TITLE: Epidemiology of road traffic accidents in cats attending emergency-care practices in the UK

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Objectives: To estimate the incidence proportion of road traffic accidents in cats attending emergency out-of-hours clinics in the UK, identify major risk factors for road traffic accident occurrence and for survival to discharge.

Methods: A retrospective study of a cohort of 33053 cats in the VetCompass database attending emergency-care practice between 1/1/2012 – 15/2/2014. Incidence proportion was calculated and logistic regression was used to identify risk factors for road traffic accident and survival to discharge following road traffic accident.

Results: Incidence proportion was estimated at 4.2% (95% confidence interval 4.0% - 4.4%). Cats aged 6 months – 2 years were at increased odds of road traffic accident, as were male cats and crossbred cats. Odds of road traffic accident was highest in the autumn. Spinal injury, abdominal injury and increasing count of injuries were associated with increased odds of death.

Impact: Road traffic accident is a frequent presentation in emergency-care practice. Identification of risk factors for death within the first 24 hours following a road traffic accident can aid veterinarian and owner decision making for treatment of cats involved in a road traffic accident.

Introduction

Road traffic accidents (RTA) in cats are a common presentation to primary-care practitioners in the UK, with estimates of between 1.4 and 4.6% of primary-care consultations in cats attributed to RTA (Kolata, 1980; Edney, 1997; Rochlitz, 2003a; O'Neill *et al.*, 2014; McDonald *et al.*, 2017). This increases to 14.1% in primary emergency out-of-hours veterinary clinics in the UK (Firth *et al.*, 2014). RTAs have been shown to result in substantial injury, with injuries to the extremities and head and neck most commonly seen and an average of 1.6 areas injured per cat (Rochlitz, 2004). There is limited information on survival in cats following a RTA, with a mortality proportion ranging from 9-16% (Kolata, 1980; Rochlitz, 2004), and an age standardised mortality rate of 29 deaths per 10,000 cat years reported in insured cats in Sweden (Egenvall and Nødtvedt, 2009) Trauma has been reported as the most common cause of mortality in young cats in the UK and the second most common cause of mortality in cats in Sweden (Egenvall and Nødtvedt, 2009; O'Neill *et al.*, 2015). Despite this, there is limited previous research into risk factors for and survival of cats involved in an RTA. Previously identified risk factors include age, sex and being out at night (Kolata, 1980; Childs and Ross, 1986; Rochlitz, 2003a, 2003b; McDonald *et al.*, 2017). There is also some evidence of a seasonal trend for RTA, with increased proportion of RTAs occurring in the summer (Kolata, 1980; Childs and Ross, 1986; Rochlitz, 2003a, 2003b). As RTAs are reported to present most frequently at night (Rochlitz, 2003b), this suggests that using data from emergency-care practice may be the most appropriate for studying the risk factors for RTAs and survival following RTA in cats (Drobatz *et al.*, 2009).

This study aimed to evaluate the incidence proportion of RTA in cats presenting to emergency-care practices in the UK, and to investigate risk factors associated with RTA events and with death following RTA.

Materials and Methods

Ethics approval was granted by the Royal Veterinary College Ethics and Welfare committee (M2014 0021). De-identified electronic patient records (EPR) were made available from Vets Now Ltd through collaboration in the VetCompass Programme (VetCompass, 2016). Data were available on patient demographic information (species, date of birth, sex, neuter status and breed), clinical notes, summary diagnosis terms using VeNom codes (Venom Coding Group, 2016) applied to the EPR by the emergency-care teams and treatment.

Sample size calculations estimated that at least 1500 cats ≤ 5 years and 1500 cats > 5 years of age would be required to detect an odds ratio (OR) of at least 1.5 for RTA in cats ≤ 5 years compared with cats > 5 years of age (assuming 5% of cats > 5years of age have an RTA, 80% power, 95% confidence) (Epi Info 7,CDC).

The study population included all cats with at least one summary term, treatment, clinical note, or bodyweight recorded at any of 50 Vets Now clinics between 1st January 2012 and 15th February 2014. Each cat was included in the population only once. The number of cats attending a clinic during the study period ranged from 219 – 1535.The case inclusion criteria for RTA required that the cat presented dead or alive to a Vets Now participating clinic and had RTA (or synonym) recorded in the EPR as a reason for the current presentation. Exclusion criteria included cats presenting with traumatic injuries that the veterinarian did not record as being related to an RTA. Potential RTA cases were identified by searching the free clinical text using the following search terms: *hit, RTA, RTC, HBC, ran over, run over, knock, traffic, collision, vehicle, car.* Potential cases were aggregated from each search and the clinical records of all identified cats were manually reviewed in detail to evaluate them against those that met the case definition. Additional data were extracted on confirmed RTA cases to record count and location of injuries sustained, treatments received, if the cats were owned, if any financial concerns for veterinary care costs were recorded, if the cat survived to discharge and mechanism of death if appropriate. All cats that were not identified as potential RTA cases or were ruled out as RTA cases were included as non-RTA cases for the risk factor analyses. Cats that had injuries that the veterinarian did not ascribe a cause to were excluded from the analysis to limit misclassification of case RTAs.

