Original Article

Journal of Feline Medicine and Surgery
1–7

DOI: 10.1177/1098612X241288175
journals.sagepub.com/home/jfm

This paper was handled and processed by the American Editorial Office (AAFP) for publication in *JFMS*

Risk factors affecting all-cause mortality in cats hospitalized by a referral soft tissue service

Michaela M Baker, Chad W Schmiedt, Meghan Lewis, Mandy L Wallace, Brian Sutherland and Janet A Grimes

Abstract

Objectives The objective of this study was to describe the all-cause mortality rate in cats hospitalized by the soft tissue surgery service of an academic referral hospital over a 5-year period and to identify specific risk factors for mortality. The hypotheses were that the all-cause mortality rate during hospitalization would be low, and cats undergoing emergency surgery and those with an American Society of Anesthesiologists (ASA) status of 3 or more would be at increased risk for mortality.

Methods The case log of cats hospitalized by the soft tissue surgery service at the University of Georgia was searched retrospectively to identify all cats hospitalized in the years 2015–2020. Data collected about each cat included age, sex and neuter status, weight, body condition score (1–9), pre-existing heart disease, chronic kidney disease, concurrent infection or cancer, emergency status, time of surgery (daytime vs after hours, which was defined as after 4 pm), if the surgery was performed on a weekday or weekend, and general type of surgery. Univariable logistic regressions were implemented to test and estimate odds ratios for the effects of risk factors on in-hospital mortality. A multivariable logistic regression was developed that initially included all risk factors with $P < 0.05$ on univariable analysis. Log-likelihood ratio test P values and profile-likelihood confidence intervals were reported.

Results The all-cause mortality rate was 6.1%. Analysis was limited because of low mortality, but multivariable analysis identified increasing ASA status and emergency surgery as significant risk factors for increased mortality while hospitalized.

Conclusions and relevance The findings of this study confirmed that increasing ASA status and emergency procedures are significant risk factors for mortality in cats. Clinicians should be aware of these risk factors and consider how to best monitor and manage these feline patients.

Keywords: All-cause mortality; risk factors; surgery; ASA status; emergent surgery

Accepted: 7 September 2024

Introduction

In cats, little is known about how general characteristics of hospital visits influence outcomes. Factors such as emergency or non-emergency presentation, type of procedure (gastrointestinal, urinary, etc) and timing of surgery (during normal business hours or after hours) may influence outcomes. Investigating and understanding causes of mortality in cats hospitalized for surgical care will allow for more accurate prognostication, targeted interventions and increased precaution in at-risk populations, with the ultimate goal of improving patient care and reducing overall mortality.

In human medicine, the most common causes of death in surgical patients are hemorrhage or hemorrhagic shock, surgical error, inappropriate airway management, intraoperative myocardial infarction and cardiac insufficiency,

Department of Small Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, Athens, GA, USA

Corresponding author:
Chad W Schmiedt DVM, DACVS-SA, Department of Small Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, 2200 College Station Road, Athens, GA 30602, USA
Email: cws@uga.edu

and drug administration errors.[1] Risk factors in people associated with higher all-cause mortality include higher American Society of Anesthesiologists (ASA) status,[1,2] emergency surgeries,[2–5] development of complications,[6,7] pre-existing conditions or comorbidities (particularly cardiac or renal disease),[3,4] older age[3] and increased complexity of the surgical procedure.[2,3,6,7]

General mortality risk in hospitalized cats has been rarely reported. In one large study that evaluated 79,178 cats anesthetized or sedated in 117 general and referral veterinary practices in the UK, the risk of anesthetic- and sedation-related death within 48 h of the procedure was 0.24%.[8] A related study identified risk factors for 189 deaths (175 directly related to anesthetic or sedation) within the same population and determined that ASA status, increasing age, extremes of weight, increasing procedural urgency and complexity, endotracheal intubation and fluid therapy increased the risk of death, while monitoring pulse and pulse oximetry reduced the risk of death.[9]

