



PREVALENCE, HAEMATOLOGICAL, BIOCHEMICAL
ABNORMALITIES AND CLINICAL SYNDROMES OF FELV
AND FELV/FIV CO-INFECTION AMONG CAT POPULATION IN
MOSCOW AND THE MOSCOW REGION, RUSSIA

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Summary

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The aims of this retrospective study were to determine the prevalence of FeLV and co-infection with FeLV and FIV among feline population of Moscow and the Moscow region, Russia, to determine the risk factors associated with the disease and to describe the clinical syndromes, haematological and biochemical abnormalities in infected cats. The prevalence of FeLV and FeLV+FIV co-infection was investigated among 11,807 cats living in Moscow and the Moscow region using PCR, ELISA and ICT methods. The overall prevalence of FeLV among household domestic cats was 12.8%. FeLV was most commonly detected in male mixed-breed cats and the cats with free outdoor access. Ninety cases of co-infection with FeLV and FIV (0.76% of the cat population) were also detected. The most common clinical signs seen in infected cats were those associated with the gastrointestinal tract. Anaemia was a common haematological abnormality in infected cats. The results of biochemical assays were nonspecific and associated with inflammatory processes in infected cats. The risk factors associated with FeLV infection were sex, breed, age, contacts with other cats and a history of outdoor access. The results presented in the study indicated a high prevalence of FeLV and a low prevalence of FeLV+FIV co-infection in cats living in Moscow and the Moscow region, Russia.

Key words: feline immunodeficiency virus (FIV), feline leukaemia virus (FeLV), immunosuppression, lymphoma

INTRODUCTION

Feline leukaemia virus (FeLV) infection and feline immunodeficiency virus (FIV) infection are chronic retroviral infections found in many felines around the world (Chui *et al.*, 2019). These viruses were

discovered in the second half of the 20th century and since then they have attracted the attention of scientists and veterinary specialists not only due to the clinical signs, associated with these infections, but

also due to their similarity to the human immunodeficiency virus (HIV) infection – this statement is especially true for FIV infection (Chhetri *et al.*, 2015; Marcondes *et al.*, 2018).

Diagnosis of FeLV and FIV infections was difficult until the end of the 20th century. Nowadays veterinary specialists profit from several diagnostic methods in their practice (Hofmann-Lehmann *et al.*, 2020) allowing detecting the viral particles and antibody against them and to determine the course of the infection, which is considered to be the main prognostic factor for the diseases (Chui *et al.*, 2018).

Previously, it was believed that FIV and FeLV were very common among the cat population, and the risk factors associated with these diseases were young age, male gender, intact status and territorial behaviour of cats associated with aggression and a high level of contacts with other cats (Westmann *et al.*, 2016; Burling *et al.*, 2017). However, nowadays, the prevalence of FeLV and FIV has significantly decreased due to the awareness of veterinary specialists of these viral diseases, due to the effective methods of diagnosis and prophylaxis (Powers *et al.*, 2018). For example, the prevalence of FeLV in Southern Germany constitutes 1.8% (Englert *et al.*, 2012), in Switzerland – 3% (Hofmann-Lehmann *et al.*, 2020), in the USA and Canada – 3.1% (Burling *et al.*, 2017).

Even though FeLV and FIV have become an almost solved issue for the developed countries (Ludwick *et al.*, 2019; Studer *et al.*, 2019), the prevalence of these two viral diseases may remain high in the developing countries (Cong *et al.*, 2016; Da Costa *et al.*, 2017; Lacerda *et al.*, 2017). In the literature, the data on the prevalence of FeLV in Russia are still not widely available due to the size of the

country and the lack of funding for research. In addition, the prevalence of FIV in the population of FeLV-infected cats has not been described in the Russian literature. Nevertheless, studies aimed at identifying the prevalence of FeLV in Russian cities have been published in recent years. For example, the prevalence of FeLV in Vladivostok was reported to be 15.9% (Moskvina *et al.*, 2019). This is the first article dedicated to the prevalence of FeLV in Moscow and the Moscow region, Russia.

