Feline leukemia virus and feline immunodeficiency virus in Canada: Recommendations for testing and management

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Abstract — Feline leukemia virus (FeLV) and feline immunodeficiency virus (FIV) are common and important infectious disease agents of cats in Canada. Seroprevalence data for FeLV and FIV in various populations of Canadian cats are reviewed and recommendations for testing and management of infections by these viruses in cats in Canada are presented. Retrovirus testing in Canada is infrequent in comparison with the United States, and efforts should be focused on reducing physical and other barriers to testing, and on education of veterinarians, veterinary team members, and cat owners regarding the importance of testing. New test methodologies for FeLV and FIV are emerging, and should be independently evaluated in order to provide practitioners with information on test reliability. Finally, more information is needed on FIV subtypes in Canada to improve diagnostics and vaccines, and to provide information on disease outcomes.

Résumé — Virus de la leucémie féline et virus de l'immunodéficience féline au Canada : Recommandations pour le dépistage et la gestion. Le virus de la leucémie féline (FeLV) et le virus de l'immunodéfience féline (FIV) sont des agents de maladies infectieuses courants et importants chez les chats du Canada. Les données de séroprévalence pour le FeLV et le FIV dans les diverses populations de chats canadiens sont examinées et des recommandations pour le dépistage et la gestion des infections par ces virus chez les chats du Canada sont présentées. Le dépistage du rétrovirus au Canada est peu fréquent comparativement aux États-Unis et les efforts devraient se concentrer sur la réduction des obstacles physiques et autres pour le dépistage et sur la sensibilisation des vétérinaires, des membres de l'équipe vétérinaire et des propriétaires de chats concernant l'importance du dépistage. De nouvelles méthodologies pour le dépistage du FeLV et du FIV commencent à être offertes et devraient être évaluées de manière indépendante afin de fournir aux praticiens des renseignements sur la fiabilité des tests. Enfin, de plus amples renseignements sont requis sur les sous-types de FIV au Canada afin d'améliorer les diagnostics et les vaccins et de fournir de l'information sur l'évolution de la maladie.

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Introduction

Feline leukemia virus (FeLV) and feline immunodeficiency virus (FIV) are retroviruses causing 2 of the most common and important infectious diseases of cats. Diseases associated with FeLV and FIV may affect any organ, and include lymphoma, blood dyscrasias, central nervous system and ocular disease, gingivostomatitis, and secondary and opportunistic infections. Organizations such as the American Association of Feline Practitioners (AAFP) (1) and the European Advisory Board on Cat Diseases (2,3) have published guidelines for prevention and management of FeLV and FIV. Prevalence data are necessary to define prophylactic, management, and therapeutic measures for stray, feral, and owned cats. Recently, comprehensive data on the seroprevalence of retrovirus infections of cats in Canada have become available, and recommendations for testing and management can now be formulated for Canadian practitioners.

Seroprevalence of FeLV and FIV in Canada

The seroprevalence of FeLV and FIV infection in a variety of North American cat populations has been described through several publications, but until recently the available data applied

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Table 1. Summary of data from FeLV and FIV seroprevalence studies in Canada

Study	Population tested	FIV	FeLV
(4)	Provinces not given		
	High risk (n = 42)	19%	n/a
	Low risk (n = 352)	1.2%	n/a
(9)	Atlantic Canada (90.5% PEI)	7.6%	n/a
(8)	PEI		
	Adult feral males (n = 65)	13.8%	7.7%
	Adult feral females (n = 74)	2.7%	5.4%
(7)	Ottawa		
	Urban strays (n = 74)	23%	6.7%
	Owned cats (n = 152)	5.9%	2.6%
(5)	AB, BC, NF, NS, ON, QC, SK (n = 325)	3.1%	2.5%
(6)	All Canadian provinces (n = 11 144)	4.3%	3.4%
(11)	NF shelter cats (n = 591)	2.5%	6.1%
(10)	SK, MB, AB (n = 1205)	5.5%	3.5%

