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Clinicopathological characteristics of cats with signs of feline lower urinary tract disease in the Czech Republic

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Abstract: A total of 214 cats with signs of feline lower urinary tract disease (FLUTD) were assessed in this study. There were 81.30% males (82.20% of them neutered) and 18.70% females (80.00% of them spayed) with an age range from 9 months to 17 years (mean 5.1 ± 3.7). Most of the cats (111; 51.90%) were diagnosed with feline idiopathic cystitis; in 57 (26.60%) cats, uroliths were detected. A urinary tract infection (UTI) as well as urethral plugs were diagnosed in 23 cats (10.75%). In 100 cats, a non-obstructive form of feline lower urinary tract disease (FLUTD) was present; in 114 cats (exclusively males) a urethral obstruction was diagnosed. Most of the cats (141; 65.90%) were indoor-housed. The cats with the UTI were significantly older when compared to the other cases of FLUTD. The most common clinical signs reported by the owners were dysuria (39.70%), oliguria/anuria (31.30%), and vomiting (24.80%). In the cats with the urethral obstruction, oliguria/anuria and non-specific systemic signs were dominant whereas in the non-obstructive form, signs of a lower urinary tract disease were more frequent. The urine specific gravity ranged from 1.008 to 1.080, while in the cats diagnosed with UTI, it was significantly lower than the other cats. Haematuria was the most common finding within the urinalysis which was diagnosed in 181 cats (84.60%): macroscopic haematuria was present in 94 patients (43.90%), microscopic haematuria was present in 87 cats (40.70%). Pyuria was found in 36 cats (16.80%). In the UTI cats, the most common bacterial isolate was *E. coli.* Results of our study are in agreement with previous reports of FLUTD in various countries, with idiopathic cystitis as the most common cause.

Keywords: feline idiopathic cystitis; urinary tract infection; urethral plugs; urolithiasis

List of abbreviations

CFU = colony forming unit; **FIC** = feline idiopathic cystitis; **FLUTD** = feline lower urinary tract disease; **hpf** = high power field; **UP** = urethral plug; **UTI** = urinary tract infection

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A feline lower urinary tract disease (FLUTD) is a common disorder in feline practice with a reported prevalence of 3–8% (Kirk et al. 2001; Lekcharoensuk et al. 2001; Adams and Dean 2009; Lund et al. 2012). It affects the feline urinary bladder and/or urethra and various possible causes have been recognised. These may include bacterial cystitis, urethral plugs (UP), urolithiasis, anatomic abnormalities, trauma and neoplasia. When the specific cause is not identified, a diagnosis of feline idiopathic cystitis (FIC) is made. According to various reports, feline idiopathic cystitis represents the single most common cause of FLUTD (Kruger et al. 1991; Buffington et al. 1997, Lekcharoensuk et al. 2001; Gerber et al. 2005; Saevik et al. 2011; Dorsch et al. 2014). Regardless of the cause, dysuria, haematuria, pollakiuria and periuria are typical signs of FLUTD (Kruger et al. 1991, Osborne et al. 1996; Buffington et al. 1997). In cats with an urethral obstruction, a combination of lower urinary tract and systemic signs, such as vomiting, anorexia and lethargy may occur (Bartges et al. 1996).

The purpose of this study was to describe the signalment, clinical findings and results of the urinalysis in cats with signs of a lower urinary tract disease in the Czech Republic.

MATERIAL AND METHODS

Cats diagnosed with FLUTD on the basis of clinical symptoms typical for a lower urinary tract disease presenting between December 2005 and December 2015 to the Department of Internal Medicine of Small Animal Clinic University of Veterinary and Pharmaceutical University Brno, Czech Republic were enrolled in the study. Only animals with complete medical records necessary for the determination of the specific cause of the FLUTD were included. The minimum data required were a complete signalment (breed, age, sex, neutering status), history (living environment, clinical symptoms), results of urinalysis (macroscopic evaluation, urine specific gravity, dipstick, urine sediment, culture), and results of ultrasound examination of the urinary tract. Both obstructive and non-obstructive cases of FLUTD were included.

The urine samples were obtained by cystocentesis, in some cases of urethral obstruction, catheterisation was acceptable. All the samples were examined within one hour after the collection. For the determination of the urine specific gravity, a hand refractometer was used. In case of a high specific gravity that exceeded the scale of the refractometer, the sample was diluted with an aliquot part of distilled water and the true result was calculated by doubling the last two numbers of the obtained result. The urine colour was evaluated macroscopically and the samples were classed as yellow, pink or red. The chemical indicators were assessed by urine dipsticks (Heptaphan; Erba Lachema, Brno, Czech Republic), the results were read visually. The results of the pH, protein (0+ – 3+ reaction), glucose (positive or negative reaction), and presence of blood (0+ – 3+ reaction) were recorded.

