Influence of pneumoperitoneum and postural change on the cardiovascular and respiratory systems in dogs.

Park YT(1), Okano S.

Author information:
(1)Laboratory of Small Animal Surgery, Kitasato University, 35-1, Higashi 23-bancho, Towada, Aomori 034-8628, Japan.

We investigated the influence of pneumoperitoneum (PP) and postural change under inhalation anesthesia with isoflurane, which is routinely used in dogs, on the cardiovascular and respiratory systems. As test animals, 6 adult beagles were used. To induce anesthesia, atropine, butorphanol and propofol were intravenously injected. Anesthesia was maintained with 1.3 MAC (1.7%) isoflurane. The following were the experiment conditions: I:E ratio, 1:1.9; tidal air exchange, 20 ml/kg; and ventilation frequency, 14 times/min. Respiration was regulated so that the PaCO2 was approximately 35 to 40 mmHg before the start of the experiment. PP with CO2 (intraperitoneal pressure 15 mmHg) and a postural change (15°C) was performed during the experiment. As parameters of circulatory kinetics, heart rate (HR), mean aortic pressure (MAP), mean pulmonary arterial pressure (MPAP), central venous pressure (CVP), femoral venous pressure (FVP) and cardiac output (CO) were measured. As parameters of respiratory kinetics, airway pressure (PAW) and blood gas (BG) were measured. There were significant increases in HR, MAP, MPAP, CVP, FVP, CO, PAW and PaCO2 after PP in the horizontal position. There were significant increases in CVP, FVP, PAW and PaCO2 after PP in the Trendelenburg position. There were significant increases in the MPAP, CVP, FVP, PAW and PaCO2 after PP in the inverse Trendelenburg position. There was a significant difference in FVP after PP between the Trendelenburg position and inverse Trendelenburg position. The results of this experiment suggest that appropriate anesthesia control, such as changing the ventilation conditions after PP, is required for laparoscopic surgery under inhalation anesthesia with isoflurane.

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A blind insertion airway device in dogs as an alternative to traditional endotracheal intubation.

James T(1), Lane M(2), Crowe D(2), Pullen W(2).

Author information:
Endotracheal intubation is the standard of care to establish a secure airway; however, laryngeal airway management systems are increasingly being used in human patients for elective surgical procedures and in emergency settings. In this study, a double lumen, blind insertion airway device (BIAD) was placed in the esophagus of dogs and evaluated for its ability to ventilate the lungs. Initially, 10 euthanized dogs were evaluated, followed by a group of 15 mixed breed dogs that were undergoing elective spay or neuter procedures, and a group of 10 healthy dogs. Post-procedure evaluation included visual examination with a laryngoscope to inspect for signs of inflammation or mucosal damage. The device provided adequate ventilation in all subjects; the dogs were under anesthesia or heavily sedated for 10 min to 2 h and recovered uneventfully. No evidence of esophagitis, aspiration pneumonia, tracheitis, subcutaneous emphysema or esophageal laceration was observed. In conclusion, the use of double lumen airway devices warrants further study as an alternative airway management system in dogs.

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Effects of dexmedetomidine on pulse pressure variation changes induced by hemorrhage followed by volume replacement in isoflurane-anesthetized dogs.


Author information:
(1)Department of Anesthesiology, Botucatu, Brazil.

OBJECTIVES: To evaluate the effects of dexmedetomidine (DEX) on changes in pulse pressure variation (PPV) induced by hemorrhage followed by volume replacement (VR) during isoflurane (ISO) anesthesia.
DESIGN: Prospective, randomized, crossover study.
SETTING: Research laboratory at a veterinary teaching hospital.
ANIMALS: Eight adult dogs.
INTERVENTIONS: Anesthesia was maintained with 1.3 times the minimum alveolar concentration (MAC) of ISO alone or ISO with DEX (ISO-DEX, 1.6 μg/kg [bolus], followed by 2 μg/kg/h). Atropine was administered 30 minutes prior to hemorrhage in the ISO-DEX treatment. Ventilation was controlled (tidal volume of 12 mL/kg, positive end-expiratory pressure of 7 cm H2O, respiratory rate of 16-20/min) under neuromuscular blockade. After recording baseline data, progressive
withdrawal of 10%, 20%, and 30% of blood volume (HV10, HV20, and HV30, respectively [measurements during hemorrhage, indicating x% of blood volume removed]) was followed by VR with autologous blood.

MEASUREMENTS AND MAIN RESULTS: In 4 of 8 ISO dogs, hemorrhage decreased mean arterial pressure (MAP) < 60 mm Hg. Based on mean arterial pressure after hemorrhage, dogs were assigned to hypotensive (HG) and normotensive (NG) groups post hoc. During ISO, stroke index and cardiac index decreased with hemorrhage (P < 0.05), while VR normalized or increased these variables. The PPV (% mean [range]) was increased by hemorrhage from 7 (5-9) to 20 (12-27) and 27 (17-40) at HV20 and HV30, respectively, only in ISO dogs in the HG; PPV returned to baseline after VR. Dexmedetomidine caused increases in systemic vascular resistance (in dogs in HG and NG), and prevented the increase in PPV with hemorrhage.

CONCLUSIONS: During ISO anesthesia, PPV increases in individuals prone to developing hypotension from hypovolemia. Because DEX prevents the increase in PPV associated with hypovolemia, PPV should not be used to guide VR in dogs that have been given DEX.

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**Perioperative and anesthetic management of complete tracheal rupture in one dog and one cat.**

Morath U(1), Gendron K, Revés NV, Adami C.

Author information:
(1) From the Anesthesiology and Pain Therapy Division, Department of Veterinary Clinical Science Vetsuisse Faculty, Berne, Switzerland.

The authors describe two animals (one dog and one cat) that were presented with severe respiratory distress after trauma. Computerized tomographic imaging under general anesthesia revealed, in both cases, complete tracheal transection. Hypoxic episodes during anesthesia were relieved by keeping the endotracheal tube (ETT) positioned in the cranial part of the transected trachea and by allowing spontaneous breathing. Surgical preparation was performed quickly, and patients were kept in a sternal position to improve ventilation and oxygenation, and were only turned into dorsal recumbency shortly before surgical incision. A sterile ETT was guided into the distal part of the transected trachea by the surgeon, at which point mechanical ventilation was started. Both animals were successfully discharged from hospital a few days after surgery. Rapid and well-coordinated teamwork seemed to contribute to the good outcome. Precise planning and communication between anesthetists, surgeons, and technicians, as well as a quick course of action prior to correct ETT positioning helped to overcome critical phases.

Anesthesia case of the month. Diaphragmatic herniation.

Melis SM(1), de Rooster H, Waelbers T, Polis I.

Author information:
(1) Department of Medicine and Clinical Biology of Small Animals, Faculty of Veterinary Medicine, Ghent University, 9820 Merelbeke, Belgium.

PMID: 25406702 [PubMed indexed for MEDLINE]


Outcome of positive-pressure ventilation in dogs and cats with congestive heart failure: 16 cases (1992-2012).

Edwards TH(1), Erickson Coleman A, Brainard BM, DeFrancesco TC, Hansen BD, Keene BW, Koenig A.

Author information:
(1) Department of Small Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, Athens, GA 30602.

OBJECTIVE: To describe the indications, duration of ventilation, underlying cardiac diseases, and outcome of dogs and cats undergoing positive-pressure ventilation (PPV) for treatment of congestive heart failure (CHF).


SETTING: Two university small animal teaching hospitals.

ANIMALS: Six cats and 10 dogs undergoing PPV for CHF.

INTERVENTIONS: None.

MEASUREMENTS AND MAIN RESULTS: Medical records were searched to identify patients requiring PPV for treatment of pulmonary edema secondary to CHF. Sixteen animals fulfilled these criteria. Patient signalment, duration of PPV, underlying cardiac disease, arterial or venous blood gas values, pharmacologic therapy before, during, and after PPV, anesthetic drugs, complications, and outcome were recorded. Overall survival to discharge was 62.5% (10/16). Mean (±SD) duration of PPV was 30.8 ± 21.3 hours and average time from presentation for CHF to initiation of PPV was 5.9 ± 6.4 hours. Azotemia at the time of initiation of ventilation, development of anuria or oliguria, and use of pentobarbital for anesthesia were negatively associated with survival (P = 0.011, P = 0.036, and P = 0.036, respectively). Survival-to-discharge rate was 77% (10/13) for patients treated after 2005 and those not receiving pentobarbital. There was no significant effect attributed to age, sex, weight, species, nature of heart...
disease, furosemide dose, length of ventilation, use of vasopressors, first-time CHF events, or plasma lactate concentration on survival to discharge.

CONCLUSIONS: Dogs and cats requiring PPV for CHF have a good overall prognosis for hospital discharge and require PPV for a relatively short duration. Azotemia, oliguria or anuria, and the use of pentobarbital are negatively associated with outcome.

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Respiratory system compliance and resistance in canine anesthesia practice: do we have a reference?

Soares JH(1).

Author information:
(1)William R. Pritchard Veterinary Medical Teaching Hospital, School of Veterinary Medicine, University of California Davis, Davis, CA, USA. jhsoares@ucdavis.edu.

Comment in

Comment on

PMID: 24673898  [PubMed - indexed for MEDLINE]


Comparison of propofol and propofol/ketamine anesthesia for evaluation of laryngeal function in healthy dogs.

McKeirnan KL(1), Gross ME, Rochat M, Payton M.

Author information:
(1)Department of Veterinary Clinical Sciences (K.M., M.G., M.R.) and Department of Statistics, Oklahoma State University, Stillwater, OK (M.P.).