Another study evaluated age and ASA status as risk factors for perianesthetic morbidity and mortality in 138 adult cats undergoing at least 30 mins of inhalant anesthesia at a veterinary teaching hospital in the USA.[10] In that study, 15/138 (11%) cats had major perianesthetic complications, and 9/138 (6.5%) cats died during the perianesthetic period, which was defined as the period from induction to 24 h postoperatively. Age was not found to be a risk factor for complications, but an ASA status of 3 or higher was found to be correlated with a higher risk of developing serious complications.[10] Cats with an ASA status of 3 or higher had a mortality rate of 1.40% (95% confidence interval [CI] 1.12–1.68), while cats with an ASA status of 2 or lower had a mortality rate of 0.11% (95% CI 0.09–0.14).[10] These data are comparable to those from the aforementioned study based in the UK, which found that the percentage of healthy cats that died during the perianesthetic period in general and referral practices was 0.11% and 0.16%, respectively, and the percentage of sick cats that died in general and referral practices was 1.51% and 0.75%, respectively.[11]

Despite these studies evaluating anesthetic risks, there remains a paucity of literature documenting all-cause mortality rates and risk factors in hospitalized cats in a tertiary referral surgical practice. The objective of this study was to report the all-cause mortality rate in cats admitted to the soft tissue surgery service of an academic referral hospital over a 5-year period and to identify specific risk factors for mortality. The hypotheses were that the all-cause mortality rate during hospitalization would be low, comparable to that reported above, and cats undergoing emergency surgery and those with an ASA status of 3 or above would be at increased risk for mortality.

Materials and methods

Data collection

The case log of cats hospitalized by the soft tissue surgery service at the University of Georgia Veterinary Teaching Hospital was searched retrospectively to identify all cats hospitalized in the years 2015–2020. The medical records of all cats identified on the case log were reviewed. The soft tissue surgery service hospitalizes cases from referral appointments and transfers from other specialty services, including emergency and critical care, internal medicine and medical oncology, among others. The soft tissue service does not hospitalize cats with primary orthopedic or neurologic surgical conditions; thus, these types of surgical cases were not included in our analyses. Cats were included if they were present on the surgical case log, hospitalized, heavily sedated or anesthetized, and had a medical record that included an operative report or a description of the procedure that was performed.

Cats were excluded if their medical records lacked an operative report or information to categorize the surgery appropriately or if they were hospitalized without a procedure being performed. In-hospital mortality was defined as death before discharge from the hospital.

Data collected from each record included age, sex and neuter status, weight, body condition score (1–9), emergency status, time of surgery (daytime vs after hours, which was defined as after 4 pm) and if the surgery was performed on a weekday or weekend (Saturday or Sunday). Cases could be labeled as both after hours and weekend. The general type of surgery performed was based on the American College of Veterinary Surgeons' procedure classification scheme (abdominal [eg, abdominal exploratory with negative findings, lymph node removal or an unresectable mass, adrenalectomy, splenectomy, diaphragmatic herniorrhaphy], gastrointestinal [eg, surgery of the esophagus, stomach, intestines, liver, pancreas, gallbladder], head and neck [eg, airway surgery, thyroid, mandibulectomy, ventral bulla osteotomy, etc], thoracic [eg, cardiovascular surgery, lung lobectomy, esophageal surgery, surgery of structures in the pleural space, etc], urogenital [eg, nephrectomy, reproductive surgery, perineal urethrostomy, ureteral surgery, etc], laparoscopic/thoracoscopic, or skin/reconstructive [eg, limb amputation, skin mass resection, reconstructive surgeries, mastectomy, etc]).[12] If a cat had multiple categories of surgery performed in a single anesthetic event, it was counted as positive in each category. The presence of specific pre-existing conditions, including heart disease, chronic kidney disease, concurrent infection or cancer, was also recorded. The presence of comorbidities was based on a case-by-case review of the information available in the medical record. Cats were categorized as having heart disease if there were abnormal physical examination findings, such as a heart murmur, arrhythmia or abnormal cardiac imaging. Cats were categorized as

having chronic kidney disease if there was biochemical evidence of chronic renal dysfunction or if renal abnormalities were identified on renal imaging studies. Cats were categorized as having cancer if there was a diagnosis based on histologic or cytologic evidence of cancer, and as having an infection if there was a positive culture, a draining wound or other clinical evidence of infection.

Finally, the type of surgery relative to wound class was recorded.[13] Procedures were considered clean if they were non-traumatic, without acute inflammation, had no reported break in sterile technique and had no entry into the gastrointestinal, urogenital or respiratory tracts. Procedures were considered clean-contaminated if there was a minor break in aseptic technique or if the gastrointestinal, urogenital or respiratory tracts were entered. Because of small numbers in each group, contaminated and dirty procedures were considered in the same category for statistical analysis and included traumatic wounds, surgeries with reported major breaks in aseptic techniques or spillage from the gastrointestinal tract, active infection or surgeries in which a perforated viscus was encountered.