FIV — Feline immunodeficiency virus; FeLV — Feline leukemia virus.
AB — Alberta; BC — British Columbia; MB — Manitoba; NF — Newfoundland; ON — Ontario; PEI — Prince Edward Island; QC — Quebec; SK — Saskatchewan.

predominantly to the United States. Presented here is a summary of FeLV and FIV seroprevalence data for cats in Canada (Table 1). In an early study (1989) evaluating the epidemiologic features of FIV infection, cats were categorized as high risk (n = 2254) or healthy with low or unknown risk (n = 511) (4). In the high-risk group, 14% were FIV seropositive compared with 1.2% in the healthy group. Furthermore, in the high risk group, FIV seropositivity was more likely in males than females, in cats over 6 years old than in younger cats, and in free-roaming cats than confined cats. In the high-risk group, FeLV seroprevalence among 1609 cats was 13%; 42 cats were reported to be from Canada, but no specific location was given. Seroprevalence of FIV was 19% among the Canadian cats. Within the healthy, low, or unknown risk group of cats, 352 were reported to be from Canada, but also no specific location was indicated. Seroprevalence of FIV for the group as a whole was 1.2%, with no breakdown for origin from Canada versus the United States.

More recently (2006), a large prospective cross-sectional survey evaluated seroprevalence of FeLV and FIV among North American cats as well as risk factors for seropositivity (5). In this study, 18 038 cats were tested at 345 veterinary clinics (n = 9970) and 145 animal shelters (n = 8068). In this population of cats, seroprevalence of FeLV was 2.3% and seroprevalence of FIV was 2.5%, while 0.3% of cats were co-infected. The risk of seropositivity for either virus was higher in adult cats (> 6 mo old) than in juveniles, and in males than in females. Other risk factors were access to outdoors and concurrent illness. The highest risk for retrovirus infection was associated with being sick and feral, followed by being sick with access to outdoors. The study included data on 325 cats from 7 Canadian provinces (AB, BC, NF, NS, ON, QC, SK), with 2.5% FeLV- and 3.1% FIV-seropositivity among them.

The first Canadian study of FeLV and FIV seroprevalence and risk factors was conducted in 2008 (6). Signalment, lifestyle factors, and test results for FeLV antigen and FIV antibody were analyzed for 11 144 cats from the 10 Canadian provinces. More cats were tested at veterinary clinics (n = 9588) than at animal shelters/rescue organizations (n = 1556). Results showed seroprevalence for FeLV antigen was 3.4% (383/11 144) and seroprevalence for FIV antibody was 4.3% (480/11 144). Fifty-eight cats (0.5%) were seropositive for both viruses. Significant risk factors for infection were age, current illness, and access to outdoors. Seropositivity for FeLV was highest in intact females (7.3%) and intact males (7.1%) and FIV seropositivity was highest in intact males (7.4%).

Several other studies have evaluated seroprevalence of FeLV and FIV in specific populations of Canadian cats. In 1 study seroprevalence was evaluated in 246 cats from 3 demographic populations in Ottawa, Ontario (7). Seroprevalence of FIV was highest in urban stray cats (23%) and lower in client-owned cats (5.9%) and in a feral cat colony (5%). The same groups of cats had 6.7%, 2.6%, and 0% seroprevalence of FeLV, respectively. Of cats trapped in a neuter and release program in Prince Edward Island (n = 185), 6.5% and 7.6% were seropositive for FeLV antigen and FIV antibody, respectively (8). All kittens (n = 46) were negative for both viruses, and seroprevalence of FeLV was higher in males than females.

Seroprevalence of FeLV among sera (n = 671) submitted to a diagnostic laboratory in Atlantic Canada, including 90.5% from Prince Edward Island, was 7.6%, and higher rates correlated with increased age and intact male status (9). In a retrospective study of 1205 samples from Saskatchewan, Manitoba and Alberta, seroprevalence rates for FeLV and FIV were 3.5% and 5.5%, respectively (10). Co-infection was uncommon, and males had higher rates of seroprevalence than females. Infection with FeLV was also significantly associated with illness (bite wounds, lethargy, and inflammatory oral disease) and increasing age.