Demographic information was extracted for all cats in the study. Age at presentation was grouped (< 6 months, 6 months – < 1 year, 1 – < 3 years, 3 – < 6 years, 6 -< 10 years, 10 – <1 5 years, ≥ 15 years, not recorded). Cats were categorised into purebred (recognised breed by International Cat Care) (International Cat Care, 2015) and crossbred, with purebred status further categorised into individual breeds. The breed variable included any breed with >100 cats in the overall study as an individual breed , with the remaining purebred cats grouped together as “other purebred” and all crossbred cats in one group. Date of presentation was categorised by season (March – May “Spring”, June – August “ Summer”, September – November “ Autumn, December – February “Winter” (Met Office, 2015)). Injuries were individually recorded and also grouped by the body location affected (head, thorax, abdomen, pelvis, limbs and tail) and any previously diagnosed disease was also recorded. Any missing data were coded as ‘not recorded’.

Data were exported to a spreadsheet (Excel 2013, Microsoft Corp.) for checking and cleaning before further export to Stata 13.1 (Stata Corporation) for statistical analyses.

Incidence proportion was determined by calculating the proportion of RTA cases out of all cats included in the study. The 95% confidence interval was calculated using standard techniques assuming binomial distribution, as for proportions (Kirkwood and Sterne, 2003). Descriptive statistics were generated to describe the age, sex, neuter status, purebred status and breed for the cases and non-cases. Injuries sustained and treatments received were also described for the RTA cases.

Separate univariable logistic regression models were constructed to examine associations between potential risk factors and presentation with RTA as the outcome, and also potential risk factors associated with all-cause death before discharge following RTA. Multivariable logistic regression was then used to examine associations between risk factors and each outcome, whilst controlling for the confounding effects of other variables in the model. Demographic risk factors were examined in both models, whilst variables associated with injuries and treatment were additionally examined in the model for death following RTA for cats presenting alive. Variables were carried forward to be assessed in the multivariable modelling if they were loosely associated with the outcome in the univariable analysis ($p < 0.2$). All variables that were dropped at this stage were assessed in the final model for a confounding effect, by examining changes to the odds ratio when included in the multivariable model. Changes of greater than 10% were considered to indicate confounding by the variable. Biologically appropriate pairwise interactions were assessed. Linearity of continuous variables was assessed by comparing the model with the continuous variable and the model with the categorical variable to assess best fit using the likelihood ratio test. Clinic attended was evaluated in the final model as a random effect to assess for clustering (Dohoo, 2010). The final model fit was assessed using the Hosmer-Lemeshow test (Hosmer and Lemeshow, 2000). Significance was set at the 5% level.

Results

Incidence proportion of RTA in cats attending primary emergency out-of-hours veterinary care

Overall, the study included 33,586 cats with at least one EPR at participating Vets Now clinics from 14th December 2011 to 14th February 2014. Of those, data searching identified 2,371 potential RTA cases from which 1,407 (59.3%) cats were confirmed as RTA cases. Of the remaining 964 cats, 431 were ruled out as RTA and classified as part of the non-RTA population and the remaining 533 cats were excluded from the risk factor analysis. This resulted in an incidence proportion of RTA events of 4.2% (95% confidence interval (C.I) 4.0% - 4.4%) for the study period. Median age at presentation for RTA cats was 2.6 years (interquartile range (IQR) 1.0 years – 5.9 years), and median age at presentation for non-RTA cats was 7.9 years (IQR 2.5 years – 14.8 years). Of cats with recorded demographic data, most with an RTA event were male (739; 64.8%), neutered (682 ;59.8%), and crossbred (830; 93.2%), as were most cats not presenting with a RTA event (56.3% male, 63.5% neutered and 88.2% crossbred). Age data were available for 89% of cats, sex and neuter data for 79.2% of cats and breed data for 60.7% of cats. The number of confirmed RTA cases at each clinic ranged from 4 – 68.

Descriptive analysis of cats presented with RTA

Of the 1,407 cats that presented with RTA, 94 (6.7%) were dead on arrival at the clinic. Of the 1,313 cats that presented alive, 433 (33%) subsequently died during the emergency-care period. Most of these cats were euthanased during the initial consultation (260; 60.2%), and a further 11 (2.6%) died without assistance at the clinic before admission to the hospital. After admission, 121 (28%) cats were euthanased, and 41 (9.3%) died without assistance.

Following an alive RTA presentation, 816 (62.1%) cats were admitted for hospitalisation, and 392 cats (29.9%) underwent radiography and 111 (8.5%) ultrasonography. In cats presented alive, general anaesthesia or sedation was used in 196 (14.9%) cats, 224 (17.1%) received oxygen therapy outside of anaesthesia, and 481 (36.6%) received at least one blood test. Just under half (45.6%) of cats presented alive received intravenous fluid therapy, with 2 (0.2%) being administered a fresh blood transfusion and 1 (0.1%) receiving a synthetic blood transfusion. Mannitol therapy was used in 19 (1.5%) of all cats and hypertonic saline in 9 (0.7%) cats, with 2 cats (0.2%) receiving both. Analgesia was provided to 1,096 (83.5%) cats. Opioid analgesia was the most commonly used pain relief (671 ; 51.2%), and 216 cats (16.5%) did not receive any analgesia. Most of the cats that did not receive any analgesia (183; 84.7%) were euthanased in the initial consultation, with a further 5 (2.3%) dying before treatment in the initial consultation. Financial concerns were reported in 211 (16.1%) of cats and a further 293 (22.4%) had no owner identified.

