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## FELINE VACCINATION GUIDELINES

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The 1998 Report of the American Association of Feline Practitioners and Academy of Feline Medicine Advisory Panel on Feline Vaccines<sup>14</sup> was developed to help veterinary practitioners formulate vaccination protocols for cats. The current panel report updates information, addresses questions, and speaks to concerns raised by the 1998 report. In addition, it reviews vaccine licensing, labeling, and liability issues and suggests ways to successfully incorporate vaccination protocol changes into a private practice setting. The material in the 1998 report is not fully reproduced here, and readers are referred to the 1998 report for more detailed information.

Vaccines play an important role in the control of infectious diseases. Most vaccines do not induce complete protection from infection or disease, however, nor do they induce the same degree of protection in all animals. Factors that negatively affect an individual animal's ability to respond to vaccination include maternal antibody interference, congenital or acquired immunodeficiencies, concurrent disease, inadequate nutrition, immunosuppressive medication, and stress (e.g., overcrowding, poor sanitation).<sup>20</sup> Every effort should be made to ensure that

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patients are healthy before vaccination. Because vaccination alone does not completely protect animals from infection and disease, environmental conditions should be addressed and exposure to infectious agents should be minimized.

The overall objectives of vaccination are to vaccinate the largest possible number of individuals in the population at risk, vaccinate each individual no more frequently than necessary, and vaccinate only against infectious agents to which individuals have a realistic risk of exposure and subsequent development of disease. Kittens younger than 16 weeks of age are generally more susceptible to infection than are adult cats and typically develop more severe disease. They represent the principal target population for vaccination.<sup>40</sup> Maternal antibody interference is the most common reason why some animals are not immunized after vaccination, and it is also the reason why a series of vaccinations is necessary for kittens younger than 12 weeks of age.<sup>20</sup> Vaccination needs of adult cats should be assessed at least once yearly and, if necessary, modified on the basis of an assessment of their risk.

## VACCINE SELECTION AND ADMINISTRATION

It is recommended that administration sites for parenteral vaccine be chosen in accordance with the guidelines established by the American Association of Feline Practitioners and adopted by the Vaccine-Associated Feline Sarcoma Task Force (Table 1).<sup>46</sup> Use of multiple-dose vials is discouraged, because inadequate mixing may result in unequal distribution of antigen and adjuvant, possibly resulting in decreased efficacy or an increased likelihood of adverse events; iatrogenic contamination is an additional risk. The panel discourages the use of polyvalent vaccines other than those containing combinations of feline panleukopenia virus, feline herpesvirus-1 (FHV-1), and feline calicivirus (FCV), exclusively. This opinion is based on the belief that as the number of antigens in a vaccine increases, so too does the probability of associated adverse events. Additionally, use of polyvalent vaccines may force practitioners to administer vaccine antigens not needed by the patient.

### Feline Panleukopenia

Feline panleukopenia is caused by feline parvovirus (FPV). The virus remains infectious for months to years in the environment and is primarily spread via the fecal-oral route. Fomites (e.g., cages, food bowls, litter boxes, health care workers) play an important role in the transmission of the organism. Clinical signs of infection include lethargy, an-

orexia, vomiting, diarrhea, fever, and profound panleukopenia; mortality is highest in young susceptible cats.<sup>12</sup> In utero infection with FPV is a common cause of cerebellar hypoplasia.<sup>12</sup>

Vaccination against FPV is highly recommended for all cats. Immunity to feline panleukopenia is primarily through antibody response to natural infection, vaccination, or passive transfer of maternal antibodies from queen to kittens. Maternal antibody may interfere with immunization when antibody titers are high during the neonatal period. Maternal antibody titers generally wane sufficiently to allow immunization by 12 weeks of age.<sup>47</sup> Immunity conferred by feline panleukopenia vaccines is considered to be excellent, and most vaccinated animals are completely protected from infection and clinical disease. Serologic and challenge exposure data indicate that a parenteral FPV vaccine induces immunity that is sustained for at least 7 years.<sup>48, 49</sup> After the initial series of vaccinations and revaccination 1 year later, cats should be vaccinated no more frequently than once every 3 years.

