/alphadolone and propanidol. Our development of a mini-pig model in which we confirmed the potential of this surfactant to produce life threatening anaphylactoid reactions [3] was a major step forward and allowed us to search for an improved formulation.

Animal studies had suggested a lack of cumulation on repeated injection and an improved quality of recovery in comparison with thiopentone. These desirable properties were confirmed in man in early clinical trials with the Cremophor formulation before a number of anaphylactoid reactions were encountered and the trials halted. Trials began again with an aqueous emulsion formulation in soybean oil in 1983 and this formulation was first marketed for use in man in 1986 and for use in veterinary anaesthesia shortly afterwards. By this time it was clear that propofol had a desirable pharmacokinetic profile and that following induction, anaesthesia could be maintained with repeated injections, or with an infusion, with remarkably clear-headed recovery occurring rapidly after the end of the procedure. Propofol's recovery profile, with a very low frequency of post operative emetic sequelae, made it an attractive component of TIVA techniques for day surgery. Further growth in this area resulted from mutual benefits achieved with propofol and the laryngeal mask airway.

Use of propofol to provide sedation as a supplement to regional anaesthesia provided a good opportunity for anaesthetists to become familiar with infusion techniques without the need for iv analgesia. The application of propofol as a maintenance agent then extended into longer procedures, particularly for airway surgery, cardiac and neurosurgery, where numerous infusion schemes were published for use with iv opioid supplementation. At this stage, infusion induction of anaesthesia became possible with the Ohmeda 9000 pump, the first of a new generation of syringe pumps with an extended range of infusion rates. These pumps could also be controlled by a computer and experts in PK modelling then led us to the technique of target controlled infusion (TCI) first approved in the UK in 1996 [4]. Further approvals for the administration of propofol by TCI have been gained in most countries of the world, but sadly not in the USA.

Over this period, anaesthetists have been at the forefront of developments in pharmacokinetics and the development of TIVA as a useful clinical technique has been facilitated by an understanding of the differences between iv agent in terms of context sensitive half time [5] and effect site equilibration time. New hypnotic and analgesic drugs, with a new understanding of pharmacokinetic concepts, have led to improvements and new options in both medical and veterinary anaesthetic practice.

References

- [1] James R and Glen JB. Synthesis, biological evaluation and preliminary structure-activity considerations of a series of alkylphenols as intravenous anaesthetic agents. *J Med Chem.* 1980; **23**: 1350-1357
- [2] Glen JB. Animal studies of the anaesthetic activity of ICI 35868. *Br J Anaesth* 1980; **52**: 731-742
- [3] Glen JB, Davies GE, Thomson DS, Scarth SC and Thompson AV (1979). An animal model for the investigation of adverse responses to iv anaesthetic agents and their solvents. *Br J Anaesth.* 1979 ; **51**: 819-827.
- [4] Glen JB. The development of 'Diprifusor': a TCI system for propofol. *Anaesthesia* 1998; **53**: Supplement 1, 13-21.
- [5] Hughes MA, Glass PSA, Jacobs JR. Context-sensitive half-time in multicompartiment pharmacokinetic models for intravenous anesthetic drugs. *Anesthesiology* 1992; **76**: 334-41

Cardio-anaesthesia
(*S. Bouchez*)

Cardiac anesthesia: physiology learned throughout history.

Stefaan Bouchez, MD, FASE.

Ghent University Hospital, BE.

Stefaan.Bouchez@ugent.be

‘The more you know from the past, the better prepared you are for the future’ Theodore Roosevelt, the 26th president of the United States of America.

Anesthesia was integral part of surgery and in most of cases, the anesthesia was performed by the youngest of the surgical teams.

Cardiac surgery was the last anatomical surgical specialty to emerge. It is the most intensely dramatic, due in part to the wide variety of intricate operations performed and the complicated apparatus needed, and in part to the symbolism of the heart, rooted deep within mankind. In the 1880’s Billroth stated that ‘Any surgeon who wishes to preserve the respect of his colleagues would never attempt to suture the heart’. It was long after world war II and the foundation of the American Society of Anesthesiologists in 1945, when anesthesia was considered as a dedicated profession next to surgery.

Cardiac anesthesia is not only about putting the cardiac patients in a reversible pharmacological coma but requires detailed knowledge about cardiovascular physiology and pathophysiology. One of the first important names in the physiology of the heart is Ernest Starling who’s experiments on anesthetized dogs learned us about relation between preload and stroke volume. When preload increases, stroke volume and cardiac output will rise. This was called ‘the law of Starling’. In one of his experiments he inserted a catheter inside the pericardium and started to infuse slowly oil to create acute tamponade. He recorded both the venous and arterial pressures during this acute heart failure setting and noticed that arterial blood pressure declined while central venous pressure increased. In fact, this is the basic pattern we notice in every patient in acute or worsening heart failure.

Starling was also one of the first physiologists to describe Pms, the non-zero cardiac arrest pressure. The non-zero arrest pressure is termed the mean systemic filling pressure which is a kind of venous pressure that drives the blood towards the right atrium. The driving force for venous return is determined by the gradient between the Pms and the right atrial pressure. The Pms is determined by the stressed volume which indicates the active blood volume in the circulation. In the figure with the bathtub this concept is explained. When the opening is on the side of the tub, only the level of water above the hole contributes to the Pms and is referred to as the stressed volume. The volume below is called unstressed volume.

The monitoring of ECG is considered routine during anesthesia. Willem Einthoven in 1893 was able to record the electrical activity of the heart and described it as ‘electrocardiogram’.

The first human catheterization was performed by Werner Forssmann in 1929. As a resident in cardiology Dr Forssmann had convinced a nurse to be his first human 'guinea pig'. He had to convince her as she held the keys to the closet, which contained the catheters. As the nurse was strapped to the surgical table in the small operating room, sweating from excitement Dr. Forssmann walked the distance of the OR and began his self-experimentation. He performed the catheterization by inserting the 65-cm-long ureteral tube into his arm and took an X-ray to document the position of the catheter. For this experiment, he faced disciplinary actions so severe that he had to abandon his cardiology internship and pursued urology instead.

At age 25 Lindbergh became famous for the first transatlantic flight from New York to Paris in 1927. As he was very interested in science and more specific in medicine, he got into contact with Alexis Carrell, a famous vascular surgeon. Together they struggled with the idea of supporting circulation with the use of a pump. In 1935 they were able to keep tissues and organs viable for several days using a perfusion pump: 'the Lindbergh perfusion pump'. This was the first step towards the development of the cardiopulmonary bypass machine and cardiac assist devices.

The electro-encephalogram is analogous to the electrocardiogram; it is a record of the electrical potentials originating in the brain. Dr Gibbs was able to record this brain activity and examined the effect of several drugs on the electroencephalogram including ether. Dr Gibbs once stated 'The anesthesiologist or surgeon could have before them on tape or screen a continuous record of the electrical activity of both heart and brain'. It took medical science decades before this actually came true. It is now common practice to have these tracings next to each other during cardiac anesthesia. The monitors we use during surgery are able to rearrange the complicated EEG signals into a clear color coded pattern (Blue inactive frequencies vs yellow / red active frequencies) 'spectrogram'. Next to the depth of anesthesia, the color coded spectrogram shows a specific pattern for the drug used during anesthesia. This way modern anesthesiologists don't have to rely on the cardiovascular signs (heart rate and hypertension) to evaluate the depth of anesthesia which often has led to the excessive administration of opioids or hypnotics in an attempt to block the 'arousal'. A too deep level of anesthesia for a long time will lead to postoperative cognitive dysfunction and even delirium in patients undergoing surgery. Sympathetic stimulation does occur during surgery without altering the depth of anesthesia! The spectrogram has also helped us to optimize the anesthetic depth during the course of cardiopulmonary bypass. Pharmacological changes and hypothermia will lower the anesthetic requirements during bypass.

Hypothermia was and is still one way of protecting the brain and other organs, including the heart. In 1952 systemic hypothermia was considered the best way to protect organ function. Hypothermia would give the surgeon the time he would need to operate on the heart. In

1952 this method was used for the first time by Floyd Lewis of Minneapolis (Minnesota) to close an atrial septal defect type II (ASD II).

Until the sixties, ether and cyclopropane were most often used for the induction and maintenance of anesthesia. Major drawbacks were the cardiorespiratory irritability of these agents and high flammability. During the sixties, newer volatile agents became available like halothane. Halothane wasn't flammable so it was considered a much safer product. While diethyl ether is still used in some parts of the world, it was phased out of use in the US in the early to mid 1970's.

The race towards the development of a circulation supporting device continued. General Motors performed experiments in 1952 but it was Dr Gibbon in 1953 who successfully used a cardiopulmonary bypass machine during cardiac surgery. Gibbon once witnessed a patient who had developed a massive pulmonary embolism following a cholecystectomy. Although a pulmonary embolectomy was performed, the patient did not survive. Gibbon believed that a machine that would have taken her venous blood, oxygenated it and returned it to her arterial system would have saved her. He began work on this machine experimenting on cats at Harvard. He became successful at maintaining cardiorespiratory function of cats for nearly four hours and published these results in 1937. World War II delayed his research for some years but on May 6, 1953, he was able to perform the first successful open heart procedure, an ASD closure, on an 18-year-old patient using total cardiopulmonary bypass. The patient lived for over 30 more years. The development of CPB finally opened the doors towards 'open' cardiac surgery.

1953 was considered a great year for anesthesia, cardiology and cardiac surgery. Next to the use of the cardiopulmonary bypass machine, Dr Seldinger published his 'Seldinger technique' (guidewire through the needle) and echocardiography was introduced by Edler and Hertz.

In the early fifties, Arthur Guyton was a brilliant student as he started his residency in cardiovascular surgery at Harvard. Unfortunately during the final year of his residency, Guyton was partially paralysed after being infected with polio. Suffering paralysis in his right leg, left arm, and both shoulders, he spent nine months in Georgia, recuperating and applying his inventive mind to building the first motorized wheelchair controlled by a "joy stick", a motorized hoist for lifting patients, special leg braces, and other devices to aid the handicapped. Due to his disability, he had to abandon his plan to become a surgeon. Instead he concentrated on physiology research and teaching, and became the head Dept. of Physiology and Biophysics at the University of Mississippi. Guyton is most famous for his experiments in the 1950s which studied the physiology of the circulation. It was this work which overturned the conventional wisdom that it was the heart itself that controlled cardiac output. The "Guyton Curves" or the venous return curves which describe the relationship between right atrial pressure and cardiac output form the basis for

understanding the physiology of circulation. This subject is well described in Guyton's textbook which is considered one of the best books on human physiology.

Remember that the driving force for venous return is the gradient between the Pms and the central venous pressure. The role of the heart is to lower the right atrial pressure. This way the heart can regulate the (Pms-CVP) gradient and is able to optimize the venous return.

Every change in venous return will consequently change cardiac output.

By matching the cardiac output curves (Frank-Starling) with the venous return curves from Guyton, circulatory physiology can be explained in an easy way. The intersection between these points determines the central venous pressure. Fluid therapy will shift the venous return curve upwards which will increase the CVP and cardiac output (=also venous return).

A decrease or an increase in cardiac function will lead to a decreased cardiac output and a rise in the right atrial filling pressure or CVP. For example: if a patient gets intubated and ventilated, venous return will decrease because of the decline in the (Pms-CVP) gradient.

Pms can be increased by the administration of fluids or vasopressors. Both will increase the stressed volume which determines the Pms.

Interestingly, most of the human (venous) blood volume is below the level of the heart while in most animals this remains above the heart. How this affects Pms and venous return is not known for all animals. From animal research, we know that Pms in swine and sheep is comparable to humans. Also blood pressure and central venous pressure seems to be the same. The only variant is the cardiac output. In human clinical practice the 'Navigator-monitor' can be used to estimate Pms and to evaluate the efficiency of the circulation.

In 1957 Prince Alexander, the 15-year-old son of King Leopold III and Princess Lilian presented with a coarctation. Jean Govaerts, who in 1956 had already performed 13 coarctation repairs and who was the most experienced cardiac surgeon in Belgium deemed himself qualified to operate on the Prince. The Princess, however, took Alexander to Robert Gross in Boston. Gross had already performed hundreds of coarctation repairs by then and he operated on the Prince on 17 September 1957. While Prince Alexander was recovering from his operation, Robert Gross convinced Princess Lilian to promote the budding discipline of heart surgery in Belgium. On her return home, the Princess financially supported transfer to Boston and appropriate specialized surgical treatment of several Belgian children with a congenital heart defect. In 1958 the 'Princess Lilian Cardiology Foundation' was founded for promotion of cardiology and heart surgery. Its goal was to 'to help patients, especially children suffering from cardiac and cardiovascular disease, regain their health so as to pursue a normal productive life'. The Princess Lilian Cardiology Foundation also financed the purchase of a heart-lung machine of the Kay-Cross type for the University Brugmann Institute in Brussels, for the Bunge Institute in Antwerp, the O.L.V. Hospital in Aalst, and for the University Hospitals in Leuven. The Foundation still exists today and primarily focuses on promoting fundamental scientific research in all medical research areas.

In South Africa on 3 December 1967, Christian Barnard transplanted the heart of accident-victim into the chest of 54-year-old Louis Wahskansky. Washkansky regaining full consciousness and being able to easily talk with his wife, before dying 18 days later of pneumonia. The anti-rejection drugs that suppressed his immune system were a major contributing factor. The waiting list for heart transplants is long and patients even die while on the waiting list. To overcome this problem, patients on the waiting can be supported by the implantation of an left ventricle assist device (LVAD). This device, implanted in the apex of the left ventricle will drain the blood from the left ventricle and pumps it towards the ascending aorta. The flow from the device is continuous so these patients are living 'pulseless'. The first heart transplantation was performed in Brussels by Georges Primo in 1973. In 1968 Dr Frits Derom (Ghent University Hospital) was able to perform the first lung transplantation in which the recipient survived for several months (>10months).

In 1969, Lowenstein published his article about 'stress-free' anesthesia using high dose of opioids (Morphine). In the seventies, morphine was replaced by the synthetic opioid Fentanyl. Since then, high dose opioids became the standard anesthetic technique during cardiac surgery. Volatile anesthetics were even abandoned until the 80's until experimental and clinical studies revealed volatile cardiac protection.

In 1969, Jeremy Swan was standing 'stress-free' on a beach in Santa Monica, (California, USA) watching sailboats gliding by when the inspiration for the catheter that would eventually bear his name came to him. "He figured the catheter could sail through the heart". Swan's original concept—to put a small sail on the catheter so that it could glide through the right atrium, right ventricle, and eventually into the pulmonary artery to measure the function of the left ventricle indirectly—was transformed into the balloon-tipped catheter that Swan, along with William Ganz and others, would describe in 1970 (*N Engl J Med* 1970) The catheter revolutionised the way we understood the physiology of heart failure and heart attacks and until present, it's still in use helping to guide the management of patients undergoing major cardiovascular surgery.

Until the seventies, common practice during cardiac surgery was to operate on a fibrillating heart. The use of cardioplegia (potassium-induced electromechanical arrest) to achieve the ideal conditions for cardiac surgical operations was introduced in 1973. Now surgeons could operate on a arrested heart in bloodless conditions. At the same time the myocardium was better protected during surgery because of the electromechanical arrest and the cooling by the cold cardioplegic solution.

During the eighties, volatile agents were reinstituted as part of a balanced anesthetic technique. Literature showed that the newer volatile agents (isoflurane, sevoflurane and desflurane) have potent cardioprotective properties : less myocardial damage and better preserved cardiac function. The anesthetic regime changed to a reduction of opioid dosage combined with the administration of volatile anesthetics.

This balanced anesthetic regime together with improved perfusion and surgical techniques has led towards less invasive surgery. On the other hand, these new techniques increased the need for 'invasive' monitoring. Next to standard invasive monitoring (arterial blood pressure, central venous pressure, pulmonary artery catheter) transesophageal echocardiography become obligatory for most of the cardiac procedures. Echocardiography is a powerful diagnostic tool in the perioperative management of patients with unique value for *preoperative* planning, *intraoperative* procedural guidance as well as evaluation, and *postoperative* follow up. It also serves as a continuous non-invasive hemodynamic monitor, superior to most invasive monitoring techniques used in major surgery and critically ill patients today.

Less than a year ago, ERAS guidelines for cardiac surgery were published. Enhanced Recovery After Surgery (ERAS) evidence-based protocols for perioperative care can lead to improvements in clinical outcomes and cost savings. ERAS starts preoperatively and continues postoperatively. It promotes a further reduction of intraoperative opioids to enhance extubation and recovery while the use of dexmedetomidine and ketamine is recommended. A list of specific perioperative recommendations is shown on the slide on ERAS.

Traditionally, anesthesia residency training mostly consisted of didactic lectures and observations. After completion of "traditional" training, anesthesia residents were allowed to perform procedures on patients under supervision. Simulation training is proved to be a more effective tool to teach anesthesiologists the skills necessary to deal with critical scenarios (anaphylaxis, cardiac arrest, difficult intubation..) Recently, also non-technical skills, have been emphasized as an important training resource. Such programs are crucial in training anesthesia residents to work efficiently as a team in the operation room. In our center, anesthesia residents are trained in echocardiography using a Vimedix simulator. Next to echocardiography, technical skills and non-technical skills are trained using the Simman which is a mannequin able to simulate almost every critical scenario.

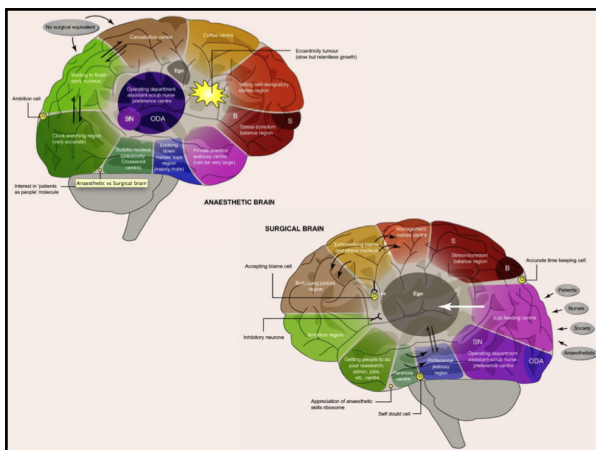
SB.

Cardiac Anesthesia :

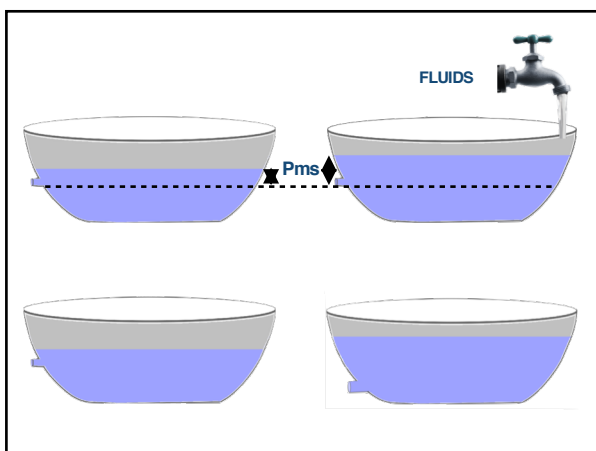
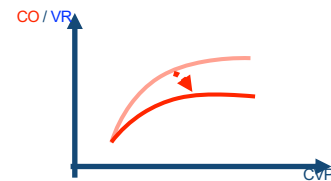
from past till present

The more you know about the past, the better prepared you are for the future...

Theodore Roosevelt

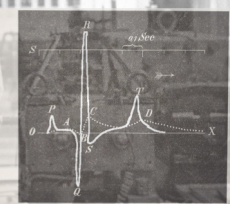


The Jarriss and Gale Lectures
 ON
SOME POINTS IN THE PATHOLOGY OF
HEART DISEASE.
Delivered at the Royal College of Surgeons of England on
Feb. 2nd, 24th, and 26th, 1897.
 BY **ERNEST H. STARLING, M.D.,**
 M.R.C.P. LOND.,
 JOINT LECTURER ON PHYSIOLOGY AT GUY'S HOSPITAL.
 LECTURE I.
Delivered on Feb. 2nd.
 ON THE COMPENSATORY MECHANISMS OF THE HEART.



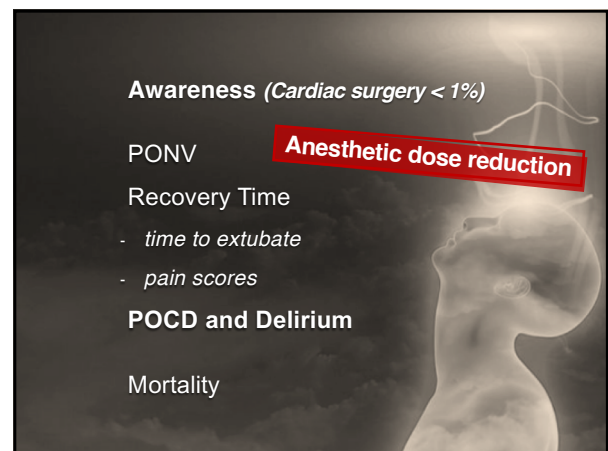
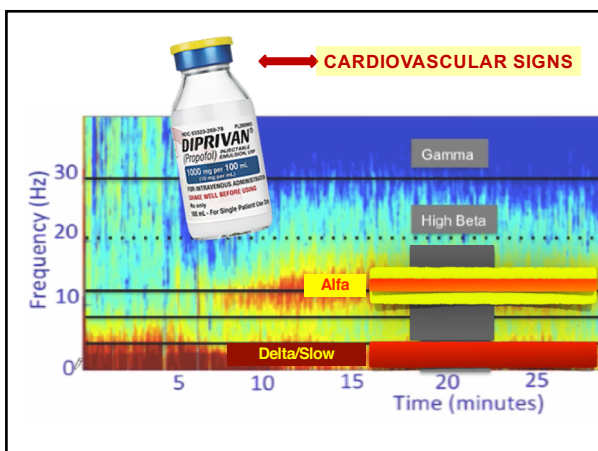
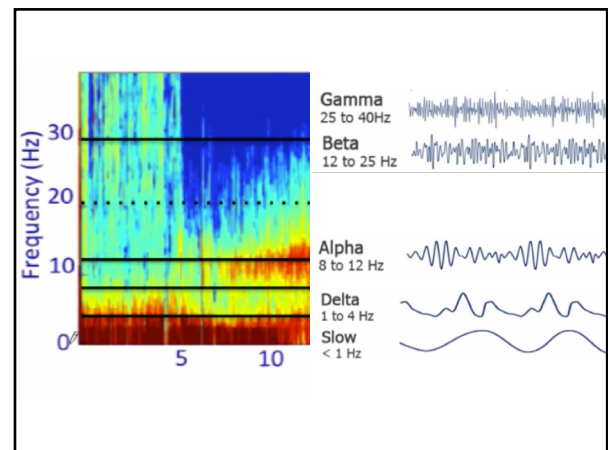
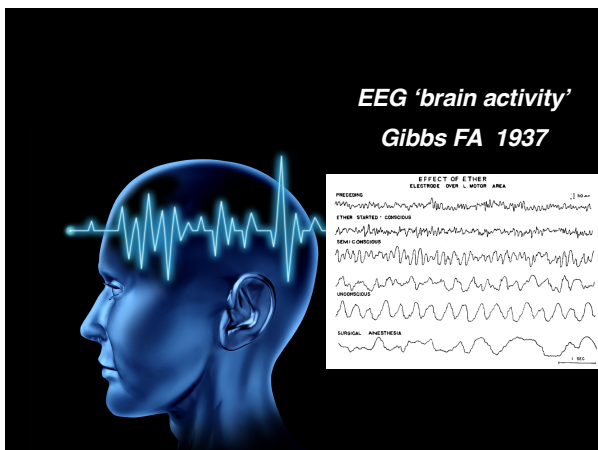
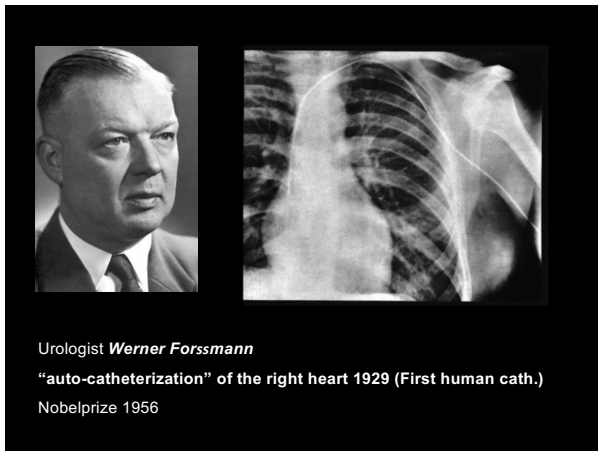
Willem Einthoven (1860-1927) : Leiden

1893 : "Electrocardiogram"
 1895 : "P-QRS-T"
 1924 : Nobel Prize



Portrait of a German. Electrocardiograph. Specimen for X-ray in which the Einthoven and Starling in the Patient. In the Case the Heart and the First Series of the Heart in the Heart.

Fig. 2. Construction of the Electrocardiogram. The first series of the direct registration. Curve of the heart in the heart.



Systemic hypothermia

'Deep Freeze' Heart Girl Making Rapid Recovery

By The United Press.
MINNEAPOLIS, Minn., Sept. 29.—A 5-year-old girl, who weighed twenty-nine pounds when her life was saved by "deep freeze" heart operation, will be ready for school soon.

Her parents, Mr. and Mrs. Francis Johnson of Minneapolis, said today, "Jacqueline is coming back nicely."

"I believe we will send her to school now," her father said. Surgeons operated on her several weeks ago to close a hole that had been in her heart since birth. Her body was refrigerated until its temperature dropped to 70 degrees—almost 20 below normal. While the blood supply pumped through her heart was

Floyd Willis (Minnesota)
sluitten ASD type II
1952



Inhaled anesthetics: 'Cardiorespiratory irritability'.

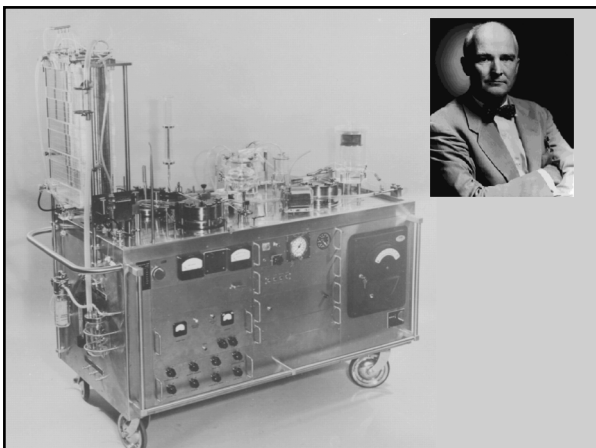
McQuiston, 1949 and 1950^{2,3}

Observations

Good prognosis if cyanosis decreased after induction of anesthesia and vice versa

Recommendations

Surface hypothermia (92 to 93 F) to reduce oxygen demand
Controlled respiration with cyclopropane-oxygen
Atropine to treat bradycardia

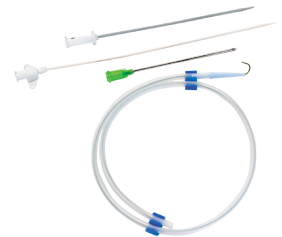


CATHETER REPLACEMENT OF THE NEEDLE IN PERCUTANEOUS ARTERIOGRAPHY

A new technique
by
Sven Ivar Seldinger

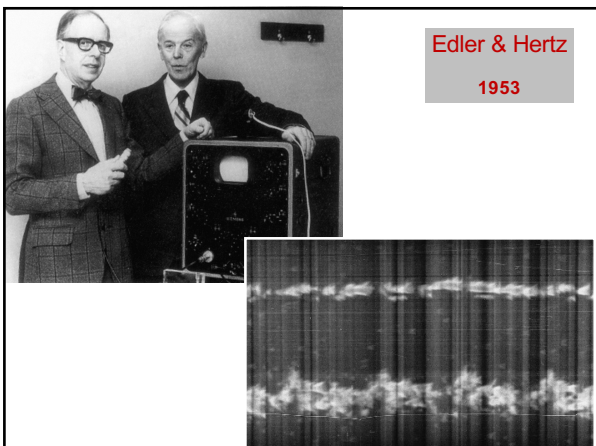
The catheter method of angiography has become more popular in the past few years, as it provides the following advantages over the method of injecting the contrast medium by means of a simple needle:

Acta radiologica 39 (5): 368-76



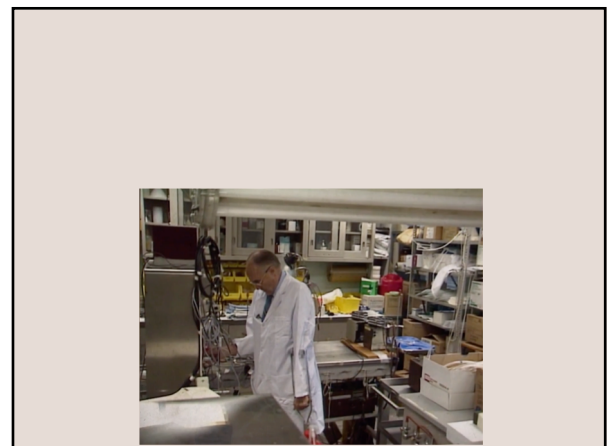
Sven Seldinger

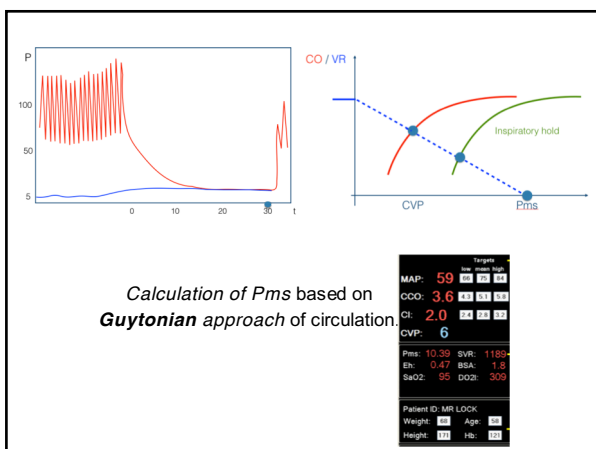
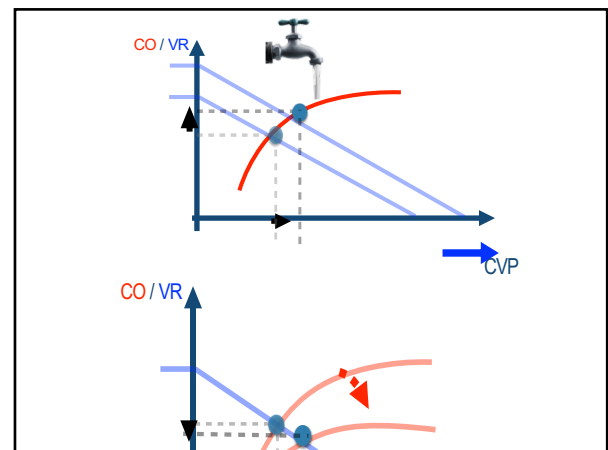
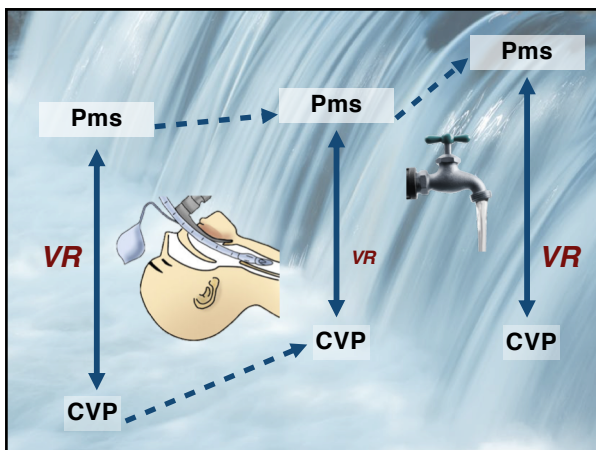
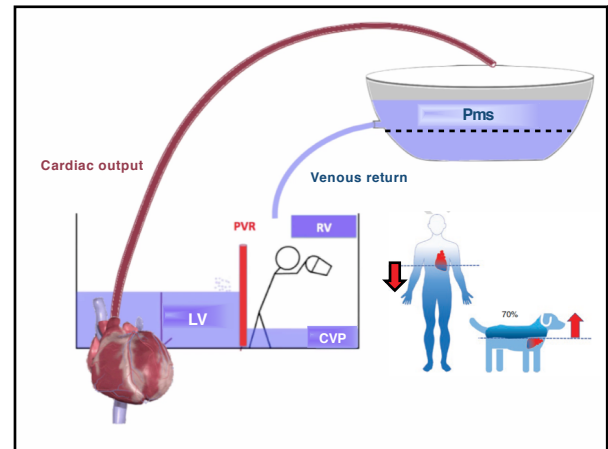
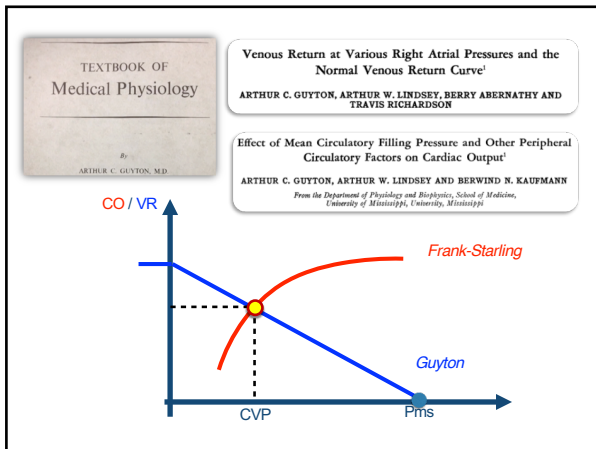
Sweden, 1953