The most common body locations injured were the skin (361; 27.5%), the pelvis (298; 22.7%), and limbs (276; 21.1%). Half of all cats (664; 50.7%) sustained two or more injuries, with 77 cats (5.9%) having no specific injury recorded during examination but were still reported as an RTA.

Risk factors for RTA in cats attending primary emergency out-of-hours veterinary care

Univariable analysis indicated associations ($p < 0.2$) between age, sex, neuter status, breed and season presented, and presentation with RTA as the outcome (see supplementary table 3). These variables were all carried forward for evaluation using multivariable modelling. Once controlled for confounding in the multivariable modelling, age, sex, purebred status and season of presentation all remained significantly associated with RTA. Clustering was identified at the clinic level ($p<0.001$) so the final reported model was a mixed-effect logistic regression model (Table 1). No evidence of confounding or interaction was identified. There was adequate model fit (Hosmer-Lemeshow $p=0.19$). Cats between 6 months and 6 years of age were at increased odds of RTA in comparison to cats 6 – 9 years ($p < 0.0001$). Male cats and crossbred cats were at 1.3 and 1.9 times the odds of RTA in comparison to female cats and purebred cats respectively (Table 1) Cats were at increased odds of RTA in the autumn (OR 1.19 95% CI 1.01 – 1.40) and at reduced odds in the winter (OR 0.83 95% C.I 0.70 – 0.96), in comparison with the spring (p< 0.0001).

Risk factors for all-cause death following RTA in cats presenting to primary emergency out-of-hours veterinary care

Univariable analysis for risk factors associated with mortality after RTA identified loose associations ($p < 0.2$) between breed, sex, neuter status, financial concerns, season of presentation, age, admission, radiography, ultrasonography, sedations/general anaesthesia, IVFT, mannitol use, analgesia use, oxygen use, blood tests, type of injury received and total count of injuries, and death among the RTA cases as an outcome (see supplementary table 4). These variables were carried forward for multivariable modelling.

The multivariable model contained 1,283 individuals (91.2% of all RTA cases), with 433 deaths. The use of NSAID therapy alone perfectly predicted survival (no deaths), so the thirty cats that received only NSAID as pain relief were dropped from the model. The fit of the final model was adequate (Hosmer-Lemeshow test result p = 0.18). No significant clustering within clinics attended was identified (rho = 1.7×10^{-7}, p = 1.00) so the results of the non-random effect model were reported. Age was included as it confounded the other risk factors in the model (Table 2). The body area injured was associated with death, with an increase odds of death seen in cats with an abdominal injury (OR 2.77 95% C.I 1.49 – 5.014 p = 0.001), spinal injury (OR 2.51 95% C.I 1.57 – 4.04 p < 0.001) or a concurrent disease reported (OR 22.41 95% C.I 2.86 – 175.88 p = 0.003) and a decreased odds of death was associated with a skin injury (OR 0.30 95% C.I 0.19 - 0.48 p < 0.001) compared with cats without these injuries. An increasing count of injuries was associated with an increase in odds of death (OR 1.66 95% C.I 1.38 - 1.99 p<0.001). Oxygen administration was associated with increased odds of death (OR 5.31 95% C.I 3.50-8.06 p<0.001). Admission to hospital and receiving blood tests were associated with decreased odds of death (OR 0.32 95% CI 0.21 – 0.49 p < 0.001 and OR 0.32 95% C.I 0.21-0.48 p<0.001 respectively).

Discussion

This study identifies RTA as a relatively common reason for presentation of cats to emergency primary-care clinics, with just over 4% of cats that presented during the study period being recorded with RTA. Younger cats and crossbred cats were at increased odds of RTA, and increased odds were also identified during the summer and autumn months compared to spring. Increasing total count of injuries recorded following a RTA was associated with increased odds of death, as were injuries to the spine and abdomen. Injuries to the skin alone were associated with a decreased odds of death.

The incidence proportion of RTA in cats presenting to emergency primary-care providers (4.2% 95% C.I 4.0% - 4.4%) identified in the current study is similar to the prevalence of traumatic injuries in cats presenting to primary-care practices (4.6% 95% C.I 3.8% - 5.3%) (O'Neill *et al.*, 2014). However, only 60% of these injuries were due to RTA. A study from the US reported that between 2.3% and 3.8% of cat admissions to two university referral hospitals were due to RTA (Kolata, 1980), and RTA related injuries account for 1.4% of consultations in primary-care practice in the UK (Edney, 1997). The higher prevalence seen in the current study most likely reflects the emergency nature of the Vets Now caseload but could be affected also by changes in the cat population or road traffic activity over time. It has previously been suggested that RTAs are more likely to occur at night (Rochlitz, 2003b) and as Vets Now clinics are mostly open overnight this may help to explain the higher prevalence estimated in the current study. Data on the precise time of presentation were not available for the present study, but would be interesting for further research in the future. .

