# Anaesthetic deaths in cats in practice



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**ABSTRACT**

Recent work suggests anaesthetic deaths are more common in cats than dogs. Current estimates report that approximately 1 in 895 healthy cats die of an anaesthetic-related death, over twice that recently reported in dogs, with the early postoperative period being the highest risk period. Risk factors associated with death include patient health status, age and weight and procedure type and urgency. Endotracheal intubation and fluid therapy have also been associated with increased odds of anaesthetic death in cats and may reflect that these are higher risk procedures in cats compared to dogs. Pulse oximeter monitoring recently was reported to be associated with reduced risk of anaesthetic death.

An awareness of these risk factors could help guide veterinary surgeons in their anaesthetic management of cats. In particular, greater attention to patient assessment and management prior to anaesthesia, as well as more careful fluid administration and monitoring during and after anaesthesia could help reduce perioperative complications in cats.

Anaesthetic death in cats has only been infrequently studied (Jones, 2001). The first major survey of anaesthetic death in small animals was undertaken in the UK 20 years ago and reported approximately 0.29% of cats died of an anaesthetic death (Clarke and Hall, 1990). Subsequent work undertaken internationally has described a lower risk of death in cats of between 0.1 – 0.25% (Joubert, 2000, Dyson et al., 1998, Brodbelt et al., 2008a, Dodman and Lamb, 1992). Though the risk of perioperative death in cats appears much lower than that reported in horses (0.09%, (Johnston et al., 2002)), it increasingly appears greater than that seen in dogs: recent work suggests healthy cats were nearly twice as likely to die as dogs (Brodbelt et al., 2008a). Hence, a re-evaluation of the risks associated with anaesthesia in cats is merited.

## FREQUENCY OF ANAESTHETIC DEATH IN CATS

Surveys undertaken in small animal practice have documented a frequency of mortality in cats that appears to be decreasing over time as anaesthetic drugs and monitoring improve, but with a trend to greater risk of death compared to dogs. The first prospective UK study of small animal practice complications was undertaken between 1984 and 1986 (Clarke and Hall, 1990). Fifty-three practices were recruited, 41,881 small animal anaesthetics were recorded including anaesthetics from over 20,000 cats and a risk of death of 0.29% was reported. For healthy cats (no systemic disease or mild to moderate systemic disease only), the risk of death was 0.18%, while in sick cats (cats with severe systemic disease limiting activity, through to life-threatening disease) over 3% died peri-operatively. A further prospective study of anaesthetic mortality in veterinary practice in Ontario, Canada recorded over six months 8,702 cat anaesthetics and a risk of perioperative cardiac arrest of 0.10% Canada (Dyson et al., 1998). For healthy cats the risk was 0.048%, while for sick patients, 0.92% of cats died. Only deaths resulting from cardiac arrest were included, suggesting this may have been an underestimate of anaesthetic death in general.

The most recent multi-centre small animal practice based study, the Confidential Enquiry into Perioperative Small Animal Fatalities (CEPSAF), was also undertaken in the UK and between 2002 and 2004, 79,178 anaesthetics and sedations were recorded in cats (Brodbelt et al., 2008a). The overall risk of death was approximately 0.24% in cats. In healthy cats, the risk was 0.11%, while in sick cats over 1% died. The risk in healthy dogs in this latter study was approximately half of that in cats (0.05% in dogs (Brodbelt et al., 2008a)) and may reflect increased risk of complications in cats related to their smaller size and other species differences. Smaller patients are predisposed to hypothermia (Dhupa, 1995, Murison, 2001), as well as to greater risk of anaesthetic drug overdose, particularly when not weighed preoperatively. Endotracheal intubation was associated with increased risk of anaesthetic death in cats in a number of studies (Brodbelt et al., 2007b, Clarke and Hall, 1990, Dyson et al., 1998)(see below) though not dogs, suggesting also this procedure may have contributed to this greater risk of deaths.

## CAUSES OF ANAESTHETIC DEATH

Cardiovascular and respiratory complications have represented the major causes of anaesthetic deaths documented in small animal studies, though gastrointestinal, neurological and hepato-renal causes have also been reported (Aaron et al., 1996, Brodbelt, 2009, Brodbelt et al., 2008a, Clarke and Hall, 1990, Dyson et al., 1998)

Cardiovascular causes include cardiac pump failure and vascular collapse, resulting in failure of delivery of blood to the vital tissues. Cardiac arrest has been reported to result from cardiac arrhythmias associated with increased circulating catecholamines, myocardial hypoxia, specific anaesthetic agents, pre-existing pathology, specific procedures (e.g. vagal traction and eye enucleation) and with myocardial depression due to relative anaesthetic overdose (Hall and Clarke, 1991, Hall and Taylor, 1994). Hypovolemia and circulatory failure were the other major causes of cardiovascular collapse and they have been seen in patients with pre-existing pathology that were insufficiently stabilised prior to anaesthesia (Brodbelt et al., 2008a, Clarke and Hall, 1990, Lumb and Jones, 1973, Dyson et al., 1998).

