Factors affecting survival to discharge in fifty-three cats diagnosed with uroabdomen, a single centre retrospective analysis. Samuel J. Hornsey, BVetMed MRCVS; Zoe Halfacree, MA VetMB CertVDI CertSAS FHEA DipECVS MRCVS; Elvin Kulendra, BVetMed MVetMed, CertVDI, DipECVS, FHEA, MRCVS; Sarah Parker DVM PhD; Nicola Kulendra, BVetMed (Hons) BVetMed CertVDI DipECVS FHEA MRCVS. From The Royal Veterinary College (Hornsey, Halfacree), North Mimms, Hatfield, United Kingdom; North Down Referrals (Kulendra and Kulendra), Bletchingley, Surrey, RH1 4QP, United Kingdom; Centre for Applied Epidemiology (Parker), Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, SK, S7N 5B4, Canada. Corresponding author: Samuel Hornsey, BVetMed MRCVS Address: 22 Old Green Road, Broadstairs, Kent, CT10 3BP, United Kingdom E-mail: hornseysamuel@gmail.com

26	Keywords:
27	Uroabdomen
28	Urinary tract
29	Survival to discharge
30	Prognosis
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32	Abbreviations:
33	PCV – Packed Cell Volume
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51 **Objectives**: To assess outcomes in cats diagnosed with uroabdomen at a single referral centre. 52 53 **Methods**: Fifty-three cats diagnosed with uroabdomen at a veterinary teaching hospital were 54 identified between June 2003 and September 2016. Data collected included signalment, presenting signs, aetiology, location of rupture, presence of concurrent injury, outcome of urine 55 culture, presence of uroliths and PCV/creatinine/potassium levels at presentation. Cats 56 57 managed medically and surgically were included and the use of urinary catheters, cystotomy tubes and abdominal drains were recorded. It was determined if patients survived to discharge, 58 59 and if they were euthanised or died. 60 **Results**: Seventy-four per cent (n=39) of cats survived to discharge. Elevations in creatinine 61 62 (P=0.03) were shown to be significantly correlated with survival to discharge. Sex, age, location of rupture, presence of uroliths, outcome of urine culture, presence of concurrent 63 injury, potassium at presentation and PCV at presentation were not associated with survival to 64 65 discharge. There was no difference in survival between cats that were medically managed and surgically managed. 66 67 68 Conclusions and relevance: Cats that develop uroabdomen have a good chance of survival. Electrolyte and biochemistry values should be assessed at the time of presentation, in addition 69 70 to the presence of concurrent injury. 71 72 73 74 75

Introduction

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Uroabdomen is defined by the presence of urine in the abdominal cavity as a consequence of rupture of the urinary tract. It can lead to metabolic and multi-systemic disturbances, which can be fatal if not treated. In cats the most common site of rupture is the urinary bladder (1). There is no age or breed predisposition (2). A previous abstract of 110 cats with pelvic fractures found that male cats were at increased risk of developing urethral rupture or uroabdomen (3). Studies in dogs have indicated that males have a higher risk of developing traumatic urinary bladder rupture and subsequently developing uroabdomen (1, 2). Delay in the diagnosis of uroabdomen has been shown to increase mortality rates (4). The most commonly reported cause of uroabdomen in both cats and dogs is blunt or vehicular trauma (1, 4-6). Iatrogenic trauma and urethral obstruction have also been identified as causes of uroabdomen (7). Presenting signs of patients with uroabdomen will vary depending on the aetiology, location and duration of urinary tract rupture. Reported clinical signs in cats include lethargy, anorexia, abdominal pain, ascites, dehydration, haematuria, dysuria, vomiting, hypothermia and other signs relating to trauma (2, 5, 8-10). Rupture of the urinary tract cannot be ruled out on palpation of an intact urinary bladder or the patients ability to urinate normally (4, 7). Patients with uroabdomen can present as an emergency and need be stabilised with medical management. Typical issues that need addressing include azotaemia, metabolic acidosis, hyponatremia, hyperphosphatemia and hyperkalaemia (4, 5, 10). Surgery may be required in some cases to correct the defect in the urinary tract.

The current literature in cats focuses on the aetiology, diagnosis and treatment of patients that develop uroabdomen (1, 5, 8). There is a paucity of information that identifies prognostic factors associated with uroabdomen in cats. This study aims to highlight factors that are associated with outcome in a retrospective population of cats.