Edler & Hertz

1953







1957 Prince Alexander
Leopold III & Liliane

Diagnosis: *coarctatio aortae*

Robert Gross (Boston, USA)



aard

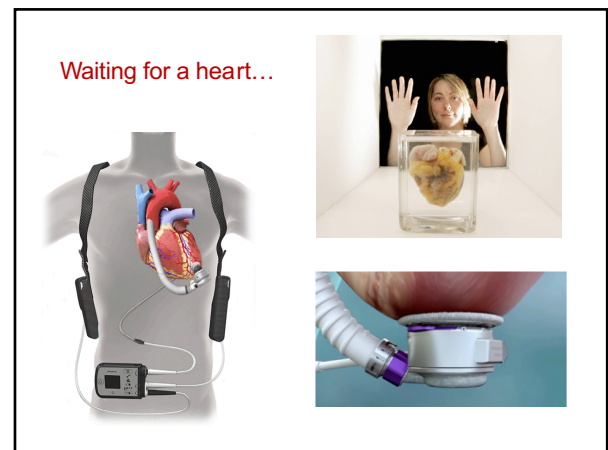
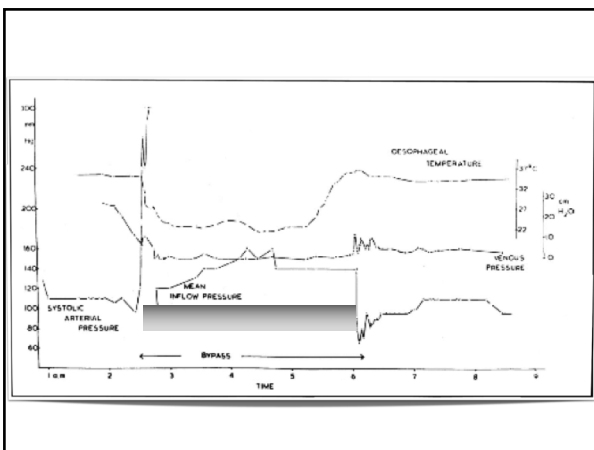
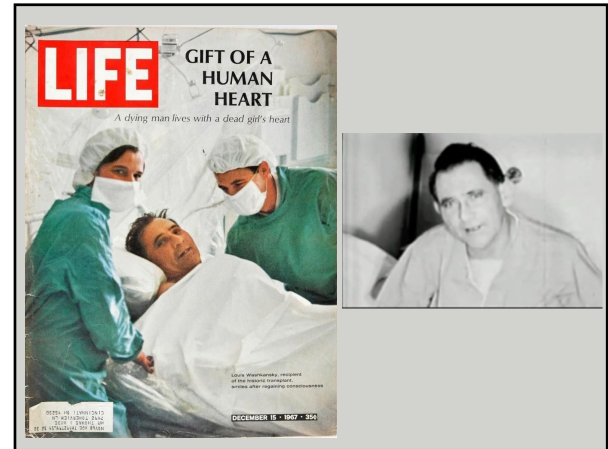
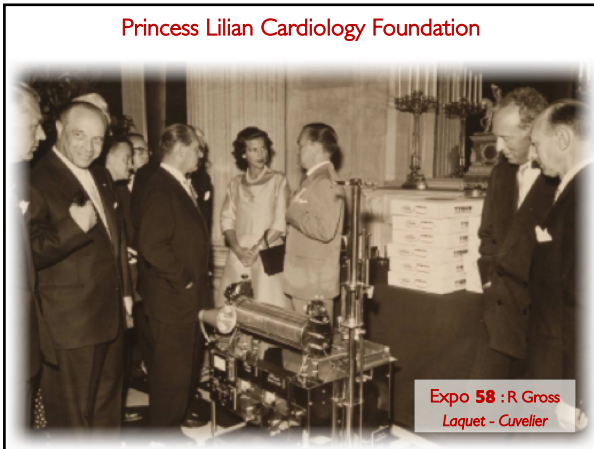
WEEKBLAD VAN DE
ECONOMISCHE BELANGEN

11 SEPTEMBER 1957

"Schier geen gevaar te duchten"
Prins Alexander met succes geopereerd

Door een vernieuwde kindchirurg in de hofstaat: wijzigingen

Princess Lilian Cardiology Foundation

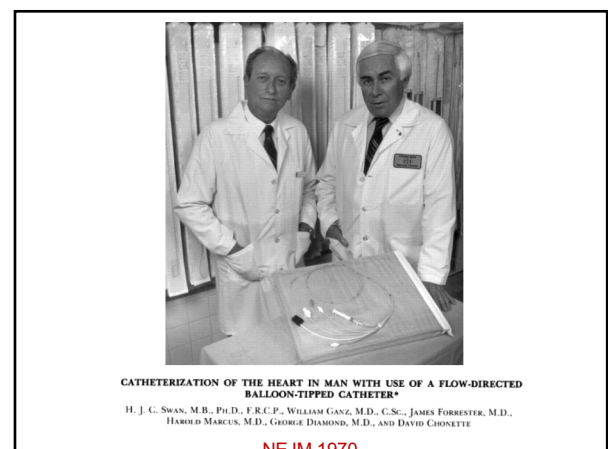


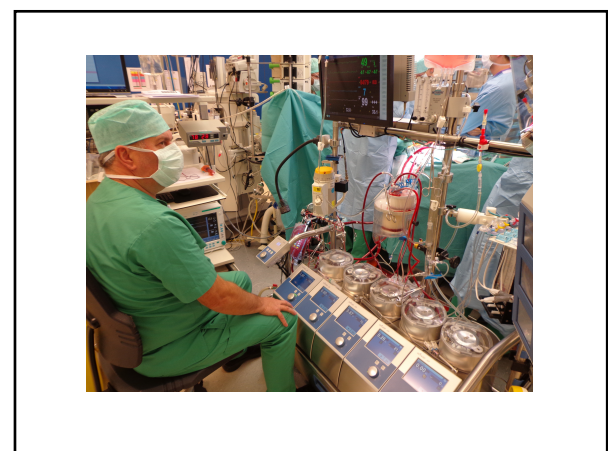
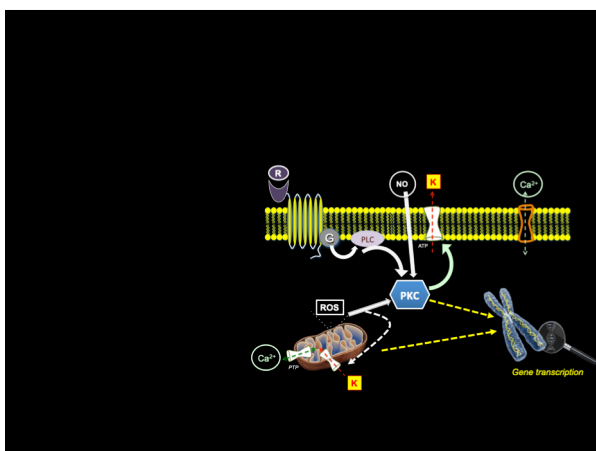
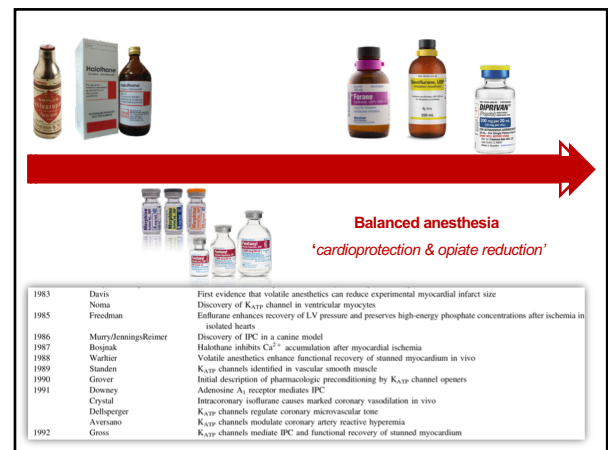
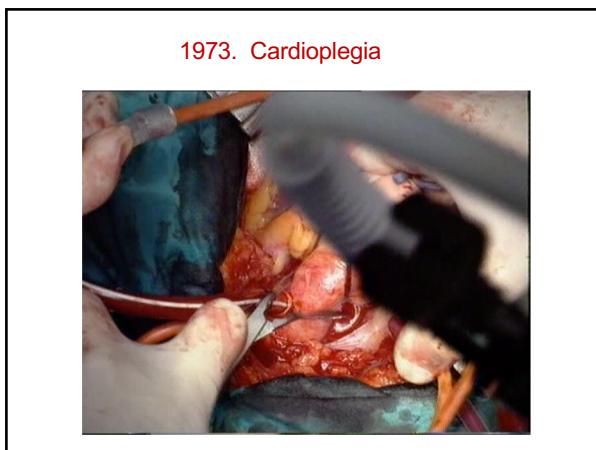
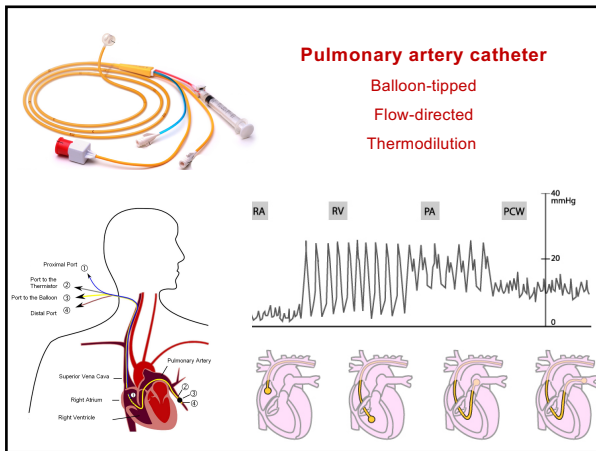
'Stress-free' anesthesia

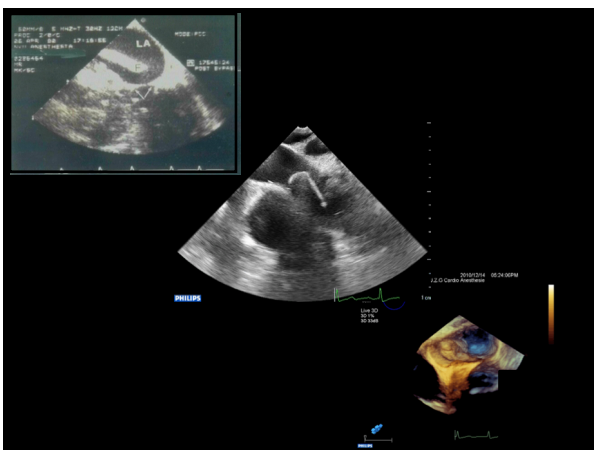
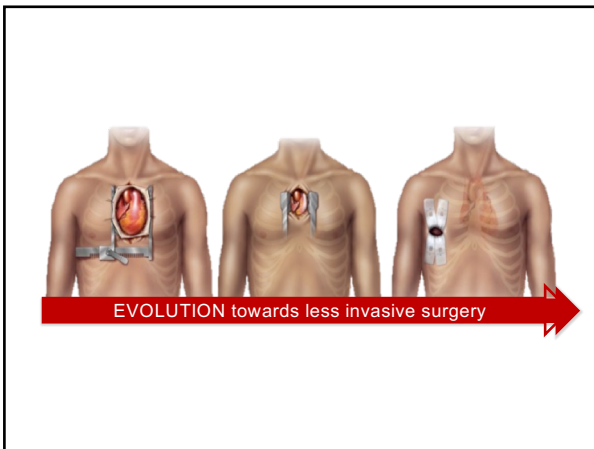
18 dec 1969

Cardiovascular Response to Large Doses of Intravenous Morphine in Man

Edward Lovenstein, M.D., Phillips Hollowell, M.D., Frederick H. Levine, M.D., Willard M. Daggett, M.D., W. Gerald Austen, M.D., and Myron B. Laves, M.D.







80's : Multiplane transducers

1987 : First workshop for intraoperative Echocardiography in US (SCA)

1999 : Guidelines Intraoperative Echocardiography

90's – 2000 : 3D echocardiography

ASE/SCA Guidelines for Performing a Comprehensive Intraoperative Multiplane Transesophageal Echocardiography Examination: Recommendations of the American Society of Echocardiography Council for Intraoperative Echocardiography and the Society of Cardiovascular Anesthesiologists Task Force for Certification in Perioperative Transesophageal Echocardiography

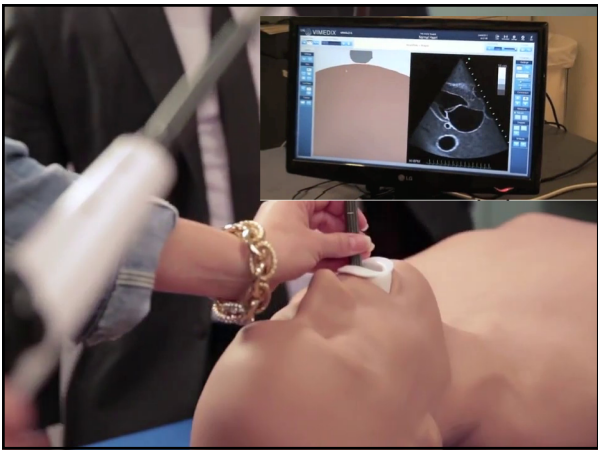
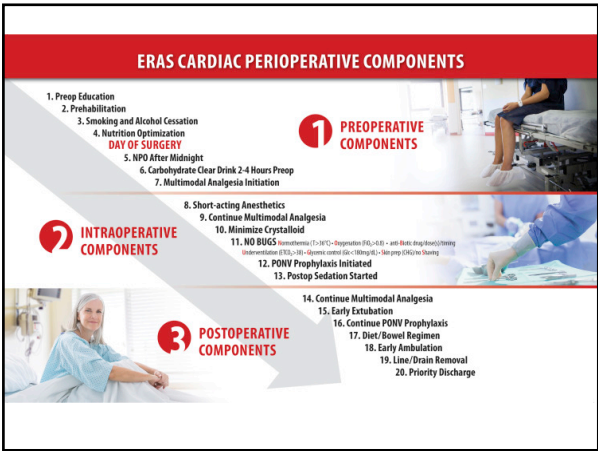
Jack S. Shanewise, MD, Albert T. Cheung, MD, Solomon Aronson, MD, William J. Stewart, MD, Richard L. Weiss, MD, Jonathan B. Mark, MD, Robert M. Savage, MD, Pamela Sears-Rogan, MD, Joseph P. Mathew, MD, Miguel A. Quiñones, MD, Michael R. Cahalan, MD, and Joseph S. Savino, MD, Atlanta, Georgia; Philadelphia, Pennsylvania; Chicago, Illinois; Cleveland, Ohio; Philadelphia, Pennsylvania; Durham, North Carolina; Cleveland, Ohio; Washington, DC; Durham, North Carolina; Houston, Texas; San Francisco, California; and Philadelphia, Pennsylvania

1. Anesthesia
 1. Drugs
 2. Monitoring (TEE)
2. Surgical innovation
3. Perfusion techniques

EVOLUTION towards less invasive surgery

Multimodal : 'opiate reduction'

- Fast track
- ERAS



Anaesthetic challenges of robotic surgery in man
(*L. Foubert*)

Robot Assisted Surgery

Anaesthetic Considerations

Luc Foubert, MD, DSc, PhD

Dept of Anaesthesia and Intensive Care
OLV Clinic Aalst

Conflict of Interest

Member Directory Board ORSI





Maximally invasive anaesthesia for minimally invasive surgery ?

- Peripheral IV line
- Central venous catheter ?
- Arterial catheter ?
- Temperature probe
- Nasogastric tube
- Forced air warming
- Swan Ganz catheter ??
- Transoesophageal echo ??
- Cerebral perfusion ??

Robot Assisted Prostatectomy

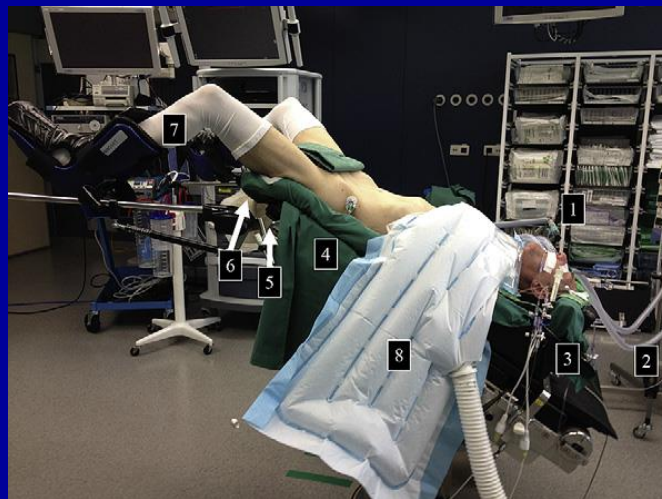
- Positioning of patient
- Haemodynamics
- Ventilation and lung mechanics
- Cerebral Perfusion Pressure
- Monitoring (Quiz/Interactive session)
- Postoperative Care

A. Patient position



Kalmar et al, *Advances in Anesthesia* 2012; 30: 75-96

Patient position



Kalmar et al, *Advances in Anesthesia* 2012; 30: 75-96

Patient Position

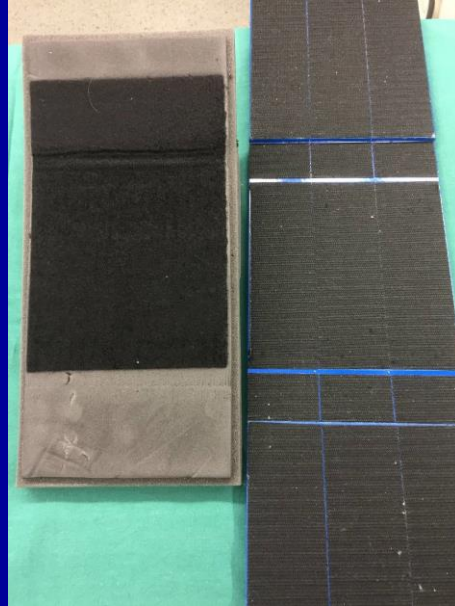
- Shoulder support : brachial plexus injury
- Head - Shoulder distance : constant
- Eye protection
- Screen position low: robot arms
- Beware of compartment syndrome











British Journal of Anaesthesia 104 (4): 433–9 (2010)
doi:10.1093/bja/aeq018 Advance Access publication February 18, 2010

BJA

CLINICAL PRACTICE

Influence of steep Trendelenburg position and CO₂ pneumoperitoneum on cardiovascular, cerebrovascular, and respiratory homeostasis during robotic prostatectomy

A. F. Kalmar¹*, L. Foubert², J. F. A. Hendrickx², A. Mottrie³, A. Absalom¹, E. P. Mortier⁴
and M. M. R. F. Struys^{1, 4}

¹Department of Anesthesiology, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands. ²Department of Anaesthesia and Intensive Care Medicine and ³Department of Urology, OLV Clinic, Aalst, Belgium. ⁴Department of Anesthesia, Ghent University, Ghent, Belgium

*Corresponding author. E-mail: a.kalmar@anest.umcg.nl

- Robotic endoscopic radical prostatectomy
- 31 consecutive patients
- Steep Trendelenburg

- Haemodynamics
- Ventilation and lung mechanics
- Cerebrovasculaire homeostasis

B. Haemodynamics

- Trendelenburg

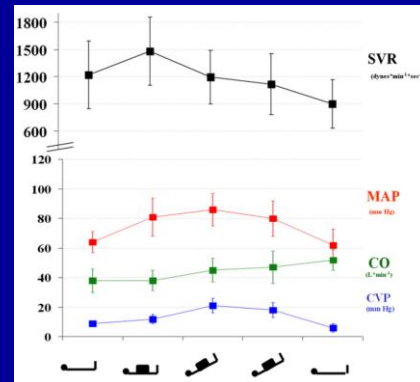
$\uparrow$ MAP & CVP

hydrostatic

- Trend + Pneumoperitoneum

$\uparrow$ MAP $>$ $\uparrow$ CVP

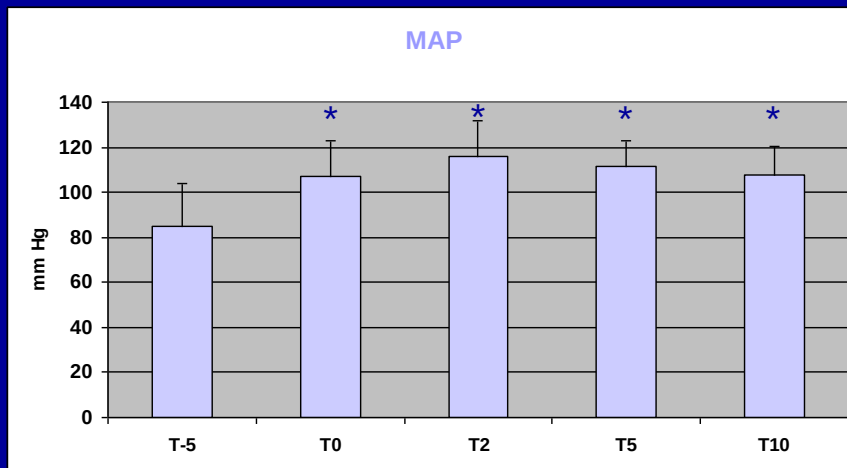
- SV $\uparrow$ CO $\uparrow$
- SVR (intra-abdominal P)



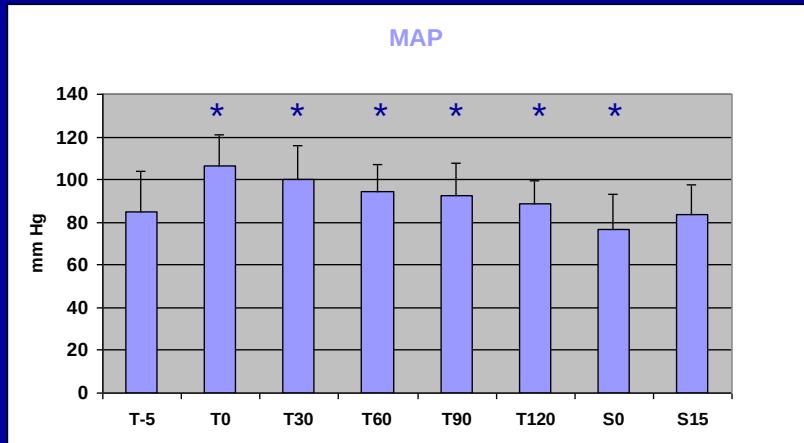
O'Malley, Anesthesiol Clin North America 2001; 1: 1-18

Lestar, Anesth Analg 2011; 113: 1069-75

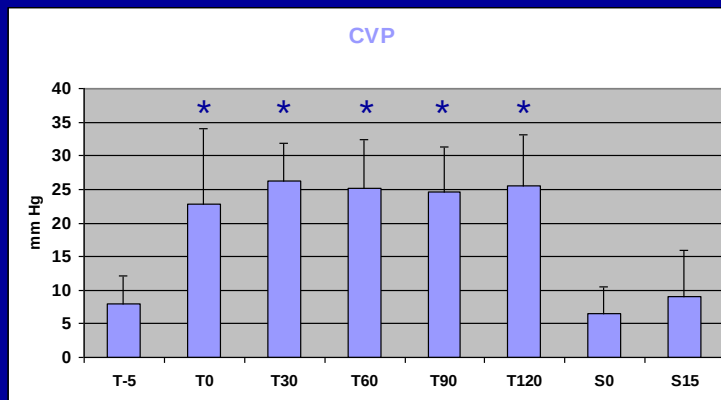
Effect of position on MAP



Effect of position on MAP



Effect of position on CVP



* $P < 0.05$ vs T-5

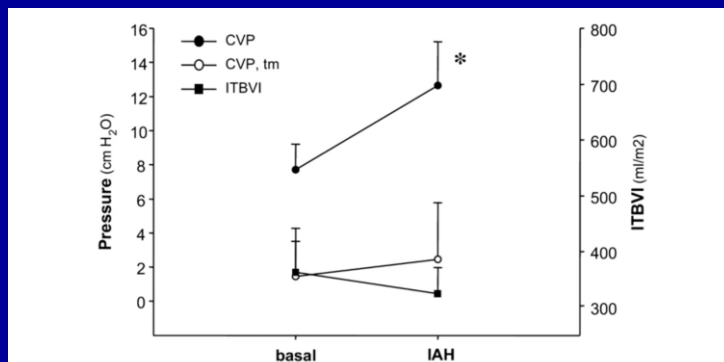
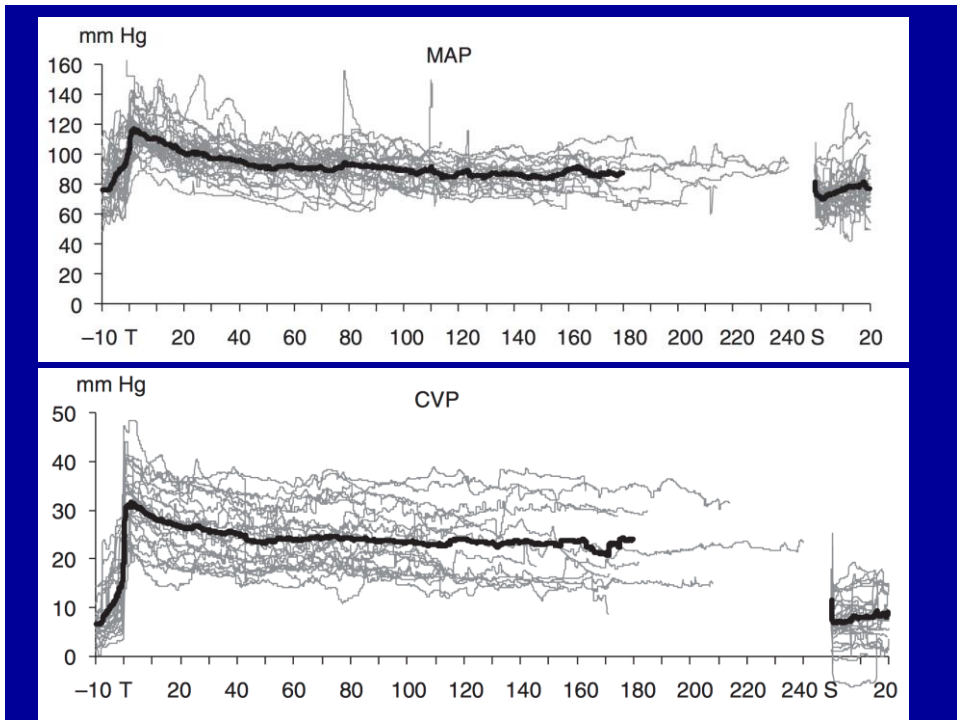
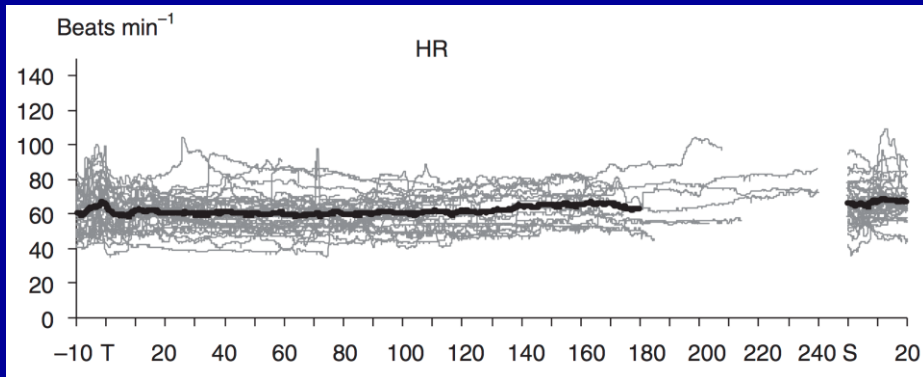


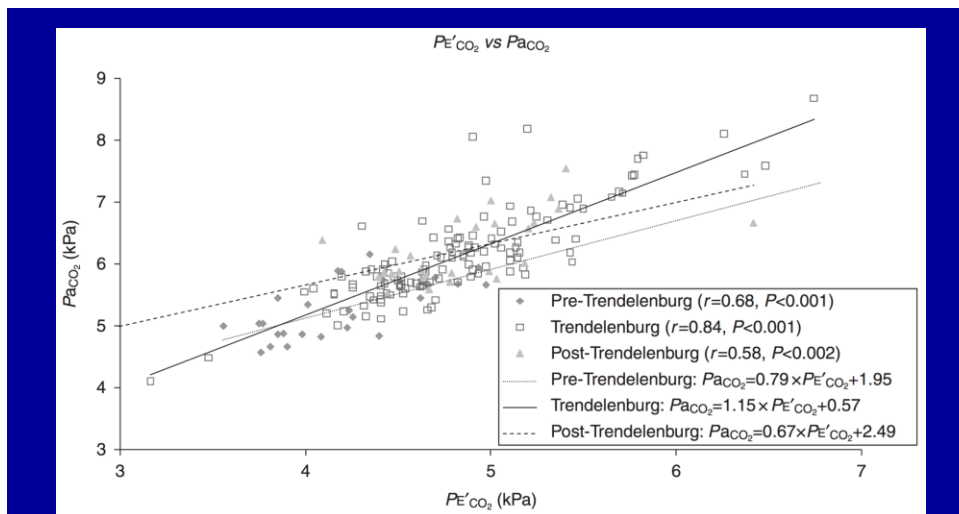
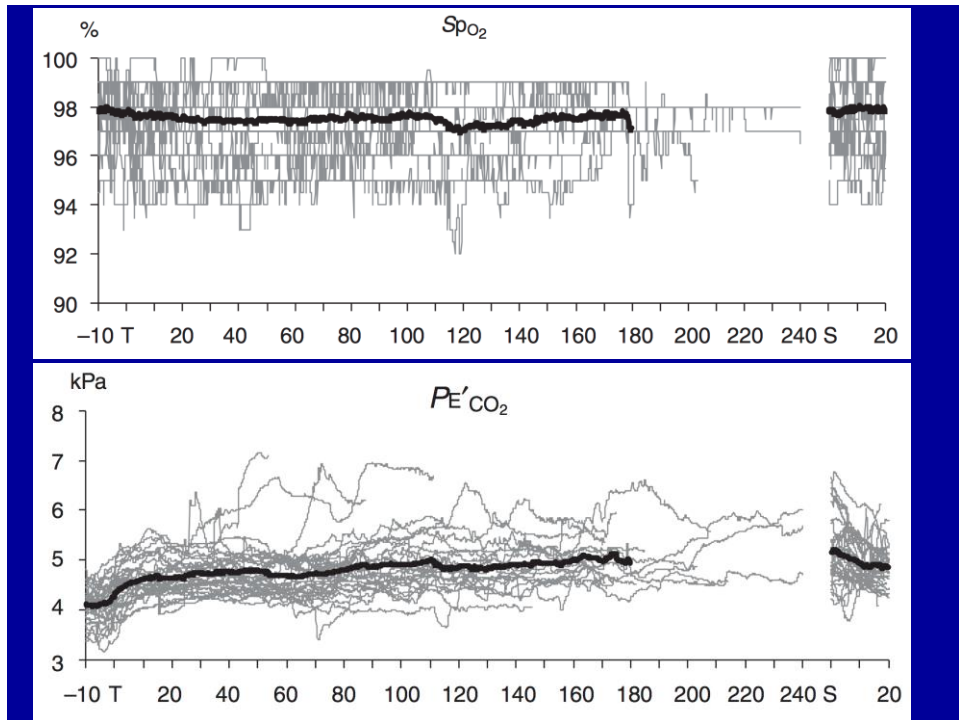
Fig. 8. The role of chest wall derangement on high CVP values during CO₂ PP. During intra-abdominal hypertension (IAH), CVP significantly rises whereas transmural pressure (CVP, tm) or intrathoracic blood volume (ITBVI) do not, underlying the role of chest wall derangement on artifactually and potentially misleading high CVP values during CO₂ PP. (Data from Valenza F, Chevillard G, Fossali T, et al. Management of mechanical ventilation during laparoscopic surgery. Best Pract Res Clin Anaesthesiol 2010;24(2):227-41.)