Statistical methods

All analyses were performed using SAS 9.4 (SAS). A significance threshold of 0.05 was used. Univariable logistic regressions were implemented to test and estimate odds ratios (ORs) for the effects of risk factors on in-hospital mortality. A multivariable logistic regression was developed using forward selection with a maximum of two factors as a result of the number of deaths (29 deaths with ASA status data). The two factors that were included were those with the lowest *P* value. These two factors were evaluated for collinearity. Log-likelihood ratio test *P* values and profile-likelihood CIs were reported. When quasi-separation was present, Firth's bias-reduced penalized-log-likelihood ratio test *P* values were reported. Data are described using percentages, median (range) or mean ± SD, as appropriate.

Results

Animals

A total of 492 cats met the inclusion criteria. The median age of all cats was 6.8 years (range 0.1–19.0). The median weight of all cats was 4.5 kg (range 0.5–9.9). There were 282 castrated males (282/492, 57.3%), 167 spayed females (167/492, 33.9%), 26 sexually intact females (26/492, 5.3%) and 17 sexually intact males (17/492, 3.5%). A total of 17 breeds were represented, with the most common breeds being domestic shorthairs (339/492, 68.9%), domestic longhairs (56/492, 11.4%) and domestic mediumhairs (38/492, 7.7%).

Multiple surgeries were performed in 26/492 (5.3%) cats. The most common general category of surgery performed was urogenital (184/492, 37.4%) followed by gastrointestinal (119/492, 24.2%), skin/reconstructive (90/492, 18.3%), head and neck (57/492, 11.6%), thoracic (42/492, 8.5%), abdominal (37/492, 7.5%) and laparoscopic/thoracoscopic (6/492, 1.2%).

Mortality

Of the 492 cats, 30 (6.1%) died: seven died and 23 were euthanized before discharge. Of the 23 cats that were euthanized postoperatively, two euthanasias occurred the same day as surgery, 19 occurred within 1 week postoperatively and three occurred more than 1 week postoperatively. Euthanasia was elected as a result of perceived poor prognosis (n = 21) or the combined concern of finances coupled with poor prognosis (n = 2). Of the seven cats that died, three deaths occurred intraoperatively and four occurred immediately postoperatively. The three deaths that occurred during surgery were the result of cardiopulmonary arrest (n = 2) and massive hemorrhage (n = 1). Causes of death for the four cats that died postoperatively were respiratory compromise (n = 1) and cardiopulmonary arrest (n = 3). Among the 30 cats that did not survive until discharge, the most common surgical category was urogenital (n = 10), followed by gastrointestinal (n = 8), thoracic (n = 7), abdominal (n = 5), skin/reconstructive (n = 4) and head and neck (n = 1). Five cats had multiple categories recorded: gastrointestinal and urogenital (n = 2), gastrointestinal and thoracic (n = 2), and skin/reconstructive and abdominal (n = 1).

Risk factors for all-cause mortality

Preoperative factors determined to be associated with higher odds for mortality on univariable analysis included spayed female sex, increasing ASA status and pre-existing cardiac disease (Tables 1 and 2). Compared with neutered males, spayed females had a 3.2-fold increased odds of mortality (OR 3.2, 95% CI 1.5–7.2; $P = 0.021$). For every 1 unit increase in ASA status, there was a 2.8-fold increased odds of mortality (OR 2.8, 95% CI 1.7–4.7; $P < 0.001$). Cats with pre-existing heart disease had a 6.3-fold increased odds of mortality (OR 6.3, 95% CI 1.3–23.3; $P = 0.024$). Intraoperative factors associated with increased risk of mortality on univariable analysis included increasing anesthesia duration, thoracic surgery and emergency status (Table 1 and 2). For every 1 h increase in anesthesia duration, there was a 1.4-fold increased odds of mortality (OR 1.4, 95% CI 1.1–2.1; $P = 0.049$). Cats undergoing thoracic surgery had a 3.7-fold increased odds of mortality (OR 3.7, 95% CI 1.4–8.6; $P = 0.011$). Of the 30 cats that died, seven underwent thoracic surgery; two of those also had primary cardiac disease. One cat had a patent ductus arteriosus that ruptured during dissection causing intraoperative mortality and another had a third-degree atrioventricular block for which an epicardial pacemaker was placed through a transxiphoid approach. That cat had a cardiopulmonary arrest during recovery and did