The current study identified that younger cats, males and crossbred cats had greater odds of RTA. These risk factor results are consistent with earlier studies (Rochlitz, 2003a, 2003b). The increased risk associated with cats 6 months – 2 years, male cats and crossbred cats may reflect behavioural differences between these groups and older, female and purebred cats. Kittens under 6 months of age are likely to be kept indoors and it is possible that older cats spend more time indoors as they are less active and therefore intrinsically have lower exposure to roads and cars. It is also possible that cats learn to avoid high risk areas with increasing age, as they get to know their home range and become more adept at avoiding traffic risks (Rochlitz, 2003a, 2003b). Purebred cats have been reported to spend significantly less time outdoors than crossbred cats and therefore have intrinsically lower exposure to roads and cars (Rochlitz, 2003a), possibly partially explaining the reduced risk seen in purebred cats in the current study. It could also be hypothesised that purebred cats would be more likely to present to emergency clinics for owner economic reasons than crossbred cats, and as such this might partially account for the reduced risk of purebred cats presenting specifically for RTA. However, given the proportion of purebred cats reported in this study (11.9%) is very similar to that reported in recent work from non-emergency general practice (11.0%(O'Neill *et al.*, 2014)), this was considered less likely. No evidence of a difference in risk between individual purebred breeds was found, though this may reflect limitations of power as counts of cats within individual breeds were relatively small. The increased risk seen in male cats may be associated with differing behaviour, such as roaming habits, compared with females. There is conflicting evidence on whether male and female cats do have differing roaming habits so there may be other unknown behaviour factors underlying the apparent association (Barratt, 1997; Liberg *et al.*, 2000; Rochlitz, 2005). Interestingly, no interaction between sex and neuter status was detected in the current study. This may be due to not having a recorded neuter status for all cats resulting in the study being underpowered to detect any interaction. A seasonal trend was found with an increased odds of RTA in summer and autumn and decreased odds in winter compared to spring, that was similar to those reported in previous studies (Childs and Ross, 1986; Rochlitz, 2003b). This is also similar to a trend seen in overall trauma admissions at a veterinary hospital in the US, where an increase in the proportion of admissions was reported in July – September in comparison to January - March (Drobatz *et al.*, 2009). It is possible that this trend is due to seasonal changes in behaviour, with cats spending more time outdoors in the summer and autumn, and more time indoors in the winter. The ability of owners to find their cats following an RTA, or transport them to a vet may also be influenced by the season and weather patterns.

The proportion of cats that died (both euthanasia and unassisted death) during the emergency-care period following presentation after an RTA (33% 95% C.I 30% - 35%) was higher in this study than that reported in a previous case series from primary-care day practice, where 16.2% of cats presenting alive following a RTA died (Rochlitz, 2004). In the same case series, only 5% of cats presenting due to RTA were euthanased, whilst 29% of cats in the current study were euthanased. Differences between studies may in part reflect the current study including cases only out of hours versus the previous study that related to presentations throughout the day. It has previously been indicated that RTAs are more likely to occur at night (Rochlitz, 2003), and it is possible that cats with more severe injuries may be presented to a veterinary clinic outside of normal working hours, whilst the owners of cats with less severe injuries may opt to wait until their usual daytime veterinary provider is available.

The distribution of injured body locations following RTA identified in the current study was in agreement with other studies, with injury to extremities more frequently recorded (Kolata, 1980; Rochlitz, 2004). As cats are most likely to be hit whilst running, it is plausible that cats are unlikely to be crushed by a wheel, with either end of the body or a limb being clipped by the wheel as it passes the cat. It is also possible that those cats that are crushed by the vehicle die before presentation to a veterinary surgeon, so are less likely to be presented. It was not possible to ascribe an animal trauma triage score to these cats due to limited information within the clinical notes. It is possible that this would be found to be associated with death prior to discharge as has been found in previous studies (Rockar, Drobatz and Shofer, 1994) given that the number of injuries recorded was negatively associated with death prior to discharge.

The associations identified between specific injury types and death after presentation are likely also to be related to the prognosis associated with different injuries. Spinal injuries have usually been associated with poor long-term prognosis (Negrin, Schatzberg and Platt, 2009) and veterinarians may also ascribe a poor short-term prognosis to abdominal injuries that require surgery due to the increased risks of general anaesthesia in an emergency scenario (Brodbelt *et al.*, 2007). This may result in some owners opting for euthanasia rather than treatment. It is also possible that the cost of treatments for severe injuries is prohibitive to many owners, and they may opt for euthanasia over treatment. The increased odds of death following RTA in cats with a concurrent condition recorded may be due to owners being less likely to pursue treatment if their pet has other chronic conditions, or these patients may be sicker overall and have an increased risk of death due to their poor health status. There was only eight of these cats in the analysis, so it is also possible that this association seen was due to an unrepresentative sample.