Chest wall derangement during CO₂ PP : misleading high CVP



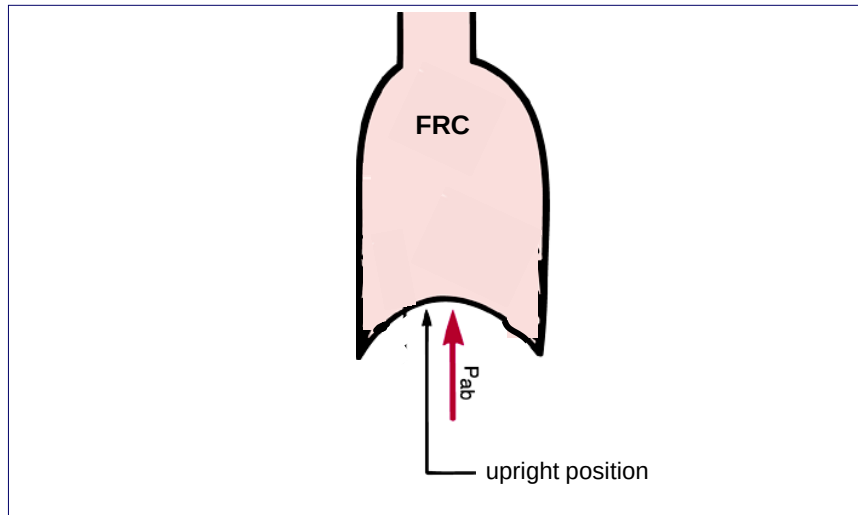
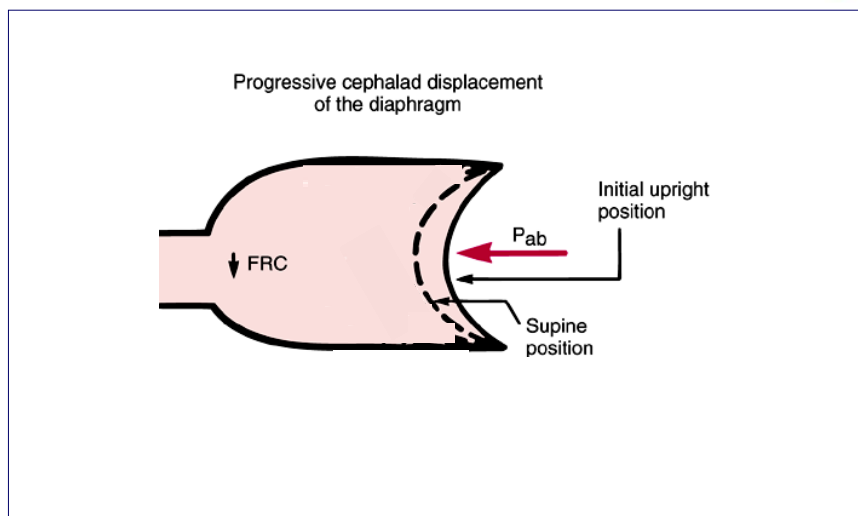
C. Ventilation and lung mechanics

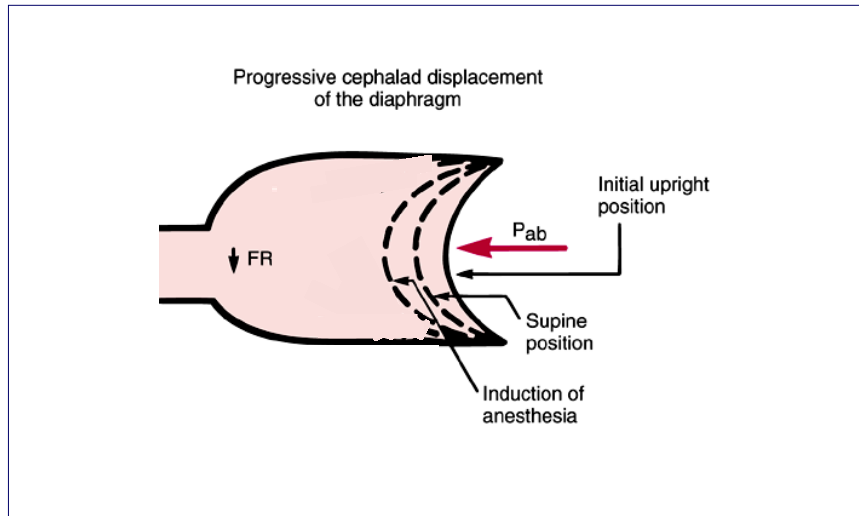
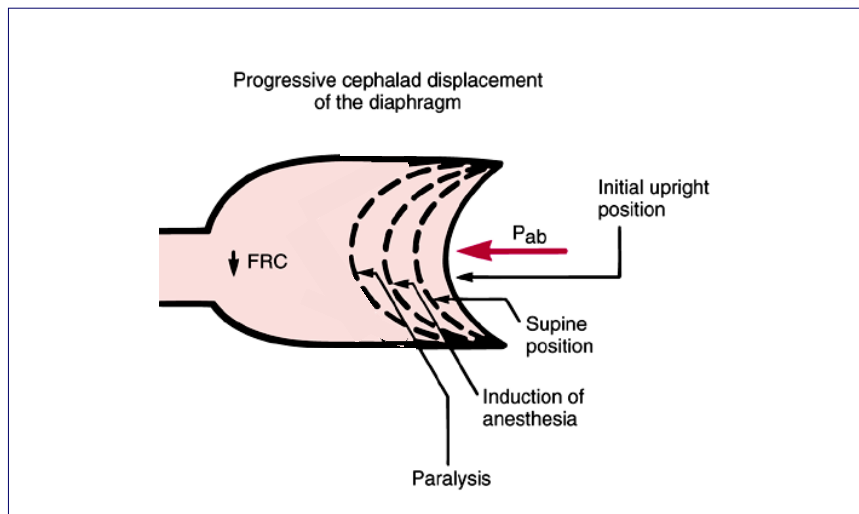
- SpO_2 : stable $\approx 98\%$
- $PE'CO_2$: during procedure : 4.12 $\longrightarrow$ 4.79 kPa
- $PaCO_2 - PE'CO_2$: 1.06 (0.40) $\longrightarrow$ 1.46 (0.53) kPa
- Reasonable correlation between $PaCO_2 - PECO_2$
- Correlation coefficients
 - Before T = 0.68
 - During T = 0.84
 - After T = 0.58

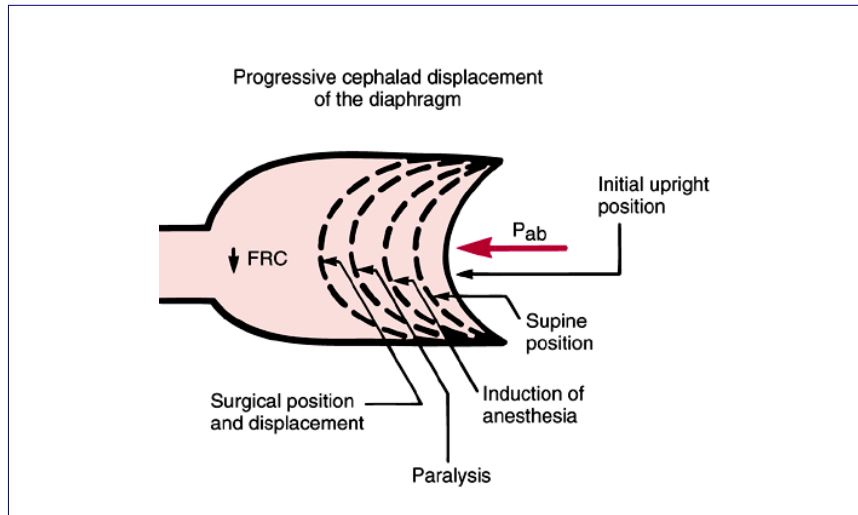
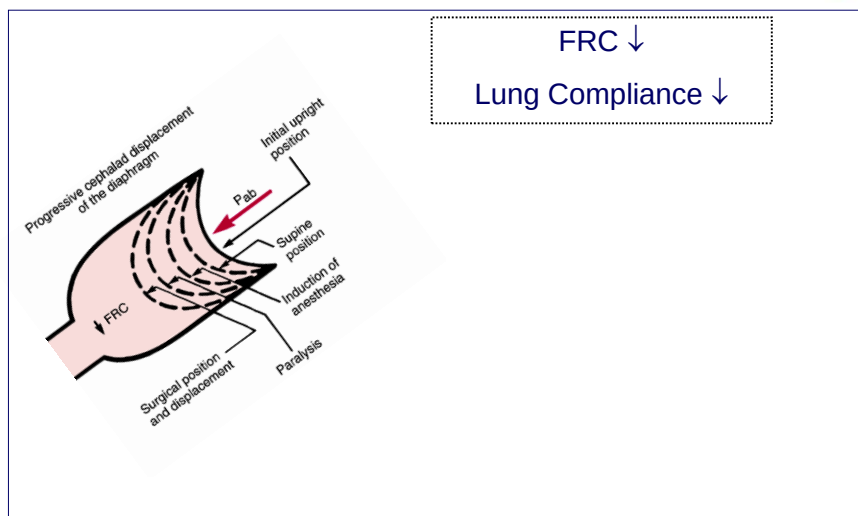


Steep increase during T: at high PE'_{CO_2} underestimation of Pa_{CO_2} by PE'_{CO_2}

PE'_{CO_2} 26 – 35 mm Hg = Pa_{CO_2} 35 – 45 mm Hg

Trendelenburg : ventilationJunior Erus'11, 2nd EditionHamburg, 5th October 2011*Trendelenburg : ventilation*Junior Erus'11, 2nd EditionHamburg, 5th October 2011

Trendelenburg : ventilationJunior Erus'11, 2nd EditionHamburg, 5th October 2011*Trendelenburg : ventilation*Junior Erus'11, 2nd EditionHamburg, 5th October 2011

Junior Erus'11, 2nd EditionHamburg, 5th October 2011Junior Erus'11, 2nd EditionHamburg, 5th October 2011

Lung mechanics

- P_{plat}

14(4) $\longrightarrow$ 20(5) cm H_2O : moderate CO_2 PP ($p < 0.05$)

26(6) cm H_2O : Trend + CO_2 PP ($p < 0.05$)

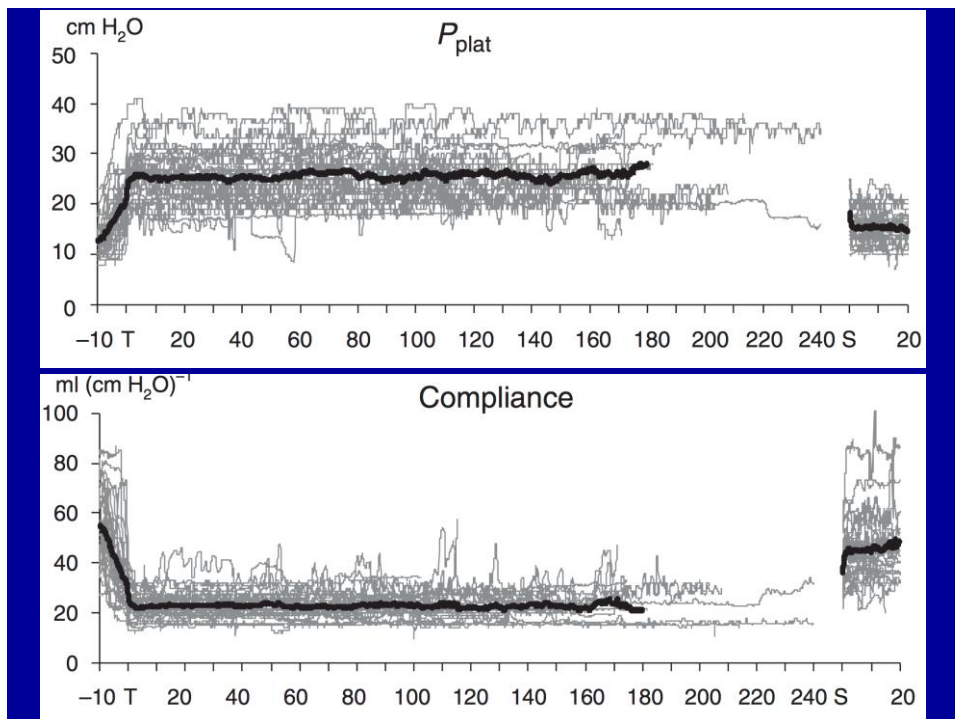
15(4) cm H_2O : supine (NS)

- Compliance

50(15) $\longrightarrow$ 23(6) ml/cm H_2O : moderate CO_2 PP

23(5) ml/cm H_2O : Trend + CO_2 PP

45(13) ml/cm H_2O : supine ($P < 0.01$)



D. Cerebral Perfusion Pressure and Trendelenburg

- $CPP = MAP - ICP$
- $CPP = MAP - CVP$

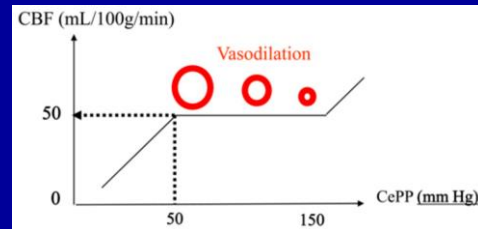
Aim:

MAP high / CVP low

$MAP - CVP \geq 50 \text{ mm Hg}$

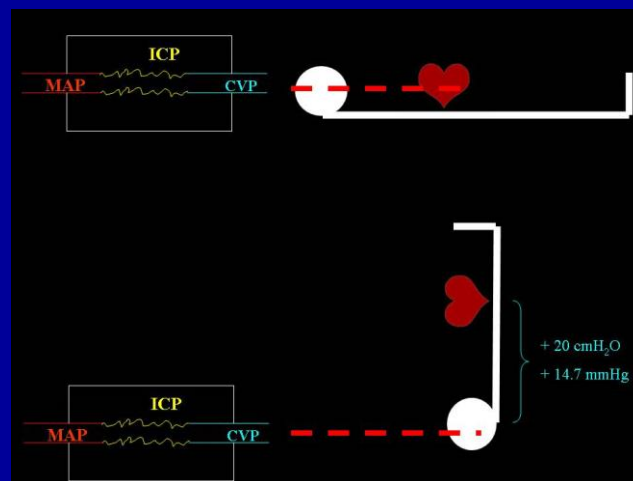
Risks

- low cerebral perfusion pressure
- cerebral oedema
- sinus cavernosus thrombosis



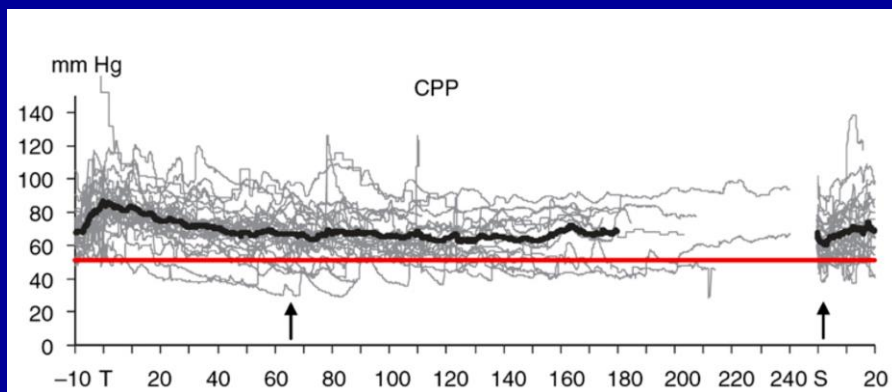
Munis et al, J Neurosurg Anesthesiol 2000; 52: 225-8

Hydrostatic effect of Trendelenburg



Cerebral Perfusion Pressure and Trendelenburg

- Early stages Trend (5 min)
 $MAP \uparrow 33.7 \text{ mm Hg}$
 $CVP \uparrow 22.7 \text{ mm Hg}$
 $\rightarrow CPP \text{ with } 11 \text{ mm Hg}$
- Next hour: modest $\downarrow$ MAP and CVP
- Baseline CPP : 71 (11) $\rightarrow$ 70 (12) mm Hg Trend



Supine : early decrease CPP : 61 (12) mm Hg
 recovery after 3'

Maintain nl $PaCO_2$!!

$\uparrow PaCO_2$ + Trend $\rightarrow$ Choroidal vasodilatation + intra-ocular pressure increase
 $\downarrow$
 Blindness

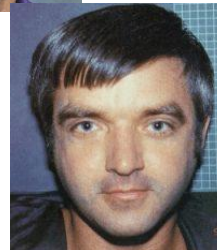
Awad et al, Anesth Analg 2009; 109: 473-8

SAS = space adaptation syndrome



ZERO GRAVITY SITUATION

- *Increased blood return from the legs*
- *Headward shifting of the blood volume*
 - *'Moon face'*
 - *'Bird legs'*
 - *Decreased smell and taste*
 - *Headache*



➡ *no clinical importance*

E. Monitoring

- Oesophageal T°
- Urinary catheter
- Neuro / Cerebral Monitoring
- Anaesthetic depth ?

E. Monitoring

- (Invasive) Pressures : Arterial & CVP
- Purists
 - Art line, P transducer at meatus acusticus
 - exact pressure at brain level (Trend)
 - exact arterial PCO₂
 - CVP
 - "measured" surrogate for ICP
 - vs. "estimate" of ICP : 14 - 21 mm Hg (20-30 cm H₂O)
 - Art + CVP → "objective" idea of ICP
- Pragmatic approach
 - NIBP : upper arm = atrial level / not at brain level
 - no CVP : estimate of ICP at 14 - 21 mm Hg

F. Quiz

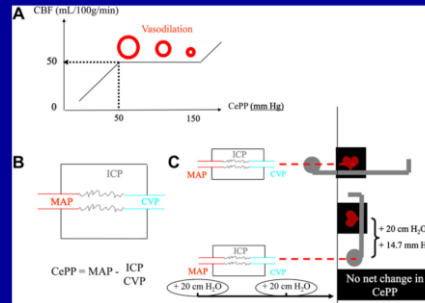
- Invasive BP or not ?
- CVP or not ?

F. Quiz

- Invasive BP or not ?
- CVP or not ?
- Beware of "reference point"
 - meatus acusticus
 - atrial / mid-axillary level

F. Quiz

- Invasive BP or not ?
- CVP or not ?
- Beware of "reference point"
 - meatus acusticus
 - atrial / mid-axillary level



- Hydrostatic pressure (Trend) increases MAP and CVP to the same extent !!

→ You may get away without invasive art line & CVP

BUT

- Art P transducer at meatus acusticus
underestimation of coronary artery pressure !!
- If no CVP
 - measure (invasive) BP at mid axillary level
 - keep MAP $\geq$ 50 mm Hg ($\geq$ 60 mm Hg)
 - "SAFE" concerning CPP
- DRAWBACK :
if CVP increases for other than hydrostatic reasons :
you will not know !!

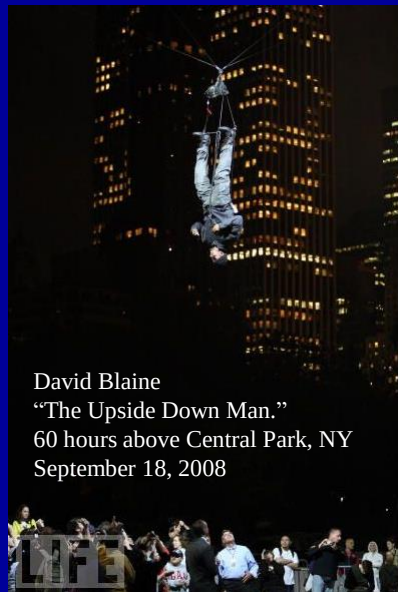
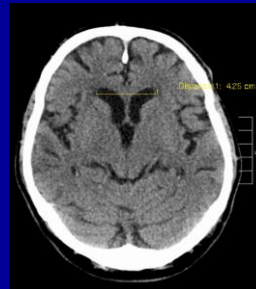
G. Postoperative Care

- Early (in OR) vs. Late (Recovery) extubation
 - Continued ventilation - head up in recovery ?
 - cerebral oedema ?

Pre-Op



Post-Op



David Blaine
 "The Upside Down Man."
 60 hours above Central Park, NY
 September 18, 2008

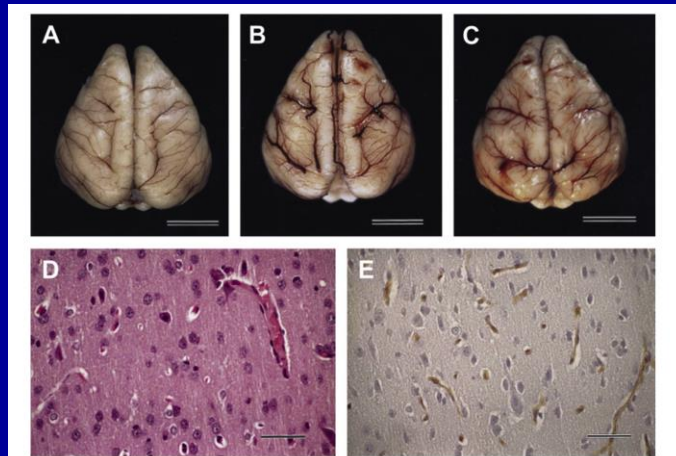


Fig. 14. Histopathology of the blood-brain barrier after 8 days of head-down tilt. Animal data (rabbits) reveal congestion of the pial vessels only after sustained (A = control, B = after 2 days, C = after 8 days) head-down tilt, without any ... neuronal tissues (light microscopical findings of the cortex in the frontal lobe excised from the 8-day head down tilt rabbit and stained with hematoxylin and eosin, D) or leakage of the special markers through the vessel walls (immunohistochemical staining of the cortex in the frontal lobe excised from the 8-day head down tilt rabbit, E). (Data from Shimoyama R, Miyata H, Ohama E, et al. Does edema formation occur in the rabbit brain exposed to head-down tilt? Jpn J Physiol 2000;50(1):141-7.)

G. Postoperative Care

- Role for steroids ?
 - probably not: peri-tumoral oedema vs. "general oedema"
- Safe airway at end of procedure
- Laryngeal soft tissue oedema
- Frusemide IV ?
 - prevention "clot formation" in urinary tract
 - follow-up: electrolytes & volume status
- Postoperative agitation
 - pain relief: paracetamol, piritramide
 - TAP blocks
 - anticholinergic drugs: bladder spasm

Summary

Table 1 Mean (SD) measured variables before, during, and after steep Trendelenburg positioning. * $P < 0.05$ compared with pre-Trendelenburg period

	Pre-Trendelenburg	Trendelenburg	Post-Trendelenburg
HR (beats min^{-1})	62 (12)	63 (10)	68 (11)*
MAP (mm Hg)	79 (14)	95 (10)*	76 (9)
CVP (mm Hg)	8 (4)	26 (6)*	8 (6)
CPP (mm Hg)	71 (11)	70 (12)	69 (13)
Sp_{O_2} (%)	98 (1)	98 (1)	98 (1)
Sct_{O_2} (%)	70 (4)	73 (4)*	74 (5)*
$P_{\text{E}'_{\text{CO}_2}}$ (kPa)	4.12 (0.40)	4.79 (0.40)*	4.92 (0.40)*
P_{Plat} (cm H_2O)	14 (4)	26 (5)*	15 (4)
Tidal volume (ml)	542 (53)	529 (66)	551 (70)
Lung compliance [ml (cm H_2O) $^{-1}$]	50 (1)	23 (5)*	45 (13)*
Minute volume (litre)	7 (1)	7 (1)*	8 (1)*

Conclusions

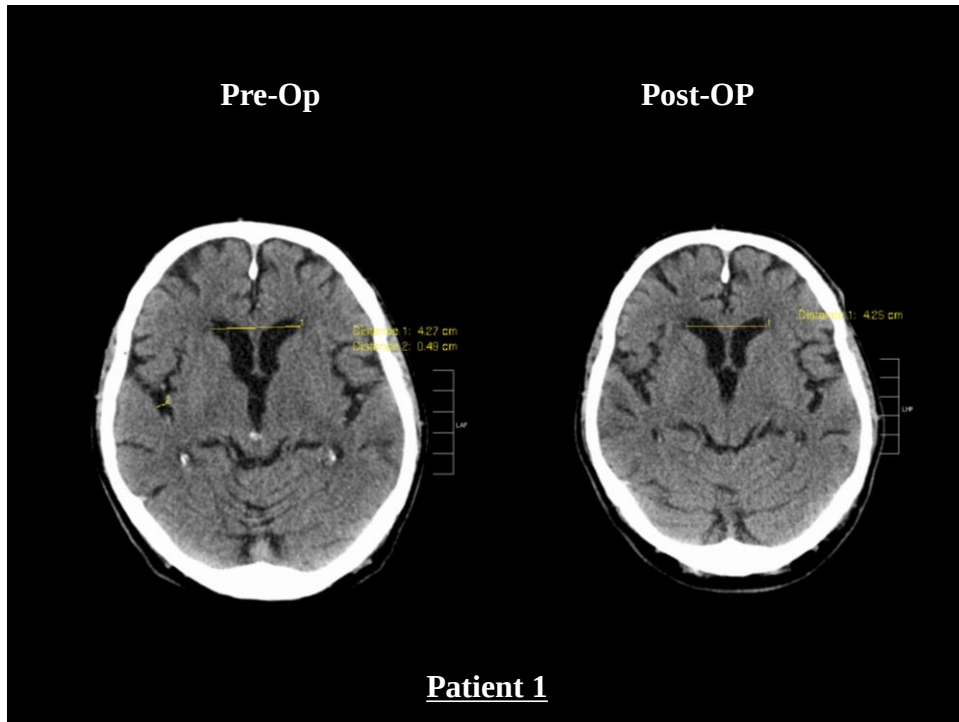
Robot Assisted Prostatectomy

- Positioning strategy
- Affects haemodynamics and lung mechanics
- CPP: within limits of autoregulation
- Changes: acceptable physiologic ranges
- Minimal invasive monitoring (CVP ?)
- (Near) normocapnia
- Simple postoperative care
- Insufficient data when at risk for disturbed blood-brain barrier: brain tumours



Dear colleague, maybe you don't remember, but there was a time that even you were sitting upside down for nine months.

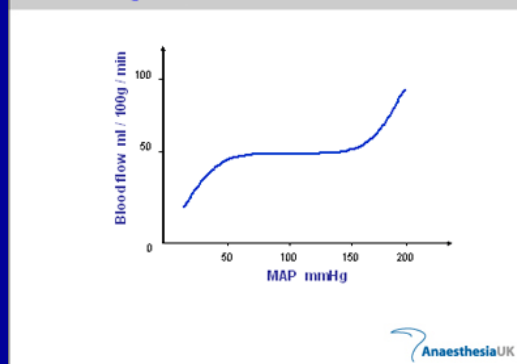
And apparently, everything turned out just fine !



Cerebral perfusion

$$CPP = MAP - ICP$$

Autoregulation of Cerebral Blood Flow



Cerebral perfusion and Trendelenburg

- $CPP = MAP - ICP$
- $CPP = MAP - Cer\ VP$
- $CPP = MAP - CVP$
- $CVP \leq Cer\ VP$

Aim: MAP high / CVP low
 $MAP - CVP \geq 60\text{ mm Hg}$

Risks

- low cerebral perfusion pressure
- cerebral oedema
- sinus cavernosus thrombosis

What can we learn from the last changes in protective lung ventilation in morbidly obese human patients?

(J. Mulier)



Jan P. Mulier (chair of dep)
Department of Anesthesiology
AZ Sint – Jan AV Brugge Belgium

Lessons to learn from optimal ventilation in the morbidly obese patient during laparoscopy?

New recommendations for lung protective ventilation in all humans & animals?

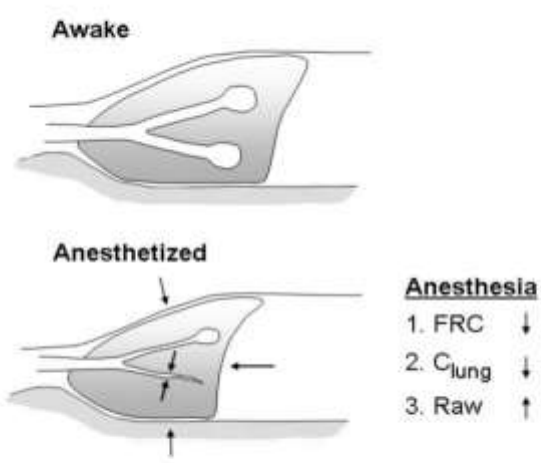
AVA Gent
12 13 sept 2019



Ventilation Problems during & after ventilation

Pneumoperitoneum (PP), Obesitas, surgical stress and inflammatory reactions

1. Compliance decrease and Atelectasis:
 1. intra operative due to anaesthesia, PP
 2. post operative due to obesity, supine position, PORC, Opioids, sedation...
2. Lung trauma:
 1. Barotrauma through high pressures
 2. Volutrauma through large tidal volume
 3. Accelleration trauma through high decelerating insufflation/desufflation
3. Lung inflammation
 1. Direct inflammatory stress: aspiration, dehydration, surgery
 2. Peripheral inflammation: obesity, peritoneal ischemia, surgical trauma...

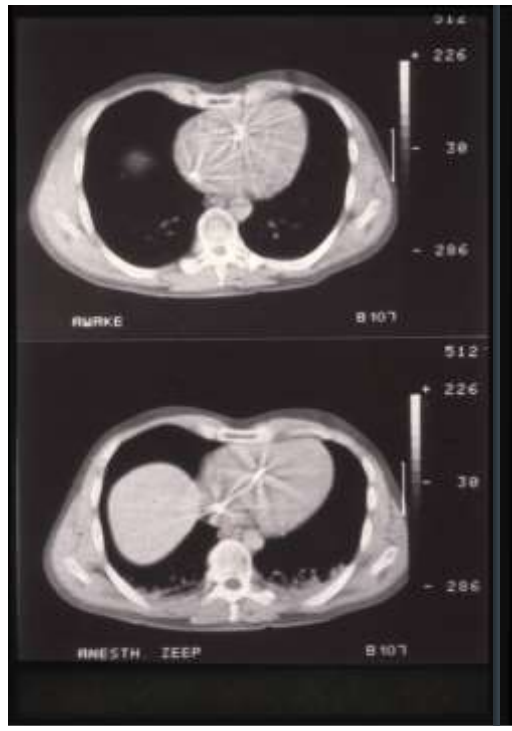


loss of muscle tone
smaller volume
reduced airway
dimensions

airway closure
atelectasis

Hedenstierna, in Millers Anesthesia 2009

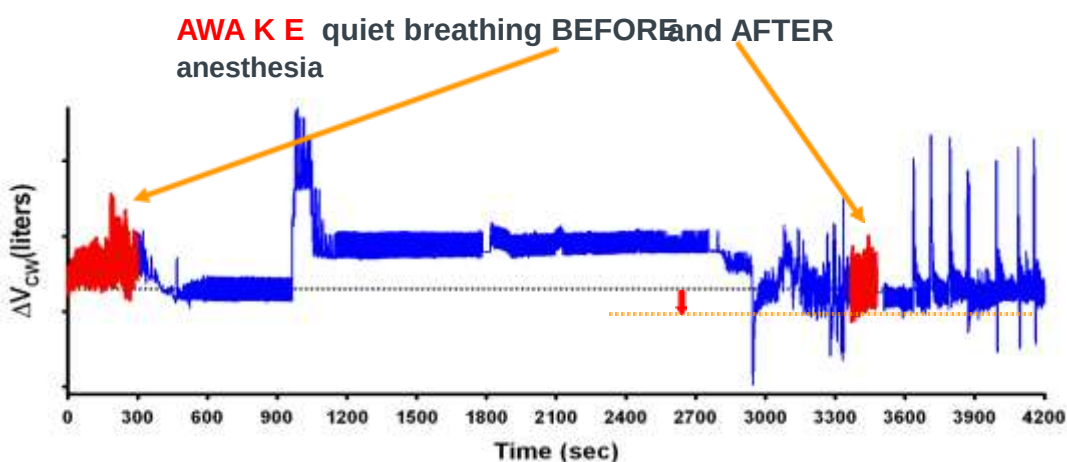
Fig15



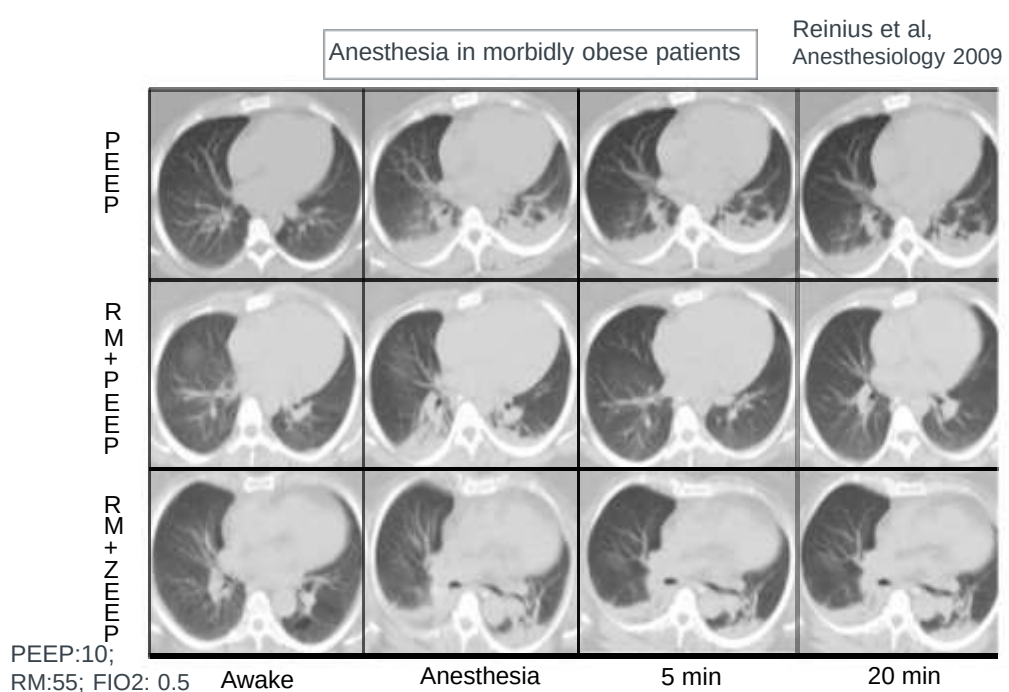
**Reduced FRC (-20%)
during anaesthesia**
Wahba, Can J Anesth 1991

**Less aeration
Atelectasis
Diaphragm up**

Hedenstierna et al, Anesthesiology 1985
Brismar et al, Anesthesiology 1985



Hedenstierna et al



Atelectasis During Anesthesia

- ⇒ During spontaneous breathing and artificial ventilation (SHUNT!)
- ⇒ With intravenous and inhalational anesthetics
- ⇒ Lasts a few days postoperatively (POSTOP PULM COMPLICATIONS?)