Modified-live virus (MLV) vaccines and adjuvanted inactivated virus vaccines for parenteral administration as well as an MLV vaccine for topical (intranasal) administration are available and effective. Experimental studies have shown that intranasal administration of canine parvovirus-2 vaccines to puppies is less effective than parenteral administration in overcoming maternal antibody interference (Ronald Schultz, PhD, personal communication, 2000). The most likely reasons are that fewer virus particles reach lymphoid tissue when the product is given intranasally compared with parenteral administration and viral replication in lymphoid tissue is required for immunization with MLV parvovirus vaccines. Although studies have not been performed in cats, the same phenomenon may occur in this species. Caution is appropriate when contemplating the use of intranasal FPV vaccines for primary immunization of kittens, especially those residing in environments where exposure to FPV is likely.

It has been found recently that some cats with panleukopenia-like disease were infected with canine parvovirus-2b. Studies show that FPV vaccines provide excellent protection not only from FPV but also from canine parvovirus-2b; thus, canine parvovirus infection should not be a concern for cats immunized as a result of vaccination with FPV vaccines.<sup>39</sup>

Serious adverse events associated with FPV vaccines are rare. Tumor formation at the site of a topically administered vaccine has not been reported. Vaccination of pregnant queens with modified-live FPV vaccines may possibly result in neurologic disease in developing fetuses<sup>52</sup>; the same concern applies to kittens vaccinated at less than 4 weeks of age. The use of MLV vaccines should be avoided in pregnant queens and kittens less than 1 month of age.<sup>52, 62</sup>

**Table 1. AMERICAN ASSOCIATION OF FELINE PRACTITIONERS AND ACADEMY OF FELINE MEDICINE FELINE VACCINE PANEL RECOMMENDED FOR VACCINATION OF CATS**

Antigen	Vaccine Types	Primary Vaccination		Booster Vaccination	Comments
		Cats < 12 Weeks Old	Cats ≥ 12 Weeks Old		
Feline parvovirus*	MLV vaccine for parenteral administration MLV vaccine for topical administration Adjuvanted inactivated-virus vaccine for parenteral administration	If ≥ 6 weeks old, vaccinate at initial visit and every 3 to 4 weeks until ≥ 12 weeks old†	Administer two doses 3 to 4 weeks apart	1 year after primary vaccination, then no more frequently than every 3 years	Highly recommended for all cats; in most cats, protection derived after administration of booster vaccination 1 year after primary vaccination is sustained for at least 3 years and probably 5 to 6 years or more; MLV vaccines should not be administered to pregnant queens or kittens < 4 weeks old
Feline herpesvirus-1 and feline calicivirus	Combined MLV vaccine for parenteral administration Combined adjuvanted inactivated-virus vaccine for parenteral administration	If > 6 weeks old, vaccinate at initial visit and every 3 to 4 weeks until ≥ 12 weeks old†	Administer two doses 3 to 4 weeks apart	1 year after primary vaccination, then every 3 years	Highly recommended for all cats; MLV vaccine should not be administered to pregnant queens
Feline herpesvirus-1 and feline calicivirus	Combined MLV vaccine for topical administration	If > 6 weeks old, vaccinate at initial visit and every 3 to 4 weeks until ≥ 12 weeks old‡	Administer one dose	1 year after primary vaccination, then every 3 years	Highly recommended for all cats; may be used as an alternative to the parenteral product; may be preferable to parenterally administered vaccines in cats reared in or entering environments in which viral upper respiratory tract disease is endemic (e.g., some catteries, boarding facilities, shelters); MLV vaccine should not be administered to pregnant queens