Table 1 Results of univariable logistic regression to identify binomial or categorical variables as risk factors for all-cause mortality in 492 cats hospitalized by the soft tissue surgery service at a veterinary teaching hospital

Risk factors	Cats with available data (n = 492)	Survivors (n = 462)	Non-survivors (n = 30)	OR description	OR	95% CI	*P* value
Significant factors							
Sex							
Spayed female	492/492 (100)	149/462 (32)	18/30 (60)	FS vs MN	3.2	1.5–7.2	0.021
Female	492/492 (100)	24/462 (5)	2/30 (7)	F vs MN	2.6	0.5–9.9	
Male	492/492 (100)	17/462 (4)	0/30 (0)	M vs MN	0.7	0.01–6.2	
Castrated male	492/492 (100)	272/462 (59)	10/30 (33)	–	–	–	–
ASA status							
1	454/492 (92.3)	44/425 (10)	0/29 (0)	Per 1 increase in score	2.8	1.7–4.7	<0.001
2		167/425 (39)	5/29 (17)				
3		180/425 (19)	16/29 (55)				
4		32/425 (8)	8/29 (28)				
5		2/425 (0)					
Emergency surgery	492/492 (100)	168/462 (64)	10/30 (33)	Y vs N	3.5	1.6–7.9	0.001
Thoracic surgery	492/492 (100)	35/462 (8)	7/30 (23)	Y vs N	3.7	1.4–8.6	0.011
Pre-existing neoplasia	492/492 (100)	81/462 (18)	1/30 (3)	Y vs N	0.2	0.01–0.8	0.018
Pre-existing heart disease	492/492 (100)	8/462 (2)	3/30 (10)	Y vs N	6.3	1.3–23.3	0.024
Non-significant factors							
Weekend	492/492 (100)	30/462 (6)	2/30 (7)	Y vs N	1.03	0.2–3.7	0.970
After hours	490/492 (99.6)	32/460 (7)	3/30 (10)	Y vs N	1.5	0.3–4.5	0.551
Pre-existing infection	492/492 (100)	54/462 (12)	5/30 (17)	Y vs N	1.5	0.5–4.0	0.437
Previous surgery 1 week	492/492 (100)	12/462 (3)	0/30 (0)	Y vs N	0.6	0.01–4.7	0.695
Multiple surgeries	492/492 (100)	22/462 (5)	4/30 (13)	Y vs N	3.1	0.9–8.8	0.081
Clean	491/492 (99.8)	113/462 (24)	10/30 (33)	Y vs N	1.01	0.6–1.6	0.978
Clean-contaminated		283/462 (61)	14/30 (47)			–	–
Contaminated		19/462 (4)	2/30 (7)		–	–	–
Dirty		46/462 (10)	4/30 (13)				
Abdominal surgery	492/492 (100)	32/462 (7)	5/30 (17)	Y vs N	2.7	0.9–7.0	0.084
Gastrointestinal surgery	492/492 (100)	111/462 (24)	8/30 (27)	Y vs N	1.2	0.5–2.6	0.746
Head and neck surgery	492/492 (100)	56/462 (12)	1/30 (3)	Y vs N	0.3	0.01–1.2	0.094
Urogenital surgery	492/492 (100)	174/462 (38)	10/30 (33)	Y vs N	0.8	0.4–1.8	0.662
Laparoscopic/ thoracoscopic surgery	492/492 (100)	6/462 (1)	0/30 (0)	Y vs N	1.2	0.01–10.2	0.927
Skin	492/492 (100)	86/462 (19)	4/30 (13)	Y vs N	0.67	0.2–1.8	0.452

Data are n (%) unless otherwise indicated
ASA = American Society of Anesthesiologists; CI = confidence interval; F = female; FS = female spayed; M = male; MN = male neutered; OR = odds ratio

not respond to cardiopulmonary resuscitation attempts. Other diagnoses in cats that died and had thoracic surgery included pyothorax (n = 1), chylothorax (n = 3) and peritoneal-pericardial diaphragmatic hernia (n = 1).

Cats undergoing emergency surgery had a 3.5-fold increased odds of mortality (OR 3.5, 95% CI 1.6–7.9; $P = 0.001$). Pre-existing neoplasia was a preoperative factor found to be protective against mortality; the odds of mortality in these cats were decreased by 80% (OR 0.2, 95% CI 0.01–0.8; $P = 0.018$). Of 82 cats with pre-existing cancer, five (6%) had emergency surgeries compared with 183/410 (45%) cats without cancer ($P < 0.001$).