The aim of this study was to determine the prevalence of FeLV among cat population of Moscow and the Moscow region, Russia, using polymerase chain reaction (PCR), enzyme-linked immunosorbent assay (ELISA) and immunochromatographic test (ICT) methods, to determine the frequency of FIV diagnosis in the population of FeLV-infected cats, to determine the risk factors associated with the disease and to describe the clinical syndromes, haematological and biochemical abnormalities seen in infected cats.

MATERIALS AND METHODS

Ethical approval

Sample collections were obtained with the consent of cat owners during routine clinical examination. The anamnesis information was obtained with the consent of the database owners. The study did not include personal information about cat owners.

Study period and location

The data for this retrospective study were collected during 1-year period (from October 2018 to October 2019). Data from a 4-year period (from August 2015 to August 2019) were included in the retrospec-

tive analysis of the medical records. The research included pre-research, laboratory examination and statistical analysis. The cats were admitted to the veterinary clinics and laboratories in Moscow and the Moscow region, Russia. „Shans Bio“ and „NEOVET“ veterinary laboratories and „Lebedi“ veterinary clinic provided the researchers with the results of blood tests and the cats' medical records.

Experimental design

The study included 6,529 male and 5,278 female cats. A total of 11,807 whole blood samples were taken from the brachial vein of cats that were handled using conventional veterinary techniques after topical application of lidocaine + prilocaine cream (Emla cream, Aspen Pharma Trading, Ireland) to the vein's puncture site. Sera were obtained after centrifugation and were analysed for the presence of FeLV antigen. Blood samples of 10,324 cats were analysed with PCR assay, 1,330 blood samples were analysed with ELISA assay and 153 samples – with ICT. The exact method of FeLV testing was prescribed by the veterinarians in charge of the case. Analysis was made on 174 clinical records including the results of complete blood count (CBC) and biochemical profiles of infected cats. The study area included such criteria as sex, breed, life expectancy, age of FeLV diagnosis, life expectancy since FeLV diagnosis, lethal outcome at the time of the study, intact and vaccination status, treatment for ecto- and endoparasites, outdoor access, contacts with other cats and history of cats' appearance. Clinical signs observed in infected cats were also analysed.

PCR assay

PCR assay based on the detection of the FeLV proviral DNA in the infected cats'

blood using TaqMan fluorogenic real-time PCR and was carried out using the Rotor-Gene Q (QIAGEN, Germany). Proviral DNA was isolated from 200 µL of whole blood samples containing EDTA K2 using a commercially available DNA extraction kit according to the manufacturer's instruction (QIAamp DNA Blood Kits, QIAGEN, Germany). Amplification was conducted using Real-Time CFX96 Touch (Biorad, USA). The primers for FeLV detection were selected from a conserved region in the U3 long terminal repeat (LTR), they included forward primer (FeLV_U3_exo_f; 5'AAC AGC AGA AGT TTC AAG GCC 3', 21 bp), reverse primer (FeLV_U3_exo_r; 5'TTA TAG CAG AAA GCG CGC G3', 19 bp) and fluorogenic probe (exoFeLV-U3-probe; 5'CCA GCA GTC TCC AGG CTC CCC A 3', 22 bp) (Tandon *et al.*, 2005). Thermal cycling conditions were 5 minutes at 95 °C for initial denaturation, five cycles of 1 minute at 95 °C and 1 minute at 64 °C for denaturation followed by 35 cycles of 1 minute at 85 °C for annealing and 1 minute at 64 °C for elongation.

ELISA assay

ELISA assay was based on the detection of FeLV antigen and FIV antibodies in whole blood samples containing EDTA K2 and serum of infected cats using IDEXX Snap FIV/FeLV Combo (IDEXX, USA) according to the manufacturer's instruction. Samples contained whole blood or serum were kept at room temperature for 30 minutes before performing a test. Three drops of the sample were mixed with 4 drops of conjugate and then were inverted 5 times. The content of the sample was added to the sample well. The results were read in 10 minutes. The left blue dot indicated presence of antibodies against FIV, thus a cat was FIV-positive.