Rabies	Adjuvanted inactivated-virus vaccine for parenteral administration every year§	Not eligible for vaccination	Administer one dose	1 year after primary vaccination, then every year	Highly recommended for all cats; rabies vaccination of cats is required by law in some regions of the country, and veterinarians should comply with state and local statutes regarding type of vaccine to be used and vaccination interval
Rabies	Adjuvanted inactivated-virus vaccine for parenteral administration every 3 years§	Not eligible for vaccination	Administer one dose	1 year after primary vaccination then every 3 years	Highly recommended for all cats; rabies vaccination of cats is required by law in some regions of the country, and veterinarians should comply with state and local statutes regarding type of vaccine to be used and vaccination interval
Rabies	Canarypox virus–vectored recombinant vaccine for parenteral administration	Administer one dose to cats as young as 8 weeks old	Administer one dose	1 year after primary vaccination, then every year	The recombinant rabies virus vaccine approved can be used as an alternative to products approved for annual use; this product does not contain an adjuvant and postvaccination inflammation at the vaccine site seems to be minimal; however, whether use of this product is associated with a decreased likelihood of vaccine-associated sarcoma formation is not presently known
Feline leukemia virus	Adjuvanted and nonadjuvanted inactivated-virus vaccines for parenteral administration	Administer two doses 3 to 4 weeks apart to cats as young as 8 weeks old¶	Administer two doses 3 to 4 weeks apart¶	Annually	Recommended for cats that are <i>not</i> restricted to a closed, indoor, FeLV-negative environment; most important for cats < 16 weeks old; not recommended for cats ≥ 16 weeks old with minimal to no risk of exposure to FeLV-infected cats

Table continued on following page

**Table 1.** AMERICAN ASSOCIATION OF FELINE PRACTITIONERS AND ACADEMY OF FELINE MEDICINE FELINE VACCINE PANEL RECOMMENDED FOR VACCINATION OF CATS (Continued).

Antigen	Vaccine Types	Primary Vaccination		Booster Vaccination	Comments
		Cats < 12 Weeks Old	Cats ≥ 12 Weeks Old		
<i>Chlamydia psittaci</i>	Modified-live vaccine for parenteral administration Adjuvanted inactivated vaccine for parenteral administration	If ≥ 9 weeks old administer two doses 3 to 4 weeks apart	Administer two doses 3 to 4 weeks apart	Annually	Not recommended for routine use; can be considered for use in cats in multiple-cat environments where <i>C. psittaci</i> infections associated with clinical disease have been documented
Feline infectious peritonitis virus	MLV vaccine for topical administration	Not approved for cats < 16 weeks old	Administer two doses 3 to 4 weeks apart to cats ≥ 16 weeks old	Annually	Not recommended for routine use at this time; there is insufficient evidence to support the conclusion that the vaccine induces clinically relevant protection
<i>Microsporium canis</i>	Adjuvanted inactivated vaccine for parenteral administration	Not approved for cats < 16 weeks old	First dose administered SC to cats ≥ 16 weeks old; second dose administered SC 12 to 16 days after the first dose; third dose administered SC 26 to 30 days after the second dose	Not stipulated	Not recommended for routine use; vaccination may be considered as one component of a comprehensive control program in multiple-cat environments in which <i>M. canis</i> infection is endemic or as adjunctive treatment to hasten resolution of clinical signs in individual cats

<i>Bordetella bronchiseptica</i>	MLV for topical administration**	Administer one dose (0.2 mL) intranasally to cats $\geq$ 4 weeks old	Administer one dose (0.2 mL) intranasally	Not stipulated	Not recommended for routine use; vaccination may be considered for cats entering or residing in multiple-cat environments where <i>B. bronchiseptica</i> infections associated with clinical disease have been documented
<i>Giardia lamblia</i>	Adjuvanted inactivated vaccine for parenteral administration	Administer the first dose to cats 8 weeks old and a second dose 3 to 4 weeks later	Administer two doses 3 to 4 weeks apart	Annually	Not recommended for routine use; vaccination may be considered as one component of a comprehensive control program in multiple-cat environments in which <i>G. lamblia</i> infections associated with clinical disease have been documented

Parenteral vaccines should be administered subcutaneously or intramuscularly.

\*Cause of feline panleukopenia.

†For kittens that are orphaned or at high risk of exposure, vaccination when as young as 4 weeks old may be indicated.