Table 2 Results of univariable logistic regression to identify continuous variables as risk factors for all-cause mortality in 492 cats hospitalized by the soft tissue surgery service at a veterinary teaching hospital

Risk factors	Cats with available data (n = 492)	Survivors (n = 462)	Non-survivors (n = 30)	OR description	OR	95% CI	*P* value
Significant factors							
Anesthesia duration (h)	486/492 (98.8)	2.43 ± 1.02	2.84 ± 1.45	Per hour	1.4	1.1–2.1	0.049
Non-significant factors							
Age (years)	454/492 (92.3)	6.96 ± 4.81	7.61 ± 4.94	Per 1 year	1.03	0.95–1.04	0.475
Body weight (kg)	454/492 (92.3)	4.65 ± 1.53	4.23 ± 1.76	Per 1 kg	0.83	0.6–1.1	0.143
BCS	454/492 (92.3)	5.32 ± 1.73	4.88 ± 1.90	Per 1 increase in score	0.9	0.7–1.1	0.225
Surgery duration (h)	454/492 (92.3)	1.41 ± 1.44	1.64 ± 1.20	Per hour	1.1	0.9–1.3	0.433
Heart rate (bpm)	412/462 (89.2)	193.48 ± 31.57	188.46 ± 39.47	Per 10 bpm	1.0	0.8–1.1	0.442

Data are n (%) or mean ± SD unless otherwise indicated
BCS = body condition score; bpm = beats per minute; CI = confidence interval; OR = odds ratio

Table 3 Significant factors for mortality in cats hospitalized at a veterinary teaching hospital soft tissue surgery service after multivariable analysis

Risk factor	OR description	Univariable	Multivariable	*P* value
ASA status	Per 1 increase in score	2.8 (1.7–4.7)	2.7 (1.6–4.7)	<0.001
Emergency	Yes vs No	3.5 (1.6–7.9)	3.0 (1.4–7.0)	0.006

Data are odds ratio (95% confidence interval) unless otherwise indicated. Because of the exclusion of cases with missing data, the above analyses represent 454 cases with 29 deaths
ASA = American Society of Anesthesiologists

For the multivariable analysis, forward selection was used and the number of factors was limited to two. The two factors included were ASA status and emergency status. Collinearity status was not a concern as both emergent and non-emergent cases had an ASA status in the range of 1–5. For the multivariable analysis, the number of cases evaluated was reduced to 454 cats (of which 29 died) as a result of 38 missing ASA status values.

There was a significant increase in odds of mortality associated with increasing ASA status and emergency surgery (Table 3). For every 1 unit increase in ASA score, there was a 2.7-fold increased odds of mortality (OR 2.7, 95% CI 1.6–4.7; $P < 0.001$). Emergency surgery was associated with a 3.0-fold increased odds of mortality (OR 3.0, 95% CI 1.4–7.0; $P = 0.006$).

Discussion

Increasing ASA status and emergency surgery were identified as significant risk factors for increased all-cause mortality in cats hospitalized with a referral soft tissue surgery service. There was a 6.1% mortality rate among the cats in the present study, which supports the hypothesis that overall mortality would be low. In addition, the hypothesis that cats undergoing emergency surgery and those with a higher ASA status would have increased odds of in-hospital mortality was accepted.

A direct comparison with previously reported mortality rates is complicated by variations in the sample population, study methods and inclusion criteria. The all-cause mortality rate found in the present study is similar to that in a previous study from a veterinary teaching hospital in the USA that identified a mortality rate of 6.5% and included cats aged over 6 months undergoing general anesthesia for at least 30 mins between June 1995 and July 1996.[10] A more recent report evaluating feline perioperative mortality assessed 79,178 cats in 117 different practices in the UK and identified a mortality rate of 0.24%. Deaths within 48 h of the end of the procedure were included, but the authors excluded deaths due to inoperable conditions and pre-existing conditions where anesthesia could not be directly attributed to death, which likely explains the difference in mortality compared with the present study, in which pre-existing conditions were included and were identified as a specific risk factor for increased mortality on univariable analysis.[8]

While the complexity of the surgical procedure was not ranked or evaluated, many of the cats that died underwent relatively complex surgical procedures. In

parallel, these cats also likely had significant underlying metabolic or hemodynamic perturbations from acute kidney injury, chronic kidney disease, post-hepatic biliary obstruction, pancreatitis, sepsis and heart disease. These morbidities would be reflected in the ASA status, and it is logical that more complicated surgeries in systemically compromised cats would have higher risk, which helps to explain why higher ASA status is associated with increased mortality.

