Enteropathogens identified in dogs entering a Florida animal shelter with normal feces or diarrhea

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Objective—To determine the frequency of enteropathogens in dogs entering an animal shelter with normal feces or diarrhea.

Design—Cross-sectional study.

Animals—100 dogs evaluated at an open-admission municipal animal shelter in Florida.

Procedures—Fecal samples were collected within 24 hours after admission from 50 dogs with normal feces and 50 dogs with diarrhea. Feces were tested by fecal flotation, antigen testing, PCR assay, and electron microscopy for selected enteropathogens.

Results—13 enteropathogens were identified. Dogs with diarrhea were significantly more likely to be infected with ≥ 1 enteropathogens (96%) than were dogs with normal feces (78%). Only *Clostridium perfringens* enterotoxin A gene was significantly more common in dogs with diarrhea (64%) than in dogs with normal feces (40%). Other enteropathogens identified in dogs with and without diarrhea included hookworms (58% and 48%, respectively), *Giardia* spp (22% and 16%, respectively), canine enteric coronavirus (2% and 18%, respectively), whipworms (12% and 8%, respectively), *Cryptosporidium* spp (12% and 2%, respectively), ascarids (8% and 8%, respectively), *Salmonella* spp (2% and 6%, respectively), *Cystoisospora* spp (2% and 4%, respectively), canine distemper virus (8% and 0%, respectively), *Dipylidium caninum* (2% and 2%, respectively), canine parvovirus (2% and 2%, respectively), and rotavirus (2% and 0%, respectively).

Conclusions and Clinical Relevance—Dogs entered the shelter with a variety of enteropathogens, many of which are pathogenic or zoonotic. Most infections were not associated with diarrhea or any specific dog characteristics, making it difficult to predict the risk of infection for individual animals. Guidelines for preventive measures and empirical treatments that are logistically and financially feasible for use in shelters should be developed for control of the most common and important enteropathogens. (*J Am Vet Med Assoc* 2012;241:338–343)

Approximately 4 million dogs enter animal shelters each year.[1] Most of these dogs are either collected as presumed unowned free-roaming strays or are relinquished as unwanted pets and may not have received optimal preventive health care prior to admission to the shelter. Once inside shelters, dogs may be intensively housed under stressful conditions. The background and housing of dogs entering shelters creates situations where dogs are at risk for introducing infectious pathogens of canine and zoonotic importance and may also acquire new infections.[2]

Quarantine of new arrivals, infectious disease screening, segregation of specific subpopulations, disease surveillance, isolation of diseased dogs, and effective vaccination are some effective tools for the control of many infectious diseases within intensively housed dogs.[2] However, many animal shelters have resource limitations, including inadequate staffing, funding, facilities, and technical expertise, that make it difficult to implement these optimal strategies. Practical healthcare protocols in shelters aim to provide protection against the most prevalent or important infections and balance other competing needs in the agency.

Diarrhea can be associated with shelter factors such as stress and dietary change in addition to contagious infections, such as parvovirus, coronavirus, and distemper virus.[3–5] Infectious enteropathogens such as *Giardia*, *Salmonella*, hookworms, and roundworms may also be shed by subclinically infected dogs, inhibiting

Abbreviations

CDV	Canine distemper virus
CECoV	Canine enteric coronavirus
CI	Confidence interval
CPEA	*Clostridium perfringens* enterotoxin A gene
CPV	Canine parvovirus
EM	Electron microscopy

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clinical disease surveillance.[6–8] We are aware of only 1 report[7] in which diarrhea in shelter dogs was correlated with identification of enteropathogens. In that report,[7] fecal samples were collected at various times during the dogs' stay in the shelter, so it was not possible to determine which infections were present at the time of admission to the shelter and which were shelter-acquired infections. The purpose of the study reported here was to identify the frequency of parasitic, bacterial, and viral enteropathogens in dogs at the time of admission to an animal shelter, to identify risk factors for infection, and to correlate enteropathogen infection with the presence of diarrhea.