‡For kittens that are orphaned or at high risk of exposure, vaccination when as young as 10–14 days old may be indicated.

§A specific route of administration may be required; see product information for details.

||Most often, the product approved for use annually is given for initial vaccination followed 1 year later and every 3 years after that by administration of the product approved for use every 3 years; however, vaccination interval must comply with local and state statutes.

¶FeLV testing is recommended before vaccination; infected cats do not derive any benefit from vaccination.

\*\*This product is not the same as the *B. bronchiseptica* vaccine approved for use in dogs; the product approved for use in dogs should not be used in cats.

MLV = modified-live virus; FeLV = feline leukemia virus; SC = subcutaneously.



## Feline Viral Rhinotracheitis and Feline Calicivirus Infection

Feline viral rhinotracheitis caused by FHV-1 and FCV infection account for up to 90% of all cases of infectious upper respiratory tract disease in cats.<sup>17</sup> Both viruses are shed in ocular, nasal, and pharyngeal secretions of infected cats.<sup>42</sup> Organisms are transmitted from cat to cat directly through sneezed macrodroplets or indirectly via contaminated fomites.<sup>17</sup> The disease is self-limiting; however, infected cats may develop chronic oculonasal disease. Latent infection is lifelong for cats infected with FHV-1; reactivation can occur during periods of stress or after corticosteroid administration. Some cats infected with FCV become persistently infected and shed virus for prolonged periods (months to years). Although rarely serious in adult cats, disease caused by these viruses may be severe, and sometimes fatal, in kittens. Lameness and chronic oral inflammatory syndromes have been linked to calicivirus infection and vaccination with modified-live calicivirus vaccines.<sup>3, 7, 10, 11, 45, 57</sup> Risk of exposure to either FHV-1 or FCV is high, because both organisms are widespread in the feline population.

Vaccination against FHV-1 and FCV is highly recommended for all cats. Immunity is through humoral and cell-mediated immune responses to natural infection or vaccination or through passive transfer of maternal antibodies from queen to kittens. Maternal antibody may interfere with induction of a systemic immune response; however, by the time that kittens are 12 weeks of age, maternal antibody titers wane sufficiently to allow parenteral immunization. Topically administered (intra-nasal, conjunctival) vaccines are capable of inducing a local immune response in the face of high maternal antibody titers.<sup>27</sup> Serologic and challenge exposure data indicate that parenteral FHV-1 and FCV vaccines induce protection that lasts at least 3 years.<sup>48, 49</sup> After the initial series of vaccinations and revaccination 1 year later, cats should be vaccinated once every 3 years.

Regardless of the route of administration, FHV-1 and FCV vaccines induce only relative but not complete protection. At best, these vaccines induce an immune response that lessens the severity of disease; vaccines are not immune to infection nor are they protected from all signs of disease.<sup>20</sup> Currently available FCV vaccines probably do not induce protection from all isolates of the virus.<sup>9</sup>

MLV and inactivated virus vaccines for parenteral administration and MLV vaccines for topical (intranasal and conjunctival) administration are available. If a susceptible cat is born into or is entering an environment in which viral upper respiratory tract disease is endemic (e.g., some catteries, boarding facilities, shelters), the use of a topical product may be advantageous. Administration of such products to kittens as young as 10 to 14 days of age could be considered in these

situations; however, products that also contain modified-live FPV antigens should not be administered to kittens younger than 4 weeks of age.<sup>62</sup> Adverse events associated with vaccination against FHV-1 and FCV include mild transient fever, sneezing, conjunctivitis, oculonasal discharge, lameness, and, for parenteral products, pain at the injection site.<sup>9, 11</sup> Sneezing, conjunctivitis, oculonasal discharge, and ulceration of the nasal philtrum are believed to occur more frequently with vaccines licensed for topical use. Tumor formation at the site of a topically administered vaccine has not been reported.