The right blue dot corresponded to presence of FeLV antigen, thus a cat was FeLV-positive.

ICT assay

The ICT assay was based on the detection of FeLV antigen in serum of infected cats using express tests (Quicking Biotech Co, China) according to the manufacturer’s instructions. One drop of the cat serum sample was mixed with 2 drops of buffer solution, and then added to the sample well. The cat was considered to be FeLV-positive if there was a red “T”-line in 10 minutes.

Haematological and biochemical assay

The results of 124 complete blood counts (CBC) and 80 biochemical assays of infected cats were analysed. CBC was carried out on an automatic haematological analyzer Biocode-Hycel Celly 70 (Biocode-Hygel, France) according to the manufacturer’s instructions. Twenty-five µL whole blood samples containing EDTA K2 were collected from infected cats for the study. The biochemical assays were carried out using a BA-400 analyzer (BioSystems, Spain). Serum samples (40 µL) obtained from the infected cats were collected for the study.

Statistical analysis

Statistical analysis was performed using Stata 16 software (StataCorp LLC, USA). The relationship between the presence of FeLV and risk factors as age, sex, intact status, contacts with other cats and history of cats’ appearance was evaluated.

RESULTS

The prevalence of FeLV in the cats’ population of Moscow and the Moscow region, Russia, was 12.8% (1514 infected cats).

Among these, 1272 cats had positive PCR results (84%), 183 cats had positive ELISA results (12%) and 59 cats had positive ICT results (3.9%). Cats with two or more similar diagnostic methods performed at a different time were not included in the statistics in order to avoid statistical error.

FeLV was most often diagnosed in male cats (61.3% or 928 cats), with most of these cats (618 cats, 66.6%) being neutered. The average age of FeLV diagnosis was 4.8 years (min – 1 month, max – 17.1 years). Average life expectancy since the diagnosis was 249.5 days (min – 1 day, max – 1469 days). At the time of the study, 81 (46.5%) out of 174 cats, whose clinical records were available have died, with higher number of dead male cats (52; 64.1%) (Table 1).

In the population of infected cats, domestic shorthair cats were the most represented – 93.1% (1410 out of 1514 cats). British shorthair cats (2.7%; 41 out of 1514) and Maine coons (2.1%; 32 out of 1514) were also represented. The proportions of other breeds ranged from 0.1% to 1.2% (Bengal cats, Scottish folds, Oriental, Siamese, Thai, Sphynx, Persian, Abyssinian, Burmese cats, etc.) (Table 2).

Table 1. Mortality rates among FeLV-positive cats

Sex	Dead FeLV-positive cats	
	Number	Percentage (95% confidence interval)
Male (n=101)	52	51.4 (42–61)
Female (n=74)	29	39.1 (28–50)

Only 42.6% of cats were treated for ectoparasites (35 of 82 cats with complete

Table 2. FeLV prevalence according to sex, breed and intact status of cats

Parameter	Number of infected cats	Prevalence (%)	95% confidence interval
Sex (n=11807)			
Male (n=6529)	928	7.8	7-8
Female (n=5278)	586	4.9	4-5
Breed (n=1514)			
Domestic shorthair	1410	93.1	92-94
British shorthair	41	2.7	2-8
Maine coon	32	2.1	3-7
Other	31	2.1	3-7
Intact status (n=1514)			
male (n=928)			
neutered male	618	66.6	63-70
intact male	310	33.4	28-39
female (n=586)			
neutered female	411	70.2	66-75
intact female	175	29.8	23-37

