Epidemiologic features of *Campylobacter* infection among cats in the upper midwestern United States

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Objective—To describe the epidemiologic features of *Camp-ylobacter* infection among cats in the Minneapolis–Saint Paul metropolitan area.

Design—Prevalence survey.

Animals—152 cats examined at 3 private veterinary clinics and an animal humane society.

Procedures—Fecal samples were submitted for bacterial culture for *Campylobacter* spp. To determine the duration of *Campylobacter* carriage, follow-up fecal samples were collected from cats with positive *Campylobacter* culture results.

Results—*Campylobacter* organisms were cultured from 37 of the 152 (24%) fecal samples. *Campylobacter* isolates were identified as *Campylobacter upsaliensis* (29 cats), *Campylobacter jejuni* (2), and *Campylobacter coli* (1); species of the remaining 5 isolates could not be determined. *Campylobacter* organisms were isolated from 36 of the 122 (30%) cats that were ≤ 1 year old but from only 1 of the 30 (3%) cats that were > 1 year old, and shedding was more common during the summer and fall months. No association between *Campylobacter* shedding and clinical signs of disease was identified. For 4 of 13 cats from which follow-up fecal samples were obtained, duration of *Campylobacter* carriage could not be determined because *Campylobacter* organisms were isolated from all follow-up samples. For the remaining 9 cats, median duration of *Campylobacter* carriage was 44 days.

Conclusions and Clinical Relevance—*C upsaliensis* can commonly be isolated from the feces of overtly healthy kittens in the Midwest United States. Because carriage may be prolonged, veterinarians should encourage good hand hygiene among owners of cats, especially among owners with new kittens in their household. (*J Am Vet Med Assoc* 2005;226:544–547).

An estimated 2.5 million human *Campylobacter* infections occur each year in the United States.[1] Cited risk factors for infection include exposure to infected poultry, milk, or water and foreign travel.[2–5] Approximately 5% of *Campylobacter* infections in humans have been associated with contact with cats, cat ownership, or having a pet with diarrhea.[2–4,6,7] The 2 most commonly identified *Campylobacter* spp involved in human infections are *Campylobacter jejuni* and *Campylobacter coli*, with approximately 90% of human infections caused by *C jejuni*. Other *Campylobacter* spp, however, are increasingly being recognized as potential pathogens. For instance, *Campylobacter upsaliensis*, which was first isolated from the feces of dogs and cats in the 1980s, has been recognized as a cause of severe gastroenteritis in human patients infected with HIV, neonatal sepsis, and abortion in women.[8–11]

Two previous studies[12,13] examined the prevalence of various zoonotic enteric organisms in cats in Colorado and New York. Both of these studies documented *Campylobacter* carriage rates of 1%. To date, however, no studies have examined the prevalence of zoonotic enteric organisms, including *Campylobacter* spp, in cats from the upper midwestern region of the United States. The purpose of the study reported here, therefore, was to describe the epidemiologic features of *Campylobacter* infection among cats with and without diarrhea in the Minneapolis–Saint Paul metropolitan area.

Materials and Methods

Sample collection—Three private veterinary clinics and an animal humane society in the Minneapolis–Saint Paul area were asked to participate in the survey. The clinics and animal shelter represented separate, nonoverlapping areas of Minneapolis and Saint Paul. Each of the participating facilities was asked to provide 2 fecal samples from 6- to 16-week-old kittens each week. To encourage participation, participating facilities were allowed to submit samples from older kittens and adult cats if no kittens in the requested age group were available.

For each fecal sample submitted, participating facilities were asked to provide information on the date the fecal sample was collected; age, sex, and breed of the cat from which the sample was collected; whether the cat had any history of recent illness; and whether the cat was receiving any medications or treatments at the time of sample collection.

Kits were provided to each facility for collection of fecal samples. Each kit included a pair of gloves, a sample identification card, transport medium,[a] and a postage-paid return container.