Increased odds of mortality after hours and on the weekends in human intensive care units has been termed the 'weekend effect'.[14,15] In a meta-analysis of human weekend surgical care and postoperative mortality, postoperative mortality was increased for elective surgeries in the days preceding the weekend and was higher on the weekend for emergency and urgent surgeries.[16] In the cats reported here, while emergency status was significantly associated with mortality, after-hours surgery was not. This is supported by a previous veterinary study in which surgical start times were evaluated for associations with morbidity and mortality in dogs and cats. In that study, after-hours surgery had no association with mortality or morbidity in dogs.[17] There were not enough deaths (five deaths in a total of 66 feline cases) to perform a statistical analysis for feline mortality, but cats undergoing emergency surgery during regular hospital hours had a higher risk of morbidity compared with that of emergency surgery performed after hours.[17] Given the small number of cases, the authors of that study were hesitant to draw conclusions from those data and suggested that a type 1 error may have occured.

Similarly, in the study presented here, it is unclear why female spayed sex was a risk factor in univariable analysis; this may also relate to the small number of cats that died and potentially reflect a type 1 error. Conversely, in the present study, cats undergoing oncologic surgeries were less likely to experience in-hospital mortality in the univariable analysis. This may be attributed to the fact that oncologic surgeries in cats are typically non-emergency procedures performed during regular business hours. Alternatively, other factors may have influenced these findings; for example, owners of cats undergoing surgery for neoplasia may be less likely to opt for euthanasia, which was a common cause of death in the cases described here. Thus, while cancer generally may indicate a less favorable long-term prognosis, cats undergoing surgical treatment for cancer have a low risk of mortality during hospitalization.

Pre-existing heart disease and thoracic surgery were both identified as risk factors in the univariable analysis, although neither was included in the final multivariable model. Two of the cats that died after thoracic surgery were undergoing procedures for a specific heart condition. Another three cats had chylothorax, which has a poor prognosis in cats, with mortality in the range of 13–57% in cats treated with conventional techniques.[18] Thus, at least in comparison with chylothorax, the disease processes associated with the need for thoracic surgery may have contributed to the mortality in those cats.

Anesthetic duration is a logical risk factor for mortality, as longer procedures may increase the risk of hypotension, hypothermia and hypoventilation, and the consequences of those factors can pose substantial risks.[19] In one study evaluating ASA status as a risk factor for anesthetic mortality in cats, anesthetic duration was a strong confounder of the influence of ASA status on mortality risk, but was not found to be an independent risk factor.[10] Another study evaluating risk factors for anesthetic mortality in cats showed no significant effect of procedure duration; however, anesthetic duration was not evaluated independently.[10]

The present study has some limitations. As a result of the retrospective design, some medical records were missing information or required inference from available documents. The diagnosis of comorbid conditions was based on a review of medical records and these diagnoses were more thorough in some cats than others. It is possible that the true percentage of cats with comorbidities may be greater or less than what was reported. The sample size of patients that died was only 6% of the total population evaluated (30/492 cats); consequently, interpretation of these results may be subject to type 1 and type 2 error and should be made with caution. In addition, the small number of deaths limited our ability to perform multivariable modeling. Selection bias from convenience sampling precludes the application of these results outside of a tertiary referral soft tissue surgery service as populations and typical patients and procedures vary among practice types.

Conclusions

The findings of this study confirmed that ASA status and emergency procedures are significant risk factors for all-cause mortality in cats hospitalized by a tertiary referral soft tissue surgery service. Spayed female sex, pre-existing heart disease, anesthesia duration and thoracic surgery were also associated with an increased risk of mortality and should be studied with greater numbers of animals. Clinicians should be aware of these risk factors and consider how to best monitor and manage these feline patients.

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding The authors received no financial support for the research, authorship, and/or publication of this article.

Ethical approval This work did not involve the use of animals and therefore ethical approval was not specifically required for publication in *JFMS*.

Informed consent This work did not involve the use of animals (including cadavers) and therefore informed consent was not required. No animals or people are identifiable within this publication, and therefore additional informed consent for publication was not required.