Materials and Methods

Study site—The present study was conducted at an open-admission municipal animal shelter in Alachua County, Fla.[a] In 2009, this shelter admitted 3,715 dogs and 3,904 cats. Dogs admitted to this shelter were either stray, owner surrendered, or confiscated. At admission, each dog received a brief physical examination by the intake technician, parenteral modified-live distemper, hepatitis, parainfluenza, and parvovirus vaccine[b]; *Bordetella bronchiseptica* vaccine intranasally[c]; pyrantel pamoate[d]; and fipronil.[e] A veterinarian examined each dog to determine its health status 1 to 7 days later. Dogs with signs of possible contagious illness such as upper respiratory disease, lethargy, and severe or bloody diarrhea were housed in an isolation ward away from healthy dogs. Most dogs were housed singly in a kennel with indoor and outdoor areas separated by a guillotine door. Kennel walls were constructed of sealed concrete block, and floors were sealed concrete but with visible cracks. Bitches with puppies or dogs from the same household were sometimes kenneled together. Kennels were spot-cleaned and hosed out daily with a quaternary ammonium product and diluted bleach (1:32) as long as the same dog occupied them and then thoroughly cleaned and disinfected with the same products between different occupants. Each dog was moved to the opposite side of the kennel door during cleaning of each half of the kennel. Floors were squeegeed after hosing but were not necessarily completely dried before the same dog was reintroduced or another dog was introduced.

Sample collection—Study investigators visited the shelter each morning before kennel cleaning from June 1 through July 1, 2009. Study dogs were those that were admitted within the previous 24 hours and had feces on the kennel floor at the time the investigators were present. Fecal samples were collected from the first 50 dogs with normal feces on the floor and the first 50 dogs with diarrhea on the floor. Investigators scored fecal consistency from 1 to 7 on the basis of appearance and texture by use of a pictorial scoring chart.[f] A score of 1 was defined as feces that were very hard and dry and left no visible residue on the ground when removed. A score of 7 was defined as being textureless, watery, flat, and occurring in puddles. Fecal consistency scores were dichotomized into a normal category (score, 1 to 3; including all textures that maintained form when picked up) or a diarrhea category (score, 4 to 7; including all textures that lost form when picked up). To avoid cross-contamination of samples, each was collected with a newly gloved hand assisted by a fresh wooden tongue depressor or fresh syringe depending on the consistency of the sample. For each dog, 3 fecal aliquots were collected into fresh plastic screw-top jars. One jar from each dog was selected for PCR assay and was individually placed into its own zipper-lock plastic bag to further reduce the chance of cross-contamination. The second jar was designated for fecal flotation and antigen testing. The third jar was designated for EM. All supplies were disposed of after each sample and were not reused. Samples were transported in a cooler and were stored at 4°C pending analysis. For each sample, information about the dog was collected, including an estimated age (on the basis of dentition or owner report), sex, health condition, source, and identification number. Address of origin was used to determine whether the community from which the dog originated was primarily urban or rural on the basis of population density, number of residents, housing density, income, and land use.[9] Investigators assigned a body condition score of 1 to 9 for each dog on the basis of a pictorial chart. Body condition scores were converted into categorical variables for analysis, including undercondition (score, 1 to 3), adequate body condition (score, 4 to 6), and overcondition (score, 7 to 9). When > 1 dog occupied a cage, as in the case of litters, a single sample was collected and some individual animal-specific information such as sex was recorded as unknown if it could not be determined from which dog the sample came.

