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RESEARCH PAPER

Prevalence and risk factors for canine post-anesthetic aspiration pneumonia (1999–2009): a multicenter study

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Abstract

Objective To determine the incidence of canine post-anesthetic aspiration pneumonia (AP) and to identify anesthetic agents, procedures and management factors associated with the development of AP.

Study design Multicenter, randomized, case-controlled retrospective study.

Animals Two hundred and forty dogs affected with AP and 488 unaffected control dogs.

Methods Electronic medical record databases at six Veterinary colleges were searched for dogs, coded for anesthesia or sedation and pneumonia from January 1999 to December 2009. The resultant 2158 records were hand-searched to determine eligibility for inclusion. Diagnosis of AP was made radiographically. Two unaffected control dogs were randomly selected for each affected dog, from a list of dogs that underwent sedation or anesthesia in the same time period and did not develop aspiration pneumonia. Fifty-seven factors were then evaluated for association with aspiration pneumonia. Data analysis was performed using univariate Chi-square or student *t*-tests, then multivariate logistic regression.

Results Incidence of post-anesthetic AP was 0.17%, from 140,711 cases anesthetized or sedated over the 10 year period. Two anesthesia-related events were significantly associated with development of AP: regurgitation and administration of hydromorphone at induction. Administration of anticholinergics was not associated with AP. Procedures associated with increased odds of aspiration pneumonia included laparotomy, upper airway surgery, neurosurgery, thoracotomy and endoscopy. Orthopedic surgery, ophthalmologic surgery, dental procedures, MRI, CT, bronchoscopy, cystoscopy, tracheoscopy and neutering were not associated with development of AP. Three patient factors were associated with the development of AP: megaesophagus, and a history of pre-existing respiratory or neurologic disease. Sixty-nine% of dogs with two or more of the above independent predictive variables developed AP.

Conclusion and clinical relevance Most anesthetic agents and procedures were not associated with the development of AP. We need to devise and evaluate strategies to protect at risk patients.

Keywords anesthesia, complications, dogs, endoscopy, megaesophagus, neurosurgery, pulmonary, thoracotomy, upper airway surgery.

Introduction

Aspiration pneumonia (AP) has become a well-recognized sequel to anesthesia in dogs, with two studies reporting that anesthesia precedes from 13 to 16% of all AP cases (Kogan et al. 2008a; Tart et al. 2010). Aspiration is defined as inhalation of gastric contents into the bronchial tree (Marik 2001), with various associated consequences. Following introduction of foreign material into the airway, the pathophysiology of AP is divided into three phases: an airway response, an inflammatory response, and then a possible secondary bacterial infection (Raghavendran et al. 2011).

The character of the aspirated fluid determines the severity of the subsequent response, with aspirated fluid containing particulate matter and with a pH $\leq$2.5 resulting in the most severe pulmonary response (Mendelson 1946; Marik 2001). Acute lung injury and acute respiratory distress syndrome are the most severe outcomes associated with aspiration of gastric contents, but these syndromes are rare (Mendelson 1946; Marik 2001). Most human patients are reported to be asymptomatic after aspiration of gastric contents (Mendelson 1946; Warner et al. 1993). The prognosis for uncomplicated cases of aspiration pneumonitis or AP in people is generally good (from 67 to >95% survival; Cameron et al. 1973; Ng & Smith 2001; Warner et al. 1993). Similar proportions of dogs are reported to survive AP (58–82%; Fransson et al. 2001; Alwood et al. 2006; Kogan et al. 2008a; Tart et al. 2010) with survival being lowest in dogs suffering from intracranial disease (Fransson et al. 2001).

The diagnosis of AP in dogs has been based on a combination of history, clinical signs, arterial hemoglobin desaturation, thoracic radiographs, transtracheal wash with bacterial cultures, or necropsy (Fransson et al. 2001; Alwood et al. 2006; Brainard et al. 2006; Kogan et al. 2008a,b; Tart et al. 2010).

There have been nine studies of AP reported since 2001 from seven Colleges of Veterinary Medicine, evaluating differing patient populations (Table 1). Various factors have been associated with the development of AP. Patient factors such as esophageal disease, vomiting and regurgitation, neurologic disorders and laryngeal disease were repeatedly identified as risk factors in these studies. Dogs that underwent neurologic surgery are at high risk of developing AP, with 25% of post-craniotomy patients reported to develop the problem (Fransson et al. 2001). Likewise, dogs with laryngeal paralysis are also at high risk, from 8 to 24% reported to develop AP following surgery

Table 1 Incidence and identified risk factors from nine retrospective studies of various canine populations manifesting post-procedure pulmonary complications

Affected/total cases (%)	Patient population	Risk factors	Author
12/49 (24.4)	Intracranial surgery	Megaesophagus, vomiting or regurgitation	Fransson et al. (2001)
19/707 (2.6)	Intervertebral disc disease	Tetraparesis, cervical spinal lesions, MRI, >1 anesthetic procedure, longer duration of first anesthetic, post-operative vomiting, regurgitation	Java et al. (2009)
7/39 (17.9)	Laryngeal paralysis	Not directly examined	Hammel et al. (2006)
33/140 (23.6)	Laryngeal paralysis	Age, bilateral disease, tracheostomy, respiratory tract abnormalities, megaesophagus, esophageal, neoplastic or neurologic disease	MacPhail & Monnet (2001)
5/66 (7.6)	Laryngeal paralysis	High esophagram scores (bolus retention or reflux)	Stanley et al. 2010
8/162 (4.9)	Laparotomy	Biliary or septic peritonitis, peri-operative vomiting, regurgitation, ASA $\geq$3, opiate or benzodiazepine reversal, emergent surgery, long duration of anesthesia, butorphanol or oxymorphone post-operatively, stored blood products, recovery in Intensive Care	Alwood et al. (2006), Brainard et al. (2006)
12/88 (13.6)	Hospital wide	Esophageal disease, vomiting, neurologic disorders, laryngeal disease, and anesthesia	Kogan et al. (2008a,b)
20/125 (16)	Hospital wide	Male large breed, esophageal disease, vomiting, neurologic disorders, laryngeal disease, and sedation/anesthesia	Tart et al. (2010)