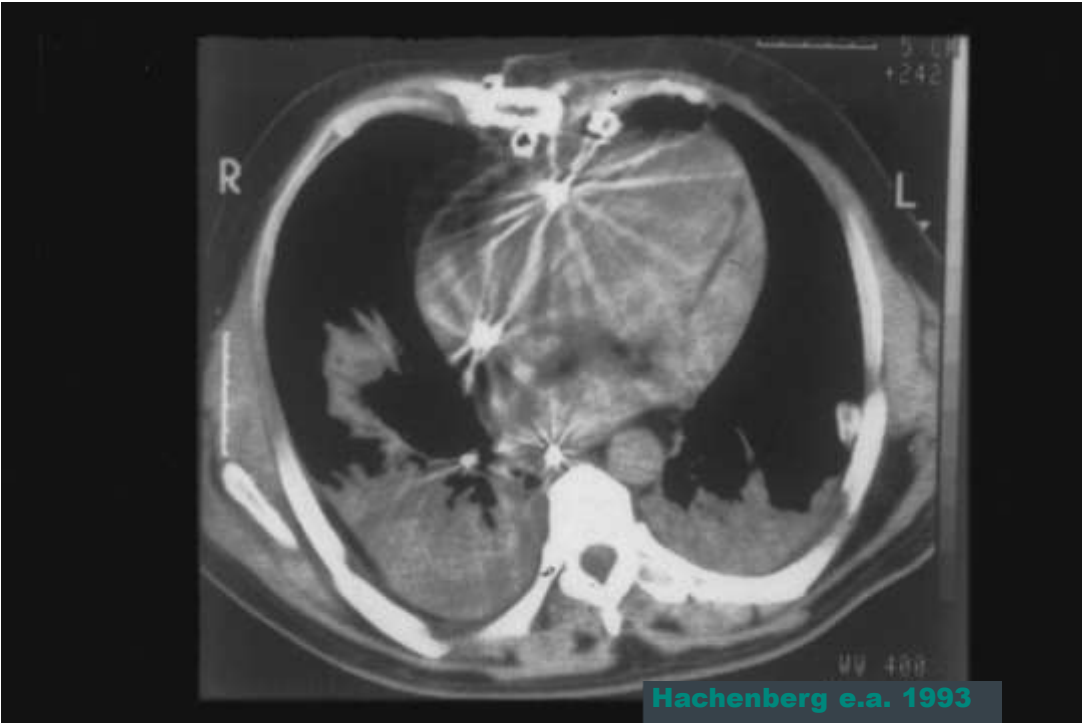
Hedenstierna et al

Atelectasis During Anesthesia

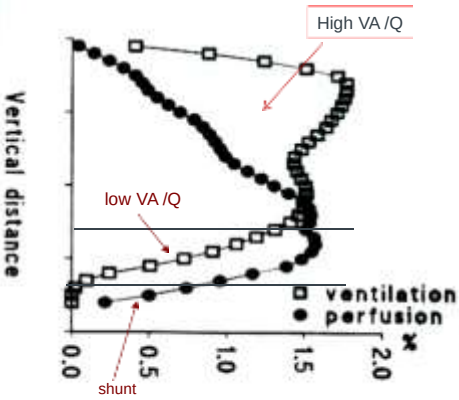
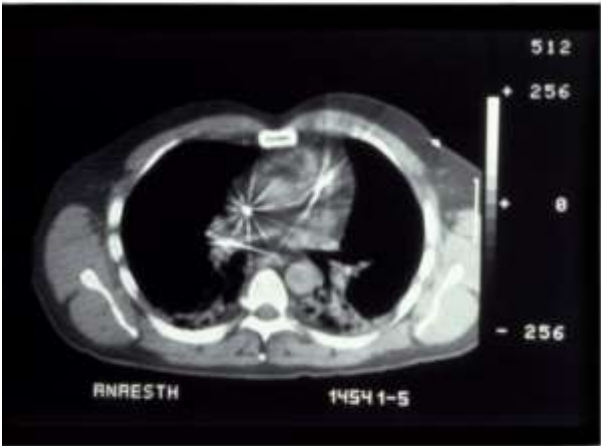
- ⇒ 90% of all patients
- ⇒ 3-4% of lung area (basal)
- ⇒ 10-15% of lung tissue
- ⇒ Not seen on x-ray



Hedenstierna et al



CT scan and vertical distribution of ventilation and perfusion
in the same lung segment



Redrawn from:
Tokics et al, J Appl Physiol 1996

The Effects of Body Mass on Lung Volumes, Respiratory Mechanics, and Gas Exchange During General Anesthesia

Paolo Pelosi, MD, Massimo Croci, MD, Irene Ravagnan, MD, Stefano Tredici, MD, Alessia Pedoto, MD, Alfredo Lissoni, MD, and Luciano Gattinoni, MD

FRC decreases most up to 40 BMI
Super obese are not worse!

(Anesth Analg 1998;87:654-60)

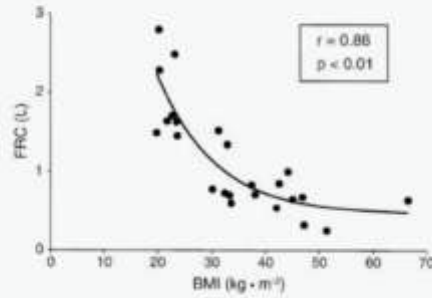


Figure 1. Relationship between functional residual capacity (FRC) and body mass index (BMI).



2019 Mulier



CHEST

Original Research

OBESITY

The Effects of Body Mass Index on Lung Volumes*

CHEST 2006; 130:827-833

Richard L. Jones, PhD, FCCP, and Mary-Magdalena U. Nadeau, RSc

Background: Obesity is a major health issue in North America, and the trend is for obesity to be a more important medical issue in the future. Since obesity can cause respiratory symptoms, many obese people are referred for pulmonary function tests (PFTs). It is well known that obesity causes decreases in lung volumes, but there has never been a large study showing the correlation between body mass index (BMI) and the various lung volumes.

Design: We collected PFT results from 373 patients sent for lung function testing who had normal values for airway function but a wide range of BMIs.

Setting: The PFTs were done in two accredited outpatient laboratories.

Results: There were significant linear relationships between BMI and vital capacity and total lung capacity, but the group mean values remained within the normal ranges even for morbidly obese patients. However, functional residual capacity (FRC) and expiratory reserve volume (ERV) decreased exponentially with increasing BMI, such that morbid obesity resulted in patients breathing near their residual volume. An important finding was that the greatest rates of change in FRC and ERV occurred in the overweight condition and in mild obesity. At a BMI of 30 kg/m², FRC and ERV were only 75% and 47%, respectively, of the values for a lean person with a BMI of 20 kg/m².

Conclusions: We showed that BMI has significant effects on all of the lung volumes, and the greatest effects were on FRC and ERV, which occurred at BMI values < 30 kg/m². Our results will assist clinicians when interpreting PFT results in patients with normal airway function. (CHEST 2006; 130:827-833)

- BMI has significant effects on all of the lung volumes,
- and the greatest effects were on FRC and ERV, which occurred at BMI values < 30 kg/m².



2019 Mulier

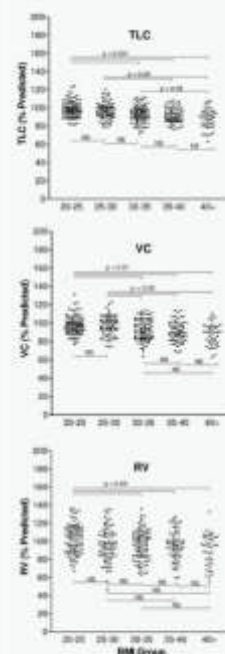


FIGURE 1. Effects of BMI on TLC, VC, and RV. The horizontal solid lines are the between-group comparisons from ANOVA and post hoc test. NS, not statistically significant (p > 0.05).

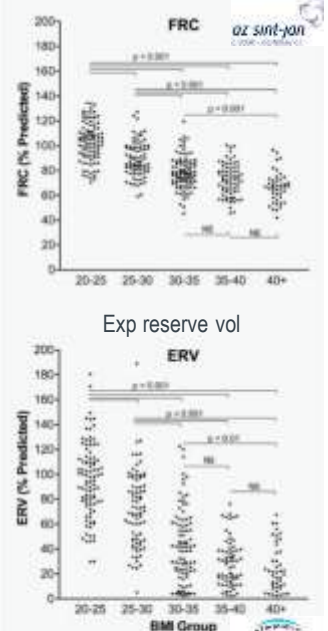


FIGURE 2. Effects of BMI on FRC and ERV. The horizontal solid lines are the between-group comparisons from ANOVA and post hoc test. NS, not statistically significant (p > 0.05).

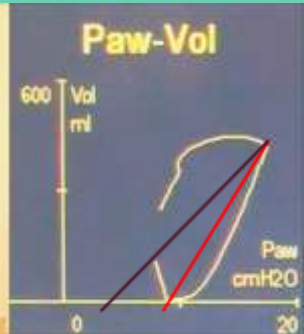
2019 Mulier



If you take lungs out of the thorax, they collapse and
peep alone is not enough to reopen them.



Ventilation with peep and no LRM



TV cst 450 ml look at driving pressure
Peep 0 -> vital capacity +peep -> open
20 ml/cmH2O -> 56 ml/cmH2O

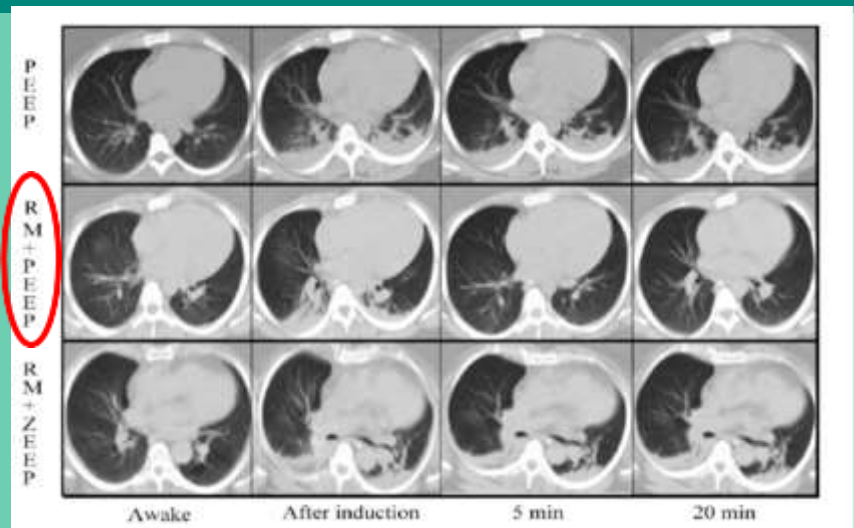
Ventilation with peep followed by LRM with peep



2019 Mulier



If you induce anesthesia, atelectasis takes place
immediately and peep is not enough to reopen it.



Reinius et al. Prevention of atelectasis in morbidly obese patients during
general anesthesia and paralysis. *anesthesiology* 2009;111:979-87



2019 Mulier



REVIEW ARTICLE

Guldner, Andreas; Kiss, Thomas; Serpa Neto, Ary; Hemmes, Sabine; Canet, Jaime; Spieth, Peter; Rocco, Patricia; Schaefer, Paulo; Gama de Abreu, Marcelo
Anesthesiology. 123(3):692-713, September 2015.

Intraoperative Protective Mechanical Ventilation for Prevention of Postoperative Pulmonary Complications
A Comprehensive Review of the Role of Tidal Volume, Positive End-expiratory Pressure, and Lung Recruitment Maneuvers

Andreas Guldner, M.D., Thomas Kiss, M.D., Ary Serpa Neto, M.D., M.Sc., Ph.D., Sabine N. T. Hemmes, M.D., Jaime Canet, M.D., Ph.D., Peter M. Spieth, M.D., Patricia R. M. Rocco, M.D., Ph.D., Marcus J. Schultz, M.D., Ph.D., Paulo Pelosi, M.D., F.E.R.S., Marcelo Gama de Abreu, M.D., M.Sc., Ph.D., D.E.S.A.

Which LRM Is the Best?

Equal but never manual with balloon!!!

A Pressure hold

B Increase in TV

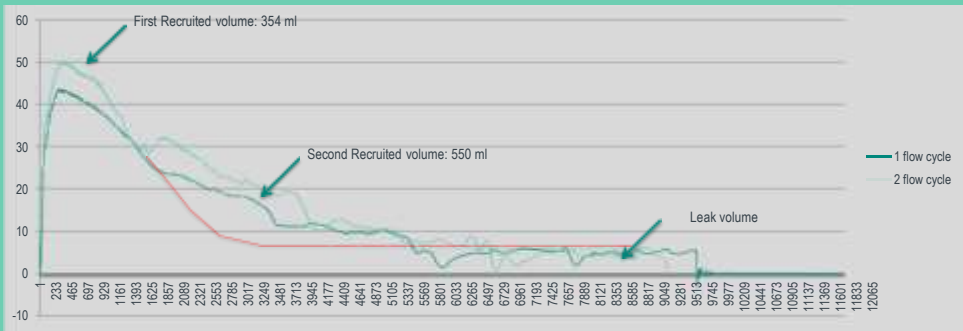
C Increase in peep

the different types of alveolar recruitment maneuvers were found to be equally effective.

Quid volutrauma? Sustained hypotension? Coughing reaction? Time taken? Interrupting when sufficient?

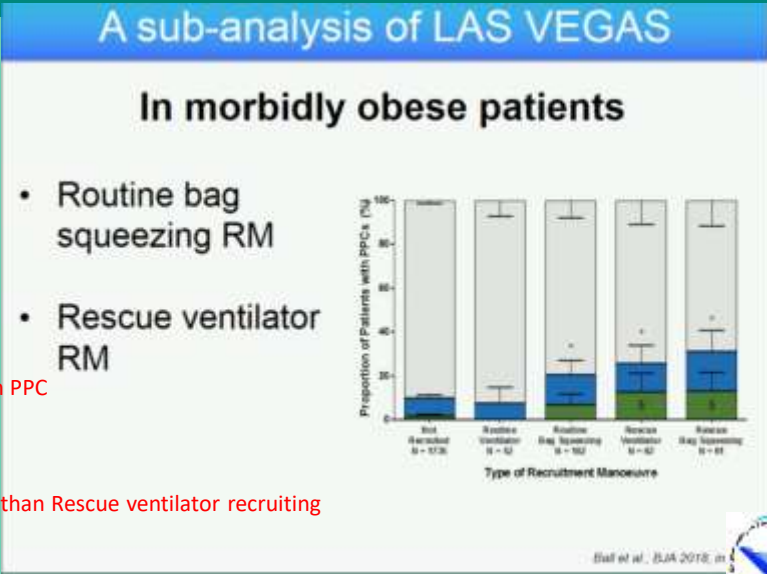
Fig. 4. Illustrative fluctuation of airway pressure during three types of lung recruitment maneuvers for intraoperative mechanical ventilation (red lines). (A) "Bag squeezing" using the airway pressure-limiting valve of the anesthesia machine. The airway pressure is difficult to control, possibly resulting in overpressure, with the risk of barotrauma, or values lower than the closing pressure of small airways when mechanical ventilation is resumed, with consequent lung derecruitment. (B) "Stepwise increase in tidal volume" during volume-controlled ventilation. Positive end-expiratory pressure (PEEP) is set at 12 cm H2O, the respiratory frequency at 6 to 8 breaths/min, and tidal volume increased from 8 ml/kg in steps of 2 ml/kg until the target opening pressure (e.g., 30 to 40 cm H2O) is achieved. After three to five breaths at that pressure, the PEEP is kept at 12 cm H2O, tidal volume reduced to 6 to 8 ml/kg, and the respiratory frequency adjusted to normocapnia. (C) Stepwise increase of PEEP at a constant driving pressure of 15 to 20 cm H2O in pressure-controlled ventilation. The PEEP is increased in steps of 5 cm H2O (30 to 60 s per step) up to 20 cm H2O. After three to five breaths at a PEEP level that allows achieving the target inspiratory pressure, PEEP and tidal volume are adjusted to the respective desired levels.

Two pressure hold recruitments at 30 cm H2O for 10 sec



2019 Mulier

never manual LRM with balloon!!!



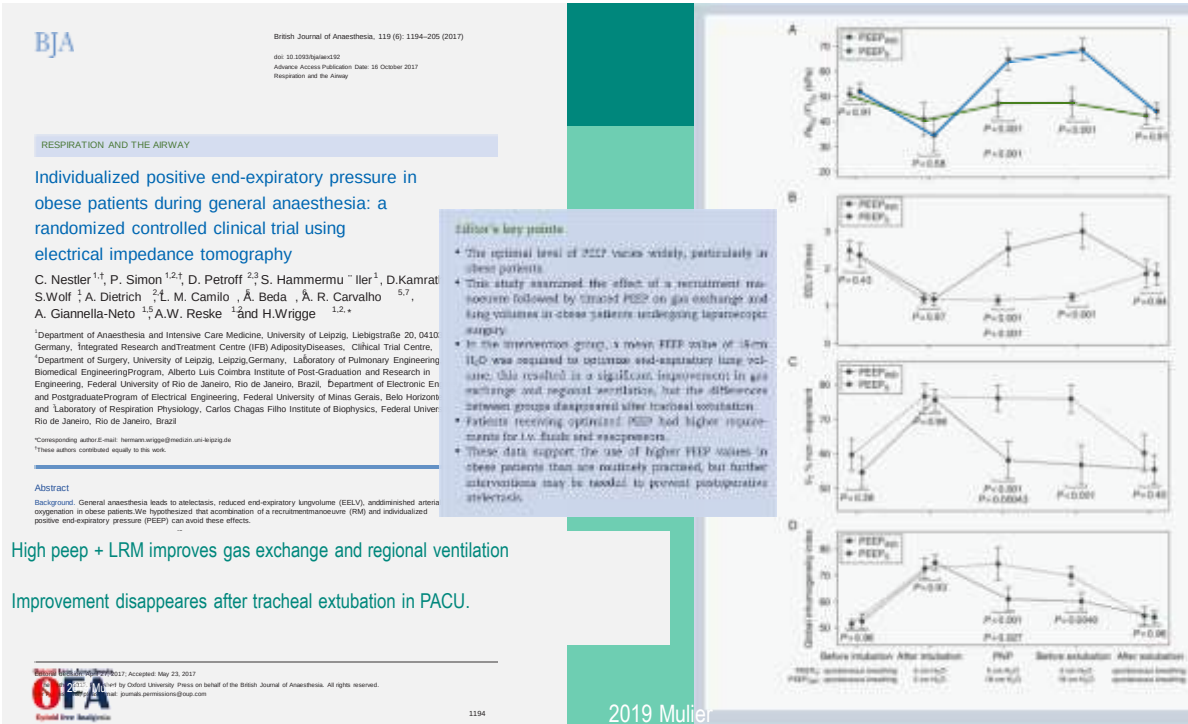
Routine ventilator recruiting no impact on PPC

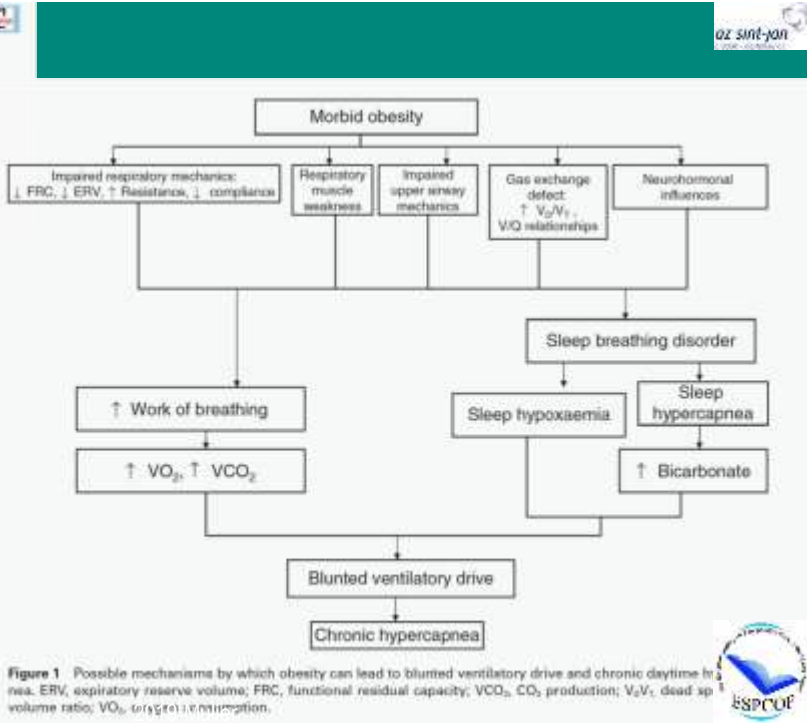
Routine manual recruiting increases PPC

Rescue manual recruiting increases more than Rescue ventilator recruiting



2019 Mulier





The Impact of Morbid Obesity, Pneumoperitoneum, and Posture on Respiratory System Mechanics and Oxygenation During Laparoscopy

Juraj Sprung, MD, PhD, David G. Whalley, MD, Chie, Tommaso Falcone, MD, David O. Warner, MD, Rolf D. Hubmayr, MD, and Jeffrey Hammett, MD

Anesth Analg 2002;94:1345–50

Static Compliance (ml/cmH₂O)

Position	Before PP	During PP
Supine	~62 (NW), ~44 (MO)	~58 (NW), ~25 (MO)
Trend	~61 (NW), ~41 (MO)	~31 (NW), ~23 (MO)
rev Trend	~61 (NW), ~50 (MO)	~36 (NW), ~28 (MO)

Inspiratory Resistance (cm H₂O/lsec)

Position	Before PP	During PP
Supine	~10 (NW), ~17 (MO)	~14 (NW), ~28 (MO)
Trend	~10 (NW), ~23 (MO)	~15 (NW), ~28 (MO)
rev Trend	~10 (NW), ~17 (MO)	~14 (NW), ~22 (MO)

- 1. Effect on compliance
 - a. Beach chair improves compliance more in obese than non obese before and during PP
- 2. Effect on resistance
 - a. Beach chair reduces resistance more in obese than non obese before and during PP
- 3. Beach chair > supine > trend

Anesthesiology 2007; 107:720-30

Effects of the Beach Chair Position, Positive End-expiratory Pressure, and Pneumoperitoneum on Respiratory Function in Morbidly Obese Patients during Anesthesia and Paralysis

Franco Vassallo, M.D., Federico Vigliani, M.D., Alberto Tassi, M.D., Silvia Francesconi, M.D., Giulio Ronconi, M.D., Massimo Guglielmi, M.D., Marco Zappalà, M.D., Enzo Lattuada, M.D., Luciano Gastromi, M.D., F.R.C.P.S.

The Beach-Chair position and PEEP counteracted the major derangements of respiratory function produced by pneumoperitoneum, anesthesia & paralysis

1 supine without PP
2 supine with PP
3 beach chair with PP
4 beach chair & PEEP with PP

Background: The authors studied the effects of the beach chair (BC) position, 10 cm H₂O positive end-expiratory pressure (PEEP), and pneumoperitoneum on respiratory function in morbidly obese patients undergoing laparoscopic gastric banding.

Methods: The authors studied 20 patients (body mass index 47.9 ± 1.9 kg/m²). PEEP was applied during each combination of position and pneumoperitoneum. The authors measured compliance (C_{rs}) of the respiratory system, end-expiratory lung volume (helium technique), arterial oxygen tension, pressure-volume curves were also taken (occlusion technique). Patients were paralyzed during total intravenous anesthesia. Tidal volume (10.5 l; milliliter ideal body weight) and respiratory rate (12 l/min) were kept constant throughout.

Results: In the supine position, respiratory function was abnormal. C_{rs} was 21.71 ± 2.26 cm H₂O and end-expiratory lung volume was 1.48 ± 0.11 l. Both the BC position and PEEP improved C_{rs} (P < 0.05). End-expiratory lung volume almost doubled (1.93 ± 0.21 and 2.91 ± 0.3 l; BC and PEEP, respectively; P < 0.05 vs. supine). PEEP also improved pressure-volume curves. Lung recruitment (0.04 ± 0.11 in the supine and 0.07 ± 0.2 in the BC position) was associated with higher energy reserves than PEEP (0.04 ± 0.11 vs. 0.07 ± 0.2). PEEP improved C_{rs} (22.1 ± 2.03 vs. 23.8 ± 1.8 cm H₂O; P < 0.05). PEEP improved C_{rs} further (23.8 ± 1.8 vs. 25.3 ± 1.5 cm H₂O; P < 0.05). End-expiratory lung volume (0.36 ± 0.1 l; P < 0.05). Changes of lung volume correlated with changes of compliance (linear regression, R² = 0.824; P < 0.001). PEEP improved oxygenation. PEEP improved oxygenation. PEEP improved oxygenation.

Conclusions: The BC position and PEEP counteracted the major derangements of respiratory function produced by anesthesia and paralysis. During pneumoperitoneum, the combination of the two maneuvers improved.

A number of authors have shown that during anesthesia and paralysis, respiratory function in obese patients is greatly impaired, 1—and further worsened when laparoscopic procedures are performed. 1-4

Several strategies have been tested to improve oxygenation. Positive end-expiratory pressure (PEEP) has been shown to improve respiratory function⁵⁻⁸ however, it may cause relative hypotension.^{9,10-12} Large tidal volumes or a high respiratory rate have been tested with negative results.¹³⁻¹⁵ PEEP has been shown to increase the fraction of inspired oxygen (F_iO₂). The effects of body positioning on respiratory mechanics have also been investigated. The head-up position has been shown to be beneficial as opposed to the head-down position.^{12,16} However, not always the case.

Apart from the investigation of Perilli et al.,¹⁷ most of the aforementioned studies investigated the effects of PEEP or PEEP, leaving the interested reader with an incomplete picture, particularly if considering the comparison between the effects of PEEP and the effects of the beach chair position on these maneuvers.

Moreover, the main end-point of many studies was respiratory system compliance and oxygenation. However, Pelosi et al.¹⁸ clearly showed that end-expiratory lung volume decreases exponentially with the increase of body mass index, and that compliance correlates with lung volume.

Based on these considerations, we tested the combined effects of the beach chair position and PEEP on respiratory function in obese patients during anesthesia and paralysis, before and after laparoscopic surgery was increased with pneumoperitoneum, giving particular reference to lung volume, considered as the main outcome variable, and its correlation to compliance.

Materials and Methods

The ethics committee of our institution (Fondazione Ospedale Maggiore, Mangiagalli e Regina Elena-IRCCS, Milan, Italy) approved the study. Patients were fully informed that the protocol would imply an extension of the anesthesia time and were aware of the potential implications of the additional time of anesthesia and paralysis. Written informed consent was obtained from each patient.

Study Population

Twenty consecutive morbidly obese patients undergoing laparoscopic gastric banding were included. Patients

Mechanical ventilation in Obese Patients (7 key points)

Adapted by JPMulier 2017 from Silva PL, Pelosi P Minerva Anestesiol 78: 1136-11 4 5, 2 0 1 2

Recruitment Maneuver !

- Vital capacity 10 seconds at 30 - 40 cmH2O
- Or Stepwise peep increase from 5 to 25 cmH2O

PEEP after LRM !

- 5 cm H2O non obese BMI<40
- 10 cm H2O pear obesity
- 15 cmH2O apple obesity
- Add 5 cm more if laparoscopy trendelenburg

Low Tidal Volume !

- 6 ml/kg LBW
- Increase RR
- Avoid peritoneal ischemia/inflam
- Accept higher etCO2

Low driving pressure !

= Plateau-peep

- < 13 cmH2O
- 13-16 cmH2O obese?

Inspired O2 Expired CO2 !

- Start O2 at 40%
- Continue at lowest possible
- Permissive hypercapnia
- Resting CO2 is elevated in obese
- Extubate under CPAP + 40% or apply peep post OP

Repeat LRM if

- Total Compliance drops (<40 ml/cmH2O)
- Driving pressure rises (>13 cmH2O)
- Do not wait till saturation drops!

Ventilation mode !

- Avoid hysteresis
- Slow insufflation
- VCV > PCV
- I:E = 1:1, look at fl
- PSV at end operati

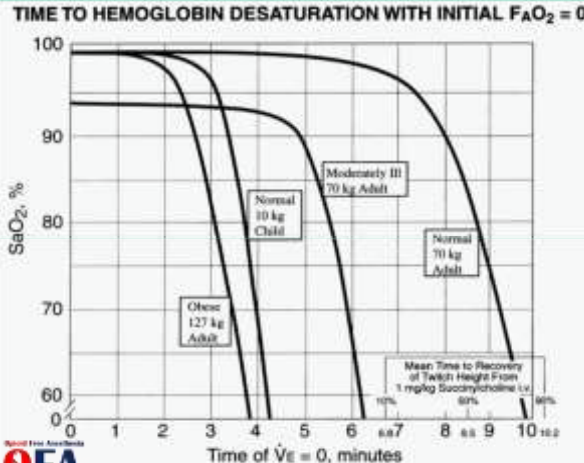


2019 Mulier



Critical Hemoglobin Desaturation Will Occur before Return to an Unparalyzed State following 1 mg/kg Intravenous Succinylcholine

Jonathan L. Benumof, M.D., Rachel Daggo, M.S.,† Reuben Benumof, Ph.D.†



TIME TO HEMOGLOBIN DESATURATION WITH INITIAL FAO2 = 0.87

Obese 127 kg Adult

Normal 10 kg Child

Moderately Ill 70 kg Adult

Normal 70 kg Adult

Mean Time to Recovery of Twitch Height From 1 mg/kg Succinylcholine i.v.

Obesity Surgery 2003, 13: 4-9

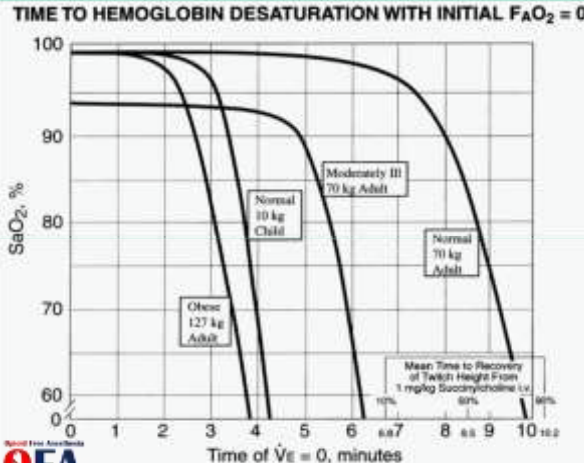
A Preliminary Study of the Optimal Anesthesia Positioning for the Morbidly Obese Patient

James Ronald Boyce, MD, FRCPC¹; Timothy Ness, MD, PhD¹; Pablo Castroman, MD¹; John J. Gleysteen, MD²



	Safe Apnea	178±55	123±24	153±63
Period (seconds)	(1 vs 3: p<0.05)			
Recovery Time (seconds)	80±30	206±64	97±41	
(seconds)	(2 vs 1: P<0.001)		(2 vs 3: P<0.001)	
Lowest SaO2 (%)	83±4	82±5	83±4	

Data is Mean±Standard Deviation.



TIME TO HEMOGLOBIN DESATURATION WITH INITIAL FAO2 = 0.87

Obese 127 kg Adult

Normal 10 kg Child

Moderately Ill 70 kg Adult

Normal 70 kg Adult

Mean Time to Recovery of Twitch Height From 1 mg/kg Succinylcholine i.v.

	Safe Apnea	178±55	123±24	153±63
Period (seconds)	(1 vs 3: p<0.05)			
Recovery Time (seconds)	80±30	206±64	97±41	
(seconds)	(2 vs 1: P<0.001)		(2 vs 3: P<0.001)	
Lowest SaO2 (%)	83±4	82±5	83±4	

Data is Mean±Standard Deviation.

Induction of obese patient

1. Prediction ? Central obesity in male, neck > 50 cm, short apnoe time!
 - a. Have help nearby - esp for Bag-mask Vent..
 - b. Be Prepared, and be prepared to be quick
2. Pre-oxygenate max **80 % FIO2** and induce ~30° head up position (**beach chair**) add pillow under thorax
 - a. Use a step to reach over patient..
 - b. Till exp FIO2 reaches 70%. (inspir setting)
3. Use **CPAP ~10cmH2O** and keep on, use gentle BIPAP, until the moment of laryngoscopy
 - a. High nasal oxygen flow with or without CPAP mask
4. Get the drug doses right!
 - a. Rocuronium 1 mg/kg LBW better than 0,6 mg/kg LBW
 - b. Pre curarisation or Magnesium sulphate for rapid relaxation
 - c. Have suggammadex available in case cannot ventilate intubate (faster recovery than suxamethonium)
5. Incremental Propofol if struggling (use BIS) – avoid awareness during difficult induction



2019 Mulier



How to prepare for extubation in an obese patient ?