Thiopental is an excellent choice for evaluation of laryngeal function. Unfortunately, thiopental is no longer manufactured. In its absence, the ideal anesthetic protocol for laryngoscopy has not been determined. Propofol and propofol/ketamine were compared for the evaluation of laryngeal function in 48
healthy dogs. Laryngeal exposure was moderate to excellent in all dogs and not significantly different between protocols. Saturation of peripheral O2 (SPO2) readings were decreased in the propofol/ketamine group, and deeper respirations were more likely to correlate with normal laryngeal function regardless of treatment group. Doxapram was administered to apneic patients to stimulate respiration and allow for evaluation of laryngeal function. No significant difference in frequency of doxapram administration between groups was noted. Doxapram resulted in higher respiratory scores and significantly increased the ability to determine normal laryngeal function. Ketamine did not allow for a reduction in propofol dose and caused increased respiratory depression, making ketamine a poor addition to propofol for laryngeal function examination. Regardless of the protocol used, laryngeal function should be determined in conjunction with the respiratory phase and depth of respirations. Patients with either absent or shallow respirations should receive doxapram for accurate evaluation of laryngeal function.

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The effects of different inspired oxygen fractions on gas exchange and Tei-index of myocardial performance in propofol-anesthetized dogs.

Ferro Lopes PC(1), Nunes N, Sousa MG, Nishimori CT, Carareto R, Dos Santos PS, Camacho AA.

Author information:
(1)Department of Veterinary Medicine and Surgery, Veterinary Surgery Postgraduate Program, College of Agricultural and Veterinary Sciences, Universidade Estadual Paulista Júlio de Mesquita Filho, Jaboticabal, SP, Brazil.

OBJECTIVE: To evaluate the influence of different inspired oxygen fractions (FiO2) on pulmonary oxygen exchange and Tei-index of myocardial performance in propofol-anesthetized dogs.

STUDY DESIGN: Prospective crossover, randomized, experimental trial.

ANIMALS: Eight adult dogs weighing 8.6 ± 1.8 kg.

METHODS: The animals were anesthetized on five occasions, receiving either an FiO2 = 1.0 (F100), 0.8 (F80), 0.6 (F60), 0.4 (F40) or 0.21 (F21). Propofol was used for induction (6.45 ± 0.69 mgkg(-1) IV) followed by a continuous rate infusion (CRI, 0.7 mgkg(-1) minute(-1)). The dogs breathed spontaneously. The initial measurements of arterial partial pressures of oxygen (PaO2) and carbon dioxide (PaCO2), arterial hemoglobin saturation (SaO2), heart rate (HR), mean arterial pressure (MAP), cardiac index (CI), stroke index (SI), pre-ejection period (PEP) and left ventricular ejection time (LVET) were performed 30 minutes after beginning the CRI (T0) and then, at 15-minute intervals (T15-T60). From these measurements the following were calculated; alveolar oxygen partial pressure (PAO2), alveolar-arterial oxygen gradient (AaDO2), arterial oxygen partial pressure/inspired oxygen fraction ratio (PaO2/FiO2), arterial-to-alveolar
oxygen tension ratio (PaO2/PAO2), respiratory index (RI), oxygen delivery (D·O2), PEP/LVET ratio, isovolumic relaxation time (IVRT) and Tei-index.

RESULTS: At T30, PaCO2 in F100 was higher than in F21. The AaDO2 mean in F100 was greater than in other treatments. PaO2/FiO2 in F21 was lower than F100 and F80 at T0 and than in F80 and F60 at T15. At T15, PaO2/PAO2 and RI in F100 were higher than in F80, F60 and F21. At T30, PaO2/PAO2 in F21 was lower than in F100 and F60. At T30, PEP/LVET in F100 was higher than F80, F40 and F21, which was lower than F80 and F40.

CONCLUSION: The Tei-index and cardiovascular parameters are not affected by different FiO2.

CLINICAL RELEVANCE: An FiO2 of 1.0 and 0.21 impaired respiratory efficiency.

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Effect of ventilation technique and airway diameter on bronchial lumen to pulmonary artery diameter ratios in clinically normal beagle dogs.

Makara M(1), Dennler M, Schnyder M, Bektas R, Kircher P, Hall E, Glaus T.

Author information:
(1)Division of Diagnostic Imaging, Vetsuisse Faculty University of Zurich, Winterthurerstrasse 260, 8057 Zurich, Switzerland.

In dogs, a mean broncho-arterial ratio of 1.45 ± 0.21 has been previously defined as normal. These values were obtained in dogs under general inhalational anesthesia using a single breath-hold technique. The purpose of the study was to determine whether ventilation technique and bronchial diameter have an effect on broncho-arterial ratios. Four healthy Beagle dogs were scanned twice, each time with positive-pressure inspiration and end expiration. For each ventilation technique, broncho-arterial ratios were grouped into those obtained from small or large bronchi using the median diameter of the bronchi as the cutoff value. Mean broncho-arterial ratios obtained using positive-pressure inspiration (1.24 ± 0.23) were statistically greater than those obtained at end expiration (1.11 ± 0.20) P = 0.005. There was a strong positive correlation between bronchial diameter and broncho-arterial ratios for both ventilation techniques (positive-pressure inspiration rs = .786, P < 0.0005 and end expiration rs = .709, P < 0.0005). Mean broncho-arterial ratio for the large bronchi obtained applying positive-pressure inspiration was 1.39 cm ± 0.20 and during end expiration was 1.22 cm ± 0.20. Mean broncho-arterial ratio for the small bronchi obtained during positive-pressure inspiration was 1.08 cm ± 0.13 and during end expiration was 1.01 cm ± 0.13. There was a statistically significant difference between these groups (F = 248.60, P = 0.005). Findings indicated that reference values obtained using positive-pressure inspiration or from the larger bronchi
may not be applicable to dogs scanned during end expiration or to the smaller bronchi.

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Effects of fluid load on cardiovascular function during stepwise lung recruitment manoeuvre in healthy dogs.

Canfrán S(1), Gómez de Segura IA, Cediel R, García-Fernández J.

Author information:
(1)Department of Animal Medicine and Surgery, Veterinary Faculty, Complutense University of Madrid, Avda. Puerta de Hierro s/n, Madrid 28040, Spain. Electronic address: scanfran@vet.ucm.es.

The aim of this study was to evaluate the effects of a stepwise lung recruitment manoeuvre (RM) on cardiac output (CO) in mechanically ventilated dogs, with or without a previous fluid load. Eight healthy adult Beagle dogs were enrolled in a prospective crossover study. Following sedation with dexmedetomidine and methadone, anaesthesia was induced with propofol and maintained with isoflurane. CO (thermodilution method) and direct arterial blood pressure were monitored. The dogs were mechanically ventilated in a volume-controlled mode (tidal volume, VT = 10 mL/kg; positive end-expiratory pressure [PEEP] = 0 cm H2O) until normocapnia was achieved (end tidal CO2 35-45 mmHg). The RM was then performed in a pressure-controlled mode, with progressive increases of the PEEP and end-inspiratory pressure of 5 cm H2O, until 15 cm H2O and 30 cm H2O were reached, respectively. After the RM, the ventilatory mode was returned to volume-control, and the PEEP was sequentially decreased to 10, 5 and 0 cm H2O. Baseline ventilation was maintained for 30 min. Next, 10 mL/kg of lactated Ringer's solution was administered within 10 min, prior to a second RM. The CO was determined before each RM (baseline) and at each pressure step. A repeated measures ANOVA test was used to compare data. Compared to baseline, CO decreased during the RM in both groups. However, there was a significantly higher CO during the second RM at the highest pressure step (P<0.05) and during all decreasing pressure steps (P<0.05). In conclusion, a previous crystalloid fluid load could reduce the impact of a RM on CO in healthy dogs.

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Basics of mechanical ventilation for dogs and cats.

Hopper K(1), Powell LL.

Author information:
(1)Department of Veterinary Surgical and Radiological Sciences, University of California, Davis, CA, USA.

Respiratory failure may occur due to hypoventilation or hypoxemia. Regardless of the cause, emergent anesthesia and intubation, accompanied by positive pressure ventilation, may be necessary and life saving. Long-term mechanical ventilation requires some specialized equipment and knowledge; however, short-term ventilation can be accomplished without the use of an intensive care unit ventilator, and can provide oxygen supplementation and carbon dioxide removal in critical patients.

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Measurement of respiratory system compliance and respiratory system resistance in healthy dogs undergoing general anaesthesia for elective orthopaedic procedures.

Bradbrook CA(1), Clark L, Dugdale AH, Burford J, Mosing M.

Author information:
(1)Davies Veterinary Specialists, Higham Gobion, UK. carlbradbrook@gmail.com

Erratum in

Comment in

OBJECTIVE: The aim of this study was to investigate normal values for the dynamic compliance of the respiratory system (Crs) and respiratory system resistance (Rrs) in mechanically ventilated anaesthetized dogs.

STUDY DESIGN: Prospective clinical study.

ANIMALS: Forty healthy dogs undergoing elective orthopaedic surgery. Body weight was (mean ± SD) 26.8 ± 10.7 kg (range: 1.9-45.0 kg), age 4.7 ± 2.9 years (range: 0.1-10.6 years).

METHODS: Dogs were premedicated with acepromazine and methadone administered intramuscularly and anaesthesia induced with propofol intravenously. After endotracheal intubation the dog’s lungs were connected to an appropriate breathing system depending on body weight and isoflurane in oxygen administered
for maintenance of anaesthesia. The lungs were ventilated mechanically with variables set to maintain normocapnia (end-tidal carbon dioxide concentration 4.7-6.0 kPa). Peak inspiratory pressure, Crs, Rrs, tidal volume, respiratory rate and positive end-expiratory pressure were recorded at 5, 30, 60, 90 and 120 minutes after start of mechanical ventilation. Cardiovascular variables were recorded at time of collection of respiratory data.

RESULTS: General additive modeling revealed the following relationships: Crs = [0.895 × body weight (kg)] + 8.845 and Rrs = [-0.0966 × body weight (kg)] + 6.965. Body weight and endotracheal tube diameter were associated with Crs (p<0.001 and p=0.002 respectively) and Rrs (p=0.017 and p=0.002 respectively), body weight being linearly related to Crs and inversely to Rrs.