The urine samples were centrifuged at 3 000 × *g* for 3 min and, subsequently, microscopically examined using a counting chamber (Vetriplast; Vacutest Kima, Arzergrande, Italy). The samples with macroscopic haematuria were evaluated without centrifugation as well. The presence of erythrocytes was classified as low (≤ 10 red blood cells/hpf – 400-fold magnification), moderate (10–50 red blood cells/hpf) and severe (> 50 red blood cells hpf). In the case of white blood cells, the presence was classified as low (0–5 leukocytes/hpf), moderate (5–10 leukocytes/hpf), and severe (> 10 leukocytes/hpf). The presence of other urine components (epithelial cells, struvite crystals, calcium oxalate crystals) was recorded without quantification.

The urine sample was inoculated on Uricult culture tests (Orion Diagnostica Oy, Espoo, Finland) that were checked 24 and 48 h after inoculation. Most of the positive dipslides were submitted to a microbiological laboratory to determine the bacterial species and antimicrobial susceptibility.

Based on the clinical findings, the results of urinalysis and urine culture and ultrasound examination, the specific cause of FLUTD was determined. A urethral plug was diagnosed by detection of organic or inorganic material in the urethra during catheterisation of the obstructed patients. Uroliths were identified by ultrasound examination. The diagnosis of a bacterial urinary tract infection was based on a positive urine culture (> 10^4 CFU/ml) of the urine sample obtained by cystocentesis or catheterisation at the time of presentation. Cats without a urethral plug, uroliths or other abnormalities found by imaging methods and with a negative urine culture were classified as having FIC. Determination of the obstructive and non-

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obstructive form was based on abdominal palpation of the urinary bladder and the evaluation of urethral patency during catheterisation.

Where available, the results of serum biochemistry (serum concentration of creatinine, urea, and potassium) in the cats with an obstructive form were recorded.

The nonparametric Mann-Whitney *U* test, Kruskal-Wallis and Tukey-HSD tests were used for the continuous parameters for the difference among the groups of the concrete causes and between the obstructive and non-obstructive forms of FLUTD. A chi-square test was used for the categorical parameters. Spearman's rank order correlation was used to measure the association between the urinalysis findings and serum biochemistry results in the male cats with an obstructive form of FLUTD. A CART (Classification and Regression Tree) type decision tree (Breiman et al. 1984) was used for the classification as an explanatory technique and for the determination of the parameters important for the diagnosis and distinction of the obstructive and non-obstructive form.

RESULTS

A total of 214 cats diagnosed with FLUTD met the inclusion criteria and were included in the study. There were 174 male cats (143 neutered) and 40 females (32 spayed). The age of the cats ranged from 9 months to 17 years (mean 5.1 ± 3.7). The list of the breeds and the number of cats presented is shown in Table 1. One hundred and forty-one cats (65.90%) lived indoors only, fifty-nine cats (27.60%) had the possibility to access the outdoors, and fourteen cats were living outdoors only (6.50%).

According to the cause of the FLUTD, the cases were divided in four groups. The detailed characteristics of each group is shown in Table 2. We also compared the patients with the obstructive and non-obstructive form of FLUTD, the results are presented in Table 3. The age of the cats with

Table 1. The list of feline breeds and the number of cats represented in this study

Breed	Number
Domestic Shorthair cat	143 (66.8%)
British Shorthair cat	39 (18.2%)
Persian cat	9 (4.2%)
Maine Coon cat	7 (3.3%)
Siberian cat	7 (3.3%)
Ragdoll	4 (1.8%)
Russian cat	3 (1.4%)
Chartreux cat	1 (0.5%)
Burmese cat	1 (0.5%)
Total	214 (100%)

Table 2. The signalment and living environment in the cats with idiopathic cystitis (FIC), urolithiasis, urinary tract infection (UTI) and urethral plugs (UP)

Group	FIC	Urolithiasis	UTI	UP
Number of cats (%)	111 (51.90%)	57 (26.60%)	23 (10.75%)	23 (10.75%)
Age (mean ± SD)	4.4 ± 3.4	4.7 ± 3.1	9.5 ± 4.5	5.2 ± 2.9
Sex				
Males	87 (78.4%)	49 (86.0%)	15 (65.2%)	23 (100%)
Males – intact	19	5	4	3
Males – neutered	68	44	11	20
Females	24 (21.6%)	8 (14.0 %)	8 (34.8%)	0 (0%)
Females – intact	5	2	2	0
Females – spayed	19	6	6	0
Living environment				
Indoor	81 (73.0%)	33 (57.9%)	10 (43.5%)	17 (73.9%)
Outdoor	8 (7.2%)	3 (5.3%)	3 (13.0%)	0 (0%)
Indoor/outdoor	22 (19.8%)	21 (36.8%)	10 (43.5%)	6 (26.1%)

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a UTI was significantly higher ($P < 0.01$) in comparison with the other groups. In contrast, the cats diagnosed with a FIC were the youngest among the FLUTD cats: six cats were younger than 1 year; eighty-one FIC cats (73.00%) were younger than 5 years. The age distribution is stated in Figure 1.