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Materials and Methods

107 Electronic medical records from a veterinary teaching hospital were analysed to identify patients diagnosed with uroabdomen over a 12-year period between June 2003 and September 108 109 2016. Inclusion criteria included cats of any age or sex that had been diagnosed with uroabdomen. 110 Cats were excluded if they were euthanised within two hours of presentation. Uroabdomen 111 112 must have been diagnosed by either comparing biochemical parameters of abdominal fluid and 113 peripheral blood or by contrast radiography, confirming extravasation of fluid from the urogenital tract into the abdominal space. Clinical management of each case was at the 114 115 discretion of the clinician. Data collected from medical records included signalment, presenting signs, aetiology, location 116 of rupture in the urinary tract, the method of diagnosis, if contrast was used, concurrent injury 117 (musculoskeletal or soft tissue), presence and type of uroliths, if the case was managed 118 119 medically or surgically, surgical procedure performed if relevant, bacterial culture results, and 120 time until discharge. The use of abdominal drains, urinary catheters and cystotomy tubes were 121 also recorded. Records also identified potassium, creatinine, packed cell volume (PCV) and total solids (TS) at presentation. For analysis, age was classified using previously published 122 123 life stage guidelines in cats (11). PCV was categorized; low (<29), normal (29-48), high (>48) using published reference ranges (12). Aetiology was categorised into the following sub-124 125 groups; external trauma (road traffic accident, other blunt trauma or dog fight), iatrogenic (cystocentesis, urinary catherization, or manual bladder expression or post-surgery), urethral obstruction, and unknown. For cats to be considered medically managed, no surgical intervention was performed, and they were managed with either an indwelling urinary catheter or abdominal drain. Survival to discharge was noted; if the patient did not survive to discharge the reason for euthansia or cause of death was identified.

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Statistical analysis

- All non-normally distributed continuous data was described using the median with a range.
- Non-parametric continuous data was analysed using the Mann Whitney Test. Categorical data
- was analysed using either Pearson's Chi-squared Test or Fishers Exact; the former used when
- cells were larger than five; p values < 0.05 were considered significant.

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Results

- Fifty-three cats met the inclusion criteria. Of these 68% (n=36) were male and 32% (n=17)
- were female. The median age of cats in this study was 4 years (range 0.75 to 12 years). The
- median body weight was 4.5kg (range 2.4kg to 7.0kg).

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- The most common presenting signs included inappetence 36% (n=19), lethargy 28% (n=15),
- abdominal pain 23% (n=12), dysuria 19% (n=10) and vomiting 15% (n=8). The most common
- cause of uroabdomen in this study was urethral obstruction 21% (n=11), followed by hit by car
- 146 19% (n=10) (Figure 1).

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Survival to discharge

- Seventy-four per cent (n=39) of cats survived to discharge; 19% (n=10) were euthanized, and
- 8% (n=4) died. The causes of death and euthanasia in cats managed medically and surgically

are represented in Figure 2. Sex, age, location of rupture, presence of uroliths, outcome of urine culture, presence of concurrent injury, potassium at presentation and PCV at presentation were not associated with survival to discharge (Table 1.). Whether a patient was medically or surgically managed had no correlation with survival to discharge.

Elevations in creatinine on presentation (P=0.03) were shown to be significantly associated with failure to survive to discharge in a univariate analysis.

Five patients had pelvic fractures, of these four survived to discharge. All pelvic fractures were caused by blunt trauma; 4 of which were road traffic accidents.

Medical management

Twenty-four per cent (n=13) of cats with uroabdomen received only medical management; of these 62% (n=8) survived to discharge. Abdominal drains were placed in six medically managed cats, of which two survived. Urinary catheters were placed in six cats, of which six survived. One cat, which did not survive had both a urinary catheter and abdominal drain.

Surgical management

Seventy-five per cent (n=40) of cats underwent surgery to manage their uroabdomen, of these 78% (n=31) survived to discharge. Contrast imaging was used to determine the location of rupture in 85% (n=34) of cats managed surgically. Four cats had pre-operative abdominal drains placed, 3 of these survived to discharge. Post operatively 5 cats were managed with a urinary catheter, all of these survived. Fifteen cats had post-operative cystotomy tubes; of these 12 survived. Ten cats had abdominal drains post-operatively; of these, six survived. Two cats had both a cystotomy tube and abdominal drain, one survived. In two cats that died due to

cardiac arrest, one died during recovery from anaesthesia and one died 5 hours after recovery from anaesthesia. Two cats were euthanised intraoperatively due to intra-operative findings suggesting a poor prognosis.