CONCLUSION AND CLINICAL RELEVANCE: Body weight was linearly related to Crs while Rrs has an inverse linear relationship with body weight in mechanically ventilated dogs. The derived values of Crs and Rrs may be used for monitoring of lung function and ventilation in healthy dogs under anaesthesia.

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Effects of reduction of inspired oxygen fraction or application of positive end-expiratory pressure after an alveolar recruitment maneuver on respiratory mechanics, gas exchange, and lung aeration in dogs during anesthesia and neuromuscular blockade.

De Monte V(1), Grasso S, De Marzo C, Crovace A, Staffieri F.

Author information:
(1)Dipartimento dell'Emergenza e dei Trapianti di Organi, Sezione di Chirurgia Veterinaria, Facoltà di Medicina Veterinaria, Università degli Studi di Bari, Aldo Moro, Valenzano, Bari, Italy.

OBJECTIVE: To evaluate the effectiveness of reduction of inspired oxygen fraction (Fio(2)) or application of positive end-expiratory pressure (PEEP) after an alveolar recruitment maneuver (ARM) in minimizing anesthesia-induced atelectasis in dogs.

ANIMALS: 30 healthy female dogs.

PROCEDURES: During anesthesia and neuromuscular blockade, dogs were mechanically ventilated under baseline conditions (tidal volume, 12 mL/kg; inspiratory-to-expiratory ratio, 1:2; Fio(2), 1; and zero end-expiratory pressure [ZEEP]). After 40 minutes, lungs were inflated (airway pressure, 40 cm H(2)O) for 20 seconds. Dogs were then exposed to baseline conditions (ZEEP100 group), baseline conditions with Fio(2) reduced to 0.4 (ZEEP40 group), or baseline conditions with PEEP at 5 cm H(2)O (PEEP100 group; 10 dogs/group). For each dog, arterial blood gas variables and respiratory system mechanics were evaluated and
CT scans of the thorax were obtained before and at 5 (T5) and 30 (T30) minutes after the ARM.

RESULTS: Compared with pre-ARM findings, atelectasis decreased and Pao(2):Fio(2) ratio increased at T5 in all groups. At T30, atelectasis and oxygenation returned to pre-ARM findings in the ZEEP100 group but remained similar to T5 findings in the other groups. At T5 and T30, lung static compliance in the PEEP100 group was higher than values in the other groups.

CONCLUSIONS AND CLINICAL RELEVANCE: Application of airway pressure of 40 cm H(2)O for 20 seconds followed by Fio(2) reduction to 0.4 or ventilation with PEEP (5 cm H(2)O) was effective in diminishing anesthesia-induced atelectasis and maintaining lung function in dogs, compared with the effects of mechanical ventilation providing an Fio(2) of 1.

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Use of a laryngeal mask airway in a brachycephalic dog with masticatory myositis and trismus.

Reed F(1), Iff I.

Author information:
(1)Small Animal Teaching Hospital, School of Veterinary Science, University of Liverpool, Leahurst, Chester High Road, Neston CH64 7TE United Kingdom. freed@staffmail.ed.ac.uk

An 8-month old, male, neutered bulldog was presented for investigation of a 2-day history of trismus. Endotracheal intubation was impossible as the dog was only able to open his mouth approximately 2 cm. A laryngeal mask airway was blindly inserted after induction of general anesthesia to maintain the patient on inhalational anesthesia and improve respiration for computed tomography and muscle biopsy. The dog recovered from anesthesia uneventfully.

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PMID: 22942446  [PubMed - indexed for MEDLINE]


Sudden generalized lung atelectasis during thoracotomy following thoracic lavage in 3 dogs.

Drynan E(1), Musk G, Raisis A.

Author information:
(1)Department of Anaesthesia, School of Veterinary and Biomedical Sciences, Murdoch University, Murdoch, Australia. e.drynan@murdoch.edu.au
OBJECTIVE: To describe sudden onset of generalized pulmonary atelectasis following thoracic lavage in 3 dogs.

SERIES SUMMARY: Thoracic lavage was performed following ligation of a patent ductus arteriosus in case 1, prior to closure of a large traumatic full thickness wound in the chest wall in case 2, and during investigation of an idiopathic spontaneous pneumothorax in case 3. In each case anesthesia and surgery were uneventful until thoracic lavage was performed, after which sudden generalized pulmonary atelectasis was observed. The atelectasis was visualized and was associated with oxyhemoglobin desaturation, decreased end-tidal carbon dioxide partial pressure (ETCO(2)), and a marked increase in the peak inspiratory pressure (PIP) required to achieve visible lung inflation. Occlusion of the endotracheal tube and cervical trachea was directly eliminated as the cause of atelectasis in cases 1 and 2, and indirectly eliminated in case 3. Improvement in pulmonary function occurred in all cases in response to increased PIP ± positive end expiratory pressure (PEEP).

NEW OR UNIQUE INFORMATION PROVIDED: Generalized atelectasis should be considered a possible complication of thoracic lavage performed during thoracotomy. In the cases presented here, it is suspected that pre-existing reduction in lung volume (due to inadequate ventilation, surgical compression, absorption atelectasis) was exacerbated by the addition of the lavage fluid to the thoracic cavity. This pre-existing lung collapse is believed to have resulted in reduction of lung volume and that further reduction below the critical closing volume occurred following instillation of saline into the thorax resulting in the subsequent development of generalized atelectasis. The performance of regular arterial blood gas analyses and different ventilation protocols may have prevented the marked atelectasis that was observed in these cases.

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Positive pressure ventilation during anesthesia in dogs: Assessment of surface area derived tidal volume.

Dyson DH(1).

Author information:
(1) Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, Ontario. ddyson@uoguelph.ca

The purpose of this study was to assess the use of surface area derived tidal volume in anesthetized ventilated dogs (n = 71, random assignment) compared to settings by experienced personnel. There was no significant difference (P = 0.1030) between methods (p(a)CO(2) of 43.1 ± 7 mmHg and 39.8 ± 7 mmHg, respectively). Surface area derived tidal volume can achieve satisfactory ventilation.
Effects of a stepwise lung recruitment manoeuvre and positive end-expiratory pressure on lung compliance and arterial blood oxygenation in healthy dogs.

Canfrán S(1), Gómez de Segura IA, Cediel R, García-Fernández J.

Author information:
(1)Department of Animal Medicine and Surgery, Veterinary Faculty, Complutense University of Madrid, Avda. Puerta de Hierro s/n, Madrid 28040, Spain.
scanfran@vet.ucm.es

This study was performed to evaluate the effects of a stepwise lung recruitment manoeuvre (RM) on dynamic lung compliance (Cdyn) and gas exchange in mechanically ventilated healthy dogs. Fourteen healthy adult dogs, scheduled for elective surgery in dorsal recumbency were employed. After anaesthetic induction, dogs were mechanically ventilated in a volume-controlled mode (tidal volume, VT=10 mL/kg); positive end-expiratory pressure (PEEP)=0 cm H(2)O; oxygen inspired fraction (FiO(2))=0.4 for 30 min (baseline). The dogs were then randomly allocated into two groups, control and RM. The ventilatory mode was maintained during the whole surgical procedure in the control group without any intervention, as in general practice. The RM was performed in a pressure-controlled mode, with progressive increases of PEEP and end-inspiratory pressure of 5 cm H(2)O until 15 cm H(2)O and 30 cm H(2)O, respectively. After RM, PEEP was decreased to 4 cm H(2)O, and the ventilatory mode was returned to volume-control. Arterial blood gases and Cdyn were determined at baseline, 20 and 60 min afterwards. Student’s t test and the one-way ANOVA test were employed to compare data. Cdyn increased in the RM group (183 ± 30% and 165 ± 24% at 20 and 60 min, respectively; P=0.000). The baseline partial pressure of arterial oxygen to FiO(2) ratio (PaO(2)/FiO(2) ratio) did not change in the control group, but was higher in the RM group (527 ± 41 mm Hg and 511 ± 46 mm Hg at 20 and 60 min, respectively; baseline 371 ± 34 mm Hg, P<0.001). In conclusion, a stepwise RM followed by the use of PEEP improves Cdyn and oxygenation in mechanically ventilated healthy dogs.

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Although left- or right-sided pneumonectomy is tolerated by normal dogs, complications impacting the respiratory, cardiovascular, and gastrointestinal systems are not uncommon. Pneumonectomy in dogs results in secondary changes in the remaining lung, which include: decreased compliance and vital capacity; and increased pulmonary vascular resistance potentially leading to right ventricular hypertrophy. Such alterations make the anesthetic management of an animal with one lung particularly challenging. This report describes a dog with a history of left pneumonectomy due to Aspergillus fumigatus pneumonia 3 yr before presentation. The dog presented with a vaginal wall prolapse, and surgical resection of the protruding vaginal wall, ovariectomy, and prophylactic gastropexy were performed. Anesthesia was induced with midazolam, fentanyl, and propofol and was maintained with isoflurane using intermittent positive pressure ventilation and a constant rate infusion of fentanyl. Epidural anesthesia was also used. Recovery and postoperative management were uncomplicated. Intensive hemodynamic and respiratory monitoring and appropriate response and treatment of any detected abnormalities, taking into consideration the pathophysiologic alterations occurring in a pneumonectomized animal, are required for successful perianesthetic management.

PMID: 22267172 [PubMed - indexed for MEDLINE]

Comparison of two different methods for physiologic dead space measurements in ventilated dogs in a clinical setting.

Mosing M(1), Staub L, Moens Y.

OBJECTIVE: To compare physiologic dead space (V(D)) and physiologic dead space to tidal volume (V(T)) ratio (V(D)/V(T)) obtained by an automated single breath test for carbon dioxide (CO(2)) (method SBT) and a manual calculation (method MC) in ventilated healthy dogs.

STUDY DESIGN: Prospective clinical study.

ANIMALS: Twenty client-owned dogs, ASA I and II undergoing anaesthesia for clinical purposes.