Cats in Newfoundland that resided predominantly in shelters (n = 591) had seroprevalences of 6.1% and 2.5% for FeLV and FIV, respectively, and the majority of retrovirus positive cats were unneutered males which had access to outdoors and showed signs of ill health (11).

Scant data exist on the prevalent FIV subtypes in Canada. A study of 35 FIV isolates from Ontario identified subtype A as the most common (23/35), even though subtype B was most common in the eastern and central United States (12). Also, 7 cats with subtype B, 1 cat with subtype C, and 4 cats with A/B or A/C inter-subtype recombinants were identified in the Canadian study.

Hence, retrovirus infections across Canada appear to be slightly more common than in the United States. Infection with FIV is more frequent than infection with FeLV, co-infection is relatively uncommon, and factors such as sample origin, cat sex, and outdoor access, appear to influence infection rates.

Diagnosis of FeLV and FIV

Testing for FeLV (see Box 1)

Preventing exposure of healthy cats to FeLV-infected cats by test and removal or isolation is an important way to prevent spread of the disease and is not replaced by vaccination as a control method (13). Serological diagnosis of FeLV relies on detection of the core antigen p27 in peripheral blood using an enzyme-linked immunosorbent assay (ELISA), either as a patient-side

Box 1. Summary of FeLV and FIV testing recommendations for cats in Canada

1) Cats that should be tested for FeLV and FIV include:
   a) At-risk cats: sick cats, cats with bite wounds or oral disease, cats with known exposure to a retrovirus-infected cat, cats in multi-cat environments where the status of all cats is not known, cats entering shelters or rescue organizations
      — Sick cats should be tested regardless of a negative FeLV or FIV test result in the past
   b) Newly acquired cats and kittens, cats about to be vaccinated for FeLV or FIV

2) Test for FeLV and FIV (patient-side or referral laboratory ELISA) at presentation
   A. Cats that test positive for FeLV and/or FIV
      I. If FeLV positive, confirm with IFA
      II. If FIV positive and $>$ 6 mo of age
         i. If not FIV vaccinated, confirm with Western blot or IFA
         ii. If known or possibly FIV-vaccinated, confirm with an alternate test methodology, such as a validated PCR test
      III. If FIV positive and $<$ 6 mo of age, re-test at intervals of 30 d until the kitten tests negative or is $\geq$ 6 mo of age
   B. Cats that test negative for FeLV and FIV
      I. Ideally, all cats should have confirmatory testing performed to ensure negative status. However, when funds are limited, confirmatory testing should be focused on sick cats and cats with other risk factors, such as bite wounds. Cats that are otherwise healthy may not undergo confirmatory testing as long as the client is informed about the small risk of a false negative test result in a healthy cat.
         i. Although FeLV retesting alone can be performed in a minimum of 30 d, it is more practical and cost-effective to retest for both viruses in a minimum of 60 d with patient-side or referral laboratory ELISA.

3) Cats at ongoing risk of infection (e.g., cats with access to outdoors) should be tested annually for FeLV and for FIV, if not FIV-vaccinated, with patient-side or referral laboratory ELISA.

4) Cats used for blood or tissue donation in practice or in shelters should have negative screening tests for FIV antibody, as well as FeLV antigen and FeLV provirus by serology and real-time PCR, respectively.

kit or at a referral laboratory. Patient-side kits may be used with anticoagulated whole blood, serum or plasma, although the test kit should be checked for the manufacturer's recommendations on sample type. Tests performed on tears or saliva are less reliable and are not recommended. Most cats will test positive with ELISA within 30 d of exposure. Confirmatory testing for cats with positive test results is strongly recommended. Virus culture is considered the gold standard for diagnosis of FeLV infection, but is not available in Canada. A second soluble antigen test can be performed, preferably using a test from a different manufacturer (Table 2), to increase the positive predictive value (reduce the risk of false positive results) (14). Immunofluorescent antibody (IFA) tests available from referral laboratories detect p27 antigen within infected leukocytes or platelets, and are recommended as confirmatory tests. Immunofluorescent antibody tests do not detect infection until secondary viremia has occurred with infection of bone marrow (6 to 8 wk after initial infection).