1. Measure TOF (if NMB have been used) and verify TOF > 90%
2. Give max 40 % O2 before extubation to avoid resorption atelectasis
3. Perform a lung recruitment followed by PEEP and verify dyn compliance > 40 ml/cmH2O
4. Set patient in 30 ° up (beach chair) and extubate under CPAP, (spont breathing)

Never disconnect ETT, aspirate in ETT, lay patient flat, set PEEP to zero during extubation



2019 Mulier



Post operative sitting



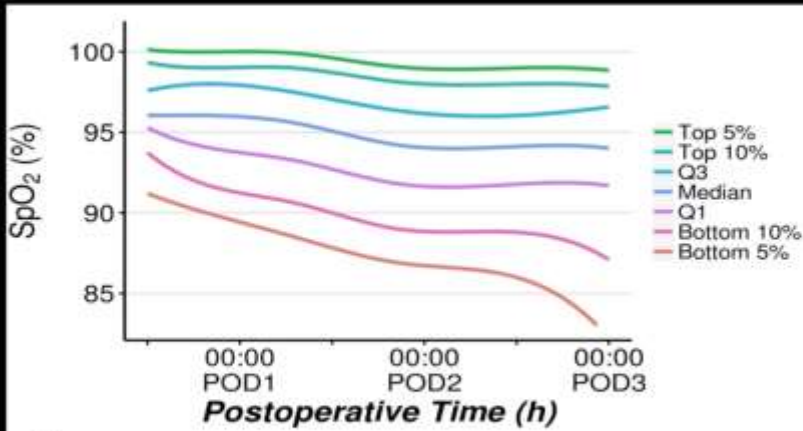




2019 Mulier



Blinded Saturation Over Time



Data From D Sessler
Cleveland clinics

1 000 pts
Saturation measured post
operative

Sun, A&A 2014

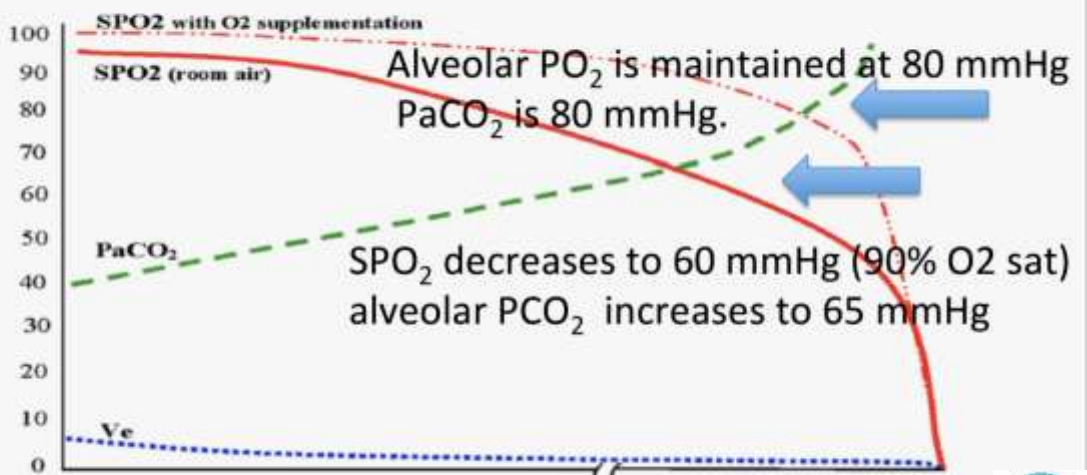
2019 Muller
Courtesy from D Sessler

2018 JPMuller
2019 Muller



CO₂ narcosis pattern of respiratory dysfunction

Curry JP et al. Patient Safety in Surgery 2014;8:29



RECC Type II pattern of respiratory dysfunction (CO₂ Narcosis).

2019 Muller
Courtesy from F Chung

2019 Muller



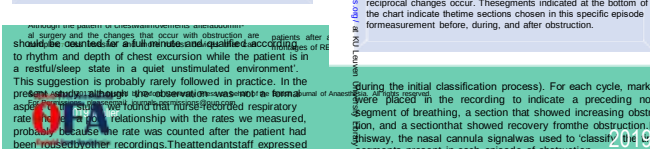
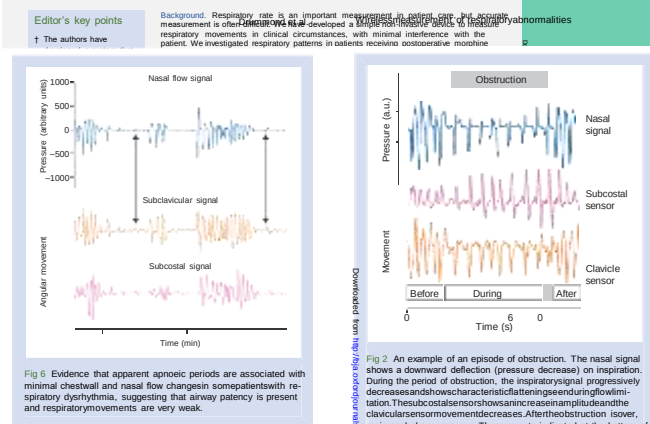
British Journal of Anaesthesia Page 1 of 8
doi:10.1093/bja/aet259

Br. J. Anaesth. August 21, 2013

Characterization of breathing patterns during patient-controlled opioid analgesia

G. B. Drummond^{1*}, A. Bates², J. Mann² and D. K. Arvind²

¹ Department of Anaesthesia and Pain Medicine, University of Edinburgh, Royal Infirmary, 51 Little France Crescent, Edinburgh EH16 4SA, UK
² Centre for Specified Computing, University of Edinburgh, Room 1.37, Informatics Forum, 10 Crichton Street, Edinburgh EH8 9AB, UK
* Corresponding author. E-mail: g.b.drummond@ed.ac.uk



PCIA (patient-controlled analgesia) after surgery: respiratory problems are common

- Breathing stops
- Obstructive breathing is frequent

After an opioid anesthesia with too much sedation
Nasal oxygen canule is not enough
Patient needs CPAP or full awake & no opioids

Mulier

Why high Risk for respiratory depression?

Hayhurst et al. Anesthesiology 2016;124(2)

A Tolerance to pain

B No Tolerance to respiratory effects

Antinociceptive effect

Morphine (mg/kg)

Baseline: Naïve patients
3.2 mg/kg/day
6.4 mg/kg/day
Abstinence: Past addiction

% Session-control V_E

Morphine (mg/kg)

Reversible tolerance to the analgesic effects of opioids (A)
No tolerance development to the respiratory effects (B)

2019 Mulier

Open access

Research



Risk factors for opioid-induced respiratory depression in surgical patients: a systematic review and meta-analyses

2018

Kapil Gupta,¹ Mahesh Nagappa,² Arun Prasad,³ Lusine Abrahamyan,⁴ Jean Wong,¹ Toby N Weingarten,⁵ Frances Chung¹

To cite: Gupta K, Nagappa M, Prasad A, et al. Risk factors for opioid-induced respiratory depression in surgical patients: a systematic review and meta-analysis. *BMJ Open* 2018;8:e024086. doi:10.1136/bmjopen-2018-024086

Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2018-024086>).

KG and FN shared first authorship.

Received: 9 May 2018
Revised: 9 August 2018
Accepted: 2 October 2018



© Author(s) (or their employer(s)) 2018. Re-use permitted under CC BY-NC. No commercial re-use, distribution, or reproduction is permitted. Published by BMJ.

For numbered affiliations, see end of article.

Correspondence to: Dr Frances Chung.



BMJ Open: first published as 10.1136/bmjopen-2018-024086 on 14 December 2018. Downloaded from <http://bmjopen.bmj.com/> on 14 December 2018 by guest. Protected by copyright.



Opioid induced post operative respiratory depression

- Incidence: 0.5%
- 85% occurred within the first 24 h.
- Increased risk:
 - cardiac disease,
 - pulmonary disease
 - OSA.
 - higher doses of opioids
- Safety by monitoring of
 - Level of sedation
 - Ventilation (respiratory rate & tidal vol)
 - pulse oximetry and capnography



2019 Mulier



O₂ post operative is risky if no respiration monitoring

No need for oxygen if no need pre operative!

- If full reversal of NMB at end of surgery (TOF > 90%)
- If open lung ventilation
 - Lung recruitment and sufficient PEEP
 - Extubation under CPAP and max 40 % O₂
- If no opioid is given intra- and post-operative
- If full awake and no sedation (no premedication)
 - Avoid benzodiazepines, rapid awakening after inhalation



2019 Mulier

111
19

Title: Lung protective ventilation during surgery: results of an expert panel discussion and practice recommendations

Authors: Christopher C Young, Erica Harris, Charles Vacchiano, Stephan Bodnar, Brooks Bukowy, Ryland Elliott, Jaclyn Migliarese, Chad Ragains, Brittany Trethewey, Amanda Woodward, Marcelo Gama de Abreu, Martin Girard, Emanuel Futier, Jan P Mulier, Paolo Pelosi, Juraj Sprung



Consensus meeting
Oct 2018 Frankfurt

Several highlights: a dedicated score should be used for pulmonary risk evaluation; positive end-expiratory pressure should be individualized to the patient in order to avoid increases in driving pressure while maintaining a low tidal volume; compliance, driving pressure, and plateau pressure should be monitored on all mechanically ventilated patients; recruitment maneuvers should be performed using the lowest effective pressure and shortest effective time or fewest number of breaths.

Conclusion: This international meeting resulted in 26 practice recommendations and statements aimed at reducing the incidence of postoperative pulmonary complications in patients undergoing surgery.

Table 1

Recommendations and statements concerning pulmonary risk assessment

Question Statement/ Recommendation	% consensus	Quality of evidence	Strength of recommendation
1.1 A dedicated score should be used for risk evaluation. The greatest risk factors include age >50 years, BMI >40 kg/m2, ASA >2, OSA, preoperative anemia, preoperative hypoxemia, emergency or urgent surgery, ventilation duration >2 hours and intraoperative factors such as hemodynamic impairment and low oxyhemoglobin saturation.	100	⊠⊠⊠□	Strong
1.2 Use a low tidal volume protective ventilation strategy (6-8 mL/kg IBW). ZEEP is not recommended. Appropriate PEEP and recruitment maneuvers may improve intraoperative respiratory function and prevent PPCs.	86	⊠⊠⊠⊠□	Strong
1.3 The formation of perioperative clinically significant atelectasis may be an important risk factor for the development of PPCs.	100	⊠⊠⊠⊠⊠⊠	Statement

PPC = postoperative pulmonary complication; BMI = body mass index; OSA = obstructive sleep apnea

Table 2

Recommendations and statements concerning case setup

Question Statement/ Recommendation	% consensus	Quality of evidence	Strength of recommendation
2.1 Individualized mechanical ventilation should be used and may improve intraoperative respiratory function, but the beneficial effects are likely to disappear after extubation.	100	⊠⊠⊠□	Strong
2.2 The ventilator should be set to deliver $V_T \leq 6-8$ mL/kg IBW and PEEP = 5 cmH2O. Evidence regarding I:E ratio settings is lacking. More research is needed to evaluate optimal intraoperative I:E ratio settings.	86	⊠⊠⊠⊠□	Strong
2.3 PEEP should be individualized to the patient in order to avoid increases in driving pressure ($P_{\text{plat}} - \text{PEEP}$) while maintaining a low V_T . To optimize intraoperative respiratory function in obese patients, during pneumoperitoneum insufflation, and during prone or Trendelenburg positioning, PEEP adjustment may be required.	100	⊠⊠⊠□	Strong

V_T = tidal volume; PEEP = positive end expiratory pressure; I:E = inspiratory:expiratory; P_{plat} = plateau pressure

Table 3

Recommendations and statements concerning ventilation management during anesthesia induction

Question Statement/ Recommendation	% consensus	Quality of evidence	Strength of recommendation
3.1 Prior to induction of anesthesia, position the patient with the HOB elevated ≥ 30-degrees (i.e. "beach chair"); avoid flat supine position. If not contraindicated, prior to the loss of spontaneous ventilation, use NIPPV or CPAP to attenuate anesthesia-induced respiratory changes.	100	⊗⊗⊗□	Strong
3.2 During induction, monitor for an obstructive breathing pattern and use a combination of appropriate techniques including positioning, application of NIPPV or CPAP, and/or placement of a nasopharyngeal airway to avoid upper airway obstruction.	100	⊗□□□	Strong
3.3 Following intubation, FiO ₂ should be set to ≤0.4. Thereafter, use the lowest possible FiO ₂ to achieve SpO ₂ ≥94%.	100	⊗□□□	Weak
3.4 No specific mode of controlled mechanical ventilation is recommended.	100	⊗□□□	Statement

NIPPV = non-invasive positive pressure ventilation; CPAP = continuous positive airway pressure; HOB = head of bed; FiO₂ = fraction of inspired oxygen; SpO₂ = peripheral oxygen saturation

Table 4

Recommendations and statements concerning respiratory system monitoring and ventilation management during anesthesia maintenance/surgery

Question Statement/ Recommendation	% consensus	Quality of evidence	Strength of recommendation
4.1 In addition to standard monitoring (ASA/ESA) dynamic compliance, driving pressure (P _{plat} -PEEP), and P _{plat} should be monitored on all controlled mechanically ventilated patients.	100	⊗⊗⊗□	Strong
4.2 Decreasing compliance caused by surgical/anesthesia factors (i.e. pneumoperitoneum, positioning, circuit disconnect) should be treated by appropriate interventions. Individualized PEEP can prevent progressive alveolar collapse. Recruitment maneuvers can reverse alveolar collapse but have limited benefit without sufficient PEEP.	86	⊗⊗⊗⊗	Statement
Increasing FiO ₂ may be effective in increasing the oxygenation, but is not an effective intervention to improve dynamic compliance of the respiratory system.			
4.3 The effectiveness of interventions aimed at optimizing respiratory system mechanics should be evaluated by measuring an improvement of the respiratory system compliance under constant tidal volume.	100	⊗⊗□□	Strong

Table 5

Recommendations and statements concerning recruitment maneuvers

Question Statement/ Recommendation	% consensus	Quality of evidence	Strength of recommendation
5.1 High quality supportive evidence is lacking to recommend a routine RM for all patients following endotracheal intubation. However, a RM may be considered according to an individual risk-benefit assessment.	57*	⊗□□□	Weak
5.2 The bag-squeezing RM should be avoided in favor of a ventilator-driven RM.	100	⊗□□□	Weak
5.3 RMs should be performed using the lowest effective P _{plat} (30-40 cmH ₂ O in non-obese, 40-50 cmH ₂ O in obese) and shortest effective time or fewest number of breaths.	100	⊗⊗□□	Weak
5.4 Continuous hemodynamic and oxygen saturation monitoring is recommended before and during RM. Ensure adequate hemodynamic stability prior to performing a RM. Avoid RMs when contraindicated.	100	⊗⊗⊗⊗	Strong
5.5 PEEP should be individualized following a RM to avoid both alveolar overdistention and collapse.	71	⊗⊗□□	Weak

RM = recruitment maneuver; P_{plat} = plateau pressure

*Consensus level <70%

Table 6

Recommendations and statements concerning ventilation management during anesthesia emergence

Question Statement/ Recommendation	% consensus	Quality of evidence	Strength of recommendation
6.1 Optimize patient positioning and avoid ZEEP during emergence. Avoid ETT suctioning immediately prior to tracheal extubation.	100	⊗□□□	Weak
6.2 Avoid apnea with ZEEP prior to extubation.	100	⊗□□□	Weak
6.3 In the appropriate clinical scenario, the use of low FiO ₂ (<0.4) during emergence from general anesthesia can improve pulmonary function in the postoperative period.	71	⊗□□□	Weak
6.4 When high FiO ₂ (>0.8) is used during emergence, the use of low FiO ₂ (<0.3) CPAP immediately following tracheal extubation may reduce the risk of resorption atelectasis.	29*	⊗□□□	Weak
6.5 Administration of postoperative supplemental oxygen is recommended when room air SpO ₂ falls below 94%. Avoid routine application of supplemental oxygen without investigating and treating the underlying cause.	100	⊗□□□	Weak
6.6 Prophylactic NIPPV/CPAP should be considered post-operatively for patients with prior routine use of NIPPV/CPAP.	100	⊗⊗□□	Strong

NIPPV = non-invasive positive pressure ventilation; CPAP = continuous positive airway pressure; HOB = head of bed; FiO₂ = fraction of inspired oxygen; SpO₂ = peripheral oxygen saturation

1. Key points in pre operative planning

- Next to body mass index (BMI), total and ideal body weight, the anaesthesiologist should also know the maximum weight ever the lean body weight (LBW) and the amount of visceral obesity measured by the waist to hip or waist to height ratio (WHR), the liver size and the subcutaneous fat layer.
- Is the morbidly obese patient having a metabolic syndrome? Yes if the patient has three of the following four elements: diabetes, dyslipidaemia, visceral obesity and hypertension. What is the impact of the metabolic syndrome on his/her lung and heart function? Obesity hypoventilation syndrome? (et CO₂ and bicarbonate)
- Cardiac assessment, however harder to assess, is important as morbidly obese patients are more likely to have atrial fibrillation, heart failure, Pulmonary hypertension or a cardiomyopathy.
- 10 kg or 10% body weight reduction (by high protein diet) pre operative is important to reduce the visceral fat and liver size. It facilitates laparoscopic surgery, lung ventilation and post-operative breathing. This is the moment to encourage some exercise and to stop smoking. Tell them they will have to mobilize on day of surgery and have to take thrombo-prophylaxis. Discuss postoperative pain management, diet and inspiratory muscle training.
- "Stop bang" questionnaire or sleep study finds patients who have obstructive sleep apnoea syndrome (OSAS). They are at risk to increase their obstructive breathing postoperative and should take their home CPAP, if prescribed to the hospital. Anaesthesiologists should give an OSAS safe anaesthetic (regional or opioid free) or give postoperative CPAP with a medium (or intensive) care (level 2 bed) bed available after anaesthesia.



2019 Mulier



2. Key points in anaesthesia induction.

- Induction is best performed in a head-up position, usually about 30 degree head-up. Anticipate hypotension post induction in this position, pre-loading if signs of hypovolemia. Measure oxygen saturation while breathing room air and after a deep inspiratory effort to differentiate pre op atelectasis from diffusion problems.
- Thorough pre-oxygenation max 80 % O₂, and a low level of CPAP (around 10cmH₂O) maintained until the moment of intubation, will maintain Functional Residual Capacity and prolong the apnoeic desaturation time (the period before significant arterial desaturation occurs). High nasal oxygen flow might help.
- Know the correct dosing scalars for Induction agents and muscle relaxants. Be aware of the increased rate of re-distribution and clearance of these agents and hence risks of awareness. Be aware that volatile absorption and rise in target site concentrations may be slower than in the non-obese
- Laryngoscopy and intubation is of similar difficulty to the non-obese population. The same predictors of difficulty should be used as in the non-obese, but with the additional recognition that a large neck circumference is associated with more difficult laryngoscopy. Fibre-optic intubation for increased BMI alone is not indicated, have video laryngoscopy available.
- Face mask ventilation is frequently problematic and the need for two-hands to hold the airway is common. Airway adjuncts (oral and/or naso/pharyngeal airways) are often helpful. Use plastic sheaths when beard is not shaved. Anticipate difficulty here.
- Laryngeal and supra-glottic devices are acceptable if the patient is in a head up position, but the splinting of the diaphragm from a large abdomen often results in inadequate minute ventilation if the patient is supine or head-down. Supraglottic airway were associated with the majority of airway disasters in the obese in NAP4. Endotracheal tubes should be the default airway in most cases.



2019 Mulier



3. Key points in anaesthesia maintenance.

- After induction start with $\text{FiO}_2 \leq 0.4$. Thereafter, use the lowest possible FiO_2 to achieve $\text{SpO}_2 \geq 94\%$.
- The ventilator should be set to deliver $V \leq 6-8 \text{ mL/kg IBW}$ with PEEP minimal $5 \text{ cmH}_2\text{O}$. Higher PEEP may be required in obese patients, during pneumoperitoneum, and during prone or Trendelenburg positioning.
- Dynamic compliance, driving pressure ($P_{\text{Plat}} - \text{PEEP}$), and P_{Plat} should be monitored in every patient. Decreasing compliance should be treated with recruitment combined with sufficient PEEP. RMs should be performed using the lowest effective P_{Plat} ($30-40 \text{ cmH}_2\text{O}$ in non-obese, $40-50 \text{ cmH}_2\text{O}$ in obese) and shortest effective time or fewest number of breaths. The bag-squeezing RM should be avoided in favor of a ventilator-driven RM
- Prefer the use of drugs, like inhalation or water-soluble, that are easy to dose and to monitor.
- Prefer loco regional anaesthesia. If general anaesthesia is required combine with loco regional or local infiltration and avoid long working sedatives and opioids.
- If NMB is required measure TOF and PTC to provide a sufficient depth.
- Depth of anaesthesia monitoring helps limit the anaesthetic load, avoids intraoperative awareness and reduces post operative sedation.



2019 Mulier



4. Key points in anaesthesia emergence.

- Be sure to have full NMB reversal,
- No sedation and lowest level of opioids possible,
- Empty stomach and avoid ETT suctioning immediately prior to tracheal extubation,
- Give lung recruitment before and CPAP during extubation in beach chair position,
- Low FiO_2 (< 0.4) during emergence from general anesthesia can improve pulmonary function in the postoperative period. When high FiO_2 (> 0.8) is used during emergence, the use of low FiO_2 (< 0.3) CPAP immediately following tracheal extubation may reduce the risk of resorption atelectasis.



2019 Mulier



5. Key points in postoperative care.

- Continue with CPAP mask if used before surgery.
- Avoid routine application of supplemental oxygen without investigating and treating the underlying cause. Postoperative oxygen is recommended when room air SpO₂ falls below 94%.
- Look for ominous patterns of SpO₂ desaturations and hypercarbia suggestive for obstructive breathing or carbonarcosis with arousal failure.
- Beach chair position or better sitting up at 60°.
- Promote early mobilization.
- Sufficient pain treatment and PONV treatment.
- Provide tromboprophylaxis.

• In case of prolonged surgery in the sitting position: be aware of rhabdomyolysis.



2019 Mulier



Conclusion

az sint-jan
Ziekenhuis - Universiteit van Antwerpen

Think about LRM in every ventilated patient: dyn C > 40, working pressure < 13 cmH₂O
LRM, after intubation, during ventilation, before extubation with lowest pressure & time possible.

Always beach chair position before during and after anesthesia
CPAP during induction & during extubation
FIO₂ max 80% during induction, FIO₂ max 40% during anesthesia & during extubation



2019 Mulier



HALLOWELL EMC

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



Anesthesia Workstation: Rats, Rabbits, Reptiles, Avian, Kittens, etc.

Model 2002 Pro: Interchangeable Bellows 0-1600 mL Kittens to Large Dogs, Foals

Tafonius Large Animal Ventilator: Horses, Cows, Lions, Bears, etc.



We Also Provide:

- Heated Hard Pads for Patient Warming
- Medical Gas Fittings & Hoses
- Vacuum Scavenging Systems
- Parts, Service & Accessories

info@hallowell.com

(413) 445-4263

Oral Presentations

Comparison of the PTA (Parasympathetic Tone Activity) and the SPI (Surgical Plethysmographic Index) to assess the analgesia / nociception balance in anaesthetized dog

Cardinali MC, Conde Ruiz CCR, Bernardy AB, Sentenac JS, Junot SJ.

Service d'Anesthésie, VetAgro Sup – Campus Vétérinaire de Lyon, Université de Lyon

This study aimed to compare the performances of the Parasympathetic Tone Activity (PTA) and the SPI (Surgical Plethysmographic Index) indexes to assess the analgesia/nociception balance in anaesthetized dogs.

Twenty-four female and male dogs were anaesthetised for neutering procedures with a standardised protocol. Both indexes were measured with dedicated monitors. Heart rate (HR), systolic arterial pressure (SAP), PTA, SPI were assessed before and after nociceptive stimulations (TCut, TExt1, TExt2, TCutSut), and fentanyl (Tfenta) administrations. Friedman tests with *a posteriori* multiple comparison were used to detect significant variations of the parameters within time 1, 3 and 5 minutes after each time-point of interest (Tinit, T+1min, T+3min, T+5min). The performance of the dynamic variation of PTA (Δ PTA) and SPI (Δ SPI) over 1 minute to predict a haemodynamic reaction (increase by > 20% in HR and/or SAP within 3 and 5 minutes) was assessed by building Receiver Operating Characteristics (ROC) curves. A p-value < 0.05 was considered significant.

Significant variations in PTA were observed at TExt2 (- 18 [24] %) and Tfenta (+ 7 [27] %) with significant haemodynamic variations at these time-points. Regarding SPI, a significant decrease at Tfenta (- 39 [14] %) was found with no significant variation at any nociceptive time-point. The performance of the indexes to predict a haemodynamic reaction was moderate for SPI (AUC3min 0.68, p<0.05) and PTA (AUC5min 0.63, p=0.05).

The performance of both indexes to evaluate the analgesia nociception balance in anaesthetized dogs were moderate.

References

Mansour C, Merlin T, Bonnet-Garin JM et al. (2017) Evaluation of the Parasympathetic Tone Activity (PTA) index to assess the analgesia/nociception balance in anaesthetised dogs. Res Vet Sci. 2017 May 10;115:271-27

Pharmacokinetics of ketamine after intravenous and intranasal administration to dexmedetomidine sedated dogs

Vlerick LV, Devreese MR, Peremans KP, Dockx RD, Croubels SC, Duchateau LD, Polis IP.

Small Animal Department, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

Department of Pharmacology, Toxicology and Biochemistry, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

Department of Veterinary Medical Imaging and Small Animal Orthopaedics, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

Ghent Experimental Psychiatry (GHEP) lab, Department of Psychiatry and Medical Psychology, Ghent University, Ghent, East Flanders, Belgium

Department of Psychiatry, University Hospital (UZBrussel), Brussels, Belgium

Biometrics Research Centre, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

Intranasal ketamine has been shown to be an effective antidepressant treatment in humans. Since several similarities are reported between human psychiatric disorders and canine anxiety disorders, intranasal ketamine could serve as an alternative treatment for anxiety disordered dogs. Therefore, this randomized crossover study aimed to examine the pharmacokinetics, absolute bioavailability, safety and tolerability of intranasal ketamine.

Seven dogs received 2 mg kg⁻¹ ketamine intravenously (IV) or intranasally (IN), with a two-week wash-out period. Prior to ketamine administration, dogs were sedated intramuscularly with dexmedetomidine (375 µg m⁻² body surface). Venous blood samples were collected at fixed times and ketamine plasma concentrations were determined by liquid chromatography-tandem mass spectrometry and modelled by non-compartmental pharmacokinetic analysis. Student t-test was used to compare both administration routes for each pharmacokinetic parameter (alpha = 0.05). Cardiovascular parameters (HR, f_R and SAP) and sedation scores were recorded at fixed times and evaluated with linear mixed models.

No significant differences in pharmacokinetic parameters were found between the two administration routes. Rapid absorption ($T_{max} = 0.25 \pm 0.14$ hours) and complete IN bioavailability ($F = 147.65 \pm 49.97\%$) were demonstrated. Elimination half-life ($T_{1/2el}$) was similar between both administration routes ($T_{1/2el}$ IV = 1.47 ± 0.24 hours, $T_{1/2el}$ IN = 1.50 ± 0.97 hours). Heart rate and sedation scores were significantly higher at 5 and 10 minutes following IV administration compared to IN administration.

This study shows that IN ketamine is completely absorbed after IN administration rendering high plasma concentrations and encourages the use of IN ketamine in veterinary medicine.

Influence of pre-anaesthetic clinical examination on anaesthetic case management in dogs and cats.

Louro LF, Maddox T, Alderson B.

University of Liverpool

The objective of this prospective clinical audit was to assess the influence of the pre-anaesthetic examination on the American Society of Anesthesiologists (ASA) Physical Status Classification and individual planning of anaesthetic case management in dogs and cats at a large university referral hospital.

Six-hundred-and-twenty-one patients, undergoing general anaesthesia or sedation for surgical, diagnostic or imaging procedures were included. Case information was reviewed by the attending anaesthetist prior to formulating an individual anaesthetic case management plan based on the available data and prior to observation and clinical examination of the patient. A pre-anaesthetic examination was subsequently performed, and anaesthetic case management was discussed with a senior anaesthetist. Any changes in ASA Physical Status Classification or anaesthetic case management plan were recorded.

Results showed that the anaesthetic protocol changed in 23.0% of the cases due to findings related to the pre-anaesthetic examination, with 93.0% of these changes made to the premedication phase. However, only 8.1% of cases were re-categorized to a different ASA Physical Status Classification, no procedures were postponed due to the pre-anaesthetic examination. Overall, 27.3% of the changes were based on the temperament of the patient. Anaesthetic and analgesic drug dosages were modified in 64.3% of the patients where anaesthetic protocol changed. Further analysis showed that anaesthesia diplomats were 6 times more likely to change an anaesthetic protocol due to the pre-anaesthetic examination than anaesthesia interns.

In conclusion, pre-anaesthetic examination is a valuable tool in evaluating pre-anaesthetic risk and formulating a tailored anaesthetic protocol.

Evaluation of routine pre-anaesthetic haematological and biochemical screening in geriatric cats and dogs

Diaz MdM, Kaartinen J, Allison A

Animal Health Trust, Newmarket, United Kingdom
Small Animal Specialist Hospital, Sydney, Australia

The benefit of routine pre-anaesthetic bloods in geriatric patients is unclear (Alef et al. 2008; Joubert, 2012). The aim of the study was to assess the impact of these tests on American Society Anaesthesia (ASA) grade and anaesthetic protocols.

Cats and dogs older than 8 years were included in this prospective, observational multi-centre study. Pre-anaesthetic blood profiles included: urea, creatinine, electrolytes, glucose, lactate, packed cell volume and total protein. Anaesthetists completed a questionnaire after patient examination and review of clinical history. An ASA classification and any expected abnormalities were recorded. Following this, blood work was reviewed and the presence of clinically significant abnormalities, changes in ASA classification, changes in anaesthetic protocol, delays or cancellations were recorded. Descriptive statistics were performed.

A total of 333 patients were included; 29 cats and 304 dogs. Blood test results were predicted correctly in 265 cases (79.6%) and incorrectly in 68 cases (20.4%). Of those, 19 (5.7%) tests were normal but expected abnormal and 49 (14.7%) the opposite. ASA grade changed in 2 cases (0.6%), increasing by one grade in both cases. Protocols were modified in 6 cases; fluid therapy was added or increased in 5 cases and one case had a change of premedication. Two cases were delayed for fluid therapy administration. No cases were cancelled.

Anaesthetists predicted blood test results correctly in most cases. Overall, blood results led to few clinically significant changes. The value of routine screening in geriatric patients should be questioned.

References

- Alef M, Von Praun F, Oechtering G (2008) Is routine pre-anaesthetic haematological and biochemical screening justified in dogs? *Vet Anaesth Analg* 35,132–140.
Joubert KE (2012) Pre-anaesthetic screening of geriatric dogs. *J S Afr Vet Assoc* 78, 31–35.

Thursday 2nd session Bourdon 1 (4.00 - 5.00 pm) - Chair: Stéphane Junot

A survey of attitudes of Slovenian veterinarians to recognition and treatment of pain in cats and dogs

Tomsič K, Sokolov C, Seliškar A.

Small Animal Clinic, Veterinary Faculty, University of Ljubljana, Slovenia
Faculty of Arts, University of Ljubljana, Slovenia

In April 2019, 680 Slovenian veterinarians were surveyed for recognition and treatment of pain in cats and dogs.

Veterinarians were solicited by e-mail to complete an on-line questionnaire. Questions were grouped in sections pertaining to demographic data, veterinary practice, pain recognition and use of analgesics.

Out of 111 respondents, 73 completed the survey and were included in further analysis. The majority of respondents (72%) was 25 to 45 years old and of female gender (71%); 50% of respondents work with companion animals only. Research results show that acute pain is generally recognized to a higher extent than chronic pain. In addition, 5% of respondents believe cats feel less pain than dogs. Metastatic osteosarcoma and pancreatitis are considered the most painful conditions, and multiple dental extractions, thoracotomy and splenectomy the most painful surgical procedures. The most frequently used NSAIDs are meloxicam in dogs and cats and carprofen in dogs, followed by firocoxib in dogs. The most frequently used opioids are methadone and tramadol in dogs and butorphanol in cats and dogs. Gabapentin is sometimes used in dogs, too. The choice of NSAIDs is influenced by cost, availability, side effects and personal experience. Opioid use is influenced by availability, record keeping, side effects, effectiveness and personal experience.

Slovenian veterinarians display a positive attitude towards recognition of pain in dogs and cats, however, there are still uncertainties in recognizing chronic pain and using multimodal analgesia.

Feline Grimace Scale for acute pain assessment: real-time versus image scoring and the influence of sedation and surgery

Evangelista MC, Benito J, Monteiro BP, Watanabe R, Doodnaught GM, Pang DJS, Steagal P.

Faculté de médecine vétérinaire - Université de Montréal

The aims of this study were to investigate the applicability of the Feline Grimace Scale (FGS) for real-time acute pain assessment and to evaluate the influence of sedation and surgery on the FGS scores in cats.