Respiratory complications included problems with airway maintenance and inadequacy of ventilation. Failed endotracheal intubation, trauma to the upper airway, inadequate ventilation and delivery of hypoxic inspired gas have all been documented (Clarke and Hall, 1990, Lumb and Jones, 1984, Dodman and Lamb, 1992, Dyson et al., 1998, Hosgood and Scholl, 1998, Hosgood and Scholl, 2002, Brodbelt et al., 2008a). Respiratory complications were an underlying cause of death in about 40-50% of cats (Clarke and Hall, 1990, Dyson et al., 1998, Lumb and Jones, 1984). Endotracheal intubation problems and respiratory obstruction also represented a major cause of death (Clarke and Hall, 1990, Dyson et al., 1998).

Other less common causes of death have included postoperative renal failure, iliac thrombosis, regurgitation and gastric contents inhalation, anaphylactic reactions, failure to regain consciousness, postoperative seizures resulting in death or euthanasia and death of unknown cause (Joubert, 2000, Dyson et al., 1998, Dodman and Lamb, 1992, Clarke and Hall, 1990, Brodbelt et al., 2008a). An understanding of these major causes of death can aid awareness of the underlying mechanisms of peri-operative deaths.

## TIMING OF ANAESTHETIC DEATH

The timing of death is important as it could allow targeting of resources and veterinary manpower to those high risk periods to reduce complications. Clarke and Hall (1990) reported deaths occurred primarily during anaesthesia (39%), with 30% occurring on induction and 31% during recovery. Similarly, Dyson and colleagues (1998) reported most cats died during anaesthesia (seven/eight cats) and only one postoperatively (13%). Interestingly, most recently, CEPSAF identified the postoperative period as the major time for cats to die (Brodbelt et al., 2008a). Over 60% of cats died during this time period. Most of these postoperative deaths occurred within three hours of termination of anaesthesia, suggesting the need for increased vigilance particularly in the early postoperative period.

## MAJOR RISK FACTORS FOR DEATH

A number of patient factors as well as anaesthetic drug and management practices have been reported as risk factors for anaesthetic death in cats (Brodbelt et al., 2007b, Clarke and Hall, 1990, Dyson et al., 1998, Gaynor et al., 1999, Hosgood and Scholl, 2002). Health status has consistently been identified as a major risk factor for anaesthetic death in cats (Clarke and Hall, 1990, Hosgood and Scholl, 2002, Brodbelt et al., 2007a, Dyson et al., 1998, Brodbelt et al., 2008a). Pre-existing pathology may reduce the therapeutic index of administered anaesthetics, predispose to cardiopulmonary depression and depress other physiological function significantly. Additionally in CEPSAF, procedural urgency was associated with increased odds of death (Brodbelt et al., 2007a) and the association was also reported for equine anaesthetic death (Johnston et al., 2002). Greater attention to preoperative assessment of patient health status and procedural urgency and improved stabilisation prior to the procedure could reduce deaths.

Increased risk with increasing age, has been identified as an important risk factor in more recent work (Brodbelt et al., 2008a). Old patients may be more susceptible to the depressant effects of anaesthetics, to hypothermia via impaired thermoregulatory mechanisms and to prolonged recovery due to tendencies to reduced metabolic function and hypothermia (Meyer, 1999, Waterman, 1981, Dhupa, 1995). Particular care would be recommended when anaesthetising older cats. Additionally, increased odds of death has been reported for small cats (Brodbelt et al., 2007a, Brodbelt et al., 2008b). Smaller patients could be more prone to drug overdose, to hypothermia and to peri-operative management difficulties (e.g. intravenous catheter placement, endotracheal intubation).

Increasing risk for patients presenting for major compared to minor procedures was documented in CEPSAF (Brodbelt et al., 2007a) and is consistent with work in equine (Johnston et al., 2004, Johnston et al., 2002) and human anaesthesia (Donati et al., 2004, Newland et al., 2002, Tiret et al., 1986). More complex and invasive procedures were likely to impose greater stress on patient physiology and when assessing patient risk prior to anaesthesia, assessment of the intended procedure's complexity should be considered. Interestingly, CEPSAF also reported an increased risk of death associated with fluid therapy administration in cats (Brodbelt et al., 2007a). Cats having fluids were nearly four times as likely to die as those that did not, suggesting that, at least in part, excessive administration of fluids and fluid overload could be a real concern in feline anaesthetic practice. A 3kg cat has a blood volume in the order of 170ml (Hall and Taylor, 1994) and with few veterinary practices measuring central venous pressure or using fluid pumps to administer intravenous fluids, the potential for volume overload was possible. Careful fluid administration and monitoring is recommended in cats, though further work is needed to confirm this observation.