METHODS: Following pre-medication, induction of anaesthesia, and intubation of the trachea, intermittent positive pressure ventilation was commenced. Mixed expired CO(2) partial pressure (PeCO(2)) was measured by two methods: method MC
by analysis, using an infrared capnograph, of the expired gas collected in a mixing box and method SBT which calculated it automatically by a device consisting of a mainstream capnograph and a pneumotachograph. At four time points arterial partial pressure of CO(2) (PaCO(2)) was measured. Physiologic dead space variables (V(D) and V(D)/V(T)) were calculated manually (method MC) or automatically (method SBT) using the Bohr-Enghoff equation. Method MC and SBT were compared using Bland-Altman plots and linear regression. Intra-class correlation coefficient (ICC) was used to measure consistency of each method.

RESULTS: Four measurement pairs were obtained in all 20 dogs for method SBT and MC. The bias was -1.15 mmHg, 7.97 mL and 0.02 for PēCO(2), V(D) and V(D)/V(T), respectively. Linear regression analysis revealed a correlation coefficient (r(2)) of 0.79, 0.94, and 0.83 for PēCO(2), V(D) and V(D)/V(T), respectively. The ICC revealed an excellent consistency for both methods.

CONCLUSIONS: The single breath test (SBT) can be used for clinical evaluation of V(D) and V(D)/V(T) in anaesthetized ventilated dogs.

CLINICAL RELEVANCE: Through measuring V(D) and V(D)/V(T) important information about lung ventilation can be obtained and the SBT is an easy method to use for this purpose.

PMID: 20712605 [PubMed - indexed for MEDLINE]


Anesthesia for patients with respiratory disease and/or airway compromise.

Grubb T(1).

Author information:
(1)College of Veterinary Medicine, Veterinary Clinical Sciences, Washington State University, Pullman, WA 99164-7010, USA. tgrubb@vetmed.wsu.edu

Because the airway extends from the oral or nasal cavity to the alveoli, airway compromise or respiratory disease has numerous manifestations. Complications can be encountered in both the upper and lower airways and include a vast range of problems including laryngeal paralysis, collapsing trachea, pneumonia, pulmonary edema, pneumothorax, intrathoracic masses and diaphragmatic hernias. Anesthesia can cause further complications because anesthetic drugs and equipment can exacerbate or even cause airway difficulties and respiratory compromise. When anesthetizing patients with respiratory disease or airway complications, the choice of the actual anesthetic drugs is not necessarily dictated by the presence of respiratory compromise, but rather by the overall health of the patient. The choice of anesthetic technique (e.g., method of induction, method of intubation, use of positive-pressure ventilation, etc.), on the other hand, is often critical.

PMID: 20515675 [PubMed - indexed for MEDLINE]

Alveolar recruiting maneuver in dogs under general anesthesia: effects on alveolar ventilation, gas exchange, and respiratory mechanics.

Staffieri F(1), De Monte V, De Marzo C, Scrascia F, Crovace A.

Author information:
(1)Dipartimento delle Emergenze e dei Trapianti d'Organo, Sezione di Chirurgia Veterinaria, Università degli Studi di Bari, Bari, Italy. f.staffieri@veterinaria.uniba.it

The aim of this study was to evaluate the effects of a recruiting maneuver (RM) on lung aeration, gas exchange, and respiratory mechanics during general anesthesia in mechanically ventilated dogs. A thoracic computed tomography (CT) scan, an arterial blood sample, and measurement of respiratory mechanics were performed 10 min before (baseline) and both 5 and 30 min after a vital capacity RM in 10 dogs under general anesthesia. The RM was performed by inflating the lung at 40 cm H(2)O for 20 s. Lung aeration was estimated by analyzing the radiographic attenuation of the CT images. Lung aeration and gas exchange improved significantly 5 min after the RM compared to baseline and returned to values similar to baseline by 30 min. Static lung compliance was not significantly affected by the RM. An RM induces a temporary improvement in lung function in healthy dogs under general anesthesia.

PMID: 20437272 [PubMed - indexed for MEDLINE]


Cardiopulmonary effects of a new inspiratory impedance threshold device in anesthetized hypotensive dogs.

Shih AC(1), Vigani A, Loring N, Pereira FG, Szarowicz M, Bandt C.

Author information:
(1)Department of Large Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville, FL 32610, USA. shiha@vetmed.ufl.edu

OBJECTIVE: To compare the hemodynamic and respiratory effects of an inspiratory impedance threshold device (ITD) in anesthetized normotensive and hypotensive dogs.

STUDY DESIGN: Prospective randomized study.

ANIMALS: Ten adult dogs.

METHODS: Dogs were anesthetized with propofol followed by isoflurane. During spontaneous ventilation, tidal volume (VT), systolic (SAP), mean (MAP) and diastolic arterial blood pressure, central venous pressure, gastric PCO(2) as an indicator of gastric perfusion, subcutaneous oxygen tension, subcutaneous blood flow, cardiac index (CI), systemic vascular resistance and blood lactate were monitored. To monitor respiratory compliance (RC) and resistance (ResR), animals
were briefly placed on mechanical ventilation. Dogs were studied under four different conditions: 1) normotension (MAP > 60 mmHg) with and without the ITD and 2) hypotension (target MAP = 40 mmHg) with and without ITD. These four conditions were performed during one anesthetic period, allowing for stabilization of parameters for each condition. Data were analyzed by anova repeated measure mixed models.

RESULTS: No cardiovascular changes were detected between no ITD and ITD in the normotensive state. During hypotension, CI was higher with the ITD (5 +/- 1.0 L minute(-1) m(-2)) compared with no ITD (4 +/- 1.3 L minute(-1) m(-2)). During hypotension, SAP was increased with ITD (80 +/- 14 mmHg) versus without ITD (67 +/- 13 mmHg). There was an increase in ResR and decreased RC with the ITD in both normotensive and hypotensive state.

CONCLUSION AND CLINICAL RELEVANCE: Impedance threshold device in dogs during isoflurane-induced hypotension improved CI and SAP but had negative effects on RC and ResR.

PMID: 20230556 [PubMed - indexed for MEDLINE]


A comparison of response time to desaturation between tracheal oximetry and peripheral oximetry.

Wang L(1), Wei W, Gong M, Mu L.

Author information:
(1)Department of Anesthesiology, NO. 1 People's Hospital of Yibin, Yibin, Sichuan, China.

OBJECTIVE: Trachea is an alternative site for pulse oxygen saturation monitoring. The response time of the oximetry probe has been reported more rapid when placed in central than in peripheral. The purpose of this study is to compare the performance of the oximetry probes placed in trachea and peripheral site during rapid desaturation.

METHODS: Endotracheal tubes with an oximetry sensor were intubated in ten anesthesia dogs. Both the oxygen saturation signals from trachea (S(t)O(2)) and tail (S(p)O(2)) were shown on the same monitoring screen. The mechanical ventilation was disconnected to produce a rapid desaturation when both S(t)O(2) and S(p)O(2) were 100%, and the mechanical ventilation was reconnected when S(p)O(2) decreased to 80%. The time of S(t)O(2) and S(p)O(2) dropped to 95, 90, 85, and 80% was recorded, respectively during the mechanical ventilation disconnection, and the arterial blood was sampled for arterial oxygen saturation (S(a)O(2)) measurement simultaneously. The levels of measurement agreement between two oximetry readings (S(p)O(2), S(t)O(2)) and S(a)O(2) were analyzed, respectively with the Bland and Altman method.

RESULTS: The mean response time of S(t)O(2) was significantly shorter than S(p)O(2) when both of them decreased from 100 to 80% (172.6 +/- 68.9 vs 220.7 +/- 72.3 s) during rapid desaturation. The 95% confidence interval for
absolute difference between S(p)O(2) and S(a)O(2) was 4.12+/-6.47%, and between S(t)O(2) and S(a)O(2) was 3.33-3.46%.

CONCLUSIONS: Oxymetry placed in trachea provides a better monitoring for detecting rapid desaturation than in peripheral.

PMID: 20224879 [PubMed - indexed for MEDLINE]


Fatal post-anaesthetic pneumothorax in a dog.

Harvey L, Murison PJ, Fews D, Murrell JC.

PMID: 20017824 [PubMed - indexed for MEDLINE]


The effects of 2 levels of the inspired oxygen fraction on blood gas variables in propofol-anesthetized dogs with high intracranial pressure.

Gonçalves Dias LG(1), Nunes N, Lopes PC, de Almeida RM, Neto GB, de Souza AL, de Almeida Belmonte E.

Author information:
(1)Departamento de Clínica e Cirurgia Veterinária, Universidade Estadual Paulista, Via de Acesso Professor Paulo Donato Castellane, s/n degrees, Jaboticabal, São Paulo CEP 14884-900, Brasil.

The influence of 2 different levels of the inspired oxygen fraction (FiO2) on blood gas variables was evaluated in dogs with high intracranial pressure (ICP) during propofol anesthesia (induction followed by a continuous rate infusion [CRI] of 0.6 mg/kg/min) and intermittent positive pressure ventilation (IPPV). Eight adult mongrel dogs were anesthetized on 2 occasions, 21 d apart, and received oxygen at an FiO2 of 1.0 (G100) or 0.6 (G60) in a randomized crossover fashion. A fiberoptic catheter was implanted on the surface of the right cerebral cortex for assessment of the ICP. An increase in the ICP was induced by temporary ligation of the jugular vein 50 min after induction of anesthesia and immediately after baseline measurement of the ICP. Blood gas measurements were taken 20 min later and then at 15-min intervals for 1 h. Numerical data were submitted to Morrison’s multivariate statistical methods. The ICP, the cerebral perfusion pressure and the mean arterial pressure did not differ significantly between FiO2 levels or measurement times after jugular ligation. The only blood gas values that differed significantly (P < 0.05) were the arterial oxygen partial pressure, which was greater with G100 than with G60 throughout the procedure, and the venous haemoglobin saturation, that was greater with G100 than with G60 at M0. There were no significant differences between FiO2 levels or measurement times in the following blood gas variables: arterial carbon dioxide partial pressure, arterial hemoglobin saturation, base deficit, bicarbonate concentration, pH,
venous oxygen partial pressure, venous carbon dioxide partial pressure and the arterial-to-end-tidal carbon dioxide difference.