Testing protocol—Fecal samples were tested in the investigators' laboratory by gross examination and fecal flotation for macroparasites, parasite eggs, cysts, oocytes, and larvae within 24 hours after collection. Feces (approx 1 g) were mixed with sodium nitrate solution (specific gravity, 1.200)[g] in a standardized flotation device,[h] incubated with a coverslip for 15 minutes, and then evaluated qualitatively by light microscopy at 40× and 100×. Feces were tested in the investigators' laboratory for *Giardia* antigen by fecal ELISA within 24 hours after collection.[i] Reported sensitivity and specificity of the *Giardia* antigen test, compared with IFA, is 95% and 99%, respectively.[j] Feces were tested in the investigators' laboratory for CPV antigen by fecal ELISA.[k] Reported sensitivity and specificity of the CPV antigen test in dogs were both 100%, compared with hemagglutination.[l] Fecal samples were tested by hydrolysis probe-based real-time PCR assay for a panel of potential enteropathogens, including CPEA (AM888388), *Salmonella* invasion A gene (EU348366), *Cryptosporidium* small-subunit rRNA (A093489), *Giardia* small-subunit rRNA gene (DQ836339), CECoV M gene type I (AF502583) and II (D13096), CPV-2 VP2 (U22139), and CDV phosphoprotein gene (AY964111) at a reference laboratory within 7 days after collection.[m] Real-time PCR assay was run with 7 quality controls, including PCR-positive controls, PCR-negative controls, negative extraction controls, DNA preanalytic quality control targeting the host 18S rRNA gene complex, RNA preanalytic quality control targeting the host 18S rRNA gene complex, an internal positive control spiked into the lysis solution, and an environmental contamination monitoring control. Finally, transmission EM was per-

formed on each fecal sample to screen nonspecifically for viral particles at a reference laboratory within 7 days after collection.[n] One hundred fields were scanned at 3,000× for suspected viral particles. Visual identification of specific viruses was made at 85,000×. Reported sensitivity for this test is 10^5 to 10^6 viral particles/mL. In the case of enteropathogens evaluated by > 1 testing methodology (*Cryptosporidium*, CDV, CECoV, CPV, and *Giardia*), a positive result with any test was interpreted as a positive result for that dog, regardless of discordant results from other methodologies.

Risk factors—Dog risk factors for enteropathogen infection that were evaluated included age (juvenile [< 6 months old] or adult [≥ 6 months old]), sex (female, male, or unknown in the case of multiple dogs per kennel), source (stray or owned), environmental origin (rural or urban), health status other than diarrhea (healthy or unhealthy), body condition (undercondition, adequate condition, or overcondition), and fecal consistency (normal or diarrhea).

Statistical analysis—Sample sizes were selected to detect a difference in infection prevalence of ≥ 30% between the group with normal feces and the group with diarrhea with a power of > 80% and $P < 0.05$. Each dog risk factor was evaluated for each enteropathogen in dogs with normal feces and in dogs with diarrhea with a χ^2 test or Fisher exact test as appropriate. Odds ratios and 95% CIs were calculated when appropriate. Values of $P < 0.05$ were considered significant. All analyses were performed with statistical software.[o]

Results

Of 366 dogs admitted to the shelter during the study period, 121 (33%) were previously owned, 245 (67%) were strays, 179 (49%) were females, 186 (51%) were males, and the sex of 2 dogs was unknown. These proportions were not significantly ($P \geq 0.2$) different from the source and sex of the 100 dogs enrolled in the study (**Table 1**). All but 6 of the dogs included in the study were considered healthy (with the exception of diarrhea) by the shelter veterinarian, and all but 4 of the dogs had normal body condition. Most dogs were adults, most were admitted as strays, and most originated from urban areas of the county. The environmental origin of 4 dogs was unknown. There were no significant differences between the group with normal feces and the group with diarrhea with the exception of age. Dogs with diarrhea were significantly ($P = 0.03$) more likely to be juveniles (12/50 [24%]) than were dogs with normal feces (4/50 [8%]).

