Salmonella bacteriuria in a cat fed a Salmonella-contaminated diet

Erika Fauth, DVM; Lisa M. Freeman, DVM, PhD; Lilian Cornjeo, DVM; Jessica E. Markovich, DVM; Nicol Janecko, MSc; J. Scott Weese, DVM, DVS

Case Description—A 9-year-old castrated male domestic shorthair cat was evaluated because of hematuria and weight loss after an 8-year history of intermittent signs of feline lower urinary tract disease (FLUTD). A complete diet history revealed that the cat was eating a commercial diet that does not undergo the same processing procedures as most pet foods and so might be at increased risk for bacterial contamination owing to a nonstandard industry cooking procedure.

Clinical Findings—The cat had a history consistent with FLUTD, but bacteriologic culture of the urine revealed Salmonella organisms. Additional analysis revealed Salmonella enterica serotype I:ROUGH-O:g,m,s:- in samples of urine and feces as well as Salmonella enterica serotype Johannesburg and Salmonella enterica serotype Senftenberg in the diet.

Treatment and Outcome—The cat responded positively to antimicrobial treatment for the Salmonella bacteriuria as well as to dietary and environmental management for the clinical signs associated with FLUTD.

Clinical Relevance—Findings in this case highlighted an additional health consequence associated with ingestion of Salmonella-contaminated food. Such contamination is of particular concern with raw meat–based diets or diets that have not undergone standard industry cooking practices. Veterinarians should obtain a diet history for every companion animal during every evaluation to help with diagnosis and optimal treatment. (J Am Vet Med Assoc 2015;247:525–530)

A 9-year-old castrated male indoor-housed domestic shorthair cat was evaluated at the internal medicine service of the Cummings School of Veterinary Medicine at Tufts University’s Foster Hospital for Small Animals because of recurrent dysuria, hematuria, and recent weight loss. The cat’s urinary tract signs began at 6 months of age with an episode of dysuria that was treated with SC fluid therapy and antimicrobials as well as the recommendation to change to a veterinary dieta (canned and dry) designed to reduce the risk for recurrence of struvite and oxalate crystalluria and urolithiasis. The cat had 1 episode of urinary obstruction at 2.6 years of age, but no uroliths were identified radiographically. Although struvite crystalluria was detected by examination of sediment from 2 urine samples obtained at that and a subsequent examination, bacteria were not evident during any urinalysis, and bacteriologic culture of at least 1 urine sample did not yield any growth. For most of the cat’s adult life, body weight was consistent at approximately 4.6 kg (10.1 lb), with a BCS of 5 on a scale from 1 to 9. The cat was housed with 1 other cat.

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ABBREVIATIONS

<table>
<thead>
<tr>
<th>BCS</th>
<th>RMBD</th>
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<td>Body condition score</td>
<td>Raw meat–based diet</td>
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In addition to a variety of medical treatments for the cat’s urinary tract signs, dietary recommendations were made. Initially, from the ages of 6 months to 4.8 years, recommendations were made to the owner to feed a diet (canned and dry) designed to reduce the risk for recurrence of struvite and oxalate crystalluria and urolithiasis. The exceptions were when a diet designed for dissolution of struvite uroliths was recommended after struvite crystals were detected via urinalysis (when the cat was 2.8 years old), when a different canned diet was offered because the owner stated that the cat did not like the recommended canned food, and when the primary care veterinarian recommended feeding only the canned food because the cat’s urine continued to be concentrated. Throughout this time, client compliance with the dietary recommendations was unclear. The medical records indicated that after the diet designed to reduce the risk for recurrence of struvite and oxalate crystalluria and urolithiasis was recommended when the cat was 6 months of age, the owner purchased the diet for only a 3-month period. At a visit shortly after development of the cat’s first urinary obstruction, the owner expressed concern about the cat not liking the recommended canned food and inquired about foods that could be considered more natural. On a subsequent visit 4 months after the initial urinary obstruction, the owner expressed concern that the cat was still not eating the recommended canned food and inquired about foods that could be considered more natural. On a subsequent visit 4 months after the initial urinary obstruction, the owner expressed concern that the cat was still not eating the recommended canned food and inquired about foods that could be considered more natural.
obstruction, a diet history revealed that the owner was feeding the cat an over-the-counter diet. After reiteration of the veterinarian’s recommendations 5 months after the initial urinary obstruction (when the cat was 2.9 years old), the owner appeared to return to feeding the recommended