Discussion

In this study, the mortality rate of cats diagnosed with uroabdomen was 26% (n=14). Other recent studies had similar mortality rates of 25% in cats that developed urethral ruptures (13), and 38.5% in a study of 26 cats with uroabdomen (5).

The most common reason for euthanasia in this study was acute kidney injury in three cats and deteriorating clinical status in three cats. In the cats with acute kidney injury, elevations in both urea and creatinine above reference range were noted post operatively. Although none of the clinical records noted financial reasons for euthanasia, it is difficult to ascertain whether this played a role in the decision to euthanise cats within this study. The owner of one cat that was medically managed declined surgery for unknown reasons, this cat was euthanised due to clinical deterioration.

Male cats were overrepresented in this study with similar findings in other studies (5) (14). Male cats have longer, and narrower urethras compared to females; previously it has been discussed that this may make bladder rupture more likely as it cannot adapt to sudden increase in urinary tract pressure (1). Although this study included more male cats, this study did not show that survival to discharge was associated with sex.

Trauma (external and iatrogenic) was the most common cause of uroabdomen in 53% of cats.

This was in consensus with other studies; a retrospective study of 26 cats with uroperitoneum

found trauma was associated with 85% of cases (5). A more recent study looking into urethral rupture in 63 cats found trauma was the cause in 56% of patients (13). There was no correlation between trauma and survival to discharge in this population of cats.

The most common location of rupture in this study was the urinary bladder, 43% (n=23), followed by the urethra, 30% (n=16), a study of 26 cats also had similar findings (5). No correlation between location of rupture and survival were made.

In this population of cats, a correlation between elevations in creatinine and not surviving to discharge were shown to be statistically significant. When patients develop uroabdomen, potassium from the urine is reabsorbed through the peritoneal membrane leading to hyperkalaemia (15). Creatinine is similarly reabsorbed, but being a larger molecule, this process occurs more slowly than potassium, therefore elevations in creatinine may suggest the presence of uroabdomen may be more prolonged, leading to a poorer outcome. All cats that did not survive to discharge within this study had creatinine levels above the normal reference range on presentation. Given the small cohort and low death rate, clear conclusions cannot be made between outcome and creatinine levels on presentation.

In this study, there was no statistically significant difference in survival between cats that were managed surgically or medically. Surgery was aimed at correcting a defect in the urinary tract or providing urinary diversion, and therefore further stabilizing patients. This study did not identify whether patients developed intraoperative or postoperative complications. Causes for euthanasia in cats that did not have surgery included deteriorating clinical status, development of anuria and poor prognosis. All cats that had only urinary catheters placed survived to

225 discharge; small tears of the bladder or urethra can heal without surgery with urinary catheter 226 placement (7, 16). 227 228 In this study, 25% of cats had concurrent injury, however this was not shown to correlate with 229 survival. Uroabdomen patients can have a variety of concurrent conditions such as fractures, neurological dysfunction, abdominal organ damage, among others. Other studies have shown 230 231 that concurrent injury negatively impacts survival. Feline trauma patients with multiple injuries were shown to have an increased mortality rate (17). Patients that had diaphragmatic hernias 232 233 with concurrent soft tissue and orthopaedic injury were shown to have a lower survival rate 234 (18). This study had a small cohort with a low death rate with a small proportion having 235 concurrent injury, which may limit our interpretation of the data. 236 237 Due to the retrospective nature of this study, it was not possible to collect all desired data for each patient. There was variability between clinician techniques and records. 238 239 In conclusion, this study indicated that cats that develop uroabdomen have a good chance of 240 241 survival. Patients should have their electrolyte and biochemistry values assessed on presentation and concurrent injury identified. Although primarily a surgical condition, in which 242 243 defects in the urinary tract should be surgical managed, sole medical management can be 244 successful in appropriate cases. 245 246 247 248 249