Discordance of ELISA and IFA test results may make it difficult to determine the true FeLV status of a cat. Typically, this is an ELISA-positive and IFA-negative status. Discordant results may be due to the stage of infection, the variability of host responses, or technical problems with testing. The status of the cat with discordant results may eventually become clear by repeating both tests in 60 d and yearly thereafter until the test results agree. Unfortunately, a substantial number of these patients have persistently discordant test results and the cat's true status may not be known. Cats with discordant test results are best considered as potential sources of infection for other cats.

Polymerase chain reaction (PCR) is offered by a number of commercial laboratories for the diagnosis of FeLV. Polymerase chain reaction detects viral DNA sequences and can be performed on blood, bone marrow, saliva, and tissues (15). Blood PCR tests for FeLV are usually positive within 1 to 2 wk of FeLV exposure. Real-time PCR assays quantify viral copy number and are therefore sensitive for detection of regressive infection, but may not be commercially available (16). However, information regarding sensitivity and specificity of specific PCR assays offered by commercial laboratories is frequently unavailable, limiting their utility until such test characteristics are established.

In the past, it was believed that about 1/3 of FeLV exposed cats became persistently viremic and about 2/3 would clear infection. New research using more sensitive detection methods suggests that most cats remain infected for life following exposure to FeLV, but that the virus is "highly contained" in cats that are clinically healthy. Cats that are persistently FeLV antigen positive are considered to have a "progressive infection" and are at risk of FeLV-associated diseases. However, an effective immune response may allow some cats to revert to a non-viremic state within weeks to months after exposure, which is termed "regressive infection." Cats with regressive infections test negative for FeLV antigen using ELISA and IFA, and virus cannot be cultured from blood; however, FeLV proviral DNA can be detected in blood using PCR (17).

Kittens can be tested for FeLV at any age, as passively acquired maternal antibody does not interfere with testing for viral antigen. Newborn kittens infected from an FeLV-positive queen may not test positive for weeks to months after birth. Feline leukemia virus can be transmitted to kittens via various routes from infected queens (in utero, via saliva during grooming, via milk), although precise data on frequency are not available (18). While it may be tempting to test only a queen and not her kittens in an attempt to conserve resources in shelter or rescue settings, it is inappropriate to test one cat as a representative for others as it may lead to erroneous assumptions about infection status. Even young kittens may be exposed to cats other than their mother; for example, stray and feral queens often share mothering of kittens. If a queen or any one of her litter of kittens tests FeLV-positive, all should be considered potentially infected and isolated, with follow-up testing to resolve status. If a queen or 1 kitten in a litter tests negative, it cannot be guaranteed that the others are also negative. Shelters sometimes test pooled blood samples from litters of kittens in order to save money; this method cannot be recommended as its reliability is unknown.

Testing for FeLV infection is not generally compromised by vaccination. However, blood collected immediately following

Table 2. Patient-side test kits for FeLV and FIV available in Canada

Test kit	Manufacturer	Assay	Comments
SNAP® FeLV	IDEXX Canada Corporation	FeLV antigen	Use with whole blood, serum, plasma
SNAP® FeLV/FIV Combo	IDEXX Canada Corporation	FeLV antigen, FIV antibody	Use with whole blood, serum, or plasma
SNAP® Feline Triple®	IDEXX Canada Corporation	FeLV antigen, FIV antibody, heartworm antigen	FIV antibody, FeLV antigen, heartworm antigen; Use with whole blood, serum, or plasma
Assure® FeLV	Synbiotics Corporation	FeLV antigen	Use with saliva, whole blood, serum, plasma
Witness® FeLV	Synbiotics Corporation	FeLV antigen	Use with whole blood, serum, plasma

FIV — Feline immunodeficiency virus; FeLV — Feline leukemia virus.

vaccination may contain detectable FeLV antigens from the vaccine, so samples should be collected prior to FeLV vaccination (19). It is not known how long this test interference persists.