## Rabies

Rabies is transmitted mainly through bite wounds of infected mammals. More cats than dogs develop rabies in the United States<sup>29</sup>; although they are relatively resistant to rabies, both species serve as potential sources of infection for human beings.<sup>21, 29</sup> Treatment is ineffective in cats that develop clinical signs and should not be attempted because of the high potential for zoonotic infection.<sup>21</sup> All instances of suspected or known rabies virus infection must be reported to local health department officials. Proper precautions and quarantine procedures as outlined by local regulations and described in the *Compendium of Animal Rabies Prevention and Control, 2000*<sup>26</sup> should be followed.

Although vaccine-associated sarcomas have been reported to develop in association with administration of a variety of vaccines, current data suggest that they are more frequently associated with administration of feline leukemia virus (FeLV) vaccines and adjuvanted rabies virus vaccines.<sup>28</sup> Inflammatory reactions are commonly observed at sites where adjuvanted rabies virus vaccines have been administered, and concern has arisen regarding the possible association between these reactions and vaccine-associated sarcomas.<sup>35</sup> With the exception of a recently approved canarypox virus–vectored recombinant feline rabies virus vaccine (Pure-Vax Feline Rabies Vaccine; Merial Limited, Iselin, NJ), all rabies virus vaccines currently on the market contain adjuvants. In rats, inflammation induced by the recombinant product seems to be minimal,<sup>34</sup> but whether the use of this vaccine is associated with a reduced likelihood of vaccine-associated sarcoma formation in cats is not yet known. The recombinant product is currently licensed only for annual administration.

Rabies virus vaccination is highly recommended for all cats and is required by law in some states and municipalities. Manufacturers are required by the US Department of Agriculture to establish, by means of experimental challenge exposure studies, the minimum duration of immunity for the rabies virus vaccines that they sell, and products approved for use every year or every 3 years are available. Statutes governing the administration of rabies virus vaccines vary considerably

throughout the United States; veterinarians should comply with the legal requirements of their area.

### **Feline Leukemia Virus Infection**

FelV infects domestic cats throughout the world. Transmission is through transfer of virus in the saliva or nasal secretions resulting from prolonged intimate contact (e.g., mutual grooming), biting, or sharing of food and water utensils. The virus may also be transmitted by transfusion of blood from an infected cat, in utero, or through the milk.<sup>33</sup> Exposure to virus persisting in the environment on fomites or in aerosolized secretions is not an efficient means of viral transmission. Clinical signs of FelV infection are primarily related to neoplasia, anemia, and diseases resulting from immunosuppression.

Kittens are the most susceptible to infection; resistance increases with maturity. Experimental data demonstrate that kittens younger than 16 weeks of age are most susceptible to infection, with cats older than this being relatively resistant.<sup>23</sup> Cats at greatest risk include outdoor cats (free-roaming pets, stray cats, and feral cats). Also at risk are cats residing in open multiple-cat environments, cats living with FelV-infected cats, and cats residing in households with unknown FelV status.

The decision to vaccinate an individual cat against FelV infection should be based on the cat's age and its risk of exposure. Vaccination against FelV is recommended for cats at risk of exposure (i.e., cats not restricted to a closed, FelV-negative, indoor environment), especially those younger than 4 months of age. Vaccination is not recommended for cats with minimal to no risk of exposure, especially those older than 4 months of age. The ability of a particular vaccine brand to induce an immune response sufficient to resist persistent viremia varies from study to study.<sup>53</sup> Because protection is not induced in all vaccinates, preventing exposure to infected cats remains the single best way to prevent FelV infection. Vaccination against FelV does not diminish the importance of testing cats to identify those that are viremic. It is of critical importance that viremic cats not be in contact with other cats, especially those younger than 4 months of age. As a result, the FelV infection status of all cats should be determined.<sup>13</sup> Adverse events associated with vaccination against FelV include local swelling or pain, transient lethargy or fever, and postvaccination granuloma formation. Although vaccine-associated sarcomas have been reported to develop in association with administration of other vaccines, current data suggest that they are more frequently associated with administration of FelV vaccines and adjuvanted rabies virus vaccines.<sup>28</sup> If vaccination is deemed appropriate, annual revaccination is recommended. Cats should be tested for FelV infection before initial vaccination and when there is a possibility that they have been exposed to FelV since they were vaccinated. The enzyme-linked immu-

nosorbent assay is the preferred screening test; the indirect immunofluorescent assay is the preferred confirmatory test.<sup>13</sup> Individuals confirmed to be infected with FeLV need not receive FeLV vaccines, but they should be segregated from uninfected cats.