All the reported clinical signs are listed in Table 4. In the cats with the non-obstructive form of FLUTD, the signs of a lower urinary tract disease, except for oliguria/anuria, were dominant. In the cats with a urethral obstruction, systemic signs and oliguria/anuria were more common (Table 5).

In 169 patients (80.00%), the urine sample was obtained by cystocentesis, both diagnostic in the non-obstructive cases and therapeutic in the obstructive form of FLUTD. In the remaining 20.00%

Table 3. The signalment and living environment in the cats with the non-obstructive and obstructive form of FLUTD

Group	Non-obstructive form	Obstructive form
Number of cats	100	114
Signalment		
Age (mean ± SD)	5.4 ± 4.4	4.8 ± 3.0
Sex		
Males	60 (60.0%)	114 (100.0%)
Males – intact	10	22
Males – neutered	50	92
Females	40 (40.0%)	0
Females – intact	9	0
Females – spayed	41	0
Living environment		
Indoor	72 (72.0%)	69 (60.5%)
Outdoor	5 (5.0%)	9 (7.9%)
Indoor/outdoor	23 (23.0%)	36 (31.6%)

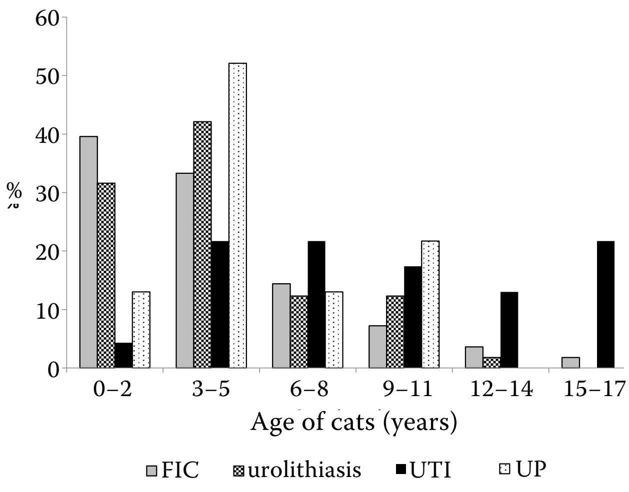

Figure 1. The age distribution (%) in the group of cats with the feline idiopathic cystitis (FIC), urolithiasis, urinary tract infection (UTI) and urethral plug (UP)

Table 4. The clinical signs reported by the owners of the cats with the feline lower urinary tract disease

Reported clinical sign	Number of cats
Dysuria	85 (39.7%)
Oliguria/anuria	67 (31.3%)
Vomiting	53 (24.8%)
Haematuria	52 (24.3%)
Pollakiuria	46 (21.5%)
Periuria	43 (20.1%)
Lethargy	43 (20.1%)
Inappetence	40 (18.7%)
Vocalisation	38 (17.8%)
Abnormal movement	12 (5.6%)
Signs of pain	7 (3.3%)
Nervousness	3 (1.4%)
Abnormal smell	2 (0.9%)
Incontinence	2 (0.9%)
Dark urine	1 (0.5%)

Table 5. Comparison of the frequency of the reported clinical signs in the cats with the non-obstructive and obstructive form of FLUTD

Group	Non-obstructive form	Obstructive form	P*
Number of cats	100	114	–
Macroscopic haematuria	41 (41.0%)	11 (9.7%)	0.326
Pollakiuria	41 (41.0%)	5 (4.4%)*	0.003
Dysuria	39 (39.0%)	46 (40.4%)	0.724
Periuria	36 (36.0%)	7 (6.1%)*	0.013
Oliguria/anuria	5 (5.0%)	62 (54.4%)*	0.004
Vomiting	3 (3.0%)	50 (43.9%)*	0.028
Lethargy	2 (2.0%)	41 (36.0%)*	0.015
Inappetence	3 (3.0%)	37 (32.5%)*	0.027
Vocalisation	13 (13.0%)	25 (21.9%)	0.220
Licking of penis/preputium	1 (1.0%)	13 (11.4%)	0.190