Sixty-five female cats (2.8 ± 0.7 kg) were included. Cats were sedated with acepromazine (0.02 mg kg^{-1}) and buprenorphine (0.02 mg kg^{-1}) IM. Following induction with propofol, anaesthesia was maintained with isoflurane and cats underwent ovariohysterectomy. Pain was evaluated at baseline, 15 minutes after sedation, and at 2, 6, 12 and 24 hours after extubation using the FGS in real-time (FGS-RT) and cats were video-recorded for subsequent image assessment (FGS-IMG; standard methodology) performed six months later. The agreement between FGS-RT and FGS-IMG scores from the same observer was calculated using the method by Bland & Altman (2007) for repeated measures. The effects of sedation (baseline versus 15 minutes after sedation) and surgery (baseline versus 24 hours after extubation) were assessed using linear mixed models ($p < 0.05$).

Minimal bias (-0.057) and narrow limits of agreement (LOA: -0.351 to 0.237) were observed between the FGS-IMG and FGS-RT. Scores at baseline (FGS-RT: 0.16 ± 0.13 and FGS-IMG: 0.14 ± 0.13) were not different after sedation (FGS-RT: 0.2 ± 0.15 and FGS-IMG: 0.16 ± 0.15) nor at 24 hours after extubation (FGS-RT: 0.16 ± 0.12 and FGS-IMG: 0.12 ± 0.12) ($p > 0.05$, all comparisons).

Real-time assessment overestimates image scoring, however with minimal clinical impact. Sedation with acepromazine-buprenorphine, and surgery did not influence the FGS scores.

References

Bland JM, Altman DG. (2007) Agreement between methods of measurement with multiple observations per individual. *J Biopharm Stat* 17, 571–582.

The analgesic effects of buprenorphine (Vetergesic or Simbadol) in cats undergoing dental extractions: a randomized, blinded, clinical trial

Watanabe RW, Marcoux JM, Evangelista ME, Dumais YD, Steagall PS.

Department of Clinical Sciences, Faculty of Veterinary Medicine, Université de Montréal

This study aimed to evaluate the analgesic efficacy of two concentrations of buprenorphine (Simbadol: 1.8 mg mL⁻¹ and Vetergesic: 0.3 mg mL⁻¹) in cats undergoing dental extractions.

Twenty-three cats with oral disease (8.2 ± 2.2 years old; 4.9 ± 0.9 kg) were included in a prospective, blinded, randomized clinical trial. Cats received either Simbadol (0.24 mg kg⁻¹, SC, every 24 hours: SG, n = 11) or Vetergesic (0.02 mg kg⁻¹, IM, every 8 hours: VG, n = 12) for three days. Cats underwent oral examination/radiographs/treatment under general anesthesia (buprenorphine-propofol-isoflurane-meloxicam-local anesthetic block) at day 1. Sedation and pain were scored using the dynamic and interactive visual analog scale (day 1) and the Glasgow composite measure pain scale-feline (CMPS-F; up to day 4), respectively. Rescue analgesia was administered with hydromorphone (0.05 or 0.1 mg kg⁻¹ IV or IM, respectively) when CMPS-F ≥ 5 . Sedation and pain scores, prevalence of rescue analgesia and resentment during drug administration were analyzed using linear mixed models and Fisher's exact test, respectively ($p < 0.05$).

Pain and sedation scores were not significantly different between groups. Sedation scores were significantly higher up to 2 hours postoperatively in both groups and pain scores in SG and VG were significantly higher up to 8 hours postoperatively and day 2, respectively than baseline. Prevalence of rescue analgesia and resentment were not significantly different between groups (SG: 27.3%, VG: 33.3% and SG: 0%, VG: 25 %, respectively).

Simbadol produced similar analgesic effects to Vetergesic without resentment during drug administration.

Pain behaviours before and after treatment of oral disease using video assessment: a prospective, blinded, randomized clinical trial

Watanabe RW, Frank DF, Steagall PS.

Department of Clinical Sciences, Faculty of Veterinary Medicine, Université de Montréal

Pain behaviours before and after treatment of oral disease using video assessment: a prospective, blinded, randomized clinical trial

This study aimed to identify pain-induced behaviours in cats before and after treatment of oral disease using video assessment.

Twenty-four cats (6 ± 3.3 years old; 4.9 ± 1.7 kg) were included in a prospective, blinded, randomized clinical trial. Cats were equally divided into minimal (G1: minimal dental treatment) or severe (G2: multiple dental extractions) oral disease groups. After acclimation (day 0), they underwent oral examination/radiographs/treatment under general anaesthesia (acepromazine-hydromorphone-propofol-isoflurane-meloxicam-local aesthetic blocks; day 1) and were discharged (day 6). Cats were filmed during 10 minutes throughout the study (total of 36 hours of videos). The duration/frequency of general/playing/feeding/post-feeding behaviours were evaluated using an ethogram and analysed using linear mixed models and a generalized linear model, respectively ($p < 0.05$).

In comparison with before surgery (baseline), duration of “not pawing the face” was significantly shorter at day 3 in G2. G2 spent significantly longer time “standing” and “laying” at days 3 and 6, respectively; G1 spent significantly less time “walking” and “standing” at days 3 and 4, respectively and significantly longer time “immobile” at day 3. In G2, durations of “pawing the ribbon” and “no/slow tail movement” were significantly longer at day 5 and shorter at day 1, respectively, than G1. Frequency of “difficulty grasping dry food” was significantly higher in G2 than G1 up to day 6. Frequency of post-feeding “head shaking” was significantly higher in both groups at day 6 when compared with baseline.

This study identified specific pain-induced behaviours in cats undergoing treatment of oral disease.

Clinical and anaesthesiologic effects of lidocaine constant rate infusion in neonatal foals during anaesthesia

Lambertini C, Mazzanti A, Romagnoli N.

Department of Veterinary Medical Sciences, Alma Mater Studiorum, University of Bologna

Lidocaine constant rate infusion (LCRI) is administered for analgesia and for a sparing effect in horses (Murrel et al. 2005; Rezende et al. 2011; Nannarone et al. 2015); no data are reported in foals.

Twenty sick young foals (up to three weeks old) undergoing laparotomy were divided into two groups in which lidocaine was administered intraoperatively $30 \mu\text{g kg}^{-1} \text{ min}^{-1}$ (group LIDO n=8) or omitted (group CON n=12). Foals were premedicated with midazolam (0.05 mg kg^{-1}) and butorphanol (0.05 mg kg^{-1}) IV. Anaesthesia was induced with ketamine (1.5 mg kg^{-1}) and propofol (0.8 mg kg^{-1}) IV and maintained with isoflurane in oxygen. Heart rate, f_R , MAP and fraction of expired isoflurane (FE_{iso}) were monitored continuously. Time of extubation, time to reach sternal recumbency and standing were recorded. The quality of recovery was assessed. Data were compared between the groups with a Student t-test and are reported as mean $\pm$ SD.

The mean HR, f_R , MAP and FE_{iso} did not differ between groups. The mean HR at baseline was $111.25 \pm 16.9 \text{ bpm}$ and $113.8 \pm 25.6 \text{ bpm}$ and intraoperatively decreased up to $81.4 \pm 11.9 \text{ bpm}$ and $75.1 \pm 14.6 \text{ bpm}$ in groups LIDO and CON respectively; in both groups the differences to baseline were statistically significant. Foals in group LIDO required more time to reach standing ($32.8 \pm 7.0 \text{ minutes}$) compared with those in group CON ($17.5 \pm 17.5 \text{ minutes}$). Recovery was good in both groups.

In foals LCRI did not change cardiorespiratory parameters, isoflurane requirements or recovery quality.

References:

- Murrell JC, White KL, Johnson CB et al. (2005) Investigation of the EEG effects of intravenous lidocaine during halothane anesthesia in ponies. *Vet Anaesth Analg* 32, 212-221.
- Nannarone S, Cenani A, Gialletti R et al. (2015) Clinical comparison of two regimens of lidocaine infusion in horses undergoing laparotomy for colic. *Vet Anaesth Analg* 42, 150-156.
- Rezende ML, Wagner AE, Mama KR, et al. (2011) Effects of intravenous administration of lidocaine on the minimum alveolar concentration of sevoflurane in horses. *Am J Vet Res* 72, 446-451

The antinociceptive effect of Magnesium Sulphate administered intravenously in standing horses

La Rosa L, Twele L, Duchateau L, Kästner SBR, Schauvliege S.

Department of Surgery and Anaesthesia of Domestic Animals, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

Equine Clinic, University of Veterinary Medicine Hanover, Hanover, Germany

Department of Comparative Physiology and Biometrics, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

Magnesium, as antagonist at N-methyl-D-aspartate receptors, is part of multimodal analgesia in humans.

In a blinded cross-over study in 5 standing horses (602 ± 53 kg, 17 ± 6 years), the antinociceptive properties of intravenous magnesium sulphate were studied. Over 15 minutes, $50 \text{ mg kg}^{-1} \text{ MgSO}_4$ (treatment Mg) or the same volume of saline (treatment S) was infused. Nociceptive thresholds (thermal/mechanical/electrical) were determined before and every 20 minutes after treatment (for 180 minutes). Blood samples were taken before treatment and 5, 10, 15, 30, 45, 60, 240, 480 and 720 minutes after treatment for serum concentration of iMg^{2+} , TMg^{2+} , iCa^{2+} and TCa^{2+} . A linear mixed model using horse as random effect and session, time, treatment and their interaction as fixed effects was used to compare the treatments, both overall and specifically at 20, 60, 120 and 180 minutes (alpha 0.05, with Bonferroni correction). Despite significant changes in Mg^{2+} and Ca^{2+} concentrations, no differences in nociceptive thresholds were found. A significant difference was found for HR at T15 (Mg 48 ± 3 ; S 37 ± 3 beats min^{-1}) ($p = 0.005$) and T120 (Mg 45 ± 3 ; S 34.7 ± 3 beats min^{-1}) ($p = 0.004$), and NIBP at T60 (Mg 111 ± 4.5 ; S 131 ± 4.5 mmHg) ($p < 0.001$). Overall, a significant difference was found for RR (Mg 19.6 ± 1 ; S 23.4 ± 1 breaths min^{-1}) ($p < 0.001$).

Although mild cardiovascular effects were seen with MgSO_4 , no changes in nociceptive thresholds were detected.

Recovery quality after romifidine vs detomidine infusion during isoflurane anaesthesia in horses

Alonso BA, Carregaro AC, Cuypers CC, Michielsen AM, Gasthuys FG, Schauvliege SS.

University of Sao Paulo
Ghent University

The influence of detomidine and romifidine on recovery quality from isoflurane anaesthesia was investigated in 63 horses undergoing elective surgery.

Horses were randomly allocated to one of three groups. In group R, romifidine was used during premedication ($80 \mu\text{g kg}^{-1}$), anaesthetic maintenance ($40 \mu\text{g kg}^{-1} \text{ h}^{-1}$) and recovery ($20 \mu\text{g kg}^{-1}$). In group D2.5, detomidine doses were respectively $15 \mu\text{g kg}^{-1}$, $5 \mu\text{g kg}^{-1} \text{ h}^{-1}$ and $2.5 \mu\text{g kg}^{-1}$, and in group D5 $15 \mu\text{g kg}^{-1}$, $5 \mu\text{g kg}^{-1} \text{ h}^{-1}$ and $5 \mu\text{g kg}^{-1}$. Other drugs for anaesthesia were identical between groups. Values monitored at regular intervals during anaesthesia were averaged per horse and, along with recovery data, analysed using generalized additive regression models.

Significant differences between groups are shown in Table 1. Other variables were comparable between groups.

Recovery quality was lower in group D5. Romifidine produced less ataxia than detomidine at both dosages.

Table 1. Significant differences ($P < 0.05$) between groups. Parametric data represented as mean $\pm$ SD, nonparametric as median (range).

	PaO ₂ (mmHg)	Age (years)	VAS: 0 (worst) to 10 (best)	Score balance & coordination: 1 (best) to 4 (worst)	Final score: 1 (best) to 6 (worst)
R	133 (90 – 208) *	5.4 (2.6 – 9.2)	7 ± 2.7	2 (1 – 2.75) *	1.5 (1 – 3.5) *
D2.5	97 (77 – 161)	3.5 (1.8 – 8.4)	6.1 ± 2.3	2 (2 – 3) *	2 (2 – 2)
D5	90 (71 – 137)	7.9 (4.3 – 16.1) *	4.5 ± 3.2 *	3 (2 – 4) *	2 (2 – 5)

* significantly different from other treatments

Effect of anaesthesia time on the quality of recovery in horses using the same anaesthetic maintenance protocol

Vermedal H, Valverde A, Skelding A, Aguilera R, Tisotti T, Tucker L, Sears W.

Ontario Veterinary College

Prolonged anaesthesia time (AT) is associated with higher morbidity and mortality rates in horses. Recovery scores (RS) after soft tissue and orthopaedic surgery were compared to correlate AT with RS.

A retrospective study (2014-2019) of 409 horses anesthetized with similar induction protocols and same balanced anaesthesia for maintenance (dexmedetomidine constant rate infusion; lidocaine boluses; isoflurane or sevoflurane; discontinuation of inhalant ≥ 10 minutes and continuation of maintenance with top ups of xylazine + ketamine before moving to recovery). Horses were divided into, AT1: AT ≤ 90 minutes and AT2: > 90 minutes and assessed for RS (scale of 1 [best] to 5 [worst]). Comparisons included a Wilcoxon rank sum test and Monte Carlo simulation (median; CI). A Spearman correlation coefficient (SCC) was used without group assignment ($p < 0.05$).

Horses in AT1 ($n = 159$) were significantly younger, 2.6 years (2.4, 3.3) *versus* 3.5 (3.0, 4.3); lighter (kg) 470 (449, 484) *versus* 490 (475, 510), than AT2 ($n = 250$); with similar distribution for sex, type of surgery, induction protocol and doses. Horses in AT1 received fewer lidocaine boluses 1.0 (1.0, 1.0) *versus* 2 (1.5, 2.0); less dexmedetomidine ($\mu\text{g kg}^{-1} \text{h}^{-1}$) 1.31 (1.25, 1.35) *versus* 1.70 (1.66, 1.73); similar end-tidal (%) isoflurane 1.2 (1.2, 1.2) or sevoflurane 2.2 (2.1, 2.3) *versus* 2.3 (2.2, 2.4); similar number of top ups before recovery 2 (2, 2), and lower RS 1 (1, 1) *versus* 2 (1, 2), than AT2. The SCC was 0.16653 ($p = 0.0007$).

Increased AT decreases the quality of recovery.

Retrospective investigation of change in body temperature in anesthetized dogs

Clark-Price SC, Bossert JL, Brunstein KA, Farrow AF, Perregrino A.

Auburn University

Body temperature (BT) decrease is a common complication of anesthesia. It follows a regular pattern in humans: an initial rapid decrease, a slow linear reduction, and a plateau. It is assumed to be similar in dogs, although not well reported. The aim of this study was to determine pattern of BT decrease during anaesthesia in dogs.

Records of dogs anesthetized in 2017 and 2018 at a veterinary hospital were examined. Inclusion criteria were a recorded body weight, baseline BT, and BT during anesthesia time points. Change in BT (ΔBT) was calculated for each time point and graphed as ΔBT over time. Dogs were grouped by weight (kg) as toy (≤ 5.5), small (5.6 to 11.4), medium (11.5 to 22.7), large (22.8 to 45.5), and giant (> 45.5) and greatest ΔBT time point for each group was compared with ANOVA. A $p < 0.05$ was used for significance.

Five hundred and fifty-five records were included. For ΔBT , a rapid phase (0 to 30 minutes), a slow phase (30 to 75 minutes), and a plateau (after 75 minutes) were identified. Toy had a greater ΔBT compared to medium, large, and giant groups. Greatest ΔBT (mean $\pm$ SD $^{\circ}C$) was -3.4 ± 2 for toy, -2.6 ± 1.4 for small, -2.2 ± 0.9 for medium, -2.4 ± 1.4 for large, and -2 ± 0.7 for giant. Time to greatest ΔBT was 86 ± 54 minutes.

Dogs followed a similar pattern of ΔBT as humans. Smaller dogs had a greater ΔBT than larger dogs.

Evaluation of the anaesthesia gas warmer “Darvall SWT Heated Breathing Circuit” on dogs body temperature undergoing elective ovariectomy

Giannettoni GG, Zilberstein ZL, Laurenza LC.

CHV ADVETIA, University of Lyon VetAgro-Sup

To compare the impact of Darvall SWT Heated Breathing System with a standard anaesthesia non-rebreathing system for the management of intraoperative hypothermia in dogs undergoing educational surgical procedures.

Sixty healthy (ASA I or II) female client-owned dogs, referred for ovariectomy, were included in this prospective, randomized study. Animals were divided in two groups: group T (Darvall SWT Heated Breathing System) and Group C (control non-heated breathing system). Animals were stratified by weight into three sub-groups: 1) < 10 kg, 2) 10 < x < 20 kg and 3) > 20 kg. The management of the standardized anaesthesia protocol was the same for all animals and fresh gas flow was fixed at 50 ml kg⁻¹ min⁻¹. The following temperature data were collected every 5 minutes: rectal, oesophageal (during the surgery), Darvall device, air delivered to the patient and ambient room temperature. Linear correlation was performed at multiples time points for the corresponding temperature over groups and subgroups.

Groups were homogeneous for age, weight, body mass and sedation temperature (T₀). Patients inspired breathing system temperatures were significantly different ($p < 0.001$) between group T and C ($31.0 \pm 1.1^{\circ}\text{C}$ and $23.7 \pm 0.7^{\circ}\text{C}$ respectively) but patients body temperatures were not different between groups and subgroups at any time point ($p > 0.05$). Rescue warming devices were necessary in both groups: 10 dogs (33.3%) in group T and 8 (26.6%) in group C.

Under the conditions tested in this study, Darvall SWT Heated Breathing Circuit alone was unsuccessful to fully prevent intraoperative hypothermia.

Does catheter insertion site matter? Contamination of cephalic and saphenous vein catheter placement site in anesthetized dogs undergoing dental scaling

Calice I, Ballas P, Vogl C, Ehling-Schulz M, Rocchi A.

University of Veterinary Medicine Vienna, Austria

Aerosol and splatter produced during dental scaling may contaminate peripheral venous catheters (PVC). Colony forming units (CFU) of agar plates positioned next to cephalic (CV) vs. saphenous veins (SV) were evaluated.

Forty-three anaesthetized dogs with a minimum length of 50-cm (tip-of-the-nose to base-of-the-tail) undergoing dental scaling received randomly PVC, placed aseptically, in CV or SV. Petri dishes containing brain-heart-infusion (BHI) soft-agar were placed next to CV and SV (n = 4, respectively) independently of PVC placement site. The lids were closed before, at 5 and 10 minutes into and at the end of the scaling. The petri dish contents were serially diluted in BHI broth (10^{-1} - 10^{-3}) and plated on Blood agar (CBA) and selective media (MacConkey for *Enterobacteriaceae*- and CNA for Gram-positive). The CFUs were measured after 48 hours of aerobic incubation at 37 °C. Additionally PVC injection port was sampled before and after scaling and bacterial species were identified (Matsuda et al. 2012). Data were analysed with descriptive statistics and ANOVA ($p < 0.05$).

Significantly higher bacterial load was found in CV placement site compared with SV ($p < 0.000001$) in CBA and CNA. A significant time-dependent increase in CFUs count was observed. No *Enterobacteriaceae* were found (MacConkey). Bacteria isolated from the injection port mainly belong to genera *Staphylococcus*, *Neisseria*, and *Bacillus*. About 50 % of the isolated species could not be identified.

When given the choice, PVC should be placed in SV instead of CV in anaesthetized dogs undergoing dental scaling to minimize potential PVC contamination.

References

Matsuda N, Matsuda M, Notake S et al. (2012) Evaluation of a simple protein extraction method for species identification of clinically relevant staphylococci by matrix-assisted laser desorption ionization-time of flight mass spectrometry. J Clin Microbiol 50 (12), 3862-3866.

Electrocardiography-guided placement of central venous catheter in critically ill dogs

Rohwedder L, Böttcher P, Kunz A, Rohwedder T.

Small Animal Clinic, Freie University Berlin, Germany
B.Braun Melsungen AG, Melsungen, Germany

The “blind external landmark technique” is the common technique for central venous catheter (CVC) placement with a 40% chance that the CVC tip will be placed in the right atrium or 5% cranial to the thoracic inlet (Claude et al. 2010; McGee et al. 1993; Chu et al. 2004).

Prospective clinical study in 7 critically ill dogs. All dogs were in lateral recumbency. The CVC were placed using a Seldinger technique (Certofix®, B. Braun, Melsungen, Germany) and the catheter was positioned using an ECG-guided placement (Certodyn®, B. Braun, Melsungen, Germany). The optimal catheter placement was determined by moving the catheter forward until maximum p-wave was present and then pulling the catheter back until the p-wave appeared normal in size. The catheter was fixed at this position and the positioning was verified using a lateral thoracic radiograph.

The mean age was 8 years (SD: 2.03) and the mean body weight was 25.9 kg (SD: 6.75). All dogs showed a significant increase of the p-wave (starting point: mean 2 mV [SD: 0.76], end point: mean 8.14 mV [SD: 2.53], $p < 0.005$) during catheter placement and in 6 of 7 dogs the p-wave had a split. At thoracic radiographs all CVC were positioned correctly behind the thoracic inlet and cranial to the right atrium.

The ECG-guided technique appears as a useful and safe procedure for critically ill dogs, being a useful alternative to radiography.

References

- Chu, KS, Hsu, JH, Wang, SS et al. (2004) Accurate central venous Port-A catheter placement: intravenous electrocardiography and surface landmark techniques compared by using transesophageal echocardiography. *Anesth Analg* 98,910–914
- Claude AK; Riedesel DH, Riedesel EA (2010) Electrocardiography-guided and retrospective analysis of central venous catheter placement in dog, *Vet Anaesth Analg* 37, 97-105
- McGee, WT, Ackerman, BL, Rouben, LR et al. (1993) Accurate placement of central venous catheters: A prospective, randomized, multicenter trial. *Crit Care Med* 21, 1118–1123

Friday 1st session Bourdon 1 (2.15 - 3.15 pm) – Chair: Sanne Melis

Identification of the sacrococcygeal epidural space using the nerve stimulator test or the running-drip method in dogs.

Martinez-Taboada F, Otero PE, Laredo F, Belda E.

The University Veterinary Teaching Hospital, The School of Veterinary Science, The University of Sydney, 65 Parramatta Road, Camperdown, New South Wales 2050, Australia
Department of Anaesthesiology, Faculty of Veterinary Science, University of Buenos Aires, Buenos Aires, Argentina
Department of Animal Medicine and Surgery, Faculty of Veterinary Medicine, University of Murcia, Murcia, Spain

This study aims to compare the nerve stimulator test and the running-drip method for successful identification of the sacrococcygeal (SCo) epidural space prior to drug administration in dogs.

Sixty-two dogs receiving an epidural block as part of the multimodal anaesthetic plan were randomly allocated to one of the two study groups. In group NS the epidural space (ES) was located using an insulated needle connected to a nerve stimulator and in group RUN the ES was identified using a Tuohy needle connected to fluid bag elevated 60 cm above the spine via a giving set. Five minutes after epidural injection, the success of the technique was assessed by the disappearance of the patella reflex. Data were checked for normality and non-parametric data was analysed using a Mann-Whitney U test. Success was analysed using a Fisher's Exact test. The level of significance was always set at $p < 0.05$.

The success in ES identification was similar between groups being 87.1% (70.2% – 96.4%) and 90.3% (74.2% – 98%) for the NS and RUN groups respectively ($p = 1.000$). The identification of the epidural space was shorter with the RUN method [26 (15–53) seconds] than with the NS [40 (19–137) seconds] ($p = 0.02252$). No other differences were found in any studied variables.

The RUN and the NS techniques were very successful in identifying the epidural space at the sacrococcygeal approach. The RUN is a fast technique that requires no specialised equipment. This could make it an interesting choice in general practice.

The effect of body position and user experience on the ease of anatomical landmark palpation for epidural injection in dogs.

Smith RC, Redondo JI, Martinez-Taboada F.

Wear Referrals, Veterinary Hospital, Bradbury, Stockton on Tees, United Kingdom

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

Department of Animal Medicine and Surgery, Faculty of Veterinary Medicine, University of Murcia, Murcia, Spain

The University Veterinary Teaching Hospital, The School of Veterinary Science, The University of Sydney, Camperdown, New South Wales, Australia

This study aimed to compare the ease of epidural landmark palpation between veterinarians with different experience level and between sternal and lateral recumbencies.

Thirty adult dogs sedated or anaesthetised and placed in both lateral and sternal recumbencies for reasons unrelated to this research (mostly radiology) were included in the study. Breed, age, weight, sex, body condition score and body mass index (Thengchaisri et al. 2014) were recorded. Two veterinarians (a recent graduate intern and an experienced anaesthetist) independently palpated and scored the ease of palpation from 0-4 (0 = easy to palpate to 4 = non-palpable) the ilial wings, the dorsal spinous processes of the sixth (L6) and seventh lumbar vertebrae (L7), the sacral crest (S1) and the lumbosacral depression (LS). The overall ease of palpation was scored 0-10 (0 = easy, 10 = extremely difficult). This method was repeated in the other recumbency. In all cases, the pelvic limbs were extended cranially and no epidural injection was performed. Data was analysed with a Yuen's test for the trimmed-means ($p < 0.05$). Data is presented as trimmed-mean (interquartile range).

The experienced observer found it harder 2.9 (2 – 4) to palpate S1 in lateral recumbency than the less experienced observer 2.6 (2 – 3) ($p = 0.04018$). There was no difference in other anatomical landmarks and no intra-observer difference was found between recumbencies.

The observer's experience had a very limited and the type of recumbency had no effect on the ease of palpation for the anatomical landmarks for a lumbosacral epidural injection.

References

Thengchaisri N, Theerapun W, Kaewmokul S et al. (2014) Abdominal obesity is associated with heart disease in dogs. BMC Vet Res 10, 131

A novel parailiac approach for sciatic nerve block in cats – a pilot study

Rodrigo-Mocholi DRM, Martinez-Taboada FMT.

Royal Veterinary College
University Of Sydney

The veterinary literature showed limited data regarding ultrasound-guided sciatic nerve (ScN) blockade in cats. Haro et al. (2012) described four different approaches for ScN blockade, of which the femoris approach was the most successful. Recently, a lateral approach, similar to the aforementioned technique, was also described (Otero & Portela 2017).

Five adult cat cadavers (3.58 ± 0.57 kg BTW) were recruited. All cadavers remained in lateral recumbency, with the pelvic limb to be stained in the uppermost position. The technique was performed on both pelvic limbs. A 15 – 16 MHz linear ultrasound (US) transducer (SonoSite M-turbo; FUJIFILM SonoSite) was placed over an imaginary line between the greater trochanter and the ischiatic tuberosity. Then, the transducer was craniodorsally moved until a longitudinal view of the ScN running over the greater ischiatic notch of the ilium was identified. Then, 0.1 mL kg^{-1} of methylene blue was instilled through a spinal needle (0.7×38 mm) using an out-of-plane technique. Immediately after the injection, the cat was turned and the technique was repeated on the contralateral limb. Later, anatomical dissections were conducted and the staining was evaluated, considering a coverage of ≥ 1 cm as positive.

The ScN was inoculated in ten pelvic limbs. Nine ScN (9/10) were positively stained.

The present US-guided technique showed high success rate for ScN blockade. Authors consider the described novel parailiac approach may be an easy and reliable technique to perform in cats, but further in-vivo studies are required to assess its clinical usage, efficiency and safety.

References

- Haro P, Laredo FG, Gil F et al. (2012) Ultrasound-guided block of the feline sciatic nerve. *J Feline Med Surg* 14, 545 – 552.
- Otero PE & Portela DA (2017) “Bloqueos regionales en el gato”, in *Manual de anestesia regional en animales de compañía: anatomía para bloqueos guiados por ecografía y neuroestimulación*. 1st ed, Inter-Médica, Ciudad Autónoma de Buenos Aires, pp 385 – 386.

Ultrasound-guided parasternal injection in dogs: a cadaveric study

Zublana ZF, Briganti BA, De Gennaro DGC, Corletto CF.

Dick White Referrals, UK
University of Pisa, Italy

Median sternotomy is associated with significant intra and post-operative nociception. The ultrasound-guided (US) parasternal block of the intercostal nerves (ICNs) is an effective means of providing analgesia in human medicine but has not been reported in dogs.

Six canine cadavers (12 - 43 kg) were used to characterise sonoanatomy of the distal intercostal space (ICS) by US imaging. A dye solution (new methylene blue) was then injected in the same subjects with a spinal needle at 0.05 mL kg⁻¹ every ICS from 2nd to 7th in one parasternal side (low volume, LV), and 0.1 mL kg⁻¹ in spaces 3th, 5th and 7th on the other (high volume, HV), under sonographic guidance. Anatomical dissection was carried out to assess the spread of the solution.

The distal portion of ICNs could not be visualised in any specimen using ultrasound, but the sonographic features of the space in which ICNs run were consistent in every ICS and easily identified. Dissection showed that LV dye stained the ICN at the injection site only, while HV dye stained in most of the cases (10/18) two ICSs (the injected and the one cranially). One HV dose covered three spaces (cranial and caudal to injection). Staining was found on the pleural surface after two injections.

A single injection of 0.1 mL kg⁻¹ at the level of the distal ICS may anaesthetise more than one ICN, but not consistently. Further investigations are needed to better characterise and to refine this locoregional technique.

References

Barr AM, Tutungi E, and Almeida AA. (2007) Parasternal intercostal block with ropivacaine for pain management after cardiac surgery: a double-blind, randomized, controlled trial. J Cardiothorac Vasc Anesth Aug 21(4), 547-53.

Lumbar erector spinae plane (ESP) block in the dog: Anatomical study and assessment of two ultrasound-guided techniques in dog cadavers.

Medina Serra RMS, Palacios Jimenez C, Foster A, Plested M, Sanchis Mora SM, Viscasillas J.

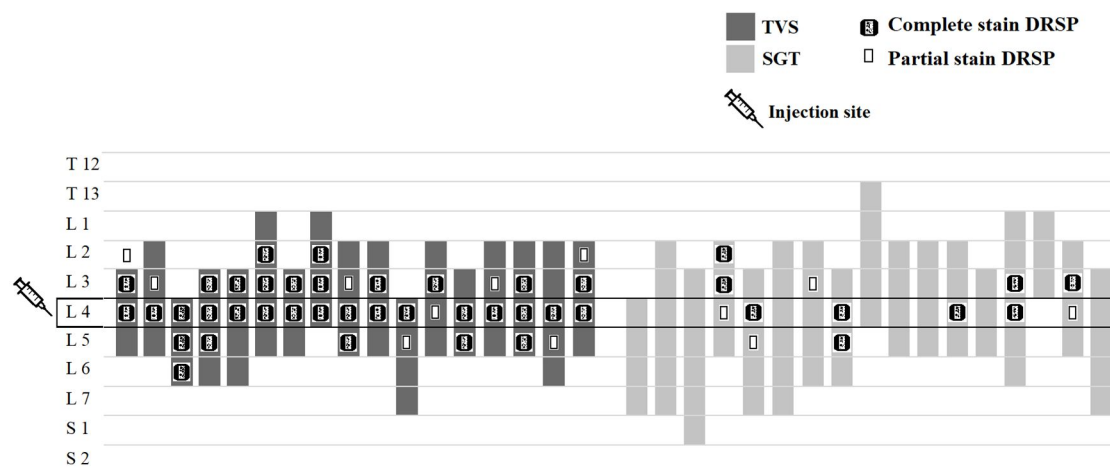
Royal Veterinary College of London

This study aimed to examine the anatomy of the lumbar epaxial region and to describe two different ultrasound-guided techniques for the lumbar erector spinae plane (ESP) block.

Two dogs (18 and 24 kg) were dissected to describe the relevant anatomy. Bilateral ESP injections with 0.4 mL kg⁻¹ of contrast-dye were performed in seventeen adult beagles (9.3 ± 1.7 kg). Two operators performed ultrasound-guided ESP blocks using either transversal approach (TVS) or sagittal approach (SGT). All the injection sites were randomly divided into two groups and assigned to each of the operators. Computed tomography and dissections were performed to assess the spread of the contrast-dye.

In all cases the contrast-dye was observed within the ESP compartment. There was no difference on the total length of the contrast-dye column between TVS and SGT (p = 0.053). TVS had multisegmental staining of dorsal ramus of the spinal nerves (DRSP) in all injections, staining DRSP at the injection site in 94% of the injections. For SGT, these values were 29% (5/17) and 23% (4/17) respectively. TVS stained more DRSP than SGT (p = 0.001) with a median (range) of 2 (2-3) versus 0 (0-3) respectively (Fig 1). TVS had epidural migration in two injections and intravascular migration in three injections. Both ultrasound-guided techniques resulted in a spread of the contrast-dye within the ESP compartment.

Although there were no differences in the total length of the contrast-dye column, TVS was superior than SGT in staining DRSP.



Ultrasound-guided peribulbar block in the dog: an anatomical cadaveric study

Foster A, Viscasillas J, Sanchis-Mora S, Medina Serra R, Stathopoulou T.

The Royal Veterinary College
Veterinario Universidad CEU Cardenal Herrera

With reduced incidence of major complications, peribulbar anaesthesia (PBA) is superseding retrobulbar anaesthesia (RBA) in humans. While blind techniques are reported in veterinary medicine, ultrasound-guided PBA techniques are not.