## Chlamydiosis

*Chlamydia psittaci* is a bacterial pathogen of the conjunctiva and respiratory tract of cats. Transmission is through direct cat-to-cat contact; fomite transmission is less likely, because the organism is unstable in the environment. Serous conjunctivitis, which may initially affect only one eye, is the most common clinical sign. Sneezing or nasal discharge may develop, but if it does develop, it is usually mild. Clinical signs are usually evident 5 to 10 days after infection and resolve with appropriate antimicrobial treatment.<sup>18</sup> Isolation rates have been reported to range from approximately 1% for cats without signs of respiratory tract disease to approximately 14% for cats with concurrent upper respiratory tract disease.<sup>56</sup> The highest rates of infection are reported for cats between 5 weeks and 9 months of age.<sup>61</sup> Immunity conferred by *C. psittaci* vaccines is similar to that conferred by FHV-1 and FCV vaccines in that vaccinates are protected from severe clinical disease but not from infection.<sup>20</sup> The frequency of adverse systemic events associated with *C. psittaci* vaccines is higher than that associated with other commonly used vaccines; reactions include lethargy, depression, anorexia, lameness, and fever 7 to 21 days after vaccination.<sup>55</sup> Because signs of disease associated with *C. psittaci* infection are comparatively mild and respond favorably to treatment, and because adverse events associated with the use of *C. psittaci* vaccines are of greater concern than adverse events associated with the use of many other products, routine vaccination against *C. psittaci* infection is not recommended. Vaccination may be considered for cats in multiple-cat environments, where infections associated with clinical disease have been confirmed. If vaccination is deemed appropriate, annual revaccination is recommended.

## Feline Infectious Peritonitis

Feline coronaviruses (FCoVs) vary considerably in pathogenic potential and have historically been grouped into two biotypes: feline enteric coronaviruses, which typically cause subclinical to mild enteric infections, and feline infectious peritonitis (FIP) viruses, which cause FIP. Currently, FIP viruses are believed to be generated as mutant variants in feline enteric coronavirus-infected cats.<sup>58, 59</sup> FCoV are widespread in feline populations worldwide, with seropositivity rates highest in crowded multiple-cat environments.<sup>43</sup> Transmission of the virus is

mainly via the fecal-oral route. In environments in which FCoV infection is endemic (e.g., most multiple-cat environments), 35% to 70% of cats are shedding FCoVs in the stool at any given time.<sup>16, 22</sup> Most infected cats remain healthy, although a few (usually between 1% and 5%) ultimately develop FIP. Affected cats rarely survive regardless of treatment.<sup>43</sup> Kittens are most often affected with FIP, but the disease reportedly can develop in cats of all ages. A genetic predisposition has been suggested, with higher disease incidence in certain lines.<sup>15, 43</sup>

Considerable controversy surrounds the ability of the currently available FIP vaccine (Primucell-FIP; Pfizer Animal Health, Exton, PA) to prevent disease. Some studies demonstrate protection from disease<sup>19, 24</sup>; others show little benefit from vaccination.<sup>36, 51</sup> Antibody-dependent enhancement of disease in vaccinates has been demonstrated in experimental challenge exposure studies,<sup>50</sup> but it is uncertain whether antibody-dependent enhancement occurs in a natural setting. Discrepancies between study results are probably attributable to differences in test methodology (e.g., strain and dose of challenge virus, genetic predisposition of the test animals). Protection from disease has not been demonstrated in animals vaccinated when younger than 16 weeks of age. Most kittens born and reared in environments in which FCoV infection is endemic are infected before reaching this age.<sup>1, 22</sup> In these instances, vaccination of infected cats has not proven beneficial. At this time, there is no evidence that the vaccine induces clinically relevant protection, and its use is not recommended.