PMCID: PMC2666315
PMID: 19436579  [PubMed - indexed for MEDLINE]

The effect of manual lung inflation vs. spontaneous inspiration on the cardiac silhouette in anesthetized dogs.

Webster N(1), Adams V, Dennis R.

Author information:
(1)Center for Small Animal Studies, Animal Health Trust, Lanwades Park, Kentford, Newmarket, Suffolk, UK CB87UU. natalie.webster@aht.org.uk

The purpose of this study was to assess radiographic heart size in anesthetized dogs, comparing radiographs made with the patient breathing spontaneously to radiographs obtained using positive pressure manual lung inflation. The hypothesis was that manual inflation would cause reduction in the cardiac size. With dogs in right recumbency a radiograph was made at peak spontaneous inspiration followed immediately a radiograph made with application of positive pressure manual inflation of the thorax. Cardiac size was assessed, both subjectively and objectively using the vertebral heart scale (VHS). Two hundred and six dogs were studied. Manual inflation resulted in a significantly greater degree of lung inflation assessed radiographically (P < 0.0001). The subjectively assessed heart size was significantly smaller in radiographs made with manual inflation, leading to different subjective categorization of heart size in 67 (32%) of dogs. The objectively measured VHS was also significantly smaller in the radiographs made using manual inflation by a mean of 0.24 of a vertebral length (95% CL of mean difference: -0.29, -0.19, P < 0.0001). A statistically significant reduction in subjective heart size and in VHS occurred with manual inflation of the lungs, and these differences may be clinically significant. Thus, if serial radiographs are obtained to assess cardiac size, the radiographic technique used should be the same.

PMID: 19400463  [PubMed - indexed for MEDLINE]

Guidelines and criteria for the placement of laryngeal mask airways in dogs.

Wiederstein I(1), Moens YP.

Author information:
(1)Clinic of Anaesthesiology and Perioperative Intensive Care, Department of
OBJECTIVE: To evaluate the criteria for the insertion and correct placement of the laryngeal mask airway (LMA) in dogs. Study design Prospective descriptive clinical study. Animals Thirty healthy dogs (ASA I or II) of different breeds, age 0.33-7.0 years (2.8 +/- 2.1; mean +/- SD), weight 2.2-59.0 kg (23.9 +/- 14.4), anaesthetized for elective surgery.

MATERIALS AND METHODS: The dogs were sedated with intravenous (IV) medetomidine (10 microg kg(-1)) and butorphanol (0.2 mg kg(-1)). If considered necessary, IV propofol (1 mg kg(-1) over 30 seconds) was administered until the LMA was inserted and positioned correctly. The position of the LMA was evaluated using predefined criteria for its insertion and inflation of the cuff, together with the ability to ventilate the dogs through the LMA.

RESULTS: The criteria for insertion, inflation and ventilation which indicated a clinically optimal position of the LMA and its seal around the larynx were met in 19 dogs (63.3%). The dogs could be manually ventilated with inspiratory peak pressures of 10 cm H(2)O without capnographic or audible evidence of leakage. In 11 dogs (36.7%), the LMA was positioned suboptimally with leakage during manual ventilation with inspiratory peak pressures not exceeding 10 cmH(2)O. There was no evidence of breed-related differences in LMA placement and position.

CONCLUSIONS AND CLINICAL RELEVANCE: The technique for the insertion of the LMA using predefined criteria to evaluate a correct positioning and a seal led to a successful placement in dogs of both brachycephalic and nonbrachycephalic breeds. The LMA, in most of the dogs, was easily placed, well tolerated and offered a useful less invasive means of securing the upper airway.

PMID: 18466166 [PubMed - indexed for MEDLINE]


Endoscopic removal of a bronchial carcinoma in a dog using one-lung ventilation.

Mosing M(1), Iff I, Moens Y.

Author information:
(1)Clinic of Anaesthesiology and Perioperative Intensive Care, University of Veterinary Medicine Vienna, Veterinärplatz 1, A-1210 Vienna, Austria. Martina@mosing.at

OBJECTIVE: To describe anesthetic management of endoscopic electrosurgical removal of a bronchial carcinoma, partially blocking the right main stem bronchus in a Cocker Spaniel.

STUDY DESIGN: Clinical case report.

ANIMALS: Dog with a bronchial carcinoma.

METHODS: To allow sufficient space for the endoscope and to avoid an oxygen-rich gas mixture in the trachea, which carries the risk of an airway fire when electrocautery is used, a 1 lumen endobronchial tube (EBT) was inserted into the left main stem bronchus. One-lung ventilation (OLV) started with a
volume-controlled ventilator was switched to pressure-controlled ventilation in combination with positive end-expiratory pressure (PEEP).
RESULTS: Resection of the bronchial carcinoma was successful. The dog was hypercapnic throughout the procedure and a high alveolar-arterial oxygen gradient was measured.
CONCLUSION: An EBT may be a feasible and safe option to provide OLV for bronchoscopic electrocautery with a closed thoracic cavity in dogs.
CLINICAL RELEVANCE: EBT intubation for OLV should be considered as part of the anesthetic management of airway diseases treated with bronchoscopic electrocautery.

PMID: 18394067 [PubMed - indexed for MEDLINE]


Normal values and incidence of cardiorespiratory complications in dogs during general anaesthesia. A review of 1281 cases.

Redondo JI(1), Rubio M, Soler G, Serra I, Soler C, Gómez-Villamandos RJ.

Author information:
(1)Department of Animal Medicine and Surgery, Cardenal Herrera-CEU University, Valencia, Spain. nacho@uch.uch.es

This paper describes the cardiorespiratory variables and the incidence of anaesthetic complications in dogs. For this, a retrospective study of 1281 anaesthesias was performed. Heart rate (HR), non-invasive mean arterial (MAP), systolic (SP) and diastolic pressures (DP), invasive mean arterial (IMAP), systolic (ISP) and diastolic pressures (IDP), central venous pressure (CVP), respiratory rate (RR), tidal volume (V(T)), minute volume (V(M)), end-tidal CO(2) (EtCO(2)), arterial oxygen saturation (SpO(2)), temperature (T) and death are reported. Data were described both globally and separately for each ASA (American Society of Anaesthesiologists classification) status. An ANOVA and a Tukey's test were used for comparing the different ASA status’ values (alpha=0.05). During anaesthetic maintenance, the mean +/- SD of the studied variables were: HR: 91+/−27 bpm. MAP: 86+/−24 mmHg. IMAP: 80+/−22 mmHg. SP: 114+/−25 mmHg. ISP: 109+/−26 mmHg. DP: 67+/−23 mmHg. IDP: 66+/−22 mmHg. CVP: 5+/−3 mmHg. RR: 19+/−11 rpm. V(T): 14+/−7 ml/kg. V(M): 191+/−93 ml/kg/min. EtCO(2): 40+/−8 mmHg. T: 37.1+/−1.7 degrees C. ASA III and ASA IV patients, compared with those with ASA I, showed higher values of HR, RR, V(T) and V(M) and lower in IMAP, CVP, EtCO(2), SpO(2) and T. The most frequent complications were bradycardia (36.3% of the patients), hypotension (37.9%), hypoventilation (63.4%), hypoxia (16.4%), hypothermia (4.8%) and death (0.9%). Cardiorespiratory complications frequently occur in dogs during general anaesthesia.

PMID: 17931219 [PubMed - indexed for MEDLINE]

Computed tomographic analysis of the effects of two inspired oxygen concentrations on pulmonary aeration in anesthetized and mechanically ventilated dogs.

Staffieri F(1), Franchini D, Carella GL, Montanaro MG, Valentini V, Driessen B, Grasso S, Crovace A.

Author information:
(1)Dipartimento delle Emergenze e dei Trapianti d'Organo, Sezione di Chirurgia Veterinaria, Università degli Studi di Bari, 70010 Valenzano, Bari, Italy.

OBJECTIVE: To compare the effect of 2 concentrations of oxygen in inspired gas (fraction of inspired oxygen [FIO(2)] 1.0 or 0.4) on pulmonary aeration and gas exchange in dogs during inhalation anesthesia.

ANIMALS: 20 healthy dogs.

PROCEDURES: Following administration of acepromazine and morphine, anesthesia was induced in each dog with thiopental and maintained with isoflurane in 100% oxygen (100% group; n = 10) or a mixture of 40% oxygen and air (40% group; 10). Dogs were placed in dorsal recumbency and were mechanically ventilated. After surgery, spiral computed tomography (CT) of the thorax was performed and PaO(2), PaCO(2), and the alveolar-arterial oxygen tension difference (P([A-a])O(2)) were assessed. The lung CT images were analyzed, and the extent of hyperinflated (-1,000 to -901 Hounsfield units [HUs]), normally aerated (-900 to -501 HUs), poorly aerated (-500 to -101 HUs), or nonaerated (-100 to +100 HUs) areas was determined.

RESULTS: Compared with the 100% oxygen group, the normally aerated lung area was significantly greater and the poorly aerated and nonaerated areas were significantly smaller in the 40% oxygen group. The time to CT (duration of surgery) was similar in both groups. Although PaCO(2) was similar in both groups, PaO(2) and P([A-a])O(2) were significantly higher in the 100% oxygen group. In both groups, pulmonary atelectasis developed preferentially in caudal lung fields.

CONCLUSION AND CLINICAL RELEVANCE: In isoflurane-anesthetized dogs, mechanical ventilation with 40% oxygen appeared to maintain significantly better lung aeration and gas exchange than ventilation with 100% oxygen.