Testing for FIV (see Box 1)

Feline immunodeficiency virus infection and antibodies to the virus persist for life. Hence, the most common method for diagnosis of FIV infection is screening for antibodies (typically against p24 and p15) using an ELISA, either with a patient-side kit or at a referral laboratory. Most cats will produce antibodies to FIV within 60 d of exposure, but the time to seroconversion can be longer. A recent study showed that sensitivity and specificity of the ELISA was very high in unvaccinated cats using commercially available test kits (SNAP® FIV/FeLV Combo and PetChek FIV antibody test; IDEXX Laboratories, Westbrook, Maine, USA) (20).

Confirmatory testing for cats with positive test results is strongly recommended, especially for low-risk cats. Although virus culture is considered the gold standard for FIV infection, it is not readily available in Canada. A different soluble antibody test has been recommended as a confirmatory test (1), but as of this writing, only one patient-side FIV antibody test was commercially available in Canada. Western blot and immunofluorescent antibody assays are available in Canada; they detect antibodies against an increased number of viral antigens and are suggested as confirmatory tests in seropositive cats with no history of FIV vaccination.

As for FeLV, it is inappropriate to test a queen as a representative for her kittens, to test 1 kitten in a litter as a representative of its litter mates, or to test pooled samples from litters of kittens. Feline immunodeficiency virus can be transmitted to kittens via various routes from infected queens (in utero, in birth fluids during labor and delivery, via milk) (21,22). Experimental evidence suggests that not all kittens in a litter will acquire infection in utero from an FIV-infected queen (22–24). When the pregnant queen is acutely infected and has a high viral load, most of the kittens will become infected. However, when the pregnant queen is chronically infected and healthy with a low viral load, few kittens will become infected.

The release of the first vaccine against FIV (Fel-O-Vax FIV®) in 2003 in Canada has complicated the ability to diagnose FIV infections. Vaccinated cats produce antibodies that cannot be distinguished from antibodies due to natural infection using currently available tests (20). Antibodies due to vaccination persist for more than 1 y, and possibly for more than 4 y (1,20). In addition, kittens born to naturally infected queens, or queens vaccinated against FIV, may acquire FIV antibodies in colostrum. Feline immunodeficiency virus antibodies persisted past 8 wk of age in more than 50% of kittens (n = 55) born to FIV-vaccinated queens (n = 12), but were no longer detectable at 12 wk of age (25). In another study, passively acquired antibodies in 5 kittens from infected queens declined to undetectable levels only by 17 wk of age (26). It is uncommon for kittens to acquire FIV infection, and most kittens that initially test positive are not truly infected and will test negative when re-evaluated, especially at or over 6 mo of age. Kittens over 6 mo of age with FIV antibodies are more likely to be infected.

Due to concerns regarding detection of passively acquired FIV antibodies, it is tempting to delay testing kittens for FIV until after 6 mo of age. Since they are a low risk group, most kittens test negative and can then be reliably considered clear of infection. However, infected kittens could be a source of infection for other cats if they are not identified and isolated. Compliance of both owners and veterinarians with retroviral testing recommendations was low in 1 published study. Because of this, delaying testing of newly acquired kittens would potentially result in many cats never being tested for FIV (27). Hence, kittens should be tested for FIV at the first opportunity.