## Dermatophytosis

Dermatophytosis in cats is primarily caused by infection with *Microsporium canis*. A variety of clinical manifestations, including transitory clinical disease and chronic infection with or without clinical signs, have been reported. Although successful treatment of individual cats is usually straightforward, elimination of endemic infection from multiple-cat environments is expensive, labor-intensive, and time-consuming.<sup>38</sup>

An *M. canis* vaccine (Fel-O-Vax MC-K; Fort Dodge Animal Health, Overland Park, KS) is approved for use as an aid in the prevention and treatment of clinical signs associated with *M. canis* infection. Vaccination has not been demonstrated to prevent infection or to eliminate *M. canis* organisms from infected cats. As a result, routine vaccination against *M. canis* infection is not recommended. At the time of this writing, the product has not been independently evaluated for efficacy. Based on studies conducted by the manufacturer, it is reasonable to consider vaccination as adjunctive treatment for individual infected cats 4 months of age or older to hasten resolution of clinical signs. If the vaccine

induces an immune response that accelerates lesion resolution, the number of infectious fungal spores produced by vaccinates may be reduced as well; thus, it is reasonable to consider vaccination as one component of a comprehensive treatment program in multiple-cat environments in which *M. canis* infection is endemic. Nonetheless, the ability of this product to hasten elimination of endemic infections from such environments has not been evaluated. The revaccination interval is not stipulated on the label. Major adverse events reportedly associated with the use of this product are pain, temporary hair loss, and formation of sterile abscesses or granulomas at the vaccine site.<sup>38</sup>

### *Bordetella bronchiseptica* Infection

*Bordetella bronchiseptica* is a small, aerobic, gram-negative coccobacillus long recognized as a respiratory tract pathogen of several species of animals. The natural route of transmission in cats is believed to be via the aerosol or intranasal route.<sup>8</sup> Experimental challenge exposure studies have shown that *B. bronchiseptica* can act as a primary pathogen in cats; inoculation of specific-pathogen-free kittens results in self-limiting disease characterized by variable degrees of fever, nasal or ocular discharge, sneezing, induced or spontaneous coughing, pulmonary rales, and submandibular lymphadenopathy.<sup>8</sup> Bronchopneumonia associated with naturally occurring *B. bronchiseptica* infection has been reported in kittens and adult cats.<sup>60</sup> Other factors, including nutritional status, overcrowding, coinfection with other agents such as FCV or FHV-1, and suboptimal hygiene, may influence the outcome of exposure.<sup>41, 54</sup>

Seroprevalence surveys suggest that exposure to the organism is common, with infection rates varying from population to population. The highest rates of seropositivity (often over 80%) are found among cats in rescue shelters and multiple-cat households, especially when there is a history of respiratory tract disease. The lowest rates are found among cats in households with few cats and no history of respiratory tract disease.<sup>4, 37</sup> Similarly, isolation rates vary. *B. bronchiseptica* was isolated from the oropharynx in 19 of 614 (3.1%) asymptomatic cats and from the distal trachea in 6 of 614 (1%) asymptomatic cats from shelters in Louisiana.<sup>25</sup> In a recent survey of 740 cats in the United Kingdom, none of the household cats were found to be infected, but 9% of cats from breeding colonies and 19% of cats from rescue shelters were found to be carrying the organism.<sup>5</sup> In the same survey, 9% of healthy cats and 14% of cats with respiratory tract disease tested positive for the organism. An additional finding was a strong positive association between oropharyngeal isolation of *B. bronchiseptica* and residence in households containing dogs with a recent history of respiratory tract disease.