It is likely that cats with the poorest prognosis are euthanased soon after presentation which may explain the reduced odds of death following RTA in cats that were hospitalised. It may also explain the reduced odds associated with pain relief treatment as cats that were euthanased at presentation did not receive pain relief. The number of cats that were reported to have not received analgesia and were not euthanased at presentation was too small to allow any meaningful analysis of the association between pain relief and death in cats not euthanased at presentation.

A number of the associations with euthansia seen are likely due to reverse causality. For example less severely injured cats may be more likely to receive blood tests and other investigations than more severely injured cats which may be euthanased or have invasive procedures postponed, rather than the blood tests themselves having a protective effect. Owner willingness to treat may be reflected in the reduced odds of death in cats receiving blood tests, rather than opting for euthanasia or first aid treatment only. It is also possible that cats receiving blood tests had problems identified that were then successfully treated. Additionally, oxygen would have been provided to the more severely injured cats which would naturally be at higher risk of death, which is reflected in the increased odds of death of cats receiving oxygen treatment. However, this does provide evidence for veterinarians that cats that require oxygen therapy do have an increased risk of euthanasia in the first 24 hours and may aid owner decision making when deciding on treatment options. .

In the multivariable model for risk factors for death, financial concerns of the owner were not associated with death as an outcome, suggesting that welfare, prognosis and veterinary guidance play a greater role in the management of these cats than the owners' ability to afford or willingness to pay for treatment. However, it is possible that an element of owner responses may reflect a reluctance to admit to having financial considerations when discussing treatment options which may have biased this finding. Stray cats were included within the variable for financial concerns. Despite being at increased risk of death at the univariable level, this association was not maintained within the multivariable model, indicating that veterinarians are opting to treat those cats without owners on a basis of their injuries sustained and prognosis rather euthanizing due to lack of owner or funds to treat.

The study had some limitations. These clinical records were not recorded primarily for research purposes, so there is the potential for some variation in the quality of data recording across clinics and veterinarians. The case definition for an RTA may lack sensitivity as veterinarians had to correctly attribute injury to a traffic incident, which may mean the apparent incidence estimated is lower than the true incidence of RTAs in cats presenting to emergency-care practices in the UK. Injuries were not always recorded in the clinical notes in some cases, so there was the possibility of injuries being misclassified or not recorded. Although, as all patients are transferred to their usual vet when they are next open, the clinical notes were usually very detailed to ensure suitable hand over of cases. Veterinary care within the UK is complex, with practices varying in size, structure and ownership and owners may have differing levels of loyalty to a veterinary practice, with some owners 'shopping around' rather than maintaining a bond with one practice. This can result in selection bias in practice based research, as accounting for these differences within the study design and methods is difficult. However, the use of big data to undertake primary-care research, such as the present study, will help limit and reduce this selection bias by ensuring large numbers of practices can be included in the study. Finally, there may be differences in the population of cats that attend emergency practice and those that do not, such as owners opting to wait for their day time vet if the cat appears to only have sustained minor injuries or if the owner cannot afford or do not know about the availability of emergency practice, limiting the generalisability of these results beyond emergency clinic attending cats.

Conclusion

This study has shown that younger, male, and crossbred cats had higher odds of emergency-care presentation with RTA. Cats with spinal and abdominal injuries following RTA were at increased odds of death or euthanasia, as were cats with a greater count of injuries. Pain relief was administered to nearly every cat that was not euthanased, indicating that emergency vets have a high awareness of the analgesic requirements for cats diagnosed with RTA. Some associations reported, in particular association of death with oxygen therapy and blood tests, may reflect reverse causality and over-interpretation of these risk factors would be cautioned. Nonetheless, an increased awareness of risk factors associated with RTA diagnosis and all-cause death can aid veterinarians in guiding their management and decision making when considering treatment options. .

No conflicts of interest have been declared

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Table 1: Multivariable analysis of risk factors for road traffic accident diagnosis in cats presenting to Vets Now practices between 14/12/11 and 14/2/14