In some cats, it may be difficult to determine if a positive FIV antibody test means the cat is truly infected with FIV, is vaccinated against FIV but not infected, or is vaccinated against FIV and also infected. Polymerase chain reaction (PCR) has been promoted by some commercial laboratories as a method to determine a cat's true infection status. This test may be used to detect FIV RNA or DNA (provirus) genetic sequences; however, PCR tests offered by some Canadian commercial laboratories may be unreliable, with misidentification of both FIV-infected and uninfected cats (28,29).

Recently, a real-time PCR assay for FIV (FIV RealPCR™, IDEXX Laboratories) for quantification of viral DNA in peripheral blood leukocytes has become commercially available in Canada and the United States. The laboratory reports test

sensitivity of 80.5% and specificity of 99.9% (30). In addition, the test is reported to be unaffected by FIV vaccination. As of this writing, the FIV RealPCR™ test has not been independently evaluated.

Due to the limited sensitivity in the context of genetically heterogeneous lentiviruses, PCR is not useful as a screening tool for FIV and will not replace patient-side or referral laboratory ELISA tests. Rather, PCR testing should be reserved for FIV-antibody positive cats that have an unknown vaccination history or that have been vaccinated against FIV but still suspected to be infected. The PCR test results must be interpreted with caution. A positive FIV PCR result from a laboratory with stringent quality control should confirm FIV infection and should not be affected by FIV vaccination. However, a negative FIV PCR result does not rule out infection, but may reflect a level of viral nucleic acid below the limit of detection, or a strain of FIV that is not detected by the test.

Other tests that detect FIV infection and are unaffected by vaccination are a real-time PCR test with concurrent determination of viral load and subtype differentiation (31), and a discriminant ELISA for antibodies to formalin-treated whole FIV and untreated transmembrane peptide (32). Neither of these tests is commercially available at this time.

Compliance with FeLV and FIV testing

Compliance with FeLV and FIV testing recommendations among veterinarians and cat owners is limited. In 1 study of 967 cats with bite wounds in the United States, only 54% of participating clinics followed recommendations to contact owners 60 d after the cats were initially treated to recommend retesting for retroviral infection, even though the veterinarians were offered financial incentives to promote compliance (27). Only 14% of the contacted owners returned their cats for testing, even though the testing was performed free of charge.

The reasons for poor compliance among veterinarians and cat owners may be due to factors such as incomplete understanding of the lifelong nature of retrovirus infections, insufficient communication skills, inconvenience of physical re-evaluation of cats, and cost. In Goldkamp et al (27), the inconvenience of returning for the second test and a lack of knowledge about the importance of retesting may have outweighed the access to testing at no charge. The difficulty of bringing a cat to the veterinary clinic is an important barrier to appropriate care, and must be addressed by veterinarians (33). In addition, some owners will decline recommended care not because of limited financial ability, but because they feel it is unnecessary, or they are uncertain or confused about the importance of the recommended care (34). Improving communication between veterinarians and cat owners may help increase compliance.

In most regions of Canada, feline retrovirus testing is performed at 1/3 to 1/2 that of the rate in the United States (Jim Morris, IDEXX Laboratories, personal communication, 2010). The cost of FeLV and FIV testing in Canada according to the suggested fee guides may be considered as a contributing factor. If the perceived cost of testing is high and the perceived value of testing is low or is unknown, owners may be less likely to follow recommendations for initial testing as well as retesting.

Table 3. Canadian Veterinary Medical Association (CVMA) suggested fees for FeLV and FIV test pricing by province

Province	FeLV Test	FeLV/FIV Combination test	Sample collection/ Handling fee
BC	n/a	$90.90	$26.40
AB	n/a	$123.40	Included
SK	n/a	$68.00	$18.80
MB	n/a	$81.40	$19.50
ON	n/a	$108.40	$30.10
QC	$40.20	$75.00	$25.00
NB	$51.80 $60.60 Stat	n/a FIV $60.60	$11.90
NS	$63.70 $74.50 Stat	$126.30	$15.00
PEI	n/a	$77.00	$22.10
NF	n/a	$76.20	$17.90

FIV — Feline immunodeficiency virus; FeLV — Feline leukemia virus.
Note: All fees are from the CVMA 2010 Provincial Suggested Small Animal Fee Guides and are reprinted with permission.