Thirteen potential enteropathogens were identified in the dogs in the present study, and most carried multiple organisms (**Table 2**). Dogs with diarrhea were significantly ($P = 0.007$) more likely to be infected with ≥ 1 enteropathogens than were dogs with normal feces (OR, 6.77; 95% CI, 1.29 to 47.19). All enteropathogens

Table 1—Characteristics of dogs having normal feces (n = 50) and dogs having diarrhea (50) within 24 hours after admission to a municipal animal shelter in northern Florida.

		No. (%) of dogs				
Variable	**Total**	**Normal feces**	**Diarrhea**	**OR**	**95% CI**	***P* value**
Age						
Adult	84	46 (92)	38 (76)	Referent		
Juvenile	16	4 (8)	12 (24)	3.63	NA	0.03
Body condition						
Undercondition	2	0 (0)	2 (4)	Referent		
Normal condition	96	48 (96)	48 (96)	NA	NA	0.50
Overcondition	2	2 (4)	0 (0)	NA	NA	0.33
Sex						
Male	56	29 (58)	27 (54)	Referent		
Female	44	21 (42)	23 (46)	1.18	0.49–2.80	0.69
Source						
Stray	60	32 (64)	28 (56)	Referent		
Owned	40	18 (36)	22 (44)	1.40	0.58–3.38	0.41
Environment						
Rural	31	15 (30)	16 (32)	Referent		
Urban	65	33 (66)	32 (64)	0.91	0.35–2.33	0.83
Unknown	4	2 (4)	2 (4)	0.94	NA	1.00
Health status						
Healthy	94	48 (96)	46 (92)	Referent		
Unhealthy	6	2 (4)	4 (8)	2.09	NA	0.68

NA = Not applicable.

Table 2—Frequency of identification of multiple enteropathogens in fecal samples from the dogs in Table 1.

	No. of enteropathogens					
Fecal consistency	**0**	**1**	**2**	**3**	**4**	**5**
Normal	11 (22)*	14 (28)	15 (30)	8 (16)	2 (4)	0 (0)
Diarrhea	2 (4)	18 (36)	16 (32)	9 (18)	4 (8)	1 (2)

*Value is significantly ($P = 0.007$) different from value for dogs with diarrhea.
Data are given as number (%) of dogs.

identified, with the exception of CDV and rotavirus, were detected in dogs both with and without diarrhea (**Table 3**). Of individual enteropathogens identified, only CPEA was significantly ($P = 0.02$) more common in dogs with diarrhea than in dogs with normal feces. Canine coronavirus was significantly ($P < 0.01$) more common in dogs with normal feces.

Each dog risk factor was evaluated for each enteropathogen in dogs with normal feces and in dogs with diarrhea. The only risk factor that was significant for any infections was source, and then only in dogs with diarrhea. Within the group of dogs with diarrhea, the frequency of identification of *Giardia* spp was significantly ($P = 0.001$) higher (OR, 22.5; 95% CI, 2.41 to 525.24) among the owner-surrendered dogs (10/22 [45%]) than among stray dogs (1/28 [4%]), the frequency of identification of CPEA was significantly ($P = 0.02$) higher (OR, 4.5; 95% CI, 1.04 to 20.86) among owner-surrendered dogs (18/22 [82%]) than among stray dogs (14/28 [50%]), and the frequency of identification of hookworms was significantly ($P = 0.03$) higher (OR, 3.61; 95% CI, 0.96 to 14.3) among stray dogs (20/28 [71%]) than among owner-surrendered dogs (9/22 [41%]).

Three assays (PCR assay, ELISA, and flotation) were used for the detection of *Giardia* spp. Nineteen samples were positive by PCR nucleic acid detection, but only 11 of these were also positive by ELISA antigen detection. No samples were positive for antigen but negative for DNA, and *Giardia* spp was not detected by fecal flotation in any sample. Two assays (PCR assay and fecal flotation) were used for detection of *Cryptosporidium* spp. Seven samples were positive by PCR assay, and none were positive by fecal flotation. Three assays (PCR assay, ELISA, and EM) were used for CPV detection. One sample was positive for CPV DNA by PCR assay, and this sample was also the only sample that was positive for antigen by ELISA. A different sample was positive for CPV by EM. Two assays were used for the detection of CECoV and CDV (PCR assay and EM). Two samples were positive for CECoV by PCR assay, and 8 samples were positive by EM. Four samples were positive for CDV by PCR assay, and none were positive by EM. One diarrheic sample was positive for rotavirus by EM.