PMID: 17764405 [PubMed - indexed for MEDLINE]


Acute pulmonary edema after diazepam-ketamine in a dog.

Boutureira J(1), Trim CM, Cornell KK.

Author information:
(1)Department of Small Animal Medicine, College of Veterinary Medicine, University of Georgia, Athens, GA 30602, USA.

An 8-year-old mixed-breed dog was anesthetized for colonoscopy. Moderate sedation
was produced by premedication with glycopyrrolate, acepromazine, and hydromorphone, and anesthesia was induced by IV injection of diazepam and ketamine. Frothy, reddish-colored fluid flowed from the endotracheal tube immediately after endotracheal intubation but ceased after several minutes. Furosemide was injected IV. Anesthesia was maintained by sevoflurane in oxygen. Ventilation and arterial blood pressure were satisfactory, however, after oxygen was administered to maintain normal hemoglobin saturation. Radiography revealed changes consistent with a diagnosis of pulmonary edema. The following day, ventricular premature contractions developed and atrial dissociation, valvular regurgitation, and pulmonary hypertension were diagnosed on echocardiography. The proposed etiology is either profound transient hypotension and/or pulmonary hypertension induced by ketamine. The cardiac abnormalities that were present the following day suggest that myocardial dysfunction after induction of anesthesia was more severe than was apparent as assessed by routine physical examination and monitoring methods.

PMID: 17565575 [PubMed - indexed for MEDLINE]


Oxygenation in medetomidine-sedated dogs with and without 100% oxygen insufflation.

Ko JC(1), Weil AB, Kitao T, Payton ME, Inoue T.

Author information:
(1)Department of Veterinary Clinical Sciences, School of Veterinary Medicine, Purdue University, West Lafayette, IN 47908, USA.

Erratum in
Vet Ther. 2007 Summer;8(2):100.

Oxygenation status was evaluated in medetomidine-sedated dogs breathing room air (M) or 100 percent oxygen (MO2). Medetomidine (40 microg/kg IV) administration resulted in peripheral vasoconstriction and decreased venous saturation as measured by an increased oxygen extraction ratio in peripheral tissues. Providing 100 percent oxygen insufflation via face mask reduced desaturation by increasing oxygen content but did not prevent vasoconstriction or reduce the oxygen extraction ratio in peripheral tissues. Atipamezole (200 microg/kg IV) reversed medetomidine-induced vasoconstriction and increased oxygen supply to tissues as indicated by a lower tissue oxygen extraction ratio. The authors conclude that 100 percent oxygen insufflation via face mask during medetomidine sedation (40 micrograms/kg [corrected] IV) benefits tissue oxygenation in healthy dogs.

PMID: 17447225 [PubMed - indexed for MEDLINE]

Use of controlled ventilation in a clinical setting.

Sereno RL(1).

Author information:
(1)Section of Anesthesia and Pain Management, School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin 53706, USA.

Mechanical ventilation has long been used to maintain ventilation in humans when the lungs are rendered incapable of oxygenation or when respiration is affected by central nervous system depression, but it has only recently been applied to similar cases in dogs and cats. Although manual ventilation is still the more common form of ventilation in dogs and cats, mechanical intermittent positive-pressure ventilation (IPPV) is a much more efficient and reliable means of maintaining the highest quality of respiratory assistance. With proper training, technicians can use IPPV to support compromised animals until they are capable of maintaining normal oxygen concentrations.

PMID: 17088397 [PubMed - indexed for MEDLINE]


Effect of positive end-expiratory pressure on oxygen delivery during 1-lung ventilation for thoracoscopy in normal dogs.

Kudnig ST(1), Monnet E, Riquelme M, Gaynor JS, Corliss D, Salman MD.

Author information:
(1)Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, USA.

OBJECTIVE: To evaluate the effect of positive end-expiratory pressure (PEEP) on oxygen delivery (DO(2)) with 1-lung ventilation during thoracoscopy in normal anesthetized dogs.

STUDY DESIGN: Prospective, controlled experimental study.

ANIMALS: Eight, adult, intact Walker Hound dogs weighing 25.6-29.2 kg.

METHODS: Anesthetized dogs had 1-lung ventilation during an open-chest condition. A Swan-Ganz catheter was used to measure pulmonary hemodynamic variables and to obtain mixed venous blood samples for blood gas analysis. A dorsal pedal catheter was used for measurement of systemic arterial pressure and to obtain arterial blood samples for blood gas analysis. Oxygen delivery was calculated and used to assess the effect of 0, 2.5, and 5 cm H(2)O PEEP during 1-lung ventilation on cardiopulmonary function. Each dog was its own control at 0 cm H(2)O PEEP. A randomized block ANOVA for repeated measures was used to evaluate the effect of the treatment on hemodynamic and pulmonary variables.

RESULTS: Use of 5 cm H(2)O PEEP induced a significant augmentation in the arterial partial pressure of oxygen (PaO(2)). Shunt fraction (Q(s)/Q(t)), physiologic dead space (V(D)/V(T)), and the alveolar-arterial oxygen difference (P(A-a)O(2)) decreased significantly after 5 cm H(2)O PEEP, compared with 1-lung
ventilation without PEEP. Use of 2.5 cm H(2)O PEEP had no significant effect on cardiopulmonary variables. Use of PEEP had no significant effect on arterial oxygen saturation (SaO(2)), DO(2), and hemodynamic variables in normal dogs. CONCLUSIONS: PEEP had no effect on DO(2) in normal dogs undergoing open-chest 1-lung ventilation because it had no adverse effect on hemodynamic variables. CLINICAL RELEVANCE: PEEP in normal dogs during open-chest 1-lung ventilation for thoracoscopy is not detrimental to cardiac output and can be recommended in clinical patients.

PMID: 16911153  [PubMed - indexed for MEDLINE]


Hemodynamic and ventilatory effects of volume or pressure controlled ventilation in dogs submitted to pneumoperitoneum. Comparative study.

[Article in English, Portuguese]

Carraretto AR(1), Vianna PT, de Almeida AV, Ganem EM.

Author information:
(1)Departamento de Anestesiologia da Faculdade de Medicina de Botucatu (FMB-UNESP), Botucatu. roberto@carraretto.med.br

BACKGROUND AND OBJECTIVES: Pressure controlled ventilation (PCV) is available in anesthesia machines, but there are no studies on its use during CO2 pneumoperitoneum (CPP). This study aimed at evaluating pressure-controlled ventilation and hemodynamic and ventilatory changes during CPP, as compared to conventional volume controlled ventilation (VCV).

METHODS: This study involved 16 dogs anesthetized with thiopental, fentanyl and pancuronium, which were randomly assigned to two groups: VC - volume controlled ventilation (n=8) and PC - pressure controlled ventilation (n=8). Hemodynamic and ventilatory parameters were monitored and recorded in 4 moments: M1 (before CPP), M2 (30 minutes after CPP = 10 mmHg), M3 (30 minutes after CPP=15 mmHg) and M4 (30 minutes after deflation).

RESULTS: With CPP, there has been significant increase in tidal volume in PC group; there has been increase in airway pressures (peak and plateau), decrease in compliance with increase in CPP pressure, increase in heart rate, maintenance of mean blood pressure with higher values in the VC group in all stages; there was also increase in right atrium pressure with significant decrease after deflation, decrease in arterial pH with minor variations in PC group, greater arterial pCO2 stability in PC group, and no significant changes in arterial pO2.

CONCLUSIONS: There were some differences in hemodynamic and ventilatory data between both ventilation control modes (VC and PC). It is possible to use pressure controlled ventilation during CPP, but the anesthesiologist must monitor and take a close look at alveolar ventilation, adjusting inspiratory pressure to ensure proper CO2 elimination and oxygenation.

PMID: 19468538  [PubMed]
Cardiopulmonary effects of positive end-expiratory pressure during one-lung ventilation in anesthetized dogs with a closed thoracic cavity.

Riquelme M(1), Monnet E, Kudnig ST, Gaynor JS, Wagner AE, Corliss D, Salman MD.

Author information:
(1)Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523-1601, USA.

OBJECTIVE: To evaluate the effects on oxygen delivery (DO2) of 2.5 and 5 cm H2O of positive end-expiratory pressure (PEEP) applied to the dependent lung during one-lung ventilation (OLV) in anesthetized dogs with a closed thoracic cavity.

ANIMALS: 7 clinically normal adult Walker Hound dogs.

PROCEDURE: Dogs were anesthetized, and catheters were inserted in a dorsal pedal artery and the pulmonary artery. Dogs were positioned in right lateral recumbency, and data were collected during OLV (baseline), after application of 2.5 cm H2O of PEEP for 15 minutes during OLV, and after application of 5 cm H2O of PEEP for 15 minutes during OLV. Hemodynamic and respiratory variables were analyzed and calculations performed to obtain DO2, and values were compared among the various time points by use of an ANOVA for repeated measures.

RESULTS: PEEP induced a significant decrease in shunt fraction that resulted in a significant increase in arterial oxygen saturation. However, it failed to significantly affect arterial oxygen content (CaO2) or cardiac output. Thus, DO2 was not affected in healthy normoxemic dogs as a net result of the application of PEEP.

CONCLUSIONS AND CLINICAL RELEVANCE: The use of PEEP during OLV in anesthetized dogs with a closed thoracic cavity did not affect DO2. Use of PEEP during OLV in dogs with a closed thoracic cavity is recommended because it does not affect cardiac output and any gain in CaO2 will be beneficial for DO2 in critically ill patients.

PMID: 16008219 [PubMed - indexed for MEDLINE]

Cardiopulmonary changes induced during one-lung ventilation in anesthetized dogs with a closed thoracic cavity.

Riquelme M(1), Monnet E, Kudnig ST, Gaynor JS, Wagner AE, Corliss D, Salman MD.

Author information:
(1)Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523-1601, USA.

OBJECTIVE: To evaluate the effects of one-lung ventilation (OLV) on oxygen
delivery (DO2) in anesthetized dogs with a closed thoracic cavity.