According to the Canadian Veterinary Medical Association's suggested fee guides, the cost of a combination FeLV/FIV test (when sample collection/handling fees are included) ranges from $100.00 in Quebec to $141.30 in Nova Scotia (Table 3). The wholesale cost of the patient-side combination test (SNAP® FIV/FeLV Combo and PetChek FIV antibody test; IDEXX Laboratories) from one Canadian distributor is $23.53/test (CDMV, Saint-Hyacinthe, Quebec). The suggested fee may be a particular deterrent to testing of healthy newly adopted kittens and cats, especially when the owner must also consider the cost of immunization, fecal parasite testing, de-worming, pre-surgical blood screening, and sterilization. Therefore, the authors suggest that a two-tier fee structure should be considered for retrovirus testing in Canada. A lower fee for testing asymptomatic cats may be created, while the fee for testing sick animals would remain at the current fee guide level for each province. Most tests in asymptomatic cats will be negative, meaning professional interpretation is straightforward and communication with the client is simple and quick. The higher fee for testing sick cats can be justified by the time required to interpret the significance of the test results and to communicate this information as well as further diagnostic or therapeutic plans to the client.

Prevention of infection and management of retrovirus-infected cats

While testing and identification of infected cats is necessary for prevention of transmission, vaccination is also an important tool. The combined use of testing and vaccination programs is assumed to have decreased the prevalence of FeLV over the last 20 years. Recommendations for the use of available FeLV vaccines have been published (1,35). Marked differences in vaccine efficacy exist and suggest that only certain inactivated whole virus or canarypox-vectored recombinant vaccines should be used (36–40). Although protection from persistent viremia and from FeLV-associated disease can be demonstrated, conflicting data exist on the ability of vaccines to confer sterilizing

immunity (37,38,41). Cats with access to outdoors should be vaccinated against FeLV infection, but should have at least 1 negative FeLV ELISA test before vaccination. When a cat is vaccinated against FeLV for the first time, owners should be instructed to confine the cat until at least 2 wk after the final vaccination to ensure an adequate immune response has developed before risk of exposure.

Recommendations for the use of FIV vaccines have also been published (1,35). Studies of the currently available FIV vaccine (Fel-O-Vax FIV®) conducted by the inventor or manufacturer have demonstrated efficacy when vaccinated cats were challenged with subtypes A and B (42–45). One independent study showed that the vaccine was not able to protect cats when they were challenged by a subtype A field strain from the United Kingdom (46). Until more independent evaluations of the vaccine have been performed against field strains of the virus, especially those prevalent in Canada, and the issue of interference with currently available antibody tests has been resolved, the use of the vaccine cannot be recommended.

Feline immunodeficiency virus vaccines are considered non-core vaccines by the AAFP (35). The AAFP guidelines recommend clients be informed of the difficulties interpreting FIV test results in vaccinated cats, the lack of knowledge about vaccine efficacy, and that vaccinated cats should be permanently identified, such as with a microchip, tattoo and/or collar. Microchip databases can be used to record FIV vaccination histories. A significant concern is the fate of lost or surrendered vaccinated cats that are tested in shelters, as the cat's vaccination history is often unavailable and a positive test result may lead to euthanasia.

Data on survival of retroviral infected cats indicate that the lifespan of FIV-infected cats appears similar to that of uninfected cats, while the lifespan of FeLV-infected cats is generally shorter. Cats infected with FIV may have a long disease-free period, especially if wellness care is provided and exposure to other infectious diseases is limited. However, it is also possible that some FIV subtypes are less pathogenic than others.