*$P < 0.05$

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Table 6. The results of the urinalysis in the cats with the idiopathic cystitis (FIC), urolithiasis, urinary tract infection (UTI), and urethral plugs (UP)

Group	FIC	Urolithiasis	UTI	Plugs
Number of cats	111	57	23	23
Cystocentesis	90 (81.1%)	42 (73.7%)	20 (87.0%)	17 (73.9%)
Catheterisation	21 (18.9%)	15 (26.3%)	3 (13.0%)	6 (26.1%)
Urine colour				
Yellow	63 (56.8%)	28 (49.1%)	15 (65.2%)	14 (60.9%)
Pink	13 (11.7%)	4 (7.0%)	2 (8.7%)	2 (8.7%)
Red	35 (31.5%)	25 (43.9%)	6 (26.1%)	7 (30.4%)
Specific gravity	1.040 ± 0.018	1.046 ± 0.016	1.032 ± 0.013*	1.039 ± 0.014
Urine pH	6.6 ± 0.9	6.7 ± 0.6	6.7 ± 0.8	6.8 ± 1.0
Dipstick – protein				
0+	4 (3.6%)	1 (1.7%)	0 (0%)	1 (4.4%)
1+	18 (16.2%)	5 (8.8%)	8 (34.8%)	7 (30.4%)
2+	30 (27.0%)	18 (31.6%)	9 (39.1%)	5 (21.7%)
3+	59 (53.2%)	33 (57.9%)	6 (26.1%)	10 (43.5%)
Dipstick – blood				
0+	22 (19.8%)	3 (5.3%)	7 (30.5%)	1 (4.4%)
1+	9 (8.1%)	6 (10.5%)	2 (8.7%)	2 (8.7%)
2+	14 (12.6%)	5 (8.8%)	3 (13.0%)	7 (30.4%)
3+	66 (59.5%)	43 (75.4%)	11 (47.8%)	13 (56.5%)
Dipstick – glucose				
Positive	16 (14.4%)	4 (7.0%)	2 (8.7%)	3 (13.0%)
Negative	95 (85.6%)	53 (93.0%)	21 (91.3%)	20 (87.0%)
Urine sediment				
Erythrocytes				
0	18 (16.2%)	2 (3.5%)	7 (30.4%)	1 (4.3%)
1–10/hpf	12 (10.8%)	2 (3.5%)	3 (13.1%)	2 (8.7%)
11–50/hpf	24 (21.6%)	13 (22.8%)	7 (30.4%)	8 (34.8%)
> 50/hpf	57 (51.4%)	40 (70.2%)	6 (26.1%)	12 (52.2%)
Leukocytes				
0	69 (62.2%)	41 (71.9%)	1 (4.3%)	12 (52.2%)
1–5/hpf	33 (29.7%)	12 (21.1%)	4 (17.4%)	8 (34.8%)
6–10/hpf	8 (7.2%)	3 (5.3%)	5 (21.7%)	2 (8.7%)
> 10/hpf	1 (0.9%)	1 (1.7%)	13 (56.6%)*	1 (4.3%)
Epithelial cells	28 (25.2%)	20 (35.1%)	9 (39.1%)	5 (21.7%)
Struvite crystals	25 (22.5%)	17 (29.8%)	2 (8.7%)*	7 (30.4%)

*$P < 0.05$
hpf = high power field

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of the cats, catheterisation was used to obtain the urine sample as part of the therapeutic protocol in the case of the urethral obstruction. Various shades of the colour yellow were found in 120 cats (56.10%). In 21 cats (9.80%), the urine was pink, and red urine was observed in the rest, 73 cats (34.10%). The urine specific gravity ranged from 1.008 to 1.080 (mean 1.044 ± 0.017). The urine pH ranged from 5 to 9 (mean 6.7 ± 0.7). In almost all of the cats (208 cats, 97.20%), a positive reaction was found for protein on the dipstick and the majority of the cats had a positive reaction for blood (181 cats; 84.60%). Taken together, the yellow urine colour with the positive blood reaction on the dipstick, there were 87 (40.70%) cats with microscopic haematuria. In the cats diagnosed with a UTI, a significantly lower urine specific gravity was found when compared to the cats with idiopathic cystitis and urolithiasis. In these cats, the occurrence of struvite crystals was less common.

The detailed characteristics of the urinalysis results for the particular FLUTD group and for the obstructive a non-obstructive form is shown in Table 6 and Table 7, respectively.

A positive urine culture was found in 23 cats that were subsequently diagnosed with a urinary tract infection. In 18 cases, a positive Uricult dipslide was sent to the laboratory for the determination of the bacterial species and the antimicrobial susceptibility tests. In the rest, five cats, the owners refused any further examinations due to the additional financial costs. In all the cases, only one bacterial isolate was found per case, the most common was *E. coli*. All the bacterial species identified in the presented cats are listed in Table 8.