Discussion

Infection with multiple enteropathogens was common at the time dogs were admitted to the animal shelter in the present study. All of these pathogens could be of clinical relevance to the health of dogs, and some are potential zoonoses, such as hookworms, ascarids, *Giardia* spp, *Cryptosporidium* spp, and *Salmonella* spp. If not controlled, these pathogens could spread to other animals at the shelter and, in the case of zoonotic pathogens, to staff, volunteers, and adopters.[2] The finding that shelter dogs have many preventable and treatable enteropathogens underscores a lack of adequate previous preventive health care for dogs entering shelters.

The prevalences of some endoparasites in dogs in the present study, particularly hookworms and *Giardia* spp, were higher than those recently reported for pet dogs in the southern United States; in that study,[10] hookworms (4.0%), *Cystoisospora* spp (3.0%), *Giardia* spp (2.3%), whipworms (1.5%), and ascarids (1.2%) were identified in pet dogs. A previous national survey[11] of shelter dogs reported the presence of hookworms (20.2%), ascarids (15.2%), whipworms (14.3%), *Cystoisospora* spp (4.8%), and *Giardia* spp (0.6%) but did not correlate enteropathogen presence with diarrhea. The dogs in the present study received pyrantel pamoate < 24 hours before sample collection. It is possible that the frequency of hookworms and ascarids could have been underesti-

Table 3—Frequency of identification of specific enteropathogens in fecal samples from the dogs in Table 1.

Enteropathogen	Fecal consistency	No. tested	No. (%) positive	OR	95% CI	*P* value
Cryptosporidium spp	Normal	50	1 (2)	Referent		
	Diarrhea	50	6 (12)	6.68	0.74–153.14	0.11
Cystoisospora spp	Normal	50	2 (4)	Referent		
	Diarrhea	50	1 (2)	0.49	0.02–7.23	1.00
Giardia spp	Normal	50	8 (16)	Referent		
	Diarrhea	50	11 (22)	1.48	0.49–4.56	0.44
CPEA	Normal	50	20 (40)	Referent		
	Diarrhea	50	32 (64)	2.67	1.10–6.51	0.02
Salmonella spp	Normal	50	3 (6)	Referent		
	Diarrhea	50	1 (2)	0.32	0.01–3.65	0.62
Ascarids	Normal	50	4 (8)	Referent		
	Diarrhea	50	4 (8)	1.00	0.19–5.14	1.00
Dipylidium caninum	Normal	50	1 (2)	Referent		
	Diarrhea	50	1 (2)	1.00	0–37.84	1.00
Hookworms	Normal	50	24 (48)	Referent		
	Diarrhea	50	29 (58)	1.50	0.63–3.56	0.32
Whipworms	Normal	50	4 (8)	Referent		
	Diarrhea	50	6 (12)	1.57	0.36–7.19	0.50
CDV	Normal	50	0 (0)	Referent		
	Diarrhea	50	4 (8)	NA	NA	0.12
CECoV	Normal	50	9 (18)	Referent		
	Diarrhea	50	1 (2)	0.09	0.0–0.77	< 0.01
CPV	Normal	50	1 (2)	Referent		
	Diarrhea	50	1 (2)	1.00	0–37.84	1.00
Rotavirus	Normal	50	0 (0)	Referent		
	Diarrhea	50	1 (2)	NA	NA	1.00

See Table 1 for key.

mated if treatment was successful in rapid removal ova-shedding parasites in some dogs.