In 1 study conducted in the United States, records of 67 963 cats that were tested for FeLV and FIV in 2000, and that had outcome information available 6 y later, were analyzed (47). Survival of infected cats was compared to age- and sex-matched uninfected cats. The 6-year survival rates were 90% for uninfected cats, 51% for FeLV-positive cats, and 65% for FIV-positive cats. Most deaths in cats with FeLV or FIV infection occurred in the first year after diagnosis, probably due to the illness that prompted the original veterinary visit or due to euthanasia for purposes of infection control.

A study of 17 289 cats in Germany tested for FeLV and FIV from 1993 to 2002 included survival data on 100 randomly selected cats: 18 FeLV-positive, 19 FIV-positive, 63 uninfected (48). The mean survival time of FeLV-positive cats (312 d) was significantly shorter than that of FeLV-negative cats (732 d). There was no statistically significant difference in the mean survival time of FIV-positive cats (785 d) compared with FIV-negative cats (625 d).

In the study of 1205 cats tested for FeLV and FIV in western Canada, FIV-positive/FeLV-negative cats were compared to randomly selected, age- and sex-matched FIV/FeLV-negative cats (10). The median survival time for FIV-positive cats (n = 39, 3.9 y) was not significantly different from that of FIV-negative cats (n = 22, 5.9 y).

Given that many retrovirus-infected cats will survive for years after diagnosis, especially FIV-infected cats, veterinarians should be familiar with guidelines for management of infected cats (1). Retrovirus-infected cats may require hospitalization for elective procedures (e.g., spay/neuter, dentistry) and for diagnosis and treatment of illness. Retroviruses become inactivated within a few hours on dry surfaces, and they are therefore considered to have little environmental persistence. However, retroviruses present in dried biological deposits may remain viable for more than a week. Both FeLV and FIV are readily inactivated by detergents and common hospital disinfectants, and there is therefore little risk for transmission between cats by indirect exposure, such as at veterinary clinics. However, hospitalized cats should not be allowed to have direct contact with one another. Isolation of hospitalized retrovirus-infected cats is not required, but they should be kept in separate cages. It is important not to keep retrovirus-infected cats in contagious disease wards as they are potentially immunosuppressed.

Although casual transmission of the viruses via the environment is unlikely, both viruses are transmitted very efficiently via contaminated body fluids, such as blood, urine, and saliva. It is therefore imperative to institute and maintain appropriate clinical practices, such as use of a single set of instruments for each surgery, adequate disinfection of cages, examination tables, endotracheal tubes, anesthetic breathing circuits, and dental instruments, as well as avoiding contamination of multi-dose vials and sharing of fluid bags among patients. Cats used for blood or tissue donation in practice or in shelters should have negative screening tests for FIV antibody and FeLV antigen by serology and FeLV provirus by real-time PCR.

In conclusion, the seroprevalence of FeLV and FIV infection in Canada appears higher than that reported for the United States. Preventing exposure of healthy cats to retrovirus-infected cats by testing and isolation or removal is important for disease control. Preventing infection of cats with FeLV and FIV is important for maintaining health and good quality of life, and for reducing the costs of veterinary care. In addition, preventing transmission of FIV may help prevent the appearance of more virulent strains or viral mutations that may confer the ability to infect other species. Further investigation into geographic variations in retrovirus seroprevalence within Canada is warranted, and may provide information to improve recommendations for testing and prevention. Screening ELISA tests for FeLV and FIV are readily available in Canada and are generally reliable. However, independent evaluation of newer test methodologies, such as PCR, is not yet widely available. Veterinarians may not be able to ascertain the diagnostic efficacy of a test offered by a particular laboratory. At the least, veterinarians should ask for information on the sensitivity and specificity as well as the positive and negative predictive values of retrovirus tests. Further investigation of FIV subtypes in Canada is necessary not only for developing molecular assays, but also for possible vaccine design and understanding of subtype association with disease outcomes. Finally, improving rates of testing for retroviruses in

Canada may necessitate greater education of veterinarians and cat owners, facilitation of cat transport to clinics, and reductions in the cost of testing. CVJ

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