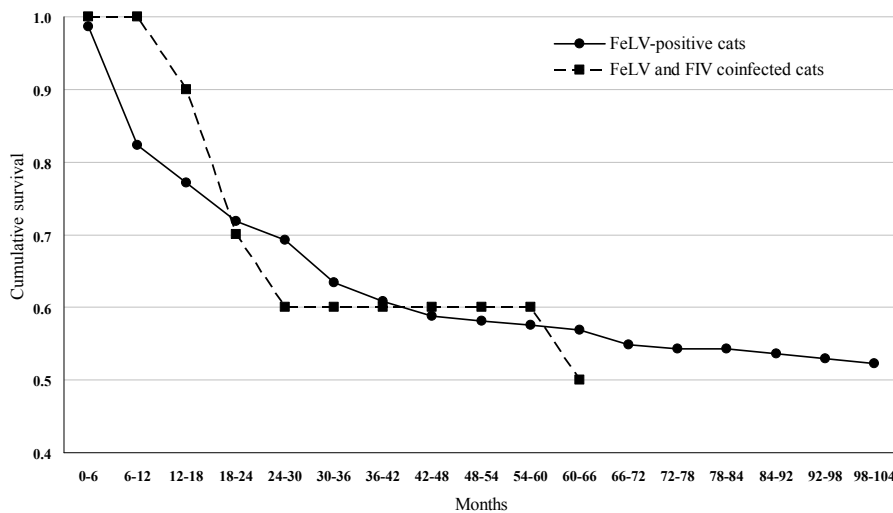


Fig. 1. Survival rates of FeLV-positive only and FeLV and FIV co-infected cats.

clinical records), and 63.2% cats were treated for endoparasites (79 of 125 cats). Half of cats were vaccinated. With respect to outdoor access, 89.7% of cats (70 of 78 cats with complete clinical records) were allowed outdoor access, while 64.8% of

cats (61 of 94 cats) had confirmed contact with other cats either at home or outdoors.

Fifty-six out of 94 cats with complete clinical records (59.5%) were taken from the street by their owners; 22.3% of cats (21 out of 94) were purchased from pro-

fessional breeders, and 12.7% (12 out of 94) did not have an established origin.

Coinfection with FIV was diagnosed in 90 cats using ELISA (5.9% of FeLV-positive cats). By the end of the study, 7 coinfecting cats (53.8% of cats whose clinical records were available) died, and 6 cats were still alive (46.2%). The average age of FeLV and FIV coinfection diagnosis was 4.9 years (min – 1.5 years, max – 11.5 years), and their average life expectancy was 238.4 days (min – 10 days, max – 974 days). Data regarding the survival rates of FeLV-positive cats and cats coinfecting with FeLV and FIV are shown on Fig. 1.

Haematological assays were performed in 124 cats and biochemical assays were performed in 80 cats. Anaemia and thrombocytopenia were the most frequent haematological abnormalities found in infected cats (Table 3). Approximately half of the infected cats had abnormalities specific for inflammatory process (increase in the level of band neutrophils and the increase in the erythrocyte sedimenta-

tion rate). The proportion of lymphocytes was decreased in one third of the cases (40 cats). The results of biochemical and electrolyte abnormalities in cats with FeLV infection are shown in Table 4.

Of the 703 owners' complaints and/or clinical signs described in the clinical records, 23.9% (168) referred to gastrointestinal disorders, 18.1% (127) complaints were nonspecific, and 17.2% (121) referred to immune-mediated disorders (Table 5). The rest of the complaints (in descending order) comprised respiratory (11.5%), urogenital (8.8%), dental (7.7%), dermatological (5.5%) disorders, neoplastic (4%), neurological (1.8%) and cardiac (1.1%) diseases. In only 0.3% of cats (2 cats), FeLV was diagnosed during the annual prophylactic clinical examination.

In the group of gastrointestinal disorders, vomiting prevailed (20.2% – 34 out of 168 cats). Owners of infected cats also complained of diarrhoea (15.4% – 26 of 168 cats). According to the ultrasound results, hepatitis (18.4% – 31 cats), spleni-

Table 3. Haematological abnormalities seen in FeLV-positive cats

Haematological parameter	Number (%) of cats affected	Change
Red blood cells	57 (46.0%)	↓
Haemoglobin	68 (54.8%)	↓
Haematocrit	75 (60.5%)	↓
Platelets	72 (58.1%)	↓
Band neutrophils	56 (45.2%)	↑
Lymphocytes	40 (32.3%)	↓
Erythrocyte sedimentation rate	47 (37.9%)	↑