Laboratory procedures—All fecal samples were submitted to the Minnesota Veterinary Diagnostic Laboratory, where bacterial culture for *Campylobacter* spp was performed. Briefly, samples were emulsified with *Brucella* (albimi) broth and plated on blood-Mueller-Hinton-KNO_3 plates[b] by means of a filtration method and on Blaser *Campylobacter* agar plates.[c] Plates were incubated for up to 6 days at 37°C in a microaerophilic atmosphere.[d] Biochemical and growth characteristics were used to determine species of presumptive *Campylobacter* isolates (curved or spiral gram-negative rods). Each isolate was tested for catalase activity, hippurate hydrolysis, H_2S production, motility, and susceptibility to nalidixic acid and cephalothin, as described.[14,15]

Samples were also submitted for bacterial culture for *Salmonella* spp; *Salmonella* isolates that were obtained were

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submitted to the National Veterinary Services Laboratory for serotyping. A direct immunofluorescent detection procedure[e] was used to determine whether fecal samples contained *Cryptosporidium* spp or *Giardia* spp; assays were performed at the University of Minnesota, College of Veterinary Medicine.

Duration of *Campylobacter* carriage—Veterinary personnel who submitted fecal samples from which *Campylobacter* organisms were isolated were contacted and asked to obtain follow-up fecal samples from affected cats. Follow-up samples were to be collected every 7 to 14 days until 2 consecutive bacterial cultures for *Campylobacter* spp were negative.

Duration of *Campylobacter* carriage was calculated by subtracting the date of collection of the first sample for which culture results were positive from the date of collection of the first sample for which culture results were negative. Cats were excluded from this analysis if follow-up samples were not collected within 60 days of collection of the initial sample for which culture results were positive.

Data analysis—A χ^2 test was used to compare prevalence of fecal shedding of *Campylobacter* spp between cats ≤ 1 year old and cats > 1 year old and between overtly healthy cats and cats with signs of disease. Seasonality of *Campylobacter* shedding was determined by graphing the number of fecal samples positive and negative for *Campylobacter* spp as a function of month of sample collection. All analyses were performed with standard statistical software[f]; values of $P < 0.05$ were considered significant.

Results

Fecal samples from 152 cats were submitted for analysis; the number of cats per participating facility ranged from 26 to 48. Breed information was available for 149 cats. One hundred six (71%) were domestic shorthairs, with the remainder representing 13 breeds. Eighty-one (53%) cats were male, and 71 (47%) were female.

Thirty-seven of the cats from which fecal samples were collected reportedly had clinical signs of disease, and the remaining 115 were healthy. Specific clinical signs of disease were reported for 21 of these 37 cats and included diarrhea (15 cats), upper respiratory tract infection (2), weight loss (1), abscess (1), FeLV infection (1), and roundworm infestation (1). Twenty-one of the 37 (57%) cats with clinical signs of disease and 101 of the 115 (89%) healthy cats were ≤ 1 year old. Cats with clinical signs of disease were significantly ($P = 0.001$) older than the healthy cats.

Prevalence of fecal *Campylobacter* shedding—Thirty-seven of the 152 (24%) cats were positive for *Campylobacter* spp. Percentage of cats from which *Campylobacter* organisms were isolated ranged from 15% to 45% for the 4 participating facilities. *Campylobacter* isolates were identified as *C upsaliensis* (29), *C jejuni* (2), and *C coli* (1). Species of the remaining 5 isolates could not be determined.

Campylobacter shedding was more commonly identified during the summer and fall months (**Figure 1**). The percentage of samples positive for *Campylobacter* organisms was 25% during June, 16% during July, 45% during August, and 25% during September.

Campylobacter organisms were isolated from 32 of the 115 (28%) healthy cats and from only 5 of the 37 (14%) cats with clinical signs of disease. There was no association between isolation of *Campylobacter* spp and detection of clinical signs of disease (odds ratio, 0.41; 95% confidence interval, 0.13 to 1.22).