In the 103 cats with the obstructive form, the results of the serum biochemistry analysis were available. According to the risk of postrenal azotaemia and hyperkalaemia, the concentrations of the creatinine, urea and potassium were monitored. The concentrations of the serum creatinine, urea and potassium ranged from 82.0 to 2 526.1 μmol/l, 4.4–117.2 mmol/l, and 2.9–10.9 mmol/l, respectively. In 51 cats (49.50%), the creatinine concentrations were above the reference range (170.0 μmol/l); in 58 cats (56.30%), one urea concentration was above the upper limit of the reference range (11.3 mmol/l). Azotemia was found in 79 cats (47.60%). Hyperkalaemia (> 5.0 mmol/l) was noticed in 32 cats (31.10%). In the cats with the increased concentrations of creatinine, urea

Table 7. Comparison of the results of the urinalysis in the cats with the non-obstructive and obstructive form of FLUTD

Group	Non-obstructive form	Obstructive form
Number of cats	100	114
Urine colour		
Yellow	67 (67.0%)	53 (46.5%)
Pink	10 (10.0%)	11 (9.7%)
Red	23 (23.0%)	50 (43.9%)
Specific gravity	1.049 ± 0.017	1.040 ± 0.016*
pH	6.5 ± 0.8	6.8 ± 0.8*
Dipstick – protein		
0+	4 (4.0%)	2 (1.8%)
1+	21 (21.0%)	17 (12.3%)
2+	30 (30.0%)	32 (28.1%)
3+	45 (45.0%)	63 (55.3%)
Dipstick – glucose		
Positive	6 (6.0%)	19 (16.7%)
Negative	94 (94.0%)	95 (83.3%)
Dipstick - blood		
0+	31 (31.0%)	2 (1.8%)
1+	10 (10.0%)	9 (7.9%)
2+	13 (13.0%)	16 (14.0%)
3+	46 (46.0%)	87 (76.3%)
Urine sediment		
Erythrocytes		
0	27 (27.0%)	1 (0.9%)*
1–10/hpf	13 (13.0%)	6 (5.3%)
11–50/hpf	19 (19.0%)	33 (28.9%)
> 50/hpf	41 (41.0%)	74 (64.9%)*
Leukocytes		
0	51 (51.0%)	72 (63.2%)
1–5/hpf	31 (31.0%)	26 (22.8%)
6–10/hpf	8 (8.0%)	10 (8.8%)
> 10/hpf	10 (10.0%)	6 (5.2%)
Epithelial cells	34 (34.0%)	26 (22.8%)
Struvite crystals	19 (19.0%)	32 (28.1%)

*$P < 0.05$

hpf = high power field

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Table 8. The list of the bacterial isolates detected in the cats with the urinary tract infection

Bacterial isolate	Number
E. coli	9
Staphylococcus sp.	4
Enterococcus faecalis	2
Proteus mirabilis	1
Streptococcus agalactiae	1
Klebsiella pneumoniae	1
Not determined	5
Total	23

and potassium, vomiting and lethargy were more common. A significant positive correlation was found among the serum levels of the creatinine, urea and potassium and the magnitude of the haematuria. In contrast, a negative correlation was found between the blood indicators and the urine specific gravity.

Using the CART type decision tree, the frequency of the non-specific clinical symptoms may help to distinguish the obstructive and non-obstructive form (Figure 2). For the determination of the cause of the FLUTD, the number of leukocytes in urine sediment was the most important factor (Figure 3).