For most enteropathogens, the risk of infection in the present study was not correlated with diarrhea, signs of disease, or other risk factors. With the exception of CDV and rotavirus, every enteropathogen was identified in both normal feces and diarrhea. Similar findings were reported in a study[7] of shelter dogs in northern California. However, in that study,[7] it was not possible to differentiate between infections acquired before or after admission to the shelter. *Clostridium perfringens* enterotoxin A gene was the most common finding and was more prevalent in dogs with diarrhea. The role of CPEA as a cause of diarrhea in dogs is debated because it is frequently detected in both normal feces and diarrhea.[7,12,13] Canine enteric coronavirus was identified more commonly in dogs with normal feces in the present study. The dogs' origin as relinquished pets versus free-roaming strays had little association with the presence of enteropathogens; only hookworms were found more commonly in strays than in owned pets, and then only in the group with diarrhea in the present study. *Clostridium perfringens* enterotoxin A gene and *Giardia* spp were found more commonly in owner-surrendered dogs in this study, but only in the group with diarrhea. The lack of reliable correlation of enteropathogens with identifiable risk factors makes it difficult for shelter staff to identify and segregate dogs that pose a risk of transmission or that require specific treatment. It also calls into question the cause-and-effect relationship between the presence of an organism and its impact on animal health. Simply identifying one or more enteropathogens in the feces of a diarrheic dog may not mean those enteropathogens are the cause of the diarrhea, and additional diagnostic testing or a therapeutic trial may be required to confirm the relationship.

Six dogs were positive for CPV or CDV in the present study. Considering that samples were collected < 24 hours after dogs received a modified-live vaccine, it is possible that the assays detected vaccine virus and not wild-type virus. In a previous study[5] at the same shelter, 65% of dogs lacked protective antibody titers against CPV or CDV at the time of admission to the shelter, and a shelter-based distemper outbreak led to the death of 600 dogs at the shelter and in the community. This illustrates the constant threat shelters face of introducing these highly contagious and deadly infections into their vulnerable dog populations. It is not practical or reliable to screen all dogs for these viruses at the time of admission to the shelter. Therefore, it is imperative to follow national shelter vaccination guidelines that call for use of modified-live virus or recombinant vaccines of all dogs at the time of admission to reduce the risk of transmission in the shelter.[14,15] The currently available canarypox-vectored recombinant CDV vaccine[p] is not detected by the PCR test used in the present study and may be useful when PCR testing is planned.

Several zoonotic enteropathogens were detected in this study, including hookworms, ascarids, *Salmonella* spp, *Giardia* spp, and *Cryptosporidium* spp. The true zoonotic potential for *Giardia* spp and *Cryptosporidium* spp is controversial because at least some dogs are believed to have host-adopted strains that pose less risk of infection to immune-competent human beings.[16–18] Both hookworms and ascarids cause larval migrans conditions in human beings and are considered to be a public health concern.[18] The CDC and the Companion Animal Parasite Council recommend treatment of all dogs for these ascarids with pyrantel pamoate.[19,20] Alternatively, fenbendazole, which has activity against hookworms, ascarids, whipworms, and *Giardia* spp, can be provided to all dogs in place of pyrantel or only to dogs infected with whipworms or *Giardia* spp.[20] Because eggs and cysts may not be detected in all infected dogs because of testing within the prepatent period or intermittent shedding, treatment should not be withheld from dogs with negative results of fecal examinations. After the initial treatment, dogs should receive monthly broad-spectrum anthelmintics with activity against heartworms, hookworms, and ascarids.[20]