One hundred twenty-two (80%) cats were ≤ 1 year old, and 30 (20%) were > 1 year old. *Campylobacter* organisms were isolated from 36 of the 122 (30%) cats that were ≤ 1 year old but from only 1 of the 30 (3%) cats that were > 1 year old ($P < 0.01$). *Campylobacter* organisms were isolated from 5 of 16 (31%) cats between 4 and 7 weeks old, 15 of 42 (36%) cats between 8 and 11 weeks old, 12 of 32 (38%) cats between 12 and 15 weeks old, 3 of 20 (15%) cats between 16 and 19 weeks old, 1 of 12 (8%) cats between 20 and 52 weeks old, and 1 of 30 (3%) cats > 52 weeks old.

Of the 122 cats ≤ 1 year old, 101 were overtly healthy and 21 had clinical signs of disease. *Campylobacter* organisms were isolated from 32 of the 101 (32%) healthy cats ≤ 1 year old and from 4 of the 21 (19%) cats ≤ 1 year old that had clinical signs of disease. *Campylobacter* organisms were not isolated from any of the 14 overtly healthy cats > 1 year old and were isolated from only 1 of the 16 cats > 1 year old with clinical signs of disease.

Isolation of enteric organisms other than *Campylobacter* spp—*Giardia* organisms were identified in feces from 9 healthy cats, including 2 cats positive for *Campylobacter* organisms. *Cryptosporidium* organisms were not isolated from any of the cats. *Salmonella enterica* serotype 4,5,12:i monophasic was isolated from 1 cat with clinical signs of disease.

Duration of *Campylobacter* carriage—Follow-up fecal samples were obtained from 16 of the 37 cats from which *Campylobacter* organisms were isolated. However, for 3 of these cats, follow-up samples were obtained > 60 days after collection of the initial sample. Therefore, these 3 cats were eliminated from analyses of duration of *Campylobacter* carriage.

For 9 of the 13 cats from which follow-up fecal samples were obtained, duration of *Campylobacter* carriage (time from initial sample collection to collection of first sample for which results of bacterial culture for *Campylobacter* spp were negative) ranged from 22 to 74 days (median, 44 days).

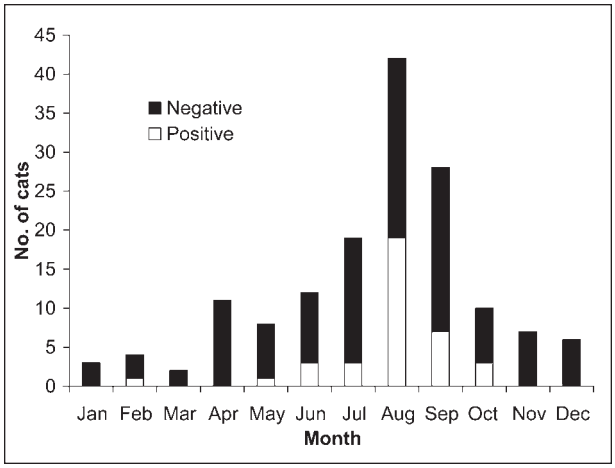

Figure 1—Results of bacterial culture of fecal samples from 152 cats in the Minneapolis–Saint Paul area for *Campylobacter* spp as a function of month of sample collection.

For the remaining 4 cats from which follow-up fecal samples were obtained, duration of *Campylobacter* carriage could not be determined because *Campylobacter* organisms were isolated from all follow-up samples. *Campylobacter* organisms were recovered for a median of 163 days (range, 112 to 196 days).

Discussion

The concern about the impact of certain zoonotic diseases on humans, particularly the growing number of humans with compromised immune system function, may have a bearing on recommendations concerning pet ownership. Even though the risk of human illness attributable to contact with pets is low, it is likely that a substantial number of sporadic cases of zoonotic disease involving humans are linked to pet contact.