Table 4. Biochemical and electrolyte abnormalities seen in FeLV-positive cats

Haematological parameter	Number (%) of cats affected	Change
Glucose	57 (46.0%)	↑
Urea	68 (54.8%)	↑
AST	75 (60.5%)	↑
C-reactive protein	72 (58.1%)	↑
K ⁺	40 (32.3%)	↓
Na ⁺	47 (37.9%)	↓

tis (11.3% – 19 cats), cholecystitis (5.9% – 10 cats) and pancreatitis (5.9% – 10 cats) prevailed. Liver lesions such as lipidosis (2.3% – 4 cats) and nonspecific hepatopathy (2.3% – 4 cats), as well as cholangitis (3.5% – 6 cats), gastritis (3.5% – 6 cats), enteritis (2.9% – 5 cats) and triditis (0.6% – 1 cat) were the least common disorders. One cat (0.6% of cases) had hypersalivation.

Table 5. Clinical syndromes observed in FeLV-positive cats

Clinical syndrome	Number (%) of complaints
Gastrointestinal	168 (23.9%)
Nonspecific	127 (18.1%)
Immune-mediated	121 (17.2%)
Respiratory	81 (11.5%)
Urogenital	62 (8.8%)
Dental	54 (7.7%)
Dermatological	39 (5.5%)
Neoplastic	28 (4.0%)
Neurological	13 (1.8%)
Cardiac	8 (1.1%)
Accidentally diagnosed	2 (0.3%)
Total	703 (100%)

Nonspecific clinical signs included lethargy (54.7% – 110 cats), fever (21.8% – 38 cats), hypothermia (4% – 7 cats), hypo- or anorexia (55.2% – 111 cats), dehydration (36.9% – 71 cats). Some animals had free fluid in body cavities: free fluid was observed in the abdominal cavity in 18.1% of cases (23 cats) and in the chest cavity – in 7.8% of cases (10 cats).

Free fluid was observed both in chest and in the abdominal cavity in 3.9% of cases (5 cats).

In the group of immune-mediated disorders, such clinical signs as anaemia (35.8% – 66 cats), icterus of the visible mucous membranes (3.4% – 6 cats), and

lymphadenopathy (26.4% – 46 cats) were observed. The greatest diversity was noted in infected cats with opportunistic diseases: feline calicivirus infection was diagnosed in 21.1% of cases (15 cats), feline panleukopenia – in 11.2% of cats (8 cats), feline enteric coronavirus and *Chlamydia felis* infection – in 8.4% of cases (6 and 6 cats, respectively). Infected animals were also diagnosed with giardiasis (5.6% – 4 cats), feline infectious peritonitis (4.2% – 3 cats), toxocarasis (2.8% – 2 cats) and *Toxoplasma gondii* infection (1.4% – 1 cat).

Neoplastic disorders were observed in 28 cats. Lymphoma was the most common neoplastic disorder in infected cats (39.2% of cases – 11 cats: alimentary lymphoma in 6 cats, mediastinal lymphoma – in 3 cats and multicentric lymphoma – in 2 cats). Three cats with FeLV infection (10.7%) were diagnosed with acute lymphoblastic leukemia. Tumours of the liver, duodenum, mammary glands, lungs and soft tissues (presumably fibrosarcoma) were diagnosed in 2 cases each (7.1%). Clinical records of the infected cats also included tumours of the jejunum, spleen, mandible, and pericardium (3.5% each).

Dental disorders were found in 54 (7.7% of cases) of owners' complaints. Gingivitis, stomatitis and gingivostomatitis were observed in 38 animals (70.3% of cases). Eleven cats (14.8%) were diagnosed with periodontitis. Besides, periodontosis was diagnosed in 3 cats (4%), and feline odontoclastic resorptive lesions (FORLs) – in 2 cats (2.7%).