Variable		RTA (%)	Non-RTA (%)	Odds Ratio (95% Confidence Interval)	P - value
Age	< 6months	59 (4.2%)	2117 (6.7%)	0.99 (0.72 - 1.35)	<0.001
	6months-<1year	211 (15%)	2442 (7.7%)	3.02 (2.41 - 3.78)	
	1-<3yrs	359 (25.5%)	5008 (18.8%)	2.47 (2.01 - 3.04)	
	3-<6yrs	206 (14.6%)	4375 (13.8%)	1.65 (1.32 - 2.06)	
	6-<10yrs	130 (9.2%)	4524 (14.3%)	Reference	
	10-<15yrs	62 (4.4%)	5879 (18.6%)	0.37 (0.27 - 0.51)	
	15-<20yrs	39 (2.8%)	4018 (12.7%)	0.35 (0.25 - 0.51)	
	Not recorded	341 (24.2%)	3283 (10.4%)	3.95 (3.19 - 4.89)	
Sex	Male	739 (52.5%)	14087 (44.5%)	1.28 (1.13 - 1.45)	<0.001
	Female	401 (28.5%)	10947 (34.6%)	Reference	
	Not recorded	267 (19.0%)	6612 (20.9%)	0.82 (0.69 - 0.98)	
Purebred status	Crossbred	830 (59.0%)	16885 (53.4%)	1.9 (1.45 - 2.48)	<0.001
	Purebred	61 (4.3%)	2270 (7.2%)	Reference	
	Not recorded	516 (36.7%)	12491 (39.5%)	1.61 (1.22 - 2.12)	
Season	Spring	246 (17.5%)	5641 (17.8%)	Reference	<0.001
	Summer	328 (23.3%)	6544 (20.7%)	1.17 (0.98 – 1.39)	
	Autumn	529 (37.6%)	10347 (32.7%)	1.19 (1.01 – 1.40)	
	Winter	304 (21.6%)	9114 (28.8%)	0.83 (0.70 – 0.99)	
Veterinary Clinic (random effect)	Rho			0.02 (0.009 -0.04)	<0.001
	Sigma			0.26 (0.18-0.37)	

Table 2: Multivariable analysis for risk factors for death prior to discharge following road traffic accident diagnosis in cats attending Vets Now practices between 14/12/11 and 14/2/14N=1283)

Variable		N	Deaths (%)	Odds ratio (95% confidence interval)	p- value
Abdominal Injury	No	1190	397 (33.4%)	Reference	0.001
	Yes	93	36 (38.7%)	2.77 (1.49 - 5.14)	
Spinal Injury	No	1104	334 (30.3%)	Reference	<0.001
	Yes	179	99 (55.3%)	2.51 (1.57 - 4.04)	
Skin Injury	No	999	383 (38.3%)	Reference	<0.001
	Yes	284	50 (17.6%)	0.3 (0.19 - 0.48)	
Concurrent Illness	No	1275	427 (33.5%)	Reference	0.003
	Yes	8	6 (75%)	22.41 (2.86 - 175.88)	
Number of recorded Injuries	(continuous)			1.66 (1.38 - 1.99)	<0.001
Admitted to the practice	No	473	271 (58.3%)	Reference	<0.001
	Yes	810	162 (20.0%)	0.32 (0.21 – 0.49)	
Pain relief	None	216	199 (92.1%)	Reference	<0.001
	NSAID[1]	30	0	~	
	Opioid	672	207 (30.8%)	0.06 (0.04 - 0.11)	
	NSAID & Opioid	395	27 (6.8%)	0.02 (0.007 - 0.03)	
Oxygen	No O2	1059	314 (29.7%)	Reference	<0.001
	O2	224	119 (53.1%)	5.31 (3.50 - 8.06)	
Blood tests	No Blood test	804	368 (45.8%)	Reference	<0.001
	Blood test	65	65 (13.6%)	0.32 (0.21 - 0.48)	
Age	< 6months	51	17 (33.3%)	Reference	0.62
	6months-<1year	192	48 (25.0%)	0.72 (0.29 - 1.75)	
	1-<3years	332	77 (23.2%)	0.70 (0.30 - 1.66)	
	3-<6years	193	52 (26.9%)	0.81 (0.33 - 2.00)	
	6-<10years	119	38 (31.9%)	0.90 (0.35 - 2.33)	
	10-<15years	61	27 (44.3%)	1.05 (0.36 - 3.11)	
	15-<20years	35	24 (68.6%)	2.36 (0.61 - 9.12)	
	No age recorded	300	150 (50%)	1.51 (0.65 - 3.54)	

[1] zero effect cell

Supplementary Table 3: Univariable analysis of risk factors for road traffic accident diagnosis in cats presenting to Vets Now practices between 14/12/11 and 14/2/14