In the present study, 24% (37/152) of cats from the Minneapolis–Saint Paul region were found to have *Campylobacter* organisms in their feces. This is in contrast with results of 2 previous studies[12,13] of the prevalence of zoonotic enteric organisms in the feces of cats, in which only 1% of cats were found to be shedding *Campylobacter* organisms in their feces. Although the difference between results of the present study and results of these 2 previous studies may reflect regional differences in prevalence, it is more likely a result of the fact that both of these previous studies focused only on detecting *C jejuni*. Only 2 of the 152 (1.3%) cats in the present study were shedding *C jejuni* in their feces, and *C upsaliensis* was isolated much more frequently than *C jejuni*. Other studies[16–20] have reported that *C upsaliensis* was recovered from 5% to 45% of feline fecal samples. *Campylobacter upsaliensis* was also the most commonly identified *Campylobacter* species isolated from commercially reared cats.[21]

Most human *Campylobacter* infections in the United States occur during the summer months,[16] and we observed a similar seasonality in the present study, with prevalence of fecal *Campylobacter* shedding highest during the summer and fall months. As previously documented,[22,23] there was no association between *Campylobacter* carriage and clinical signs of disease in the present study.

Most (36/37) cats from which *Campylobacter* organisms were isolated in the present study were ≤ 1 year old. This is similar to the situation in people, in which infants have the highest age-specific *Campylobacter* isolation rate (14 per 100,000 person years).[24] This is likely a reflection of a naive population.

The present study was one of the few studies to date that have examined the duration of *Campylobacter* carriage in cats. To do this, we tested serial fecal samples from cats known to be shedding the organism. There are some limitations, however, to our assessment. First, only prevalent cases were followed up, and it was not known how long cats had been infected when *Campylobacter* shedding was first identified. Second, it was not feasible to collect samples from cats on a daily basis to determine the actual number of days that the cats shed the organism. With these limitations in mind, however, our results provide an estimate of carriage duration in cats.

Median carriage duration for 9 cats in the present study was 44 days. Importantly, however, carriage duration could not be determined in the other 4 cats from which follow-up samples were collected because *Campylobacter* organisms were isolated from all fecal samples obtained from these cats. This extended shedding period reinforces the recommendation that veterinarians should encourage good hand hygiene among cat owners and their children, especially when new kittens are added to the household. Because most (32/37) cats shedding *Campylobacter* organisms in the present study were overtly healthy, clinical condition cannot be used to predict whether cats are shedding zoonotic enteric organisms.

Campylobacter upsaliensis has increasingly been recognized as a human pathogen. In Australia, *C upsaliensis* was the second most common *Campylobacter* species isolated from adult HIV-infected patients.[8] Similar findings have been documented in Los Angeles County.[11] Recently, an outbreak of *C upsaliensis* infection involving 44 children in 4 day care centers in Brussels was identified[25]; in that outbreak, transmission was postulated to be person to person. Case reports have been published describing neonatal sepsis secondary to *C upsaliensis* infection in a child who had recently acquired a puppy with diarrhea[10] and describing abortion associated with *C upsaliensis* infection in a young woman who had contact with a healthy adult cat.[9] *Campylobacter upsaliensis* infection is likely underdiagnosed in people because of the variability of culture procedures among clinical laboratories and the susceptibility of the organism to antimicrobials used in isolation media.[11,25] Because of the zoonotic importance of *Campylobacter* infections, veterinary diagnostic laboratories may want to review their isolation protocols.

a. Protocol Parasitology System, Fisher Diagnostics, Swedesboro, NJ.
b. Difco Mueller-Hinton agar, Becton, Dickinson & Co, Sparks, Mass.
c. Difco Campylobacter antimicrobic supplement B (Blaser), Becton, Dickinson & Co, Sparks, Mass.
d. AnaeroPack system, Mitsubishi Gas Chemical America Inc, New York, NY.
e. MeriFluor Cryptosporidium/Giardia direct immunofluorescent detection procedure, Meridian Bioscience Inc, Cincinnati, Ohio.
f. Statistix, version 7.0, Analytical Software, Tallahassee, Fla.

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