Urogenital disorders were recorded in 62 cases of cats with FeLV (8.8% of cases). Urolithiasis was most often diagnosed in infected cats (20.9% of cases – 13 cats). In 14.5% of cases (9 cats), cats had chronic kidney disease (CKD). The proportion of nephritis and nephrosis ac-

counted for 22.5% of cases (8 and 6 cats, respectively). In 7 cats (11.2%), nephropathy was nonspecific. Endometritis and urocystitis were diagnosed in 6.4% of cats (4 cases for each diagnosis). Nephrosclerosis (3 cases – 4.8%), foetal mortality (3 cases – 4.8%), foetal resorption (1.6% of cases – 1 cat) and dystocia (1.6% of cases – 1 cat) with following Cesarean section were the least common pathologies.

In the group of dermatological pathologies, bite wounds and soft tissue oedema in the bite area were the most frequently seen disorders (20 cats – 51.2% of cases). Otitis externa was observed in 28.2% of cases (11 cats), with *Malassezia* spp. otitis externa diagnosed in 6 cats (54.5%) using cytology. In 12.8% of cases (5 cats), nonspecific dermatitis was found in infected cats (any further diagnostics was not carried out to discover its etiology). Poor wound healing, *Microsporum canis* infection and haemorrhages in the subcutaneous fat accompanied the course of FeLV infection in 7.5% of cases (2.5% for each pathology – 1 animal).

Neurological syndromes were the least frequently observed in infected cats – 13 cases (1.8%). Ataxia was seen in 46.1% of cases (6 cats), and anisocoria – in 23% of cases (3 cats). Tremor (7.6% of cases – 1 cat), nystagmus (7.6% of cases), cervical ventroflexion (7.6% of cases), and vocalisation (7.6% of cases) were the least common pathologies associated with FeLV infection.

DISCUSSION

FeLV infection is a chronic viral disease that is found in many cats around the world. Most developed countries keep statistics on the prevalence of the disease: for example, the prevalence of FeLV constitutes 7.3% in Switzerland (Hoffman-

Lehmann *et al.*, 2018), 3.1% – in the USA and Canada (Burling *et al.*, 2017), and 11.33% – in Northwest China (Cong *et al.*, 2016). The low prevalence of FeLV in the developed countries can be explained by the effective methods of disease control applied in these countries. Nevertheless, studies of the prevalence of FeLV in Russia have not been published yet and observations can be made based only on sporadic studies of the FeLV prevalence in the Russian cities. To date, only one study of the FeLV prevalence in Vladivostok, Russia has been published, and its authors concluded that FeLV was found in 15.9% of cats admitted to veterinary clinics (Moskvina *et al.*, 2019).

In our study, 12.8% of the examined cats were provirus-positive. The prevalence of FeLV in Moscow and the Moscow region, Russia, correlates with data on the FeLV prevalence in developing countries: for example, the FeLV prevalence of 12.5% in Brazil (Lacerda *et al.*, 2017). The risk factors associated with the FeLV infection were male gender of the cats (61.3%), outdoor access (89.7%), confirmed contacts with other cats (64.8%), mature (4.8 years), life on the street as a kitten (59.5%) and the presence of gastrointestinal diseases (23.9%). Domestic short-haired cats (93.1%) were most susceptible to FeLV infection – the mixed-breed cats' population is predominant in Russia. Despite the fact that the intact status of male cats was a risk factor for the diagnosis of FeLV in previous studies (Chhetri *et al.*, 2015), these data were not confirmed in our study: 66.6% of cats were spayed.

The average life expectancy of FeLV-positive cats was 249.5 days – these data contradict the results from the previous studies, indicating that the life expectancy of infected cats can be compared to that of

healthy cats (Englert *et al.*, 2012). This can be explained by the fact that animals were admitted to the veterinary clinics in a grave condition, as well as by the fact that drugs which are used for the treatment of FeLV abroad are not currently available in Russia.

According to the results of the previous studies, coinfection with FIV in FeLV-infected cats significantly worsens the prognosis of the disease and shortens the life expectancy in coinfecting cats (Da Costa *et al.*, 2017). However, the results of our study did not confirm this information (the average life expectancy of FIV and FeLV-coinfecting cats was 238.4 days). We believe that this may be due to the shorter life expectancy of FeLV-infected cats in our study compared to the previously reported results.