Variable		RTA (%)	Not RTA (%)	Odds Ratio for RTA	95% Confidence Interval	P-Value*
Age (N=29429)	Less than 6months	61 (5.7%)	2139 (7.5%)	0.4	0.30 - 0.53	
	6months-<1year	209 (19.6%)	2422 (8.5%)	1.2	1.01 – 1.44	
	1-<2yrs	359 (33.7%)	5007 (17.7%)	Base		
	3-<5yrs	206 (19.3%)	4374 (15.4%)	0.66	0.55 – 0.78	<0.0001
	6-<9yrs	130 (12.2%)	4524 (16.0%)	0.4	0.33 – 0.49	
	10-<14yrs	62 (5.8%)	5879 (20.7%)	0.15	0.11 – 0.19	
	15-<19yrs	39 (3.7%)	4018 (14.2%)	0.14	0.10 – 0.19	
Sex (N=26174)	Male	739 (64.8%)	14087 (56.3%)	1.29	1.13 - 1.50	<0.001
	Female	401 (35.2%)	10947 (43.7%)	Base		
Neuter Status (N=26174)	Entire	458 (40.2%)	9127 (36.5%)	1.17	1.04 - 1.32	0.01
	Neutered	682 (59.8%)	15907 (63.5%)	Base		
Breed (N=20046)	Crossbred	830 (93.2%)	16885 (88.1%)	1.19	1.06-1.33	<0.001
	Purebred	61 (6.9%)	2270 (11.9%)	Base		
Most Common Breed (N=20046)	Crossbred	830 (93.2%)	16885 (88.1%)	Base		
	Bengal	19 (2.9%)	304 (1.6%)	1.27	0.80 - 2.03	
	British Shorthair	10 (1.2%)	295 (1.5%)	0.69	0.37 – 1.30	
	Persian	3 (0.3%)	297(1.6%)	0.21	0.07 – 0.64	<0.0001
	Siamese	5 (0.7%)	271 (1.4%)	0.38	0.16 - 0.91	
	Burmese	2 (0.2%)	217 (1.1%)	0.19	0.05 - 0.76	
	Maine Coon	7 (0.8%)	181 (0.9%)	0.79	0.37 - 1.68	
	Ragamuffin	3 (0.3%)	185 (1.0%)	0.33	0.11 - 1.03	
	Other Purebred	12 (1.4%)	520 (2.7%)	0.47	0.26 - 0.84	
Season presented (N=33053)	Spring	246 (17.5%)	5641 (17.8%)	Base		
	Summer	328 (23.3%)	6544 (20.7%)	1.15	0.97-1.36	<0.0001
	Autumn	529 (37.6%)	10347 (32.7%)	1.17	1.00 - 1.37	
	Winter	304 (21.6%)	9114 (28.8%)	0.77	0.64 - 0.91	

*** All p-values calculated using the Likelihood Ratio Test**

Supplementary Table 4 part 1: Univariable analysis for risk factors for death following RTA in cats presented to VetsNow practices between 14/12/11 and 14/2/14

		Total (%)	Deaths (%)	Odds Ratio	95% C.I[1]	p-value[2]
Breed (N=835)	Crossbred	755 (92.9%)	252 (32.5%)	Base		0.27
	Purebred	59 (7.1%)	15 (25.4%)	0.71	0.39 – 1.30	
Most Common Breed (N=835)	Crossbred	775 (92.8%)	252 (32.5%)	Base		0.19
	Bengal	18 (2.2%)	7 (38.9%)	1.32	0.51 - 3.44	
	British Shorthair	10 (1.2%)	1 (10%)	0.23	0.03 - 1.83	
	Other Pedigree	32 (3.8%)	7(21.9%)	0.58	0.25 - 1.64	
Sex (N=1075)	Male	696 (64.7%)	211 (30.3%)	Base		0.11
	Female	379 (35.2%)	133 (35.1%)	1.24	0.95 - 1.62	
Neuter Status (N=1075)	Entire	431 (40.1%)	167 (38.8%)	Base		<0.001
	Neutered	644 (59.9%)	177 (27.5%)	0.6	0.46 - 0.78	
Financial Concerns (N=1311)	No financial Concerns	809 (61.6%)	223 (27.6%)	Base		<0.0001
	Stray	293 (22.4%)	120 (56.9%)	3.47	2.53 - 4.74	
	Financial concerns	211 (16.1%)	90 (30.7%)	1.17	0.87 - 1.56	
Season of presentation (N=1311)	Spring	234 (17.8%)	82 (35.0%)	Base		0.44
	Summer	307 (23.4%)	110 (36.0%)	1.45	0.73 - 1.48	
	Autumn	490 (37.3%)	152 (31.0%)	0.83	0.60 - 1.16	
	Winter	282 (21.5%)	89 (31.6%)	0.86	0.59 - 1.23	
Age (N=1011)	<6months	53 (5.3%)	16 (30.2%)	Base		<0.0001
	6months-<1year	201 (19.9%)	49 (24.4%)	0.75	0.38 - 1.46	
	1-≤2years	342 (33.8%)	7 (22.5%)	0.67	0.35 - 1.27	
	3-≤5years	196 (19.4%)	52 (26.5%)	0.84	0.43 - 1.63	
	6-≤9years	123 (12.2%)	38 (30.9%)	1.03	0.51 - 2.08	
	10-≤14years	61 (6.1%)	27 (44.3%)	1.84	0.85 - 3.98	
	15-≤20years	35 (3.5%)	24 (68.6%)	5.05	2.00 - 12.70	
Admit (N=1313)	Not Admitted	497 (37.9%)	271 (54.5%)	Base		<0.001
	Admitted	816 (62.1%)	162 (19.8%)	0.21	0.16 - 0.26	
Radiograph (N=1311)	No Radiograph	921 (70.1%)	346 (37.6%)	Base		
	Radiograph	392 (29.9%)	87 (22.2%)	0.47	0.36 - 0.62	<0.001
Ultrasound (N=1311)	No ultrasound	1202 (91.5%)	414 (34.4%)	Base		
	Ultrasound	111 (8.5%)	19 (17.1%)	0.39	0.24 - 0.66	<0.001

[1] Confidence Interval

[2] All p-values calculated using the likelihood ratio test

Supplementary Table 4 part 2: Univariable analysis for risk factors for death following RTA in cats presented to VetsNow practices between 14/12/11 and 14/2/14

