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REVIEW ARTICLE

Equine anaesthesia-associated mortality: where are we now?

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Abstract

Objectives To review the literature concerning mortality associated with general anaesthesia in horses and to assess whether there is evidence for a reduction in mortality over the 20 years since the Confidential Enquiry into Perioperative Equine Fatalities (CEPEF).

Databases used PubMed, Scopus, Google Scholar. Search terms used: horse; pony; equine; anaesthesia; anesthesia; recovery; morbidity, and mortality.

Conclusions The most recent studies, in which isoflurane and sevoflurane have been more commonly used for anaesthesia maintenance, report fewer intraoperative cardiac arrests than older studies in which halothane was favoured. Catastrophic fractures, however, have become the greatest cause of recovery-associated mortality.

Keywords anaesthesia, equine, mortality, recovery.

Introduction

Acknowledgement of changes in anaesthesia practice since the conclusion of the original Confidential Enquiry into Perioperative Equine Fatalities [CEPEF 1-3 (Johnston et al. 1995, 2002, 2004)] led to plans for a further study [(CEPEF 4 (Bettschart & Johnston 2011; Gent & Bettschart-Wolfensberger 2013; Wohlfender et al. 2015)], the final results of which are eagerly awaited. Until those results become available, however, it is appropriate to review the mortality associated with equine anaesthesia and to investigate the developments that have occurred over the two decades since the publication of the first reports.

Comparative mortality

Mortality associated with equine anaesthesia has been reported to be approximately 1% in healthy elective cases, but figures have ranged from 0.08% to 1.8%, depending upon study design (Mitchell 1969; Tevik 1983; Young & Taylor 1990, 1993; Johnston et al. 1995, 2002, 2004; Mee et al. 1998 a, b; Bidwell et al. 2007) (Table S1). The number of postoperative days included, and whether or not anaesthesia was considered to be directly related to the outcome, affect the definition of 'mortality' [see below and Bidwell et al. (2007)]. Much higher mortality rates have been reported in emergency cases, particularly those requiring abdominal surgery for 'colic' (intra-abdominal conditions requiring surgical exploration) or Caesarean section, and range from 7.8% (Johnston et al. 2002) to 19.5%, even when animals with inoperable lesions are excluded (Mee et al. 1998 b). The true contribution of anaesthesia to mortality in such cases is difficult to evaluate. Horses may survive emergency anaesthesia and colic surgery only to succumb to the complications of endotoxaemia and/or intractable postoperative ileus, or financial constraints may limit continued treatment in the early postoperative phase (Ducharme et al. 1983; Hunt et al. 1986).

The rate of ~ 1% that is considered to reflect the incidence of anaesthesia-associated mortality in healthy horses is between a hundred- and a thousand-fold greater than the incidences of mortality associated with anaesthesia in humans (0.01–0.001%) (Lunn & Mushin 1982; Jones 2001; Irwin & Kong 2014), 20-fold greater than that in dogs (0.05%), 10-fold greater than that in cats (0.11%), and not dissimilar from that reported for rabbits (0.73%) (Brodbelt et al. 2008). There is, therefore, much room for improvement.

Jones (2001) suggested that reductions in anaesthesia-related mortality, particularly for humans, had occurred over time as a result of the introduction of 'safer anaesthetic techniques' and attempts to reduce human error (through training and the use of existing and new monitoring devices). However, he also cautioned that the increasing complexity of surgery might offset some past and future improvements. In addition, Keats (1990) cautioned against the comparison of studies over time during which many factors were likely to change; he also suggested that anaesthetic mortality had not decreased 'because we create new mechanisms of mortality at the same rate we solve them'. Irwin & Kong (2014) reminded us that although human anaesthesia itself may now be relatively safe, surgery is not!

Equine mortality

Several studies evaluating mortality associated with general anaesthesia and surgery in horses have identified various risk factors which may help to inform case management and/or highlight increased risk (Table S1). The largest study to date has been the CEPEF [n = 41,824, CEPEF 1 and 2 (Johnston et al. 1995, 2002); n = 11,336, CEPEF-3 (Johnston et al. 2004)]. This series of multicentre studies spanned over 8 years (February 1991 to September 1999) of data collection and identified the most common causes of death, as well as several risk factors (Table S1).

The CEPEF studies reported mortality rates of 0.9% in healthy horses within 7 days of anaesthesia and surgery, and 1.9% in all cases (including horses with colic or dystocia, foals, and horses undergoing fracture repair) (Johnston et al. 2002). A third of the deaths were attributed to intraoperative cardiac arrest or postoperative cardiovascular collapse, and around another third to fractures (limb or neck) and post-anaesthesia myopathy (PAM). Postoperative myopathy is associated with poor intraoperative muscle perfusion and oxygen delivery (Grandy et al. 1987) and it is likely that at least some of the fractures occurred as a consequence of myopathy-induced pain or weakness.

In addition to CEPEF, several smaller-scale, single-centre studies have reported mortality rates between 0.08% and 1.5% in horses undergoing elective procedures (Mitchell 1969; Mee et al. 1998 a; Bidwell et al. 2007; Senior et al. 2007; Dugdale et al. 2016). These values should be interpreted in the light of smaller sample sizes and differences in the horse populations served by each centre, and with consideration of the inconsistencies in definitions of 'mortality' between studies [see Senior (2013) for a recent review]. Furthermore, comparison between studies is also hindered by variations in anaesthetist experience.

The largest single-centre study (n = 17,961) included almost half the number of horses in CEPEF-1 and 2, but reported mortality of only 0.12% in a sample that included horses undergoing emergency abdominal surgery (Bidwell et al. 2007). Half of these deaths were caused by intraoperative cardiac arrest and the remainder by PAM, neuropathy or fracture (Table S1). When all deaths occurring within the first 7 days post-surgery were included, the mortality rate doubled to 0.24%, which is still comparatively low (Bidwell et al. 2007). The majority of procedures, however, were of <1 hour in duration, which may have had a major influence on the results.

The discrepancy between the mortality rates observed in the CEPEF study and those in the single-centre study reported by Bidwell et al. (2007) probably reflects the differences between the very wide range of different practices, clinics and hospitals included in the CEPEF study, with their differences in caseloads, anaesthesia protocols and both anaesthetic and surgical experience, and a study conducted in a highly efficient single centre performing primarily short routine procedures in a relatively homogeneous group of patients with a uniformly high standard of anaesthetic care, respectively. Furthermore, even within equine hospitals, there is likely to be variation in experience and training amongst clinicians. To date, there is no evidence that lack of experience adversely influences equine anaesthesia-associated mortality (Johnston et al. 2002). However, there is anecdotal evidence for the opposite, probably because the most experienced anaesthetists tend to be responsible for cases