FeLV-positive cats admitted to the veterinary clinics often had no history of treatments against ectoparasites (57.4%), endoparasites (36.8%), and vaccinations against the common feline infections (50%). The presence of ecto- and endoparasites in infected cats, as well as the presence of opportunistic infections in 21.1% of FeLV-positive cats, significantly worsened the clinical signs accompanying the underlying disease, decreased the average life expectancy of infected cats, and worsened the prognosis of the underlying disease (46.5% of cats having died by the end of the study) (Burling *et al.*, 2017).

Anaemia was the most frequently diagnosed haematological abnormality in FeLV-infected cats and most often, it was of non-regenerative nature. Anaemia significantly worsens the prognosis for FeLV-infected cats so it should increase the clinician's suspicion of FeLV infection in case of its detection in CBC data. The results of biochemical blood assays corresponded to the results presented in

previous studies (Da Costa *et al.*, 2017). It can be concluded that a veterinary specialist should not rely on the results of the biochemical blood profile in order to detect FeLV infection, because of nonspecific findings that reflect the state of the general health status of FeLV-infected cats with concurrent diseases. However, this analysis is essential for the treatment of non-FeLV-related diseases and for the prognosis of the life expectancy in FeLV-infected cats.

The results presented in this study reflect the non-specificity of the clinical signs associated with the FeLV infection in cats: 20.2% of complaints were addressed to vomiting in sick cats and 15.4% – to diarrhoea. The prevalence of gastrointestinal disorders in FeLV-positive cats reflects the so-called panleukopenia-like syndrome associated with the lesions of the small intestinal crypts (Hofmann-Lehmann *et al.*, 2020).

Some cats showed lethargy (54.7%), fever (21.8%), signs of hypo- or anorexia (55.2%), dehydration (36.9%), which had developed because of these underlying conditions, and anaemia (54.8–60.5%). These clinical signs may correspond to any inflammatory, infectious and neoplastic process developing in a FeLV-negative cat, therefore, the veterinarian's awareness regarding the presence of the FeLV infection should be increased if these signs accompany any risk factors associated with FeLV.

Despite the fact that lymphoma is currently the most commonly diagnosed in FeLV-negative cats (Westmann *et al.*, 2016), this neoplastic process was found in 39.2% of cats with FeLV. It should be noted that the presence of FeLV in cats with lymphoma significantly worsens the prognosis of this viral disease to grave (Powers *et al.*, 2018). The use of chemo-

therapy for lymphoma in a FeLV-infected cat should be discussed with the cat's owner, as the side effects associated with chemotherapy are more severe in infected than in FeLV-negative cats.

A veterinary specialist should also pay attention to the presence of chronic dental problems in mature cats with the risk for the FeLV infection (7.7% of complaints), and the presence of bite wounds (2.7% of complaints), which are the main route of FeLV and FIV transmission.

Urogenital and nervous system abnormalities were the least frequently diagnosed in infected cats (8.8% and 1.8%). We believe that these pathologies were not opportunistic for FeLV infection and were developing without affecting the FeLV outcome.

CONCLUSION

This is the first study evaluating the prevalence of FeLV and co-infection with FeLV and FIV in Moscow and the Moscow region with emphasis on risk factors, the clinical signs and laboratory abnormalities associated with FeLV infection. The results presented in our study indicated a high prevalence of FeLV and a low prevalence of co-infection with FeLV and FIV in cats living in Moscow and the Moscow region, Russia. The risk factors associated with FeLV infection were sex, age and breed of the cats, a history of an outdoor access and contacts with other cats. Animals admitted to the veterinary clinics had a wide range of clinical manifestations associated with FeLV infection, with the GI pathologies being the most common presented. The most significant abnormality in haematological parameters in infected cats that can rise a clinician's awareness towards FeLV infection was anaemia. Further studies are required re-

garding the prevalence of FeLV in Russia (and particularly in Moscow), the risk factors and clinical signs associated with the causative agent of the viral disease.

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