The PBA was performed bilaterally in 10 thawed Beagle cadavers, by two operators assigned randomly to each cadaver. Methylene blue was injected in 5 dogs, with methylene blue and iohexol contrast (50:50) injected in the remaining 5 dogs. Injection volume was calculated based on cranium length, as described by Klaumann et al (2018). The ultrasound probe was positioned caudal to the orbital ligament in a longitudinal position in order to identify the myofascial cone. Injection was performed using an in-plane technique. A computed-tomography (CT) scan was performed on dogs injected with dye *and* contrast, to identify spread of contrast. Dissection to visualise dye spread in the orbit was performed bilaterally on all dogs.

Inter-operator variability was not significantly different ($p = 0.5$). Computed tomography imaging illustrated peribulbar contrast spread in 9/10 injections (90%), with retrobulbar spread for the remaining injection. Dissection could not confirm retrobulbar spread in this case. Peribulbar spread was noted in 19/20 injections (95%) on dissection. Coverage of the maxillary nerve was noted on 3/20 (15%) injections on dissection.

Spread of contrast into the skull was noted on CT imaging in 5/10 (50%) injections. No further complications were noted.

The ultrasound-guided technique described here could represent an alternative option for PBA in dogs. Further studies are required to evaluate this technique in clinical cases.

References

Klaumann RP, Moreno JCD and Montiani-Ferreira F (2018) A morphometric study of the canine skull and periorbita and its implications for regional ocular anesthesia.

Assessment of perioperative pain in intact and gonadectomized dogs undergoing orthopaedic surgery (preliminary results)

Karamichali P, Anagnostou T, Kazakos G, Prassinis N, Savvas I.

Anaesthesiology & Intensive Care Unit, Companion Animal Clinic, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University, Thessaloniki, Greece

Surgery & Obstetrics Unit, Companion Animal Clinic, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University, Thessaloniki, Greece

Gonadectomy may decrease nociceptive thresholds and modify pain modulating pathways (Ito et al. 2004).

Fifty dogs (5.46 ± 0.437 years, 15.43 ± 1.759 kg), presented for orthopedic knee surgery were allocated into 4 groups (female intact $n = 9$, female gonadectomized $n = 17$, male intact $n = 16$, male gonadectomized $n = 8$). All patients received acepromazine 0.05 mg kg^{-1} mixed with morphine 0.2 mg kg^{-1} for premedication, anesthesia was induced with propofol and maintained with isoflurane and fentanyl infusion. Pre-emptively, all dogs received carprofen 4 mg kg^{-1} subcutaneously. Pain was measured using the University of Melbourne Pain Scale (UMPS) and an algometer (mechanical pain threshold) preoperatively and then upon arrival to the recovery room and 1, 2, 4, 6, 9 and 21 hours later, on the incision site, a healthy region nearest to the incision site and on the corresponding region of the contralateral healthy limb. A general linear model for repeated measures was performed to compare the effect gonadectomy on UMPS scores and pain thresholds.

Gonadectomized dogs had non-significantly higher UMPS scores than intact dogs (5.034 ± 0.338 vs 4.096 ± 0.328 , $p = 0.052$). In female dogs, the mean pain threshold at the incision site was higher in intact than in gonadectomized ones at 2 and 4 hours, and at the healthy region nearest to the incision site, at 1, 2 and 4 hours ($p \leq 0.05$).

Female gonadectomized dogs experience more intense pain than female intact dogs in the first 4h postoperatively after knee surgery.

References

Ito A, Takeda M, Furue H, Shibata K, Hori M (2004) Administration of estrogen shortly after ovariectomy mimics the anti-nociceptive action and change in 5-HT_{1A}- like receptor expression induced by calcitonin in ovariectomized rats. Bone 35, 697-703

Systematic Review: Anaesthetic Protocols and Management as Confounders in Rodent Blood Oxygen Level Dependent Functional Magnetic Resonance Imaging (BOLD fMRI)

Steiner AR, Rousseau-Blass F, Schroeter A, Hartnack S, Bettschart-Wolfensberger R.

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

Department of Clinical Sciences, Faculty of Veterinary Medicine, Université de Montréal, Saint-Hyacinthe, Canada

Institute for Biomedical Engineering, University and ETH Zurich, Zurich, Switzerland

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

Mostly performed under anaesthesia, BOLD fMRI is widely used in rodent models. The choice of anaesthetic protocols may affect BOLD fMRI readouts, directly or via changing physiological balance.

The present study systematically reviewed the literature investigating the influence of different anaesthesia regimes and changes in physiological parameters as confounders of BOLD fMRI in rats and mice, according to de Vries et al. (2015). Four databases were searched.

One hundred and twenty-two publications met predefined inclusion criteria. Dose rates of anaesthetics and timing of image acquisition relative to induction of anaesthesia commonly influenced readouts under otherwise identical conditions. Dose-dependent effects were not necessarily monotonic, and more pronounced under isoflurane than under medetomidine. After bolus-administration of an anaesthetic, responses to stimulation (activations) and functional connectivity (fc) gradually increased despite initiation of constant rate infusions. With prolonged imaging, complex patterns of temporal evolution arose. The heterogeneity of included studies prevented strong conclusions for pairwise comparison of anaesthetics regarding characteristic patterns of activations or fc. Arterial blood pressure, PaO₂ and PaCO₂ affected BOLD signal across various experimental paradigms and should therefore be monitored and maintained at stable physiological levels throughout experiments.

Despite high risk of bias in all included studies, our review supports that BOLD fMRI studies risk to be confounded by anaesthetic protocols and management. Establishing evidence-based optimal dose ranges and imaging timepoints for a selection of anaesthetic protocols, as well as standards of anaesthetic monitoring should therefore be a priority for improving the validity of anaesthetised BOLD fMRI in rodent models.

De Vries RBM, Hooijmans CR, Langendam MW. et al. 2015. A protocol format for the preparation, registration and publication of systematic reviews of animal intervention studies. *Evid.-based preclin. med.*, 2, 1-9.

The effect of inhaled albuterol on PaO₂ in anesthetized horses receiving a FiO₂ of 0.5 or > 0.95

Caldwell FJ, Boone LH, Weatherall KM, Auckburally A, Lascola KM, Clark-Price SC, Hanson RR.

Auburn University
Southern Counties Veterinary Specialists, Auburn

Albuterol increases PaO₂ in hypoxemic anesthetized clinical horses. Controlled research is lacking. The aim of this pilot study was to determine effect of inhaled albuterol on PaO₂ in anesthetized research horses receiving 0.5 or > 0.95 FiO₂.

In a prospective study, 14 horses were anesthetized and received a FiO₂ of 0.5 (n = 7) or > 0.95 (n = 7). Horses were maintained on isoflurane and mechanically ventilated. After 15 minutes, PaO₂ was determined (baseline). Within each FiO₂ group, 5 horses were administered inhaled albuterol (2 µg kg⁻¹) and 2 horses received no treatment (controls). At 10, 20, 30 and 40 minutes after baseline, PaO₂ was determined. Data were analyzed with repeated measures ANOVA with significance at p < 0.05. Results are Mean ± SD.

Parameter (mm Hg)	FiO ₂	Albuterol	Baseline	10 min	20 min	30 min	40 min
PaO ₂	0.5	Yes	92.2 ± 25.7	119 ± 32*	122.2 ± 36.3*	115.4 ± 35.3*	112.4 ± 38.6
PaO ₂	0.5	No	142 ± 36.8	135 ± 32.5	117 ± 18.4	115 ± 12.7	110 ± 11.3
PaO ₂	>0.95	Yes	271.6 ± 135.1	389 ± 104.7*	384 ± 74.1*	376 ± 81.8	341.8 ± 109
PaO ₂	>0.95	No	250 ± 196.6	252.5 ± 184.6	260.5 ± 191.6	239 ± 162.6	233.5 ± 183.1

(* different from baseline)

Within groups, FiO₂ did not differ between times (0.51 ± 0.04, 0.95 ± 0.009).

Inhaled albuterol increased PaO₂ for 20 to 30 minutes in anesthetized healthy horses receiving a FiO₂ of 0.5 or >0.95.

Pharmacokinetics of carprofen in pigs

Bošnjak M, Kržan M, Lamprecht Tratar U, Dolenc J, Čemažar M, Seliškar A.

Department of Experimental Oncology, Institute of Oncology Ljubljana, Slovenia

Department of Pharmacology and Experimental Toxicology, Faculty of Medicine, University of Ljubljana, Slovenia

Food Safety Department, Veterinary Faculty, University of Ljubljana, Slovenia

Faculty of Health Sciences, University of Primorska, Slovenia

Small Animal Clinic, Veterinary Faculty, University of Ljubljana, Slovenia

This study investigated pharmacokinetics of carprofen after a single intravenous and multiple oral doses in pigs

Eight anaesthetised pigs undergoing electroporation of pancreatic cells were studied. Carprofen 4 mg kg^{-1} was given IV after the placement of central venous catheter under general anaesthesia. Blood samples were collected immediately before and 5, 10, 20, 30, and 60 minutes and 2, 4, 6, 8, 12 and 24 hours after carprofen administration. Afterwards, the same dose of carprofen was given orally, daily for six days and blood collected at 36, 48, 60, 72, 96, 120, 144 and 168 hours after carprofen administration. Plasma was analysed using liquid chromatography with mass spectrometry. Standard pharmacokinetic parameters were calculated by compartmental analysis of plasma concentration–time curves using Graph Pad Prism.

The initial plasma concentration of IV carprofen was estimated at $54.57 \pm 3.92 \text{ } \mu\text{g mL}^{-1}$ and decreased to $8.26 \pm 1.07 \text{ } \mu\text{g mL}^{-1}$ 24 hours later. The elimination curve showed bi-exponential decline; a rapid distribution phase with $t_{1/2\alpha}$ of 0.21 ± 0.03 hour and a slower elimination phase with $t_{1/2\beta}$ 17.27 ± 3.78 hour. The calculated pharmacokinetic parameters were as follows: AUC $351.7 \pm 25.53 \text{ } \mu\text{g hour mL}^{-1}$, volume of distribution 3.7 L and plasma clearance rate $380.1 \pm 81.1 \text{ mL hour}^{-1}$. The plasma concentration of carprofen, given orally from day 2 to 7 varied from 9.03 ± 1.87 to $11.49 \pm 2.15 \text{ } \mu\text{g mL}^{-1}$.

In conclusion, carprofen can be regarded as a long-acting NSAID in pigs from a pharmacokinetic point of view.

Propofol and fentanyl in a porcine model of sepsis. Is it the right choice?

Casoni D, Liu S, Spadavecchia C, Jakob SM.

Experimental Surgery Facility (ESF), Department of Biomedical Research, Faculty of Medicine, University of Berne, Switzerland

Department of Intensive Care Medicine, Inselspital, Bern University Hospital, University of Bern, Switzerland

Anaesthesia Division, Veterinary Clinical Department, Vetsuisse Faculty, University of Berne, Switzerland

Experimentally induced septic pigs are worldwide anaesthetised with combinations of GABA-agonists and opioids. This study aims at reporting the effects of propofol-fentanyl infusion on temperature, hemodynamic and anaesthesia stability in control and septic pigs.

Twenty pigs received IM xylazine (2 mg kg^{-1}) and ketamine (20 mg kg^{-1}). Following tracheal intubation achieved with IV midazolam, propofol and fentanyl were infused continuously. After instrumentation, anaesthesia was maintained for 91 (IQR 90 - 91.6) hours. Anaesthesia stability was evaluated with presence of both spontaneous movements and shivering and Bispectral Index (BIS) (10 pigs); temperature was measured with a Swanz-Ganz catheter. Noradrenaline was administered if MAP was $\leq 65 \text{ mmHg}$. Differences between control and septic pigs were compared with Mann-Whitney test ($p = 0.05$).

Data collected completely in 19 pigs; one control pig died prematurely (62 hours). During maintenance, median of propofol and fentanyl in septic pigs was 9.52 mg and $6.88 \mu\text{g kg}^{-1} \text{ hour}^{-1}$ respectively with no difference to control. Median temperature before sepsis induction was 39.8°C in control and septic pigs. Noradrenaline use was significantly shorter in control (11.1 hours, IQR 0 - 52) than in septic pigs (59.9, IQR 28.3 - 52). Repeated shivering and movements were recorded in 4 septic and 6 control and in 2 septic and 1 control, respectively. In control pigs, BIS (73, IQR 68.5 - 74) was significantly higher than in septic.

Propofol-fentanyl did not prevent the use of noradrenaline in control pigs and was associated with hyperthermia before sepsis. Anaesthesia was not always stable.

A new photoplethysmographic device for continuous assessment of urethral mucosa perfusion: evaluation in a porcine model.

Cardinali MC, Magnin MM, Bonnet-Garin JMBG, Allaouchiche BA, Junot SJ.

VetAgro Sup Campus Vétérinaire de Lyon, Université de Lyon, Unité APCSe, 1 Avenue Bourgelat, 69280, Marcy L'Etoile, France

Hospice Civils de Lyon, Centre hospitalier Lyon sud, Reanimation medicale, Université Claude Bernard Lyon 1, Unité APCSe, 5 place d'Anserval, 69437 Lyon, Cedex 03, France,

A new photoplethysmographic device for continuous assessment of urethral mucosa perfusion: evaluation in a porcine model

This study aims to evaluate an innovative device designed to monitor urethral mucosa perfusion. It consists of an indwelling urinary catheter equipped with an infrared photoplethysmographic (PPG) sensor in contact with the urethral mucosa that provides a continuous urethral perfusion index (uPI).

Twelve female piglets were anaesthetised using a standardised protocol (tiletamine/zolazepam, morphine, propofol, sevoflurane) and equipped with the urethral PPG probe. Heart rate mean arterial pressure (MAP), cardiac index and uPI were continuously recorded. With variable doses of sevoflurane and norepinephrine, the animals were exposed to a wide range of MAP, from low to high. Friedman tests with a *posteriori* multiple comparison were performed to assess within time variations and a generalized linear mixed model (GLMM) was used to assess the relationship between uPI and MAP.

Urethral perfusion index and other hemodynamic parameters varied significantly during the pharmacological manoeuvres. There was a positive correlation between MAP and uPI (Pearson coefficient: +0.83) below a specific MAP value (63 ± 10 mmHg), called dissociation threshold (DT). Above this threshold, uPI and MAP were then negatively correlated (Pearson coefficient: -0.76). This relationship assessed with the GLMM yielded a significant positive fixed effect coefficient (+0.2, $P < 0.00001$) below the DT and a significant negative fixed effect (-0.14, $p < 0.00001$) above DT.

The PPG device allowed the detection of alterations of the urethral mucosa perfusion associated with hypotension or administration of high dose of vasopressors. Further studies are warranted to evaluate this device in a clinical setting.

Friday 2nd session Bourdon 2 (3.45 - 4.45 pm) – Chair: Chiarra De Gennaro

Evaluation of the ability of minimally-invasive monitoring devices to assess fluid responsiveness in endotoxaemic beagles.

Muehlestein MB, Steblaj B, Joerger FB, Briganti A, Kutter APN.

Department of Clinical Diagnostics and Services, Vetsuisse Faculty of the University of Zurich, Switzerland

Department of Veterinary Sciences, University of Pisa, Pisa, Italy

Fluid responsiveness (FR) is used to assess if patients benefit from fluid therapy. The aim of this study was to examine different minimally-invasive haemodynamic parameters in assessing FR in endotoxaemic beagles.

In 6 sevoflurane-anaesthetized mechanically-ventilated beagles, endotoxaemic shock was induced by injecting 1 mg kg⁻¹ *E. coli* lipopolisaccharide (LPS) IV as part of a larger project. Ten minutes after LPS, 3 Ringer's Acetate boluses (10 mL kg⁻¹) were given each over 10 minutes. Haemodynamic data were collected immediately after each bolus. Thereafter shock was treated with noradrenaline ± dexmedetomidine to reach two predetermined MAP goals. After a wash-out period of 20 minutes another 3 boluses were administered and measurements were repeated equally. Thermodilution was the reference method used to measure change of stroke volume (Δ SV). HR, invasive arterial, right atrial and pulmonary capillary wedge pressure (PCWP), pulse pressure (PP) and PPvariation, pulse wave transit time and stroke volume variation (SVV, measured by pressure recording analytical method) were recorded. Stroke distance and flow time corrected (FTc) were measured with oesophageal Doppler.

Using Receiver Operating Characteristics (ROC), 35 measurements (19 responders and 16 non-responders) were evaluated. A change in PP > 20% was the most significant indicator of FR (Δ SV > 15%) with an area under ROC (AUROC) of 0.74 (sensitivity of 74% and specificity of 75%). AUROC > 0.6 were found with % Δ HR (0.62), % Δ MAP (0.66), PCWP (0.66), SVV (0.61) and FTc (0.65).

Conclusion: in endotoxaemic beagles, none of the minimally-invasive monitoring parameters could predict FR with high sensitivity and specificity.

Assessment of immediate and owner perceived recovery following three different premedication drugs in dogs undergoing anaesthesia for radiotherapy

Miller C, Bell AM, Pawson P.

University of Glasgow

The effect of three different premedications on immediate and delayed recovery, as perceived by the owner, were assessed in dogs anaesthetised repeatedly for radiotherapy.

Fifteen ASA II, client-owned dogs undergoing radiotherapy, were allocated to each receive three different premedications using a Latin square design. Drugs, given IV, were: alfentanil $10 \mu\text{g kg}^{-1}$ with atropine $10 \mu\text{g kg}^{-1}$ (AA); butorphanol 0.2 mg kg^{-1} (B) and medetomidine $2 \mu\text{g kg}^{-1}$ (antagonised with atipamezole $10 \mu\text{g kg}^{-1}$ IM at the end of anaesthesia) (M). Anaesthesia was induced with IV propofol and maintained with sevoflurane in oxygen. All dogs were mechanically ventilated to maintain normocapnia. At the end of anaesthesia dogs were observed, without stimulation, for 20 minutes and times to extubation, sternal recumbency and standing were recorded. Owners completed a questionnaire reporting changes in activity, appetite, sleep and behaviour at home. Data were analysed using a mixed effect model ANOVA, significance set at $p < 0.05$.

Duration of anaesthesia was similar in all groups (15.7 ± 6.4 minutes). Extubation was significantly faster after AA, (6.5 ± 2.5 minutes), compared to B (8.9 ± 3.5 minutes) and M (9.5 ± 4.1 minutes). After 20 minutes, only 4/15 dogs receiving B were standing, compared to M (11/15) and AA (13/15). Reduced activity (10/15) and reduced appetite (6/15) were reported more frequently by owners after B compared to AA (4/15 and 0/15, respectively) and M (1/15 and 1/15, respectively).

Butorphanol was associated with slower recoveries and may be undesirable when a rapid complete recovery is needed.

Effect of airway management method on the incidence of haemoglobin oxygen desaturation during feline bronchoscopy and bronchoalveolar lavage

Tucker PK, Hibbert A, MacFarlane P.

University of Bristol

The aim of the study was to investigate if an orotracheal oxygen catheter, endotracheal tube or laryngeal mask airway affected the incidence of haemoglobin oxygen desaturation in cats undergoing bronchoscopy and bronchoalveolar lavage (BAL).

Twenty cats of mixed breeds, ages and weights were recruited. They had terbutaline 0.015 mg kg^{-1} twice daily preceding bronchoscopy; sedated with 0.3 mg kg^{-1} butorphanol with 0.003 or 0.006 mg kg^{-1} dexmedetomidine IV or IM. Anaesthesia was induced with propofol IV and maintained with propofol $0.1 - 0.5 \text{ mg kg}^{-1} \text{ min}^{-1}$ for bronchoscopy and BAL. Group allocation was randomised: endotracheal tube or laryngeal mask airway (group A) or orotracheal oxygen catheter (group B). Haemoglobin oxygen saturation was continuously recorded. Desaturation was defined as $\text{SpO}_2 < 90\%$ for more than 4s. The incidence of desaturation was analysed with chi-squared and the time spent desaturated with Mann Whitney U.

The incidence of desaturation was 85% and did not differ between groups during bronchoscopy and BAL ($p = 0.12$) or recovery ($p = 0.6$). Initial analysis suggested duration of desaturation differed between groups ($p = 0.029$). Two cases in group A suffered protracted desaturation (20.3 and 16.2 minutes) presumed to be due to bronchoconstriction. When excluded as statistical outliers, the groups no longer differ significantly ($p = 0.315$).

No difference was identified in the incidence of haemoglobin oxygen desaturation between endotracheal tube, laryngeal mask airway or orotracheal oxygen catheter use in this study. We do not recommend one method over another. Desaturation was most common during recovery from anaesthesia.

Influence of three oxygen flow rates on oxygen partial pressure and inspired oxygen fraction over time in sixty-nine cats recovering from anaesthesia in an oxygen

Didier C, Polo-Paredes G, Bernard E, Junot S, Verwaerde P, Jourdan G.

UP Anesthésie-Réanimation, Département des Sciences Cliniques (CHUVAC), Ecole Nationale Vétérinaire de Toulouse, Université Toulouse-Midi-Pyrénées, Toulouse, France
CHUVAC, Ecole Nationale Vétérinaire de Toulouse, Université Toulouse-Midi-Pyrénées, Toulouse, France

Service d'anesthésie, VetAgro Sup - Campus Vétérinaire de Lyon, Université de Lyon, Marcy-L'Étoile, France

Pôle Anesthésie-Réanimation-Urgences-Soins intensifs, Centre Hospitalier Universitaire Vétérinaire d'Alfort (CHUVA), Ecole Nationale Vétérinaire d'Alfort, Université Paris-Est, Maisons-Alfort, France

This study aimed to describe the ambient oxygen partial pressure (PpO₂) variations and inspired oxygen fraction (FiO₂) in healthy cats recovering from anaesthesia in an oxygen cage. Data were collected prospectively in 69 intubated cats. At T₀ (end of anaesthesia), cats were transferred into an oxygen cage (T50M, Vetario, UK), with the oxygen flowmeter set at 1, 3 or 5 L minute⁻¹, with or without humidifier (groups 1, 1H, 3, 3H, 5, 5H). The animals FiO₂, cage PpO₂, PpCO₂, temperature and relative humidity were recorded every 30 seconds from T₀ until extubation. A Kruskal-Wallis test followed by a Dunn post-hoc test with Bonferroni correction was used to compare FiO₂ and PpO₂ variations over time.

Baseline values were not statistically different. A significant increase in PpO₂ and FiO₂ was observed at T+30 minutes with significant differences between the 3 flow rates, irrespective to the relative humidity (Table 1).

In cats recovering in an oxygen cage, the oxygen flow rate influenced significantly the ambient oxygen level.

	1	1H	3	3H	5	5H
PpO₂-T30 (kPa) (Slope_{T0-T30})	41.33 ± 3.12 (0.71)	41.03 ± 4.20 (0.76)	60.66 ± 1.65 (1.77)	59.34 ± 3.67 (1.62)	75.39 ± 1.91 (2.72)	73.98 ± 1.09 (2.69)
FiO₂-T30 (%)	42.09 ± 3.39	41.04 ± 4.27	61.12 ± 1.54	59.72 ± 3.39	74.68 ± 1.97	73.70 ± 1.11
PpCO₂-T30 (kPa)	0.31 ± 0.11	0.26 ± 0.08	0.18 ± 0.08	0.18 ± 0.04	0.05 ± 0.06	0.12 ± 0.04

Table 1. Oxygen partial pressures (T_{+30min}) and their variations

Poster Presentations

Ultrasound guided transabdominal plane block in pigs: a cadaveric pilot study

Michielsen A, Rodrigo-Mocholi D, Cornillie P, Gasthuys F, Schauvliege S.

Department of Surgery and Anaesthesia of Domestic Animals, Faculty of Veterinary Medicine, Ghent University

Clinical Sciences and Services, Royal Veterinary College, Queen Mother Hospital for Animals, London

The aim of this study was to develop an ultrasound (US)-guided transabdominal plane (TAP) block in pigs.

Fifteen cadavers (14 female and 1 male, 30 hemi-abdomens, mean $\pm$ standard deviation 35.6 $\pm$ 5.2 kg) were included. After studying the abdominal wall innervation in 2 hemi-abdomens, a pilot study (4 hemi-abdomens) was performed to establish the injection points. Subsequently, a two- and three-point injection technique (14 and 10 hemi-abdomens) were performed using 0.3 mL kg⁻¹ hemi-abdomen⁻¹ of 1% methylene blue in lateral recumbency under US guidance (Figure 1). Nerve staining was considered successful if methylene blue was deposited on the nerve over a distance of >1 cm during dissection.

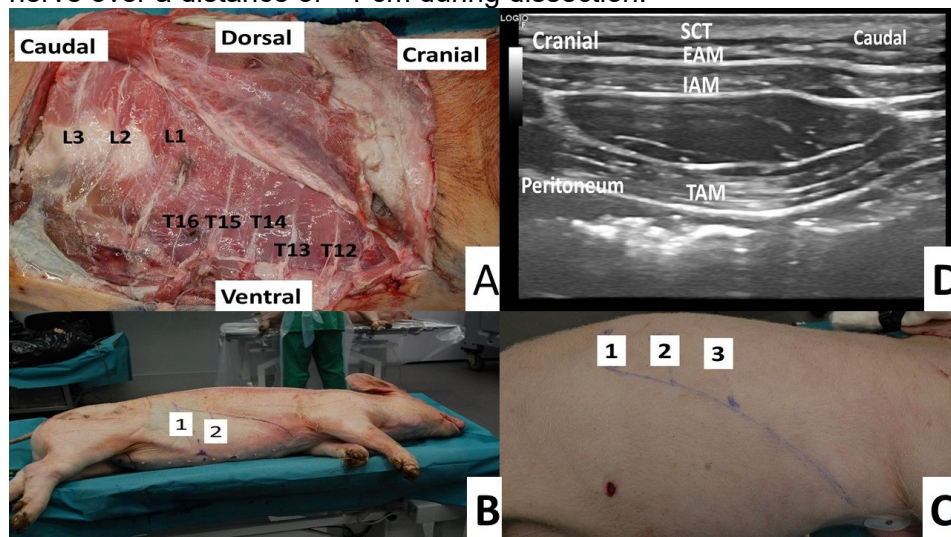


Figure 1: A: Anatomical dissection B: Two point injection: caudal and cranial injection respectively at the end and at 2/3 of the rib arch C: Extra injection between the cranial and caudal injection point D: US-image post-injection.

Abbreviations: SCT= skin and subcutaneous tissue TAM= transverse abdominal muscle IAM/EAM= internal/external abdominal muscle.

Nerve	Two-point technique (%)	Three-point technique (%)
T12	21.4	40
T13	28.6	90
T14	50	50
T15	57.1	80
T16	50	80
L1	92.8	50
L2	78.6	30
L3	21.4	0

Table 1: Comparing nerve staining upon dissection with the different techniques.

The two- and three-point ultrasound guided TAP block injection technique provided sufficient staining of the nerves T12 to L3 in a majority of the pigs. Further studies are necessary to assess the clinical intra- and postoperative efficacy in pigs.

Propofol or Alfaxalone? Effects of total intravenous anaesthesia on respiratory function in pigs.

Lervik A, Toverud SF, Krøntveit R, Haga HA.

Norwegian University of Life Sciences, Faculty of Veterinary Medicine, Dep. Companion Animal Clinical Sciences

Animal Health and Welfare Branch, Veterinary Inspectorate and Force Health Protection Norwegian Armed Forces Joint Medical Services, Sessvollmoen, Norway

Norwegian Medicines Agency, HTA and Reimbursement, Oslo, Norway

Respiratory depression is common during TIVA, necessitating supportive treatment.

Sixteen Landrace and Duroc hybrid pigs with mean body weight 25.4 ± 3.9 kg were randomised to two treatments. Following premedication with ketamine 10 mg kg^{-1} and midazolam 1 mg kg^{-1} IM, and intravenous induction by either propofol or alfaxalone to allow endotracheal intubation, anaesthesia was maintained by propofol at $8 \text{ mg kg}^{-1} \text{ hour}^{-1}$ IV or alfaxalone $5 \text{ mg kg}^{-1} \text{ hour}^{-1}$ IV combined with ketamine $5 \text{ mg kg}^{-1} \text{ hour}^{-1}$ and dexmedetomidine $4 \mu\text{g kg}^{-1} \text{ hour}^{-1}$ IV. The pigs breathed room air spontaneously. SpO_2 , PECO_2 and f_R was measured for 60 minutes, in addition to inspired V_T using a pitot tube and spirometry. If SpO_2 dropped below 80% or if $\text{PE} \cdot \text{CO}_2$ increased above 10.0 kPa, the pigs were recorded as failing to complete the study. Supportive measures were taken, and time to failure was statistically compared between treatments.

Alfaxalone treated pigs had higher respiratory rates and lower $\text{PE} \cdot \text{CO}_2$ than propofol treated pigs, with f_R being 7.3 min^{-1} higher ($p = 0.01$) and PECO_2 0.8 kPa lower ($p = 0.05$). SpO_2 decreased by 0.6 % and f_R by 1.0 min^{-1} per kg increase in body weight in both treatment groups. Three of eight propofol treated and two of eight alfaxalone treated pigs failed to complete the study. A Kaplan-Meier analysis of time to failure revealed no significant difference between treatments ($p = 0.750$).

In conclusion, no major differences were found when comparing treatments. Supportive measures must be available when using both protocols.

Influence of the presence or absence of an observer on pain assessment in rabbits submitted to orthopaedic surgery

Pinho RH, Leach MC, Rocha FDL, Armani DJC, Ferreira-Souza G, Dissenha A, Calciolari K, Minto BW, Luna SPL.

Department of Anaesthesiology, School of Medicine (FMB); São Paulo State University (Unesp), Botucatu, SP, Brazil

School of Natural and Environmental Science; Newcastle University; Newcastle upon Tyne, United Kingdom

Department of Veterinary Clinic and Surgery, School of Agronomic and Veterinary Sciences (FCAV), São Paulo State University (Unesp), Jaboticabal, SP, Brazil

This study aimed to identify postoperative pain behaviours in rabbits and evaluate the influence of the presence of an observer on these behaviours.

Partial radio-ostectomy was performed in 28 rabbits. Five minutes of video footage were recorded in both the presence (Pr) and in the absence (Ab) of an observer before (0h) and 1 hour (1h) after surgery, to create an ethogram. The Wilcoxon test compared the frequency and duration of the behaviours between 0h and 1h in Ab and between Ab and Pr at 0h and 1h. Differences were considered significant when $p < 0.05$. Results are expressed as median and interquartile range.

In Ab, the behaviours "active", "exploring", "dog posture", "eating carrot", "normal posture" decreased and "lying", "inactive", "dorsal movement", "wincing" and "lifting limb" increased at 1h. Compared to Ab, in Pr, the rabbits were less "active" at 0h (Pr – 280; 162 - 300; Ab - 300; 300 - 300) and 1h (Pr – 0; 0 - 78; Ab - 11; 0 - 300) and showed less duration for "exploring" at 0h (Pr – 2,5; 0 - 32; Ab - 39; 4 - 63) and "lifting limb" at 1h (Pr - 0; 0 - 0; Ab - 0; 0 - 65) and less frequency for "dorsal movement" at 1h (Pr - 0; 0 - 0; Ab - 0; 0 - 1).

Ethogram identified behaviours related to postoperative pain in rabbits. The behaviours changed in the presence of the observer, showing that remote pain assessment should be preferable in rabbits.

Reliability and odds ratio of different evaluators in assessing sedation in horses

Oliveira AR, Gozalo-Marcilla M, Schauvliege S, Ringer SK, Puoli-Filho JNP, Luna SPL.

Department of Veterinary Surgery and Anaesthesiology, School of Veterinary Medicine and Animal Science (FMVZ); São Paulo State University (Unesp), Botucatu, SP, Brazil

The Royal (Dick) School of Veterinary Studies and the Roslin Institute, The University of Edinburgh, Easter Bush Campus, Midlothian, UK

Department of Surgery and Anaesthesia of Domestic Animal, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

Equine Department, Anaesthesiology Section, Vetsuisse Faculty, University of Zurich, Zurich, Switzerland

Department of Animal Production, School of Veterinary Medicine and Animal Science (FMVZ); São Paulo State University (Unesp), Botucatu, SP, Brazil

Reproducibility is an indispensable test to guarantee validation of a measurement and previous training is an essential step to ensure reliability. This study aimed to evaluate intra and inter-reliability and odds ratio of four observers in testing two scales for evaluation of sedation in horses.

Four experienced anaesthesiologists scored a facial (photos) and a behavioural sedation scale (videos of 45 seconds) of horses submitted to different sedation protocols. The digital media, including unsedated and slightly and deeply sedated horses, was evaluated twice, with a three weeks interval. Inter and intra-reliability were calculated by Spearman correlation. The chances of each evaluator identifying sedation using the facial scale were calculated by odds ratio.

Inter-reliability ranged between 79 and 92% for the facial and from 84 to 89% for the behavioural scale. Intra-reliability for the facial scale was 95%, 87%, 95% and 94% and for the behavioural scale was 88%, 82%, 91% and 85% for evaluator 1 (E1), E2, E3 and E4 respectively.

Table 1: Odds ratio of facial changes to differentiate sedated *versus* unsedated horses.

	Ears	Eyes	Lower lip	Upper lip
E1	85.00*	44.20*	85.00*	21.00*
E2	10.82	10.82	26.71*	10.82
E3	6.53	10.82	6.53	26.71*
E4	17	17	44.20*	44.20*

* $p < 0.0001$

All observers showed excellent intra and inter-reliability, indicating that these evaluators may be selected for a validation process. Odds ratio varied among the observers and according to the different items of the facial scale, showing that E1 was the best evaluator.