		Total (%)	Deaths (%)	Odds Ratio	95% C.I[1]	p-value[2]
Maximum sedation or anaesthesia (N=1311)	None	1117 (85.1%)	396 (35.0%)	Base		<0.0001
	Sedation	104 (7.9%)	23 (22.1%)	0.52	0.32 - 0.83	
	General Anaesthesia	92 (7%)	14 (15.2%)	0.33	0.18 - 0.58	
IVFT (N=1311)	No IVFT	714 (54.5%)	323 (45.2%)	Base		<0.001
	IVFT	599 (45.6%)	110 (18.4%)	0.27	0.21 - 0.35	
Blood Transfusion (N=1311)	None	1310 (99.8%)	432 (33%)	Base		-
	Fresh blood	2 (0.16%)	0	-	-	-
	Synthetic blood	1 (0.08%)	1 (100%)	-	-	0.21
Mannitol Infusion (N=1311)	None	1283 (97.7%)	420 (32.7%)	Base		<0.0001
	Mannitol	19 (1.45%)	6 (31.6%)	0.95	0.36 - 2.52	
	Hypertonic Saline	9 (0.69%)	6 (66.7%)	4.11	1.02 - 16.51	
	Mannitol & Hypertonic Saline	2 (0.15%)	1 (50%)	2.06	0.13 – 32.93	
Analgesia (N=1311)	None	216 (16.5%)	199 (92.1%)	Base		<0.001
	NSAID	30 (2.3%)	0	-	-	
	Opioid	671 (51.2%)	207 (30.9%)	0.04	0.02 - 0.06	
	NSAID & Opioid	395 (30.1%)	27 (7.4%)	0.006	0.003 - 0.01	
Oxygen (N=1311)	No O2	1089 (82.9%)	314 (28.8%)	Base		<0.0001
	O2	224 (17.1%)	119 (53.1%)	2.8	2.09 - 3.75	
Bloods Test (N=1311)	No Blood test	832 (63.5%)	368 (44.2%)	Base		<0.001
	Blood Test	481 (36.5%)	65 (13.5%)	0.2	0.14 - 0.27	
Abdomen (N=1311)	No Abdominal injury	1220 (92.9%)	397 (32.5%)	Base		0.22
	Abdominal Injury	93 (7.1%)	36 (38.7%)	1.31	0.85 - 2.02	
Thorax (N=1311)	No Thoracic Injury	1070 (81.5%)	316 (28.8%)	Base		<0.001
	Thoracic Injury	243 (18.5%)	117 (48.1%)	2.22	1.67 -2.94	
Head (N=1311)	No Head Injury	893 (68%)	250 (28.0%)	Base		<0.001
	Head Injury	420 (32%)	183 (43.6%)	1.99	1.56 - 2.53	
Limb (N=1311)	No Limb Injury	1037 (78.9%)	361 (34.8%)	Base		0.006
	Limb Injury	276 (21.1%)	72 (26.1%)	0.66	0.49 - 0.89	
Spine (N=1311)	No Spinal Injury	1132 (86.2%)	334 (29.5%)	Base		<0.001
	Spinal Injury	181 (13.8%)	99 (54.7%)	2.89	2.10 – 3.97	

[1] Confidence Interval

[2] All p-values calculated using the likelihood ratio test

Supplementary Table 4 part 3: Univariable analysis for risk factors for death following RTA in cats presented to Vetsnow practices between 14/12/11 and 14/2/14

		Total (%)	Died (%)	Odds Ratio	95% C.I[1]	P-value[2]
Pelvis (N=1311)	No Pelvic Injury	1015 (77.3%)	337 (33.2%)	Base		0.75
	Pelvic Injury	298 (22.7%)	96 (32.2%)	0.96	0.73 - 1.26	
Skin (N=1311)	No Skin Injury	952 (72.5%)	381 (40.0%)	Base		<0.001
	Skin Injury	361 (27.5%)	52 (14.4%)	0.25	0.18 - 0.35	
Hypovolaemic Shock (N=1311)	No Hypovolaemic Shock	1156 (88.1%)	363 (31.4%)	Base		0.001
	Hypovolaemic Shock	157 (12.0%)	70 (44.6%)	1.76	1.25 - 2.47	
Concurrent conditions (N=1311)	No Concurrent conditions	1304 (99.3%)	427 (32.8%)	Base		0.05
	Concurrent conditions	9 (0.7%)	6 (66.7%)	4.11	1.02 - 16.57	
Total number of recorded injuries (N=1311)	0	77(5.9%)	21 (27.3%)	Base		<0.0001
	1	572 (43.6%)	145 (25.4%)	0.91	0.53 - 1.55	
	2	415 (31.6%)	157 (37.8%)	1.62	0.94 - 2.78	
	3	179 (13.6%)	78 (43.6%)	2.06	1.15 - 3.68	
	4	56 (4.3%)	26 (46.4%)	2.31	1.12 – 4.78	
	5+	14 (1.1%)	6(42.86%)	2	0.62 - 6.45	

[1] Confidence Interval
[2] All p-values calculated using the likelihood ratio test