**ANIMALS:** 7 clinically normal adult Walker Hound dogs.

**PROCEDURE:** Dogs were anesthetized. Catheters were inserted in a dorsal pedal artery and the pulmonary artery. Dogs were positioned in right lateral recumbency. Data were collected at baseline (Paco2 of 35 to 45 mm Hg), during two-lung ventilation, and 15 minutes after creating OLV. Hemodynamic and respiratory variables were analyzed and calculations performed to obtain DO2, and values were compared among the various time points by use of an ANOVA for repeated measures.

**RESULTS:** OLV induced a significant augmentation of shunt fraction that resulted in a significant reduction in Pao2, arterial oxygen saturation, and arterial oxygen content. Cardiac index was not significantly changed. The net result was that DO2 was not significantly affected by OLV.

**CONCLUSIONS AND CLINICAL RELEVANCE:** Use of OLV in healthy dogs does not induce significant changes in DO2, which is the ultimate variable to use when evaluating tissue oxygenation. One-lung ventilation can be initiated safely in dogs before entering the thoracic cavity during surgery. Additional studies are necessary to evaluate OLV in clinically affected patients and variations in age, body position, and type of anesthetic protocol.

PMID: 16008218 [PubMed - indexed for MEDLINE]


Effect of one-lung ventilation on oxygen delivery in anesthetized dogs with an open thoracic cavity.

Kudnig ST(1), Monnet E, Riquelme M, Gaynor JS, Corliss D, Salman MD.

Author information:
(1)Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523, USA.

**OBJECTIVE:** To evaluate effects of one-lung ventilation on oxygen delivery in anesthetized dogs with an open thoracic cavity.

**ANIMALS:** 8 clinically normal adult Walker Hound dogs.

**PROCEDURE:** Each dog was anesthetized and subjected to one-lung ventilation during a period when it had an open thoracic cavity. A Swan-Ganz catheter was used to measure hemodynamic variables and obtain mixed-venous blood samples. A catheter was inserted in the dorsal pedal artery to measure arterial pressure and obtain arterial blood samples. Oxygen delivery index was calculated and used to assess effects of one-lung ventilation on cardiopulmonary function. Effects on hemodynamic and pulmonary variables were analyzed.

**RESULTS:** One-lung ventilation caused significant decreases in PaO2, arterial oxygen saturation (SaO2), mixed-venous oxygen saturation, and arterial oxygen content (CaO2). One-lung ventilation caused significant increases in PaCO2, physiologic dead space, and alveolar-arterial oxygen difference. Changes in SaO2, CaO2, and PaCO2, although significantly different, were not considered to be of clinical importance. One-lung ventilation induced a significant increase in
pulmonary arterial wedge pressure, mean pulmonary artery pressure, and shunt fraction. One-lung ventilation did not have a significant effect on cardiac index, systemic vascular resistance index, pulmonary vascular resistance index, and oxygen delivery index.

CONCLUSIONS AND CLINICAL RELEVANCE: One-lung ventilation affected gas exchange and hemodynamic function, although oxygen delivery in clinically normal dogs was not affected during a period with an open thoracic cavity. One-lung ventilation can be used safely in healthy dogs with an open thoracic cavity during surgery.

PMID: 12693534 [PubMed - indexed for MEDLINE]


Comparison of a sidestream capnograph and a mainstream capnograph in mechanically ventilated dogs.

Teixeira Neto FJ(1), Carregaro AB, Mannarino R, Cruz ML, Luna SP.

Author information:
(1)Department of Veterinary Surgery and Anesthesiology, Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista, Botucatu, SP, 18618-000, Brazil.

OBJECTIVE: To compare the ability of a sidestream capnograph and a mainstream capnograph to measure end-tidal CO2 (ETCO2) and provide accurate estimates of PaCO2 in mechanically ventilated dogs.

DESIGN: Randomized, double Latin square.

ANIMALS: 6 healthy adult dogs.

PROCEDURE: Anesthesia was induced and neuromuscular blockade achieved by IV administration of pancuronium bromide. Mechanical ventilation was used to induce conditions of standard ventilation, hyperventilation, and hypoventilation. While tidal volume was held constant, changes in minute volume ventilation and PaCO2 were made by changing the respiratory rate. Arterial blood gas analysis was performed and ETCO2 measurements were obtained by use of either a mainstream or a sidestream capnographic analyzer.

RESULTS: A linear regression model and bias analysis were used to compare PaCO2 and ETCO2 measurements; ETCO2 measurements obtained by both capnographs correlated well with PaCO2. Compared with PaCO2, mainstream ETCO2 values differed by 3.15 +/- 4.89 mm Hg (mean bias +/- SD), whereas the bias observed with the sidestream ETCO2 system was significantly higher (5.65 +/- 5.57 mm Hg). Regardless of the device used to measure ETCO2, bias increased as PaCO2 exceeded 60 mm Hg.

CONCLUSIONS AND CLINICAL RELEVANCE: Although the mainstream capnograph was slightly more accurate, both methods of ETCO2 measurement correlated well with PaCO2 and reflected changes in the ventilatory status. However, ETCO2 values > 45 mm Hg may inaccurately reflect the severity of hypoventilation as PaCO2 may be underestimated during conditions of hypercapnia (PaCO2 > 60 mm Hg).

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The influence of ventilation mode (spontaneous ventilation, IPPV and PEEP) on cardiopulmonary parameters in sevoflurane anaesthetized dogs.

Polis I(1), Gasthuys F, Laevens H, Van Ham L, De Rick A.

Author information:
(1)Department of Small Animal Medicine and Clinical Biology, Faculty of Veterinary Medicine, Ghent University, Belgium. inegborgh.polis@rug.ac.be

The purpose of this study was to investigate the cardiopulmonary influences of sevoflurane in oxygen at two anaesthetic concentrations (1.5 and 2 MAC) during spontaneous and controlled ventilation in dogs. After premedication with fentanyl-droperidol (5 microg/kg and 0.25 mg/kg intramuscularly) and induction with propofol (6 mg/kg intravenously) six dogs were anaesthetized for 3 h. Three types of ventilation were compared: spontaneous ventilation (SpV), intermittent positive pressure ventilation (IPPV), and positive end expiratory pressure ventilation (PEEP, 5 cm H2O). Heart rate, haemoglobin oxygen saturation, arterial blood pressures, right atrial and pulmonary arterial pressures, pulmonary capillary wedge pressure and cardiac output were measured. End tidal CO2 %, inspiratory oxygen fraction, respiration rate and tidal volume were recorded using a multi-gas analyser and a respirometer. Acid-base and blood gas analyses were performed. Cardiac index, stroke volume, stroke index, systemic and pulmonary vascular resistance, left and right ventricular stroke work index were calculated. Increasing the MAC value during sevoflurane anaesthesia with spontaneous ventilation induced a marked cardiopulmonary depression; on the other hand, heart rate increased significantly, but the increases were not clinically relevant. The influences of artificial respiration on cardiopulmonary parameters during 1.5 MAC sevoflurane anaesthesia were minimal. In contrast, PEEP ventilation during 2 MAC concentration had more pronounced negative influences, especially on right cardiac parameters. In conclusion, at 1.5 MAC, a surgical anaesthesia level, sevoflurane can be used safely in healthy dogs during spontaneous and controlled ventilation (IPPV and PEEP of 5 cm H2O).

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Cat Ventilation anesthesia


Clinical evaluation of the v-gel supraglottic airway device in comparison with a classical laryngeal mask and endotracheal intubation in cats during spontaneous and controlled mechanical ventilation.

Prasse SA(1), Schrack J(2), Wenger S(3), Mosing M(1).
OBJECTIVE: To compare airway management during induction of anaesthesia, in spontaneous ventilation and controlled mechanical ventilation (CMV), using a cat-specific supraglottic airway device (the v-gel), a classical laryngeal mask (LM) or an endotracheal tube (ETT).

STUDY DESIGN: Prospective, randomized clinical trial.

ANIMALS: Forty-five healthy cats.

METHODS: After premedication, cats were randomly allocated to one of three groups to secure the airway: 1) v-gel; 2) LM; or 3) ETT (cuff pressure: 20 cm H2 O).

Cats were anaesthetized for elective procedures. The dose of propofol necessary to insert the v-gel, LM or ETT, the number of attempts required to achieve insertion and leakage during spontaneous ventilation and CMV at different peak inspiratory pressures (8, 10, 12, 14 and 16 cm H2 O) were recorded. Leakage of >20% of tidal volume was considered as a criterion for exclusion. Significance was set at a p-value of <0.05.

RESULTS: Cats in the v-gel group required a median (range) of 3 mg kg(-1) (2-5 mg kg(-1) ) of propofol for successful placement, which was significantly less than the 5 mg kg(-1) (3-7 mg kg(-1) ) required for endotracheal intubation (p = 0.005). No significant difference in the total dose of propofol was observed between the v-gel and LM [3 mg kg(-1) (2-7 mg kg(-1) ] groups or the ETT and LM groups. Significantly more cats in the ETT group were excluded for leakage of >20% during CMV at all pressure settings.

CONCLUSIONS AND CLINICAL RELEVANCE: The v-gel is a practical alternative to the LM and ETT for securing the airway after induction of anaesthesia and for CMV up to 16 cm H2 O in healthy cats. The v-gel can be inserted at a more superficial level of anaesthesia than the ETT and showed significantly less leakage during CMV than the ETT.

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Traumatic tracheal diverticulum corrected with resection and anastomosis during one-lung ventilation and total intravenous anesthesia in a cat.

Sayre RS(1), Lepiz M(1), Wall C(1), Thieman-Mankin K(1), Dobbin J(1).

Author information:
(1)Department of Small and Large Animal Clinical Sciences, Texas A&M University,
OBJECTIVE: This report describes the clinical findings and diagnostic images of a traumatic intrathoracic tracheal avulsion with a tracheal diverticulum in a cat. Furthermore, a complete description of the tracheal resection and anastomosis using one-lung ventilation (OLV) with total and partial intravenous anesthesia is made.