Definitive diagnosis of disease associated with *B. bronchiseptica* infection may be difficult, in part, because signs of infection often mimic those associated with FHV-1 or FCV infection. Isolation of *B. bronchiseptica* from a cat with respiratory tract disease is supportive of the diagnosis, but carriage of the organism in asymptomatic cats precludes establishing a direct cause-and-effect relation. Resolution of disease with appropriately chosen antimicrobial medication might suggest a causative role for *B. bronchiseptica*, but the self-limiting nature of many cases of viral upper respiratory tract disease prevents attributing disease resolution solely to antimicrobial treatment.

A vaccine (Protex-Bb; Intervet) to prevent disease caused by infection with *B. bronchiseptica* has recently been licensed. The product contains a live reduced-virulence culture of *B. bronchiseptica* and is licensed for administration via the intranasal route in cats 4 weeks of age and older. Efficacy of the vaccine has not been independently evaluated; however, in studies conducted by the manufacturer to gain vaccine licensure, vaccinated 4-week-old specific-pathogen-free cats experienced less severe signs of disease than did unvaccinated controls when exposed to challenge 3 weeks after vaccination. Similar results were obtained when 8-week-old kittens were exposed to challenge 72 hours after vaccination. As of this writing, studies to evaluate the duration of protection induced by the vaccine have not been completed and the revaccination interval is not yet stipulated on the label. Routine use of this vaccine is not recommended. It is reasonable to consider vaccinating cats entering or residing in multiple-cat environments (e.g., shelters, catteries, boarding facilities) where disease associated with *B. bronchiseptica* infection has been confirmed. The ability of the product to reduce the prevalence of infection or the severity of disease in such environments has not been evaluated, however.

## Giardiasis

Infection of cats with the protozoan *Giardia lamblia* is associated with acute or chronic gastrointestinal disease ranging in severity from subclinical to severe.<sup>32, 64</sup> Because infected cats shed cysts intermittently, diagnosis of *G. lamblia* infection is often cumbersome and usually requires multiple fecal examinations. Several methods of diagnosis are available, including examination of a fecal smear, the zinc sulfate centrifugation method, and use of an enzyme-linked immunosorbent assay to test feces.<sup>64</sup> There are currently no approved treatment methods for cats, and although treatment commonly controls signs of disease, it is uncertain that it clears infection.<sup>63</sup> Treatment effectiveness is highly variable, and resistant organisms are commonly encountered.<sup>31, 63</sup> *G. lamblia* is

transmitted via the fecal-oral route; cysts may be ingested from contaminated water, from direct cat-to-cat transmission especially in crowded environments (e.g., through mutual grooming), from exposure to contaminated litter boxes, and from consuming prey.<sup>30, 31</sup> Giardiasis is a recognized zoonotic disease, but the role of cats in transmission of the organism is not well established.<sup>2, 6, 64</sup>

A vaccine has recently been licensed by the US Department of Agriculture (Fel-O-Vax Giardia; Fort Dodge Animal Health) as an aid in the prevention of disease associated with *G. lamblia* infection and reduction in the severity of shedding of cysts. This vaccine is composed of quantified, homogenated, and chemically inactivated *G. lamblia* trophozoites, and it contains an adjuvant commonly found in other feline products from the manufacturer but different from the adjuvant in the manufacturer's canine product. The vaccine is approved for use in cats 8 weeks of age and older. At the time of this writing, the vaccine has not been independently evaluated for efficacy, but in studies conducted by the manufacturer to gain vaccine licensure, vaccinates had a statistically significant reduction in severity of clinical signs (diarrhea), duration of cyst shedding, and prevalence of infection (percentage of cats with trophozoites at the end of the trial) compared with control animals. Protection was demonstrated to persist for at least 1 year after vaccination.

Routine use of this vaccine is not recommended, but because vaccinates had less severe clinical disease and shed cysts for a shorter time, it is reasonable to consider vaccination as part of a comprehensive control program in environments where exposure to *G. lamblia* is clinically significant. When parasite exposure is ongoing, revaccination at annual intervals is recommended. Some vaccinates may shed cysts subsequent to *G. lamblia* exposure; thus, proper hygiene and sanitation practices should be implemented even with vaccinated cats. The ability of this product to aid in hastening elimination of endemic infection from multiple-cat environments has not been evaluated.

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