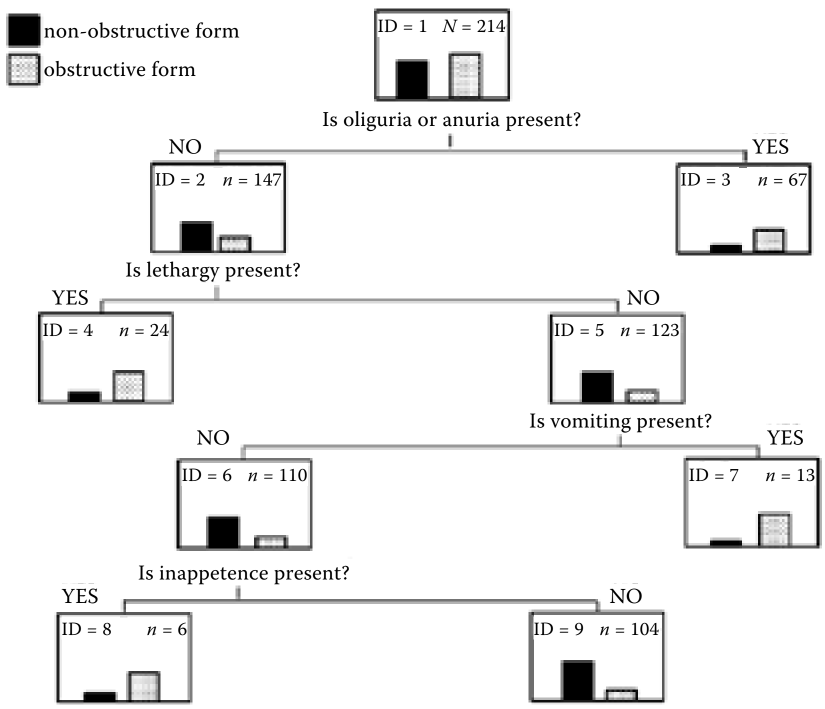

Figure 2. The decision tree for distinguishing the obstructive and non-obstructive form of FLUTD according to the clinical signs

ID = identifier of terminal node ordering by division; *N*/*n* = number of cats

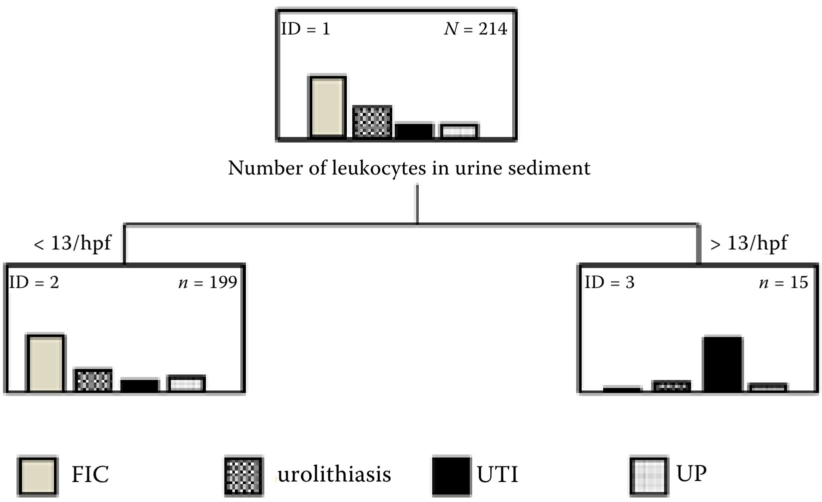

Figure 3. The decision tree for the diagnosis of the urinary tract infection as a cause of FLUTD

FIC = feline idiopathic cystitis; hpf = high power field; ID = identifier of terminal node ordering by division; *N*/*n* = number of cats; UP = urethral plug; UTI = urinary tract infection

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DISCUSSION

The most common cause of FLUTD in this report was the idiopathic cystitis found in 51.90% of the cats. This finding is consistent with previous reports suggesting FIC as a leading cause of feline lower urinary tract disease with a reported prevalence ranging from 51% to 63% (Kruger et al. 1991; Barsanti et al. 1996; Buffington et al. 1997; Lekcharoensuk et al. 2001; Gerber et al. 2005; Saevik et al. 2011; Dorsch et al. 2014; Lew-Kojrys et al. 2017).

The cats diagnosed with idiopathic cystitis were the youngest among the FLUTD cats when 73% of the FIC cats were younger than 5 years and six cats (5.40%) were younger than one year. Feline idiopathic cystitis is seen over a wide age range of cats, in our study, it was 9 months to 15 years. A higher risk in cats in North America, between 2 and 7 years, has been reported by Lekcharoensuk et al. (2001) and an average age of around 5–6 years in the population of Swiss, Norwegian, and German cats (Gerber et al. 2005; Saevik et al. 2011; Dorsch et al. 2014). Our results are closer to the more recent study of Polish cats, where the mean age of the FIC cats was 4.35 years (Lew-Kojrys et al. 2017). According to the current knowledge, idiopathic cystitis is a result of the inadequate reaction to variable stressors due to the chronic activation of the central threat response system (CTRS) (Buffington 2011). It is believed, that the CTRS may be sensitised by threatening events that can occur early in life, even before birth, when the CTRS is the most plastic and vulnerable (Buffington 2009). When these susceptible cats live in an inappropriate environment, clinical symptoms of a lower urinary tract disease may occur in a very young age. Defauw et al. (2011) reported that being more fearful or nervous than the other cats in the same household or having conflicts with other cats as risk factors for FIC, suggesting that the susceptible cats are not able to cope with stress.

