

RESEARCH PAPER

Retrospective study of intra-anesthetic predictors of prolonged hospitalization, increased cost of care and mortality for canine patients at a veterinary teaching hospital

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Abstract

Objective To determine the impact of intra-operative anesthetic variables on the length of hospitalization, cost of care and mortality in dogs.

Study design Retrospective, observational study.

Animals A total of 235 dogs undergoing general anesthesia.

Methods Medical records of dogs undergoing general anesthesia between 2007 and 2014 at the University of Georgia Veterinary Teaching Hospital were reviewed. Data collected included demographic data, American Society of Anesthesiologists (ASA) physical status, type and duration of anesthesia, hemodynamic variables, temperature, ventilation, fluid therapy and adjunctive drugs administered. Outcome variables were length of hospitalization in the intensive care unit (ICU), hospital charges and survival to discharge.

Results The only factor significantly associated with duration of ICU care was higher ASA status ($p < 0.0001$). Factors associated with increased cost of hospitalization were ICU duration ($p < 0.0001$), anesthesia duration ($p < 0.0001$), hemorrhage amount ($p < 0.0001$), colloid use ($p = 0.0081$), increased age ($p = 0.0253$), increased weight ($p = 0.0293$) and presence of hypertension ($p = 0.0179$). Overall mortality rate was 5.1%. The only factors negatively associated with survival were the administration of colloids ($p < 0.0008$) and ASA status ($p = 0.0314$).

Conclusions and clinical relevance Several intrinsic patient factors and intraoperative hemodynamic variables were significantly associated with postoperative morbidity and mortality in dogs. These factors might have prognostic value in conjunction with preoperative risk assessment, and patient outcome may be improved by stricter intraoperative control of these variables.

Keywords cost, dog, hospitalization, monitoring, survival.

Introduction

Most of the veterinary literature focuses on preoperative risk factors for adverse anesthetic events (Garcia de Carellan Mateo et al. 2015). Increasing emphasis has been placed on the conjecture that intraoperative anesthetic management has an important impact on both short- and long-term patient morbidity and mortality (Proudman et al. 2006; Brodbelt et al. 2007, 2008). It is widely accepted that adverse events that occur under general anesthesia can affect not only immediate recovery, but also long-term outcome. However, while studies in the human literature have evaluated associations between adverse anesthetic events and subsequent morbidity and mortality (Reich et al. 2002; Monk et al. 2005; Kheterpal et al. 2009; Tassoudis et al. 2011; Kertai et al. 2014), no such large-scale population studies comparing stability under anesthesia and case outcome exist in veterinary medicine.

Evidence from both human and veterinary literature suggests a substantial contribution of preoperative risk factors to adverse outcomes, and numerous classification schemes have been used to characterize these risks (Leung & Dzankic 2001; Lupei et al. 2014). Perhaps the most widely used is the American Society of Anesthesiologists (ASA) physical status classification system, which uses a patient's physical status to help predict the anesthetic risk. Studies in human (Lupei et al. 2014), equine (Dugdale et al. 2016) and small companion animal anesthesia (Brodbelt et al. 2008) have shown an increased risk of death associated with higher ASA status.

One study (Lupei et al. 2014) further demonstrated an association between ASA status and postoperative intensive care unit (ICU) outcome in humans. The length of hospitalization in the ICU, use of mechanical ventilation (MV), number of acquired organ dysfunctions, vasopressor treatment and readmission to the ICU increased with patient ASA status ≥ 3 . Unsurprisingly, in addition to the poorer patient outcome, increased time of hospitalization in the ICU was also associated with substantial increases in healthcare cost.

Despite the growing literature describing preoperative risk factors in both human and veterinary medicine, the effect of intraoperative variables, such as abnormal hemodynamic parameters, are not well characterized. One group (Kheterpal et al. 2009) evaluated both pre- and intraoperative risk factors for perioperative cardiac adverse events (CAEs) in humans within 30 days of noncardiac surgery. Of 7740 operations, 1.1% of patients experienced a CAE. Independent predictors of risk included advanced age, high body mass index, emergency surgery, duration of the procedure, intraoperative administration of packed red blood cells, intraoperative hypotension, defined as mean arterial pressure (MAP) < 50 mmHg or heart rate (HR) > 100 beats minute^{-1} and pre-existing cardiovascular disease.

Such data are less abundant in the veterinary literature. Despite the presumption that abnormalities such as hypotension or tachycardia under anesthesia are likely to be associated with poorer recovery, specific literature addressing the impact of intraoperative anesthetic hemodynamic management on perioperative outcomes is more limited than in human medicine. One study (Grimes et al. 2011) demonstrated an association between intraoperative hypotension and the development of septic peritonitis following gastrointestinal surgery in dogs. Another

study (Duke et al. 2006) showed a decreased incidence of postanesthetic myopathy in horses when MAP was maintained above 70 mmHg compared with only 60 mmHg during general anesthesia. Similar studies addressing a broad range of outcomes are lacking. The purpose of the present preliminary study was to determine the impact of numerous intraoperative anesthetic variables on morbidity surrogates: cost of care, length of hospitalization and survival to discharge. The hypothesis was that intra-anesthetic events had a significant effect on duration of ICU stay, cost of hospitalization and survival to discharge.

Materials and methods

Animals

Medical records of dogs undergoing general anesthesia between 2007 and 2014 at the University of Georgia Veterinary Teaching Hospital were reviewed. General anesthesia is defined here as a drug-induced unconsciousness characterized by a controlled and reversible depression of the central nervous system and analgesia sufficient to allow endotracheal intubation. Records were randomly selected across the years of interest. Cases that had an anesthesia charge code on the invoice were considered for inclusion. Cases that did not have a complete anesthesia record were excluded. There were no other exclusion criteria. From this sample, more than 200 cases were enrolled in a sequential fashion. The sample size was estimated to require 10 dogs per variable of interest for a multivariable model (Guglielminotti et al. 2015).

Data collection

Data collected from the medical record included demographic data such as species, breed, age, body weight, reproductive status and ASA status. The anesthetic agent (inhalant anesthetics and injectable agents), duration of anesthesia and intraoperative complications were recorded. When a gas analyzer was used, end-tidal inhalant ($\text{F}_{\text{E}}\text{Inhalant}$) peak and nadir were recorded, and the area under the curve (AUC) of $\text{F}_{\text{E}}\text{Inhalant}$ concentration for the duration of the procedure was calculated. Cardiovascular parameters recorded included HR, blood pressure and the type of arrhythmia if applicable. Hypotension was defined as a MAP below 60 mmHg or a systolic arterial pressure (SAP) below 90 mmHg (Haskins 2015). Hypertension was defined as a SAP above 145 mmHg

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