CASE SUMMARY: A 3-year-old neutered male domestic shorthair cat weighing 6.8 kg was presented to the University Teaching Hospital for evaluation of increased respiratory noise 3 months following unknown trauma. Approximately 12 weeks prior to presentation, the cat had been seen by the primary care veterinarian for respiratory distress. At that time, the cat had undergone a tracheal ballooning procedure for a distal tracheal stricture diagnosed by tracheoscopy. The tracheal ballooning had provided only temporary relief. At presentation to our institution, the cat had increased respiratory effort with harsh upper airway noise auscultated during thoracic examination. The remainder of the physical examination was normal. Diagnostics included a tracheoscopy and a thoracic computed tomographic examination. The cat was diagnosed with tracheal avulsion, pseudotrachea with a tracheal diverticulum, and stenosis of the avulsed tracheal ends. Surgical correction of the tracheal stricture via a thoracotomy was performed using OLV with total and partial intravenous anesthesia. The cat recovered uneventfully and at last follow-up was active and doing well.

UNIQUE INFORMATION PROVIDED: This case report describes OLV using standard anesthesia equipment that is available at most private practices. Furthermore, this case describes the computed tomographic images of the intrathoracic tracheal avulsion and offers a positive outcome for tracheal resection and anastomosis.

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Perioperative and anesthetic management of complete tracheal rupture in one dog and one cat.

Morath U(1), Gendron K, Revés NV, Adami C.

Author information:
(1)From the Anesthesiology and Pain Therapy Division, Department of Veterinary Clinical Science Vetsuisse Faculty, Berne, Switzerland.

The authors describe two animals (one dog and one cat) that were presented with severe respiratory distress after trauma. Computerized tomographic imaging under general anesthesia revealed, in both cases, complete tracheal transection. Hypoxic episodes during anesthesia were relieved by keeping the endotracheal tube (ETT) positioned in the cranial part of the transected trachea and by allowing spontaneous breathing. Surgical preparation was performed quickly, and patients
were kept in a sternal position to improve ventilation and oxygenation, and were only turned into dorsal recumbency shortly before surgical incision. A sterile ETT was guided into the distal part of the transected trachea by the surgeon, at which point mechanical ventilation was started. Both animals were successfully discharged from hospital a few days after surgery. Rapid and well-coordinated teamwork seemed to contribute to the good outcome. Precise planning and communication between anesthetists, surgeons, and technicians, as well as a quick course of action prior to correct ETT positioning helped to overcome critical phases.

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**Pneumomediastinum in cats: 45 cases (2000-2010).**

Thomas EK(1), Syring RS.

Author information:
(1)Department of Clinical Studies-Philadelphia, School of Veterinary Medicine, University of Pennsylvania, 3859 Spruce St, Philadelphia, PA 19104, USA.
emily.thomas@vets-now.com

OBJECTIVE: To characterize the incidence, etiology, presenting complaint, clinical course, and outcome of cats with pneumomediastinum.

DESIGN: Retrospective study from the period of January 1st, 2000 to December 31st, 2010.

SETTING: University teaching hospital.

ANIMALS: Forty-five cats with a radiographic diagnosis of pneumomediastinum.

INTERVENTIONS: None.

MEASUREMENTS AND MAIN RESULTS: Medical and radiographic records were reviewed to identify cats with a radiographic diagnosis of pneumomediastinum. Clinical data were retrieved, including signalment, history, presenting clinical signs, diagnostic test results, treatment, complications, and survival to discharge. In 31 of 45 (69%) cats the pneumomediastinum was secondary to an obvious inciting cause. General anesthesia with endotracheal intubation and positive pressure ventilation was the most common cause in 17 of 45 (38%) cases. This was followed by trauma in 12 of 45 (27%) cats, and tracheal foreign bodies in 2 of 45 (4%) cats. Spontaneous pneumomediastinum (unknown underlying cause) was diagnosed in 14 of 45 (31%) of cases. Onset of clinical signs and diagnosis of spontaneous pneumomediastinum was preceded by emesis in 6 of 14 cats. Common presenting signs were tachypnea seen in 27 of 45 (60%) cats, increased respiratory effort in 26 of 45 (58%) cats, and subcutaneous emphysema in 30 of 45 (66%) cats. Concurrent pneumothorax was identified in 21 of 45 (47%) cats, pleural effusion in 10 of 45 (22%), and pneumoretroperitoneum in 21 of 45 (47%). The mainstay of treatment was supportive care and treatment of the underlying disease process. The prognosis for recovery was good, with 87% survival until hospital discharge.

CONCLUSIONS: Pneumomediastinum in cats is an infrequently diagnosed condition. It
is often secondary to an event such as general anesthesia with endotracheal intubation and positive pressure ventilation but less frequently may occur spontaneously. The prognosis is good with appropriate supportive care.

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**Basics of mechanical ventilation for dogs and cats.**

Hopper K(1), Powell LL.

Author information:
(1)Department of Veterinary Surgical and Radiological Sciences, University of California, Davis, CA, USA.

Respiratory failure may occur due to hypoventilation or hypoxemia. Regardless of the cause, emergent anesthesia and intubation, accompanied by positive pressure ventilation, may be necessary and life saving. Long-term mechanical ventilation requires some specialized equipment and knowledge; however, short-term ventilation can be accomplished without the use of an intensive care unit ventilator, and can provide oxygen supplementation and carbon dioxide removal in critical patients.

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**A comparison of 3 anesthetic protocols for 24 hours of mechanical ventilation in cats.**

Boudreau AE(1), Bersenas AM, Kerr CL, Holowaychuk MK, Johnson RJ.

Author information:
(1)Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada. aboudrea@uoguelph.ca

OBJECTIVE: To compare the recovery times, recovery quality, and cardiovascular (CV) effects of 3 anesthetic protocols during 24 hours of mechanical ventilation (MV) in healthy cats.

DESIGN: Prospective, randomized, crossover study.

SETTING: Research laboratory at a veterinary teaching hospital.
ANIMALS: Six healthy intact male purpose-bred cats.

INTERVENTIONS: Each cat was randomly assigned to receive 3 anesthetic protocols for 24 hours of MV; Protocol K consisted of ketamine, Protocol P, propofol; and Protocol PK, propofol plus fixed-rate low-dose ketamine. Each infusion drug dose was adjusted using a sedation scoring system. All protocols included fixed doses of fentanyl (10 μg/kg/h) and midazolam (0.5 mg/kg/h).

MEASUREMENTS AND MAIN RESULTS: Drug doses and recovery times were recorded. Recovery quality was scored. Blood gas results, CV parameters, and frequency of bradycardia or hypotension requiring interventions were recorded. The mean dose ± standard error of K was 81.3 ± 3.3 μg/kg/m. The median dose (95% cardiac index) of propofol (μg/kg/m) in PK was 16.0 (13.1, 19.6) and in P was 48.1 (39.3, 58.9). P necessitated significantly more propofol than PK (P < 0.05). Protocol K (35.6 ± 3.2 hours) had significantly longer times to full recovery compared to P (18.2 ± 3.2 hours). Protocol K had significantly longer times to head up, crawling, and standing compared to P and PK. Cats sedated with PK (2.33 ± 0.47) required significantly more interventions for hypotension than K (0.50 ± 0.47). Protocol P (3.2 ± 0.4) and PK (1.4 ± 0.3) required significantly more interventions for bradycardia compared to K (0.8 ± 0.3). When comparing protocol K to P and PK, significant differences in blood pressure, lactate, oxygen delivery, and oxygen consumption were noted.

CONCLUSIONS: Cats anesthetized with P had shorter times to full recovery compared to K. Cats anesthetized with K required fewer interventions for bradycardia or hypotension but had longer recovery times compared to P or PK. Protocol PK reduced the propofol dose required to maintain optimal anesthesia.

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Noninvasive ventilation in cats.

Brown JE(1), Bersenas AM, Mathews KA, Kerr CL.

Author information:
(1)Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada. jebrown@uoguelph.ca

OBJECTIVE: The primary objective of this study was to assess the feasibility of noninvasive mechanical ventilation (NIV) in cats. The secondary objective was to determine whether cardiovascular parameters and anesthetic drug requirements associated with noninvasive ventilation differ from those associated with invasive ventilation.

DESIGN: Randomized, cross-over design.

SETTING: A research laboratory in a veterinary teaching hospital.

ANIMALS: Eight healthy adult cats, 3 intact females and 5 intact males, weighing between 3 and 6 kg, were used.
INTERVENTIONS: Each cat was randomly assigned to NIV via nasal mask, or invasive ventilation using an endotracheal tube. Mechanical ventilation was performed for 6 hours. Anesthesia was provided using continuous infusions of propofol and butorphanol. After a minimum 9-day washout period, the procedure was repeated using the alternate ventilation interface.

MEASUREMENTS AND MAIN RESULTS: Cardiovascular parameters (heart rate, rectal temperature, direct arterial blood pressure), arterial blood gases, drug requirements, sedation score, and ventilation parameters, were monitored throughout the procedures. These values were evaluated using ANCOVA for repeated measures. All cats were effectively ventilated using NIV. There were no significant differences in cardiovascular parameters, drug requirements, or sedation scores between groups. Although PaCO(2) values did not differ, PaO(2) values were significantly higher in the invasively ventilated group. Inspiratory tidal volumes were similar between groups, whereas expiratory tidal volumes were significantly lower in the NIV group. Inspiratory pressures were significantly higher in the invasively ventilated group. Respiratory frequency was significantly higher in the invasively ventilated group.

CONCLUSIONS: NIV of cats is possible. However, currently it does not confer any cardiovascular benefit over invasive ventilation and drug requirements are similar. Use of a correctly fitted mask is essential for successful NIV as air leaks account for the observed discrepancy between inspiratory and expiratory volumes. Further investigation into this modality is warranted.

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