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296	Tables
297	Table 1. Characteristics of cats diagnosed with uroabdomen associated with survival to
298	discharge.
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300	Figures
301	Figure 1. Aetiology of cats in this study diagnosed with uroabdomen.
302	Figure 2. Causes of death and euthanasia of cats in this study that did not survive to
303	discharge.
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314	Ethical Approval:
315	This work involved the use of non-experimental animal(s) only (owned or unowned), and
316	followed established internationally recognised high standards ('best practice') of individual
317	veterinary clinical patient care. Ethical approval from a committee was not necessarily
318	required.
319	Informed Consent:
320	Informed consent (either verbal or written) was obtained from the owner or legal custodian of
321	all animal(s) described in this work for the procedure(s) undertaken.
322	Informed Consent for Publications:
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324	No animals or humans are identifiable within this publication, and therefore additional Informed Consent for publication was not required.
325	informed Consent for publication was not required.
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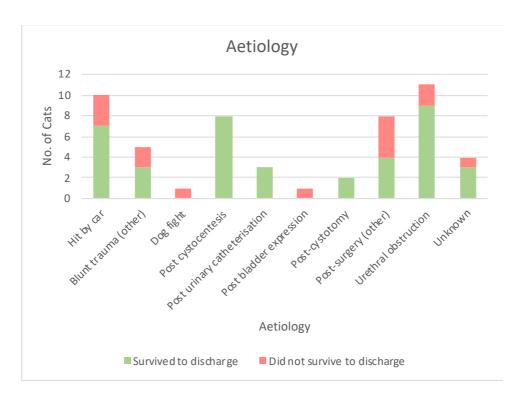


Figure 1. Aetiology of cats in this study diagnosed with uroabdomen.

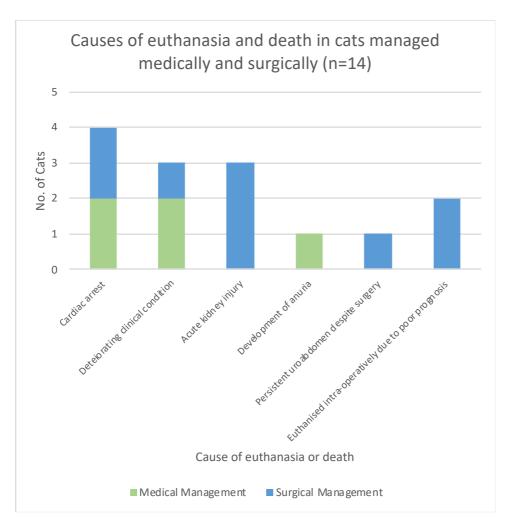


Figure 2. Causes of death and euthanasia of cats in this study that did not survive to discharge.

	Medically Managed (13)		Surgically Managed (40)	
Characteristics	Survived to discharge (8)	Did not survive to discharge (5)	Survived to discharge (31)	Did not survive to discharge (9)
Sex				
Male	7	3	23	3
Female	1	2	8	6
Age				
Junior (7months – 2 years)	5	2	11	1
Prime Adult (3 – 6 years)	1	1	10	2
Mature (7 – 10 years)	2	2	10	6
Location of Rupture				
Bladder (n=23)	5	0	15	3
Urethra (n=16)	1	2	10	3
Ureter (n=6)	0	1	4	1
Unknown (n=8)	2	2	2	2
Aetiology				
Road traffic accident	0	2	7	1
Blunt trauma (other)	0	0	3	2
Dog fight	0	0	0	1
Post cystocentesis	4	0	4	0
Post urinary catheter placement	1	0	2	0
Post bladder expression	0	1	0	0
Post-operative (cystotomy)	1	0	1	0
Post-operative (other)	0	1	4	3
Urethral obstruction	2	1	7	1
Unknown	0	0	3	1
Concurrent injury			• •	_
No concurrent injury	8	3	23	6
Musculoskeletal	0	2	3	1
Soft tissue	0	0	3	2
Musculoskeletal and soft tissue	0	0	2	0
Uroliths				
Present	3	1	8	3
Not present	5	3	20	4
Culture performed	2	2		1
Positive	3	2	5	1

Negative	3	1	15	1
Creatinine (µmol/L)	185 (86 - 905)	571 (339 – 1526)	428 (280 – 1520)	890 (253 – 1439)
Potassium (mEq/L)	4.4(3.5-7.3)	6.1(4.9 - 8.7)	5.51(4.3 - 9.4)	6.5 (4.1-8.5)
PCV				
Low	1	0	8	1
Normal	3	4	7	4
High	1	0	5	0

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Table 1. Characteristics of cats diagnosed with uroabdomen associated with survival to discharge.