Mandibular nerve block in juvenile Nile crocodile: a cadaveric study

Bianchi C, Adami C, Dirrig, Cuff, D'Ovidio, Monticelli P.

Royal Veterinary College, UK
Private Practice, Italy

The aim of this cadaveric study was to develop a technique to perform the mandibular nerve block in juvenile Nile crocodiles.

One first crocodile head was dissected to study the anatomy and course of the mandibular nerve. Computed tomography (CT) exam was performed in two other heads to identify useful landmarks. Following, a hypodermic needle was inserted percutaneously, with a rostro-ventral angle, through the external mandibular foramen of 17 hemimandibles, until it reached the splenial bone. The injections were performed with a mixture 1:1 of methylene blue and iohexol; injection volumes were 0.5 (n=7) and 1 ml (n=10) for hemimandibles ≤ 15 and > 15 cm long, respectively. Iohexol spread and nerve staining with methylene blue were assessed with CT and anatomical dissection, respectively. Data was analysed with either one sample T-test or Mann-Whitney Rank Sum test.

Stain of the mandibular nerve in the temporal fossa, stain of the medial branch of the mandibular nerve, and dorso-ventral and medio-lateral spread of iohexol from the injection point were greater in group 1 than in group 0.5 ($p < 0.001$). The caudal spread of iohexol was greater in group 1 than in group 0.5 ($p = 0.01$), whereas there were no differences between groups in rostral spread of the contrast and in the stain of both the medial mandibular foramen and the temporal fossa.

The technique was feasible and easy to perform. Both injection volumes consistently resulted in stain of the mandibular nerve and spread of contrast in the anatomical region of interest.



Effects of local infiltration with ropivacaine and its combination with meloxicam on the isoflurane requirements and cardiovascular response during feline ovariohysterectomy

Carapeba GOL, Nicácio IPGA, Stelle ABF, Bruno TS, Nicácio GM, Costa Jr JS, Cassu RN.

Postgraduate Program in Animal Science, University of Western São Paulo, Brazil
Faculty of Veterinary Medicine, Department of Veterinary Surgery and Anaesthesiology,
University of Western São Paulo, Brazil

Loco-regional anaesthesia has been widely used in small animal practice due to analgesic and anaesthetic-sparing properties (McMillan et al. 2012; Vicente et al. 2018). This prospective, randomized, blinded, clinical study aimed to investigate the effect of the local anesthesia on the isoflurane requirements and cardiovascular response during feline ovariohysterectomy.

Forty-five cats were premedicated with acepromazine (0.05 mg kg^{-1}) and pethidine (6 mg kg^{-1}). Anaesthesia was induced with propofol to effect and maintained with isoflurane/ O_2 . The subjects were distributed into three groups ($n = 15$), consisting of the pre-incisional infiltration at the surgical site (midline incision, ovarian pedicles and caudal uterine body) with saline solution 0.9% (group S), ropivacaine 0.25% alone (1 mg kg^{-1} , group R), and combined with meloxicam (0.2 mg kg^{-1} , group RM). Intraoperatively, cardiopulmonary variables and FE'ISO were monitored. FE'ISO was adjusted according to changes in SAP and HR. Data were analysed using ANOVA followed by a Tukey's test.

Compared to S and R groups, the mean FE'ISO in the RM was decreased by means of 21.9% and 15.6%, respectively. Mean overall FE'ISO, HR and PAS were significantly lower in the RM ($0.88 \pm 0.14\%$; $121 \pm 14 \text{ beats minute}^{-1}$; $95 \pm 10 \text{ mmHg}$) compared to the S ($1.13 \pm 0.23\%$; $150 \pm 13 \text{ beats minute}^{-1}$; $112 \pm 21 \text{ mmHg}$) and R groups ($1.05 \pm 0.13\%$; $148 \pm 16 \text{ beats minute}^{-1}$; $109 \pm 26 \text{ mmHg}$).

Local infiltration with ropivacaine and meloxicam seems to be an effective technique to decrease isoflurane requirements and autonomic response during ovariohysterectomy in cats.

References

- McMillan MW, Seymour CJ, Brearley JC (2012) Effect of intratesticular lidocaine on isoflurane requirements in dogs undergoing routine castration. *J Small Anim Pract* 53, 393-397.
Vicente D, Bergström A (2018) Evaluation of intraoperative analgesia provided by incisional lidocaine and bupivacaine in cats undergoing ovariohysterectomy. *J Feline Med Surg* 20, 922-927.

Comparison of local and systemic administration of meloxicam for postoperative pain management in cats undergoing ovariohysterectomy

Stelle ABF, Carapeba GOL, Nicácio IPGA, Bruno TS, Nicácio GM, Costa Jr JS, Teixeira Neto FJ, Cassu RN.

Faculty of Veterinary Medicine, Department of Veterinary Surgery and Anaesthesiology, University of Western São Paulo, Brazil
Postgraduate Program in Animal Science, University of Western São Paulo, Brazil
School of Veterinary Medicine and Animal Science, Department of Veterinary Surgery and Anaesthesiology, São Paulo State University (Unesp), Brazil

Evidence has shown that peripheral administration of NSAIDs plays an important role in postoperative pain management (Kroin et al. 2016).

This study aimed to compare the analgesic efficacy of local and systemic administration of meloxicam (0.2 mg kg^{-1}) in feline ovariohysterectomy. Thirty cats were sedated with IM acepromazine (0.05 mg kg^{-1}) plus pethidine (6 mg kg^{-1}). Anaesthesia was induced with propofol and maintained with isoflurane/ O_2 . After removal of the ovarian and uterus, the cats were randomly allocated into two groups ($n = 15$) to receive meloxicam diluted in 1 mL of saline 0.9% (LG) or 1 mL of saline 0.9% (SCG), which were administered into the ovarian pedicles, uterine cervix and midline incision. Cats in SCG received SC meloxicam after intubation.

Pain was assessed by a blinded observer using an Interactive Visual Analog Scale (IVAS), the UNESP-Botucatu Multidimensional Composite Pain Scale (MCPS), and mechanical nociceptive thresholds (MNT) at 0.5, 1, 2, 4, 6, 8, 12, 18, and 24 hours post-extubation. Rescue analgesia was provided with IM morphine (0.1 mg kg^{-1}). Data were analysed using t-tests, Fisher's exact test, Mann-Whitney and Friedman tests ($p < 0.05$).

Total MNT, IVAS and MCPS range did not differ between groups (LG: $189 \pm 59 \text{ g}$, $5 \pm 3 \text{ mm}$, 1 ± 0.5 ; SCG: $191 \pm 60 \text{ g}$, $7.1 \pm 4 \text{ mm}$, 1.8 ± 1 , respectively). The number of rescue morphine doses was significantly higher in SCG (7 doses) compared with LG (none dose).

Local infiltration of meloxicam decreased postoperative analgesic requirements following feline ovariohysterectomy.

References

Kroin JS, Li J, Moric M, Birmingham BW, et al. (2016) Local infiltration of analgesics at surgical wound to reduce postoperative pain after laparotomy in rats. *Reg Anesth Pain Med* 41, 691-695.

Anaesthesia management in dogs and cats in Lower Saxony

Kästner S, Goossens L, Samp A.

University of Veterinary Medicine Hannover, Foundation
Ecuphar GmbH, Greifswald

In 2016, guidelines for anaesthesia management in dogs and cats were released in Germany (1). The purpose of the survey was to determine, which aspects of these guidelines are fulfilled in daily small animal anaesthesia practice.

All practices and clinics that treat small animals in Lower Saxony received an anonymous questionnaire. The responses of 454 veterinary institutions (return rate 36.6%) were analysed by descriptive statistics.

The majority of facilities use injection anaesthesia only (54.8% in dogs, 60.7% in cats). An intravenous catheter is established routinely in 47.4% and 8.3%, of dogs and cats, respectively. Most establishments do not intubate dogs (41.4%) or cats (50.9%) routinely. In 54.6% of facilities an oxygen source is available. About two-thirds have the equipment for performing controlled ventilation. The majority of facilities always use active or passive warming devices. Xylazine is the most commonly used sedative (79.4%) and ketamine is the most commonly used anaesthetic (97%). Isoflurane is the most commonly used inhalation anaesthetic (95%), in conjunction with an endotracheal tube in the majority of cases. Approximately two-thirds of the facilities use additional perioperative analgesics, with 60% being NSAIDs. In 52.6% of the questionnaires information on monitoring was provided. Clinical monitoring most commonly comprises respiratory rate and the protective reflexes. The most popular monitoring tool is the pulse oximeter.

More than half of the 454 veterinary facilities work exclusively with injection anaesthesia based on ketamine and an alpha-2 agonist. The recommendations in the anaesthesia guideline are often not fully implemented in small animal practice.

References

Alef M, Driessen B, Hauschild G et al. (2016) Leitlinie Anästhesiologische Versorgung bei Hund und Katze. Tierarztl Prax Ausg K Kleintiere Heimtiere 44(4), 261-271.

Is BIS a useful monitoring tool during balanced neuroanaesthesia in rabbits?

Preliminary results

Casoni D, Petrucci MF, Wanderer S, Spadavecchia C.

Experimental Surgery Facility (ESF), Department of Biomedical Research, Faculty of Medicine, University of Berne, Switzerland

Neurosurgery Clinic, Cantonal Hospital Aarau, Switzerland

Anaesthesia Division, Veterinary Clinical Department, Vetsuisse Faculty, University of Berne, Switzerland

The use of Bispectral Index (BIS) in rabbit anaesthesia is controversial (Martin-Cancho et al. 2006, Romanov et al. 2014). Aims of this study were to evaluate whether BIS was reliable indicator of anaesthesia depth, and it was altered by bilateral carotid clamping.

Twenty-six New Zealand white rabbits were anaesthetised for microsurgical creation of a bifurcation aneurysm at the left carotid. After SC dexmedetomidine ($100 \mu\text{g kg}^{-1}$), ketamine (20 mg kg^{-1}) and methadone (0.3 mg kg^{-1}), propofol (1 mg kg^{-1}) was administered, if needed, for tracheal intubation. Anaesthesia was maintained with isoflurane in oxygen aiming at absence of autonomic response with maximal FE' 1.3%, combined with lidocaine ($50 \mu\text{g kg}^{-1} \text{ minute}^{-1}$) and fentanyl ($5 \mu\text{g kg}^{-1} \text{ hour}^{-1}$). Blood pressure, PR, HR, SpO_2 , fR, temperature, Fi and FE' of oxygen, CO_2 and isoflurane, BIS, and suppression ratio were recorded. Values of BIS over time were compared with ANOVA in ranks followed by Tukey test and the value pre and post-ischemia with Signed rank test ($p = 0.05$).

No burst suppression was observed on the EEG. BIS values recorded during anaesthesia were stable over time (median 65.5 - 72.5). BIS was significantly higher at extubation (median 91, IQR 74.5 - 95) than at any other time point, and at the end of anaesthesia (median 72, IQR 72 - 83.5) than at any other time point until surgery start. Clamping and reperfusion did not significantly affect the BIS.

Anaesthesia depth deemed clinically adequate was reflected by a stable BIS with values higher than in humans.

References

Martin-Cancho MF, Lima JR, Luis L, et al., 2006. Relationship of bispectral index values, haemodynamic changes and recovery times during sevoflurane or propofol anaesthesia in rabbits. *Lab Animals* 40, 28–42.

Romanov A, Moon RS, Wang M et al., 2014 Paradoxical Increase in the Bispectral Index during Deep Anesthesia in New Zealand White Rabbits. *JAALAS* 1, 74-80.

The Antinociceptive effect of Magnesium Sulphate administered in the epidural space in standing horses

La Rosa L, Twele L, Duchateau L, Kästner SBR, Schauvliege S.

Department of Surgery and Anaesthesia of Domestic Animals, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

Equine Clinic, University of Veterinary Medicine Hanover, Hanover, Germany

Department of Comparative Physiology and Biometrics, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium

The antinociceptive properties of epidural magnesium sulphate (MgSO_4) were investigated in standing horses.

Six horses (535 to 686 kg, 10 to 17 years) were enrolled in a placebo-controlled, blinded cross-over study. Three baseline measurements of electrical, thermal and mechanical thresholds were performed at the hindlegs in a random order, afterwards $1 \text{ mg kg}^{-1} \text{ MgSO}_4$ (treatment Mg) diluted to 15 ml or the same volume of saline (treatment S) was administered through an epidural catheter over 15 minutes. Nociceptive thresholds were determined after 20, 40, 60, 80, 100, 120, 140, 160 and 180 minutes. Blood samples were collected before treatment and every 30 minutes throughout the study. Data were assessed for normality by the Shapiro-Wilk test. For statistical analysis, a linear mixed model using horse as a random effect and session, time, treatment and its interaction as fixed effects was used. Treatments were compared specifically at 20, 60, 120 and 180 minutes, and tested at the Bonferroni adjusted significance level of 0.0125.

Two horses collapsed during injection of MgSO_4 , one stood up immediately and continued the study, the other one was excluded from further analysis because it took a longer time to stand up. No significant differences between the two treatment groups were observed for nociceptive thresholds. A significant difference was only found for HR, at timepoint 180 ($\text{Mg } 43 \pm 4.3$; $\text{S } 31 \pm 4.7$) ($p = 0.009$).

This study failed to demonstrate any analgesic properties of MgSO_4 administered epidurally in standing horses when using electrical, thermal and mechanical thresholds.

Automated tracking of horse behaviour, preliminary data

Auer U, Rother O, Hoffbauer M, Larenza-Menzies P.

Vetmeduni Vienna, Austria

Loopbio GmbH, Kritzensdorf, Austria

The current study evaluated the feasibility of automated video-tracking software to monitor the head movements of horses, setting the basis for future pain evaluation studies.

Six horses were video-recorded (two frames per second) over a 4-hour period. Video recordings were transferred to a computer and the movement and orientation of the horse heads were analysed with an image processing and tracking software (Loopy® Neural Network, Kritzensdorf, Austria). The tip of the nose and ears were marked every 10 frames using the annotation feature of the software on the first 2,500 frames. The annotation creating an image-processing algorithm and train a convolutional neural network, to predict the marker directly from images. Subsequently, prediction of the complete video sequence was run with the model and data downloaded. The SD of X_{head} and Y_{head} was calculated and displayed on a time line to track the movement of the head. For the orientation, the image center was determined (x_0, y_0) and $X_{\text{head}}-X_0$; Y_0-Y_{head} calculated and displayed as density plots. Plots and SD graphs were compared against the visual inspection of the video to identify resting/sleeping and moving/eating behaviors.

Resting/sleeping, moving/eating behaviours and their duration could be determined on the graphs and related with the visual inspection of the video recordings.

The software seems to identify activity and position of the horse heads over a 4-hour period. Further calculation of the time budget of different behavioural categories may help to determine the overall activity of horses and identify painful stages.

Efficacy of two epidural techniques in dogs undergoing unilateral perineal hernia repair: preliminary results

Salla K, Lepajoe J, Åhlberg T, Mölsä S, Casoni D.

Department of Equine and Small Animal Medicine, Faculty of Veterinary Medicine, University of Helsinki, Finland

Similar cranial spread of contrast medium between lumbosacral and sacrococcygeal epidural injections has been demonstrated in dog cadavers (Vesovski et al., 2019). Aim of the current study was to compare the need of rescue opioids between two epidural techniques.

Thirty-seven dogs undergoing perineal hernia repair were included in this randomized, blinded study. Dogs were premedicated with acepromazine (0.02 mg kg^{-1}) and butorphanol (0.3 mg kg^{-1}) IM. Anaesthesia was induced with propofol and maintained with sevoflurane ($\text{FE}'_{\text{Sevo}} 2.3 \%$) in oxygen. Epidural ropivacaine 1% (0.2 mL kg^{-1}) was administered in either lumbosacral (LS) or sacrococcygeal (SC) space under computed tomography guidance. Intra-operative fentanyl $3 \mu\text{g kg}^{-1}$ IV, was administered if two out of three parameters (HR, f_R and MAP) were increased more than 20% from baseline values before surgical incision. Dogs received meloxicam 0.2 mg kg^{-1} IV postoperatively. Glasgow Composite Pain Scale (GCPS) was assessed six hours after epidural injection. Methadone (0.2 mg kg^{-1} IV) was administered if the GCPS score was $\geq 6/24$. The need of fentanyl or methadone was recorded as Yes or No. Mann-Whitney U and Fisher's Exact tests were used and p set at 0.05.

Results are shown in Table 1. A maximum of two fentanyl boluses was needed per dog. No significant differences were detected between techniques.

Both epidural techniques provided good intra-operative analgesia and similar consumption of postoperative methadone.

Table 1.

Epidural technique	Dogs received fentanyl	GCPS at 6 hours	Dogs received methadone
LS	2/19	2 (1-8)	4/18
SC	6/18	3 (1-7)	3/17

References

Vesovski S, Makara M & Matinez-Taboada F (2019). Computer tomographic comparison of cranial spread of contrast in lumbosacral and sacrococcygeal epidural injections in dog cadavers. *Vet Anaesth Analg* doi: 10.1016/j.vaa.2019.02.007.

Anaesthetic-related deaths in dogs in Spain: COMPLRED 2016-2019

Redondo JL.

Universidad CEU Cardenal Herrera

The aim of this study was to establish the current canine anaesthetic mortality in Spain.

A prospective multi-centric study was undertaken in 84 veterinary centres between 2016 and 2019. 14974 dogs were anesthetized (7379 females and 7595 males; age: 6.2 ± 4.0 years; weight: 16.4 ± 12.4 Kg) for different reasons: 5398 minor (MIN), 3830 abdominal (ABD), 2530 orthopaedic (ORTH), 3064 diagnostic (DIAG) and 152 thoracic surgery (TOR). Patients were classified by ASA status: 4451 ASA I, 7488 ASA II, 2567 ASA III and 468 ASA IV-V. Anaesthetic-related death was defined as occurring after premedication and within 48 hours after extubation. Data were analysed using a logistic binomial regression ($p < 0.05$).

Seventy-one dogs died. Mortality rate was 0.47%: ASA I 0.04%, ASA II 0.23%, ASA III 0.90%, ASA IV-V 6.20%. Nine patients died during the maintenance, 55 at the first 24 hours and 16 between 24-48 hours. Seven patients died in MIN procedures, 34 in ABD, 6 in DIAG, 20 in ORTH, 4 in TOR. When compared to ASA I, patients ASA III (Odds ratio (OR): 19.5, $p < 0.001$) and IV-V (OR: 74.3, $p < 0.001$) had increased mortality. A mortality rate increase was observed in ORTH surgeries (OR: 4.2, $p = 0.002$), taking MIN as reference. Emergency anaesthesias increased the mortality (OR: 2.8, $p = 0.004$). The use of locoregional anaesthesia reduced the mortality (OR: 0.4, $p = 0.01$).

Most of deaths happened postoperatively (78%). The use of locoregional anaesthesia could be considered as a protective factor.

Anaesthetic-related deaths in dogs in Argentina: COMPLRED 2016-2019

Redondo JI.

Universidad CEU Cardenal Herrera

The aim of this study was to establish the canine anaesthetic mortality in Argentina.

A prospective multi-centric study was undertaken in 37 veterinary centres between 2017 and 2019. A total of 4082 dogs were anesthetized (2313 females and 1769 males; age: 6.6 ± 4.3 years; weight: 16.9 ± 12.8 Kg) for different reasons: 1700 minor procedures (MIN), 1605 abdominal interventions (ABD); 516 orthopaedic surgery (ORTH), 192 diagnostic procedures (DIAG) and 69 thoracic surgery (TOR). Patients were classified by ASA status: 934 ASA I, 2179 ASA II, 784 ASA III and 185 ASA IV-V. Anaesthetic-related death was defined as occurring after premedication and within 48 hours after extubation. Data were analysed using a logistic binomial regression ($p < 0.05$).

Fifty-five dogs died. Mortality rate was 1.35 %: ASA I 0.11%, ASA II 0.32%, ASA III 2.30%, ASA IV-V 15.68%. Two patients died during induction, 2 patients during the maintenance, 39 at the first 24 hours and 12 between 24-48 hours. Twelve patients died in MIN procedures, 39 in ABD, 2 in ORTH and 2 in TOR. Logistic regression did not found risk (or protective) factors. Most of deaths happened during the postoperative time. More cases are needed for increase the statistic potency of the analysis in order to find relationships between death and potential risk factors.

Reviewing results of an audit of anaesthetic machines and vaporizers in veterinary clinics and hospitals in Spain and Portugal

Redondo JI, Doménech L, Mateu C, Bañeres A, Martínez, Lopes D.

Dpto. Medicina y Cirugía Animal. Universidad CEU Cardenal Herrera

Dpto. Matemáticas, Física y Ciencias Tecnológicas. Universidad CEU Cardenal Herrera

Ecuphar Veterinaria SLU

Belphar Lda.

To review the data collected from an audit in anaesthetic machines and vaporizers in Spanish and Portuguese veterinary clinics.

Data were collected between January 2016 and June 2019 by Ecuphar Veterinaria, a company dedicated to check the operation, calibration and repair of anaesthetic machines and vaporizers. Data were anonymized to meet the requirements of the General Data Protection Regulation (EU 2016/679). Descriptive statistic was used to analyse the data.

One thousand, five hundred and thirty-seven forms about anaesthetic machines and 1890 of vaporizers were collected. After the initial review, 44% of the machines got a CONFORMING result, 21% had some problems which were fixed during the visit and 35% got a NON-CONFORMING result. The percentage of fails in the different parts of the machine were: source of O₂: 23%, flowmeters: 16%, connections: 20%. oxygen pipes: 18%, high-flow oxygen flush: 15%. fresh gas output: 17%; manometer: 14%; inspiratory valve 19%; expiratory valve: 20%; APL valve: 24%. canister: 38%; gas evaluation system: 45%; reservoir bag: 23%. Ayre's T piece: 42%; coaxial: 25%; circle circuit: 23%. 1529 vaporizers reached a CONFORMING result, while 361 (19%) were NON-CONFORMING.

A high percentage of machines and vaporizers have problems. A periodical review of the equipment by a qualified technical service should be mandatory to detect problems and to improve the safety in anaesthesia.

The clinical effect of xylazine premedication, ketamine induction and maintenance with isoflurane in oxygen/air mixture in water buffalo calves (*Bubalus bubalis*) undergoing general anaesthesia for a closed castration surgery

Cerasoli I, Varasano V, Guerri G, Straticò P, De Amiciis I, Vignola G, Petrizzi L.

University of Teramo

According to the current European legislation, few drugs are licensed for general anaesthesia (GA) in domestic water buffaloes (*Bubalus bubalis*) (EU 37/2010). Protocols reported in veterinary literature describe the use of drugs not allowed in those ruminants.

Eight water buffalo calves were sedated intramuscularly (IM) with 0.1 mg kg⁻¹ of xylazine. The quality of sedation, presence or absence of salivation, tympany, regurgitation were monitored and recorded at 2 and 5 minutes after IM injection and after that every 5 minutes. GA was induced with ketamine 2 mg kg⁻¹ intravenously (IV). Top up of xylazine (0.025 mg kg⁻¹) and ketamine (0.5 mg kg⁻¹) IV, if needed to gain orotracheal intubation, were registered. GA was maintained with isoflurane in oxygen/air mixture (1:2 ratio). Analgesia was achieved with lidocaine 2% (10 mL) for each testicle (intrafunicular block), and flunixin meglumine (1.1 mg kg⁻¹) IV. Presence of ataxia, degree of sedation, pain, HR, fR, invasive blood pressure, arterial blood gasses, airways pressures and gasses were recorded. A descriptive analysis was used for ordinal values and continuous data.

Supplemental doses of xylazine and ketamine were needed in 8/8 and 7/8 buffaloes respectively. Jugular IV catheter placement was challenging, and in 6/8 cases auricular vein was used. Hypoventilation (P_{E'} CO₂ > 45 mmHg) and salivation were reported in 8/8 and 7/8 subjects respectively.

The protocol described is suitable for GA in water buffaloes, however an increased dose of xylazine may be needed to smoothen the induction. The marginal auricular vein should be considered as IV access.

Nerve stimulator-guided mid-humeral block of the radial, ulnar, median and musculocutaneous (RUMM block) nerves in *Macaca fascicularis* with radius and ulna fracture

Lopez-Ramis V, Arenillas Baquero M, García Menéndez E, Álvarez Gómez de Segura I.

Department of Animal Medicine and Surgery, Complutense University of Madrid, Spain
Private Veterinary Anaesthesia and Analgesia Service, Madrid, Spain

A ten-year-old, 7.8-kg, male research macaque (*Macaca fascicularis*) was anaesthetized for surgical fracture repair. Ketamine (8 mg kg⁻¹) and medetomidine (20 µg kg⁻¹) were administered intramuscularly for sedation. During preoxygenation, the saphenous vein was catheterized, and anaesthesia induced intravenously with propofol (1 mg kg⁻¹). The trachea was intubated and connected to a rebreathing circuit. Anaesthesia was maintained with isoflurane in 100% oxygen. Continuous monitoring of physiological variables was recorded every 5 minutes.

A peripheral block of the radial, ulnar, musculocutaneous and median nerves (RUMM block) was performed based upon previous descriptions provided by both the human and the veterinary literature (Carles et al. 2001, Dupré 2006, Castiñeiras et al. 2015). The monkey was placed in dorsal recumbency and an isolated needle attached to a neurostimulator (2 Hz) was introduced through the upper and middle third of the arm immediately above the brachial artery identified by palpation. The initial current (1 mA) was reduced while repositioning the needle tip as required to elicit muscular contractions with 0.3-0.5 mA for each nerve. Bupivacaine 0.5% was administered (total volume 4 ml). No additional intraoperative analgesic drugs were required, and no adverse events or further complications were observed during surgery. Meloxicam (0.2 mg kg⁻¹) was administered subcutaneously at the end of the procedure and recovery was considered to be excellent. Both meloxicam (0.1 mg kg⁻¹) and tramadol (2 mg kg⁻¹) were administered postoperatively during two weeks.

We conclude that the RUMM block provided sufficient perioperative analgesia in a monkey anaesthetized for forearm fracture repair.

References

- Carles M, Pulcini A, Macchi P et al. (2001) An evaluation of the brachial plexus block at the humeral canal using a neurostimulator (1417 patients): The efficacy, safety and predictive criteria of failure. *Anesth Analg* 92, 194-198.
- Dupré LJ (2006) Block of the branches of the brachial plexus and brachial canal. *Ann Fr Anesth Reanim* 25, 237-241.
- Castiñeiras D, Viscasillas J and Seymour C (2015) A modified approach for performing ultrasound-guided radial, ulnar, median and musculocutaneous nerve block in a dog. *Vet Anaesth Analg* 6, 659-661.

Use of fentanyl patches for postoperative pain control after kidney embolization in a sheep model

Bonastre C, Rodriguez-Zapater S, Serrano-Casorran C, Fuente S, Lopez-Minguez S, de Gregorio MA.

Minimally Invasive Techniques Research Group (GITMI), University of Zaragoza
Department of Animal Pathology, University of Zaragoza
Department of Paediatrics, University of Zaragoza
Radiology and Physical Medicine, University of Zaragoza

Sheep is an experimental model for intravascular procedures as kidney embolization (KE). Opioid analgesia is necessary in humans after KE (Hom et al. 1999). Fentanyl patch is an easy option to administrate analgesia in this species.

A transarterial KE model was performed in 5 sheep (60.2 ± 7.04 kg). Twenty-four hours before the intervention a fentanyl patch ($150 \mu\text{g hour}^{-1}$) was placed on the inner side of the forelimb and was changed 3 days after placement. Four veterinarians trained in pain evaluation used Sheep Grimace Scale (SGS) (Häger et al. 2017) to assess postoperative pain at 12 and 24 hours after intervention and after that, once a day until seventh day. They also evaluated 2 healthy sheep (10 evaluations per sheep) as controls. Mean of the 4 evaluators was obtained at each evaluation moment. Parametric data were showed as mean $\pm$ standard deviation and non-parametric ones as median (range). In normal distributions, Student's t-test was used for comparing means; for non-normal distributions, the Mann-Whitney U test was applied.

SGS scores did not exceed 2.5 points, except in one animal that was euthanized at 6th day due to an acute renal failure (3.75 points), being the maximum possible score of 7 points. Median of controls was 0.50 (1.50). Except for 12-hour evaluation (1.55 ± 0.76 points), no significant differences were observed regarding controls score in any evaluation.

The use of a fentanyl patch was adequate for the control of postoperative pain within the first 7 days for kidney embolization.

References

- Hom D, Eiley D, Lumerman JH et al. (1999) Complete renal embolization as an alternative to nephrectomy. *J Urol* 161, 24–27.
- Häger C, Biernot S, Buettner M et al. (2017) The Sheep Grimace Scale as an indicator of post-operative distress and pain in laboratory sheep. *PLoS One* 12, e0175839.

Dexmedetomidine for perioperative management of five dogs submitted to a pheochromocytoma ablation

Lambertini C, Joechler M, Foglia A, Romagnoli N.

Department of Veterinary Medical Sciences, Alma Mater Studiorum, University of Bologna

Pheochromocytoma (PHEO) ablation produces severe cardiovascular complications. In humans, dexmedetomidine minimizes hemodynamic alterations during surgical PHEO manipulation (Singh and Singh 2014).

Five mixed breed dogs undergoing adrenalectomy for PHEO were premedicated with dexmedetomidine ($1 \mu\text{g kg}^{-1}$) and methadone (0.2 mg kg^{-1}) IM. Anaesthesia was induced with propofol IV and maintained with isoflurane in oxygen. Dexmedetomidine ($0.5 \mu\text{g kg}^{-1} \text{ h}^{-1}$) and remifentanyl ($3 \mu\text{g kg}^{-1} \text{ min}^{-1}$) or fentanyl ($5\text{-}10 \mu\text{g kg}^{-1} \text{ h}^{-1}$) were administered IV. Cardiorespiratory parameters were monitored throughout the procedure. After extubation, dexmedetomidine was discontinued and post-operative analgesia was provided by methadone (0.1 mg kg^{-1}) IM. Episode of hypotension, hypertension and arrhythmias were recorded and quantified. Data were analysed with a descriptive statistic and are shown as mean $\pm$ SD.

In all dogs, sedation and induction were smooth without hemodynamic alterations. The mean HR intraoperatively was $77.9 \pm 15.9 \text{ beats min}^{-1}$ and the mean MAP was $75.1 \pm 4.7 \text{ mmHg}$. One dog experienced atrioventricular blocks and a transient increase in blood pressure up to a MAP of 125 mmHg . Two dogs experienced transient hypotension (MAP 50 mmHg): one dog was treated with crystalloid administration; but in the other one dobutamine was administered IV. All dogs were discharged within 10 days.

Perioperative administration of dexmedetomidine along with remifentanyl or fentanyl in dogs with PHEO provided satisfactory sedation and analgesia. In addition, dexmedetomidine, by means of its effect of inhibition of catecholamines' outflow (Moura et al. 2006; Jung et al. 2012), prevented significant alteration in HR and blood pressure during mass manipulation.

References

- Moura E, Afonso J, Hein L et al. (2006) $\alpha 2$ -adrenoceptor subtypes involved in the regulation of catecholamine release from the adrenal medulla of mice. *Br J Pharmacol* 149, 1049-1058.
- Jung JW, Park JK, Jeon SY et al. (2012) Dexmedetomidine and remifentanyl in the perioperative management of an adolescent undergoing resection of pheochromocytoma -A case report- *Korean J Anesthesiol* 63, 555–558.
- Singh S & Singh A (2014) Dexmedetomidine induced catecholamine suppression in pheochromocytoma. *J Nat Sci Biol Med* 5, 182-183.

Comparison of sevoflurane MAC sparing effects of methadone and levomethadone at a 2:1 dose ratio in cats

Thiesfeld N, Kästner SBR, Noll M, Söbbeler FJ, Tünsmeier J.

Small Animal Clinic, University of Veterinary Medicine Hanover Foundation, Bünteweg 9, 30559 Hannover, Germany

The aim of this study was the comparison of the MAC sparing effects of 2 doses of methadone and levomethadone assumed as equipotent in cats.

In a randomized blinded cross-over study 6 healthy cats received either 0.4 mg kg⁻¹ methadone (M) or 0.2 mg kg⁻¹ levomethadone (L) intravenously with a minimal wash out of 1 week. Anaesthesia was induced with sevoflurane in 100% oxygen via face mask. After orotracheal intubation sevoflurane concentrations were collected from the distal end of the tube. Before and after treatment MAC was determined at 57m above sea level by transdermal constant current stimulation (50 mA) via adhesive electrodes at a thoracic limb using the bracketing technique (Sonner 2002). Non-normally distributed parameters were analyzed by Wilcoxon-Sign-Rank-Test and results are displayed as median [minimum – maximum].

Baseline MAC did not differ with 3.6 [3.25 - 4.05] Vol.% in M and 3.55 [2.95 – 4.55] Vol.% in L between treatments. Opioid administration did not significantly affect MAC in M 3.75 [2.95 - 4.35] Vol.% or L 3.85 [2.75 ± 4.05] Vol.%, respectively. Time between treatment and MAC determination was longer in L with 184 ± 48 minutes compared to M with 131 ± 52 minutes (p = 0.03).

The investigated doses of methadone and levomethadone can be assumed as equipotent concerning their effects on MAC in cats. However, as the opioids' effect on MAC was individually variable, at average both drugs had no MAC sparing or increasing effect in cats.

References

Sonner JM (2002) Issues in the design and interpretation of minimum alveolar anaesthetic concentration (MAC) studies. *Anesth Analg*, 95, 609-14