Although shelter staff rarely have the opportunity to perform thorough diagnostic testing on each dog that enters the shelter, several practical options exist to limit transmission within the facility. Infections that can enter the shelter via a single animal and then spread to other animals in the facility are of the greatest concern. Vaccination at admission is inexpensive and greatly reduces the risk of CPV and CDV transmission after infected dogs enter the shelter unrecognized.[14,15] This protection begins to appear within hours after immunization in dogs lacking maternal antibodies. Treatment of all dogs with pyrantel pamoate is also an inexpensive approach to control of hookworms and ascarids, which are among the most common zoonotic endoparasites recognized in sheltered dogs. Hookworm eggs require a week to become infectious in the environment, whereas whipworms and ascarid eggs require approximately 1 month.[18] *Giardia* spp and *Cryptosporidium* spp are immediately infectious.[20] Prompt removal of feces and construction with solid surfaces that can be readily sanitized reduce the risk of transmission of these enteropathogens. Once a facility has become contaminated with infective eggs, larvae, or cysts, particularly on dirt or turf surfaces, elimination becomes much more difficult and a cycle of transmission within the shelter may be established. For these reasons, dogs held for short terms in the shelter are most safely kept in individual housing units constructed of solid surfaces. Dogs in longer-term confinement require more opportunity for exercise and enrichment and should have access to play areas that are constructed of materials that facilitate biosecurity.

Multiple testing modalities were used for several organisms, and in each case, discordant test results were observed in the present study. Polymerase chain reaction detection of nucleic acids is extremely sensitive. This enhances the opportunity to detect organisms but does not necessarily distinguish clinically important infections from mere colonization and may yield positive results due to recent live virus vaccination. Fecal flotation has low sensitivity for small organisms such as *Giardia* spp and *Cryptosporidium* spp, which are more readily identified by antigen or PCR testing.[21] Electron microscopy is less sensitive for viruses than PCR assay or antigen testing but has the advantage of screening for a wide variety of viruses and is not restricted by virus-specific reagents.

Shelters have several objectives when developing strategic enteropathogen control programs for dogs in

their care, including enhancing the health and welfare of individual dogs entering the shelter, prevention of transmission to other animals within the shelter or in the new home following adoption, and prevention of zoonotic transmission to shelter staff, volunteers, visitors, and adopters. Routine treatment for the most common enteropathogens with more in-depth diagnostic evaluation for dogs with unresponsive gastrointestinal signs combined with vigilant disease surveillance, effective sanitation, and appropriate facility construction offer a reasonable approach to balance risk and cost. Adopters should be provided with a written record of their new dog's treatment history and be advised to visit a veterinarian as soon as possible to develop a long-term preventive health-care plan for their new pet.

a. Alachua County Animal Services, Gainesville, Fla.
b. Duramune Max 5, Fort Dodge Animal Health, Fort Dodge, Iowa.
c. Bronchi-Shield III, Fort Dodge Animal Health, Fort Dodge, Iowa.
d. Strongid, Pfizer, New York, NY.
e. Frontline, Merial, Lyon, France.
f. Fecal Scoring System, Nestle Purina, St Louis, Mo.
g. Fecasol Solution, Evsco Pharmaceuticals, Buena, NJ.
h. Fecalyzer, Evsco Pharmaceuticals, Buena, NJ.
i. SNAP *Giardia* Antigen Test, IDEXX Laboratories Inc, Westbrook, Me.
j. Package insert, SNAP *Giardia* Antigen Test, IDEXX Laboratories Inc, Westbrook, Me.
k. SNAP Parvo Test, IDEXX Laboratories Inc, Westbrook, Me.
l. Package insert, SNAP Parvo Antigen Test, IDEXX Laboratories Inc, Westbrook, Me.
m. RealPCR Canine Diarrhea Panel, IDEXX Laboratories Inc, West Sacramento, Calif.
n. Kissimmee Diagnostic Laboratory, Division of Animal Industry, Florida Department of Agriculture and Consumer Services, Kissimmee, Fla.
o. Epi Info, version 3.5.1, CDC, Atlanta, Ga.
p. Recombitek rDistemper, Merial, Duluth, Ga.

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