Reduced odds of anaesthetic death when pulse and pulse oximetry monitoring were undertaken was also reported in CEPSAF in cats (Brodbelt et al., 2007a). Theoretical analyses in human anaesthesia support these findings and have suggested pulse oximetry would have detected 40-82% of reported peri-operative incidents, and when combined with capnography 88-93% (Webb et al., 1993, Tinker et al., 1989, Eichhorn et al., 1986). These findings suggest that some form of assessment of cardiovascular function (pulse quality and rate) and respiratory function (oxygen saturation) may be important in minimising mortality. Pulse oximetry was not routinely available in veterinary practice at the time of the last UK study (Clarke and Hall, 1990), and one could speculate that this now widely adopted monitoring device has contributed to the reduced risk of anaesthetic death reported in the UK and it should be recommended for routine use in practice.

Individual anaesthetic drugs appeared less important. Early work identified premedication with acepromazine as being associated with reduced odds of death (Brodbelt et al., 2006, Clarke and Hall, 1990) and major morbid complications (Dyson et al., 1998), compared to no premedication, while the use of alpha$_2$ agonist, xylazine, was associated with increased odds of death (Clarke and Hall, 1990, Dyson et al., 1998). In CEPSAF, though there were trends to reduced odds with the administration of acepromazine, after adjustment for major confounders this was not a major factor in cats. Further, when evaluating premedication with the newer alpha$_2$ agonist medetomidine, no increased odds of death were detected (Brodbelt et al., 2007a). The specific induction agent used also did not appear to be a major factor in CEPSAF, in contrast to earlier work where there was a tendency to increased risk with the use of thiopental and ketamine and lower risk with alphadolone / alphaxalone (Saffan) (Brodbelt et al., 2007a, Brodbelt et al., 2008b, Clarke and Hall, 1990). The lack of a consistent difference in risks with different anaesthetic agents was likely to reflect that the effect of these drugs was less important in comparison to patient and management factors.

In summary, major risk factors reported for anaesthetic death in cats include poor health status, old age, limited monitoring and endotracheal intubation (Clarke and Hall, 1990, Dyson et al., 1998, Hosgood and Scholl, 2002, Brodbelt et al., 2007a). Additionally, CEPSAF identified a number of previously unreported risk factors including the use of pulse oximetry and pulse monitoring reducing odds and administration of fluid therapy increasing odds of death in cats (Brodbelt et al., 2007a). An awareness of these risk factors could aid veterinarians to identify, prior to anaesthesia, those patients at greatest risk of complication and manage them more appropriately to reduce mortality.

## CONCLUSIONS

Encouragingly, anaesthetic death is increasingly rare in small animal practice: however, cats do appear at greater risk than dogs. Closer attention to cats in the early postoperative period, more careful preoperative evaluation and preparation and modification of their anaesthetic management could reduce mortality. Perioperative fluid therapy in cats could benefit from more careful monitoring and administration to reduce complications. Close monitoring of the cats under anaesthesia with the use of pulse oximetry has been associated with reduced risk of death and would be recommended. Further work is merited to continue to assess the risk of anaesthetic death in feline anaesthetic practice.

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## SELF-ASSESSMENT QUESTIONS

### 1. WHICH OF THE FOLLOWING FACTORS HAVE BEEN ASSOCIATED WITH AN INCREASED RISK OF ANAESTHETIC DEATH?

a) Monitoring with pulse oximetry
b) Administration of fluid therapy
c) Poor patient health status
d) Only b and c
e) All of the above

### 2. THE RISK OF ANAESTHETIC DEATH IN CATS WAS RECENTLY REPORTED IN THE UK (CEPSAF) TO BE LOWER THAN THAT OF DOGS? TRUE OR FALSE.

### 3. POOR HEALTH STATUS IS LIKELY TO INCREASE RISK OF ANAESTHETIC DEATH DUE TO:

a) Reduced therapeutic index of anaesthetic drugs
b) Pre-existing cardiopulmonary depression
c) Reduced ability to metabolise anaesthetic agents
d) A only
e) All of the above

### 4. TO REDUCE THE POTENTIAL TO FLUID OVERLOAD CATS DURING ANAESTHESIA WHICH OF THE FOLLOWING APPROACHES COULD BE ADOPTED?

a) Use a fluid pump to administer fluids
b) Administer fluids with a paediatric burette giving set
c) Monitor central venous pressure during anaesthesia
d) A or b only
e) All of the above

### 5. THE EARLY POSTOPERATIVE PERIOD WAS RECENTLY REPORTED TO BE THE HIGHEST RISK PERIOD FOR ANAESTHETIC DEATH IN CATS. TRUE OR FALSE?

Answers: 1: D, 2: false, 3: e, 4: e, 5: true