The majority of cats of the present study lived strictly indoors which is also consistent with previous reports (Defauw et al. 2011; Dorsch et al. 2014; Lew-Kojrys et al. 2017). The indoor environment with no access to the outside associated with using a litter box, lower activity level, lower hunting behaviour are other risk factors suggesting that an indoor environment frequently does not meet the feline's natural needs and it acts as a stressor.

The most common breed affected regardless of the cause of FLUTD were Domestic Shorthair cats which are the most common cats in the Czech Republic. The second were British Shorthair cats, Persian cats and Maine Coon cats which corresponds to the estimated breed popularity. Lekcharoensuk et al. (2001) reported that Persian, Manx and Himalayan cats had an increased risk of developing FLUTD, in terms of FIC, a breed predisposition has not been identified (Lekcharoensuk et al. 2001; Defauw et al. 2011; Saevik et al. 2011). In our group, the number of cats other than the Domestic Shorthair is low and, thus, insufficient for a statistical analysis.

In our study, males were overrepresented in the whole group and in all the subgroups formed according to the cause of the FLUTD. The urethral plugs were only found in the males. The highest proportion of females was found in the UTI subgroup (34.80%). This finding corresponds with the results of previous reports (Lekcharoensuk et al. 2001; Cameron et al. 2004; Gerber et al, 2005; Saevik et al. 2011; Dorsch et al. 2014; Lew-Kojrys et al. 2017). In male cats, where the risk of obstructive uropathy is higher and, thus, treatment is more often required. In females, clinical symptoms may be subtle and overlooked. This may explain the higher proportion of males in the FLUTD groups.

Most of the cats in our study were spayed or neutered similarly to previous reports (Dorsch et al. 2014; Lew-Kojrys et al. 2017). The importance of the reproductive status in the pathogenesis of FLUTD is difficult to interpret when the majority of the cats kept indoors were spayed or neutered. The status as neutered may be linked to being overweight, which was found as a risk factor as well as the lower activity levels (Defauw et al. 2011; Segev et al. 2011).

In this study, 53.30% of the cases were obstructive. A urethral obstruction was found in the males only. Male cats are anatomically more prone to urethral obstruction because of their progressively narrowed urethra. The relationship between castration and the urethral obstruction is not well established. Borges et al. (2017) compared penises from intact and neutered male cats using a histomorphometric analysis and found a significant decrease in the density of the elastic fibres and a significant increase of the density of the collagen fibres in the corpus spongiosum in the neutered animals. This finding may play a role in reducing the compliance

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of the periurethral region and, thus, predispose the cats to a urethral obstruction.

The second most common cause of FLUTD in our study was urolithiasis diagnosed by ultrasonography. Similar results were reported by Kruger et al. (1991) and Gerber et al. (2005), urolithiasis was less frequent in Norwegian, German and Polish cats (Saevik et al. 2011; Dorsch et al. 2014; Lew-Kojrys et al. 2017). The higher proportion of cats with urolithiasis may be caused by the inclusion of patients with sand in the urinary bladder that was detected by the ultrasonography which is more sensitive for the evaluation of small cystoliths and mineralised debris (Brabson et al. 2015). The mineral type was only known in three cats where surgery was performed (struvite urolithiasis in two cats, calcium oxalate urolith in one cat). In the rest of the cats, medical dissolution was started or the cats were lost for further evaluation.

In our group, a urinary tract infection was detected in 23 cases (10.75%). The incidence of urinary tract infections in cats is generally low. The reported prevalence in young to middle-aged cats ranges from 1% to 3% (Lekcharoensuk et al. 2001; Kruger et al. 2009). The feline urinary tract is generally considered a hostile environment for microorganisms. Local defence mechanisms (the local intrinsic antibody production, a protective glycosaminoglycan layer in the urinary bladder, the physical and chemical properties of the urine) together with the urodynamics associated with normal urination are the most important host defence mechanisms (Litster et al. 2011). Nevertheless, even a higher prevalence of UTIs in the FLUTD cats was reported ranging between 4.9–22.0% (Kraijer et al. 2003; Gerber et al. 2005; Eggertsdottir et al. 2007; Bailiff et al. 2008; Dorsch et al. 2014; Lew-Kojrys et al. 2017). The different results may be caused by the different methodology with various inclusion criteria (e.g., inclusion of voided samples). In our study, in total, 169 urine samples were obtained by cystocentesis and 20 of them (11.80%) were positive. Forty-five samples were obtained by catheterisation and only three of them (6.70%) were positive.