ORCID iD Chad W Schmiedt https://orcid.org/0000-0003-1561-0736

References

1 Kawashima Y, Seo N, Morita K, et al. **Annual study of perioperative mortality and morbidity for the year of 1999 in Japan: the outlines–report of the Japan Society of Anesthesiologists Committee on Operating Room Safety.** *Masui* 2001; 50: 1260–1274.

2 Heeney A, Hand F, Bates J, et al. **Surgical mortality – an analysis of all deaths within a general surgical department.** *Surgeon* 2014; 12: 121–128.

3 Pedersen T, Eliasen K and Henriksen E. **A prospective study of mortality associated with anaesthesia and surgery: risk indicators of mortality in hospital.** *Acta Anaesthesiol Scand* 1990; 34: 176–182.

4 Fowkes FG, Lunn JN, Farrow SC, et al. **Epidemiology in anaesthesia. III: mortality risk in patients with coexisting physical disease.** *Br J Anaesth* 1982; 54: 819–825.

5 Mullen MG, Michaels AD, Mehaffey JH, et al. **Risk associated with complications and mortality after urgent surgery vs elective and emergency surgery: implications for defining "quality" and reporting outcomes for urgent surgery.** *JAMA Surg* 2017; 152: 768–774.

6 Pedersen T. **Complications and death following anaesthesia. A prospective study with special reference to the influence of patient-, anaesthesia-, and surgery-related risk factors.** *Dan Med Bull* 1994; 41: 319–331.

7 Tiret L, Desmonts JM, Hatton F, et al. **Complications associated with anaesthesia – a prospective survey in France.** *Can Anaesth Soc J* 1986; 33: 336–344.

8 Brodbelt DC, Blissitt KJ, Hammond RA, et al. **The risk of death: the confidential enquiry into perioperative small animal fatalities.** *Vet Anaesth Analg* 2008; 35: 365–373.

9 Brodbelt DC, Pfeiffer DU, Young LE, et al. **Risk factors for anaesthetic-related death in cats: results from the confidential enquiry into perioperative small animal fatalities (CEPSAF).** *Br J Anaesth* 2007; 99: 617–623.

10 Hosgood G. **Evaluation of age and American Society of Anesthesiologists (ASA) physical status as risk factors for perianesthetic morbidity and mortality in the cat.** *J Vet Emerg Crit Care* 2002; 12: 9–15.

11 Brodbelt D. **Perioperative mortality in small animal anaesthesia.** *Vet J* 2009; 182: 152–161.

12 American College of Veterinary Surgeons. **Small animal surgical procedures.** https://www.acvs.org/sites/default/files/files/Residency/Procedures/Small%20Animal%20Surgical%20Procedures%20as%20of%203-31-2021.pdf (2021, accessed 11 December 2020).

13 National Healthcare Safety Network. Surgical site infection event (SSI). https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf (2023, accessed 1 August 2023).

14 Hall AM, Stelfox HT, Wang X, et al. **Association between afterhours admission to the intensive care unit, strained capacity, and mortality: a retrospective cohort study.** *Crit Care* 2018; 22: 97. DOI: 10.1186/s13054-018-2027-8.

15 Honeyford K, Cecil E, Lo M, et al. **The weekend effect: does hospital mortality differ by day of the week? A systematic review and meta-analysis.** *BMC Health Serv Res* 2018; 18: 870. DOI: 10.1186/s12913-018-3688-3.

16 Smith SA, Yamamoto JM, Roberts DJ, et al. **Weekend surgical care and postoperative mortality: a systematic review and meta-analysis of cohort studies.** *Med Care* 2018; 56: 121–129.

17 McConkey MJ, Alexopoulos ET and Hernandez JA. **Associations between surgical start time (regular vs after hours) and morbidity and mortality during hospitalization in dogs and cats.** *J Vet Emerg Crit Care (San Antonio)* 2021; 31: 629–637.

18 Reeves LA, Anderson KM, Luther JK, et al. **Treatment of idiopathic chylothorax in dogs and cats: a systematic review.** *Vet Surg* 2020; 49: 70–79.

19 Smith MD, Barletta M, Young CN, et al. **Retrospective study of intra-anesthetic predictors of prolonged hospitalization, increased cost of care and mortality for canine patients at a veterinary teaching hospital.** *Vet Anaesth Analg* 2017; 44: 1321–1331.