A higher prevalence of UTIs are reported in older cats (> 10 years), females (Lekcharoensuk et al. 2001; Bailiff et al. 2008; Litster et al. 2011; Lew-Kojrys et al. 2017), and cats with concurrent diseases such as diabetes mellitus, hyperthyroidism and chronic kidney disease (Mayer-Roenne et al. 2007; Bailiff et al. 2008; Martinez-Ruzafa et al. 2012). A higher UTI risk is also associated with the previous catheterisation or in cats with a perineal urethrostomy (Ruda and Heiene 2012). The cats diagnosed with UTI in our study were significantly older when compared to the other subgroups, which is consistent with previous reports. In the UTI subgroup, the highest proportion of females was found. A urinary tract infection was found in 23 cats (10.75%). In five cats, a concurrent problem predisposing to a urinary tract infection was detected. Three male cats had a perineal urethrostomy, one of them also received an immunosuppressive treatment for pemphigus. One female cat had a pelvic fracture affecting the urinary bladder function in its history and one had a chronic kidney disease. In addition, six male cats had catheterisation in their history within the last month. When we exclude these cats, the prevalence of UTIs was 5.6% which is closer to the reports from the United States (Lekcharoensuk et al. 2001).

The most common finding in the urinalysis was haematuria found in 84.6% of the cats. According to the published reports, haematuria was observed in 97% of the cats by Kruger et al. (1991), in 94% of the Polish cats (Lew-Kojrys et al. 2017), in 91% of the German cats (Dorsch et al. 2014) and in 83% of the Norwegian cats (Saevik et al. 2011). There were no significant differences in the frequency of haematuria in the cats with FIC, urolithiasis, UTI or urethral plugs. When comparing the groups of the non-obstructive and obstructive form of FLUTD, a higher frequency of haematuria was found in the cats with a urethral obstruction that was statistically significant when expressed as the number of erythrocytes in the urine sediment. Haematuria may occur due to a variety of causes including inflammation, neoplasia or trauma in the urinary tract. Trauma may be iatrogenic caused by palpation, catheterisation or cystocentesis (Thompson and Watson 2017). Idiopathic cystitis, urinary tract infections and urolithiasis alone can cause haematuria, although the degree of the gross haematuria caused by these conditions has not been evaluated. According to our results, there are no significant differences. Obstruction of the urethra leads to increased pressure in the bladder and the urethra proximal to the obstruction. A submucosal haemorrhage and necrosis of the epithelium can occur within 10 h of the obstruction (Fischer et al. 2009). Cats with a prolonged urethral obstruction are prone to have a more pronounced haema-

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turia. In our study, the prevalence of haematuria was found to correlate well with the clinicopathological abnormalities associated with a urethral obstruction, which is consistent with the results of Brabson et al. (2015).

The results of the urinalysis and the finding of more than 13 white blood cells/hpf may suggest the presence of a urinary tract infection and the need of a urine culture. Martinez-Ruzafa et al. (2012) reported the sensitivity and specificity of pyuria for UTI 52.9% and 85.5%, respectively. Nevertheless, for that study, pyuria was defined as the presence of 5 white blood cells per high power field.

The urine specific gravity in the UTI subgroup was significantly lower when compared to the other subgroup which is in agreement with the results of Martinez-Rustafa et al. (2012). A lower urine specific gravity represents the impairment of the local host defence mechanism when the decreased urine osmolality may favour the proliferation of bacteria that would be inhibited in the concentrated urine. Nevertheless, Bailiff et al. (2008) did not find any correlation between the specific gravity and the risk of UTI.

The only crystals found in the urine sediment were struvites. In the cats with FIC, urolithiasis and urethral plugs, the struvite crystals were present in an approximately equal frequency. In the cats with UTI, the presence of struvite crystals was significantly less common, probably due to the lower urine specific gravity in these cats.

According to the urine dipsticks results, a common finding was proteinuria of varying degrees. Nevertheless, no conclusions can be made about the presence of the urine protein because the result of the dipstick is affected by the urine specific gravity, urine pH and the presence of blood (Lyon et al. 2010).

A urethral obstruction is a life-threatening condition that needs immediate intervention. Diagnosis may be straightforward – a cat presented with a history of straining to urinate with a distended urinary bladder. Nevertheless, the history can already suggest the presence of a urethral obstruction: in cats with an obstructive form of FLUTD, a higher frequency of non-specific symptoms (vomiting, lethargy, inappetence) was found. Oliguria and anuria were reported by the owners in 54.40% of cats with urethral obstruction only, thus, further information about the clinical status may help.

Our findings are in agreement with previous studies where feline idiopathic cystitis is the most common cause of a feline lower urinary tract disease. The cats diagnosed with FIC were significantly younger in comparison with the rest of the FLUTD cats which may be affected by the nature of the disease. The cats with a urinary tract infection were significantly older. The finding of a more severe pyuria may suggest a urinary tract infection. The presence of non-specific symptoms may help with the diagnosis of the urethral obstruction.

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Conflict of interest

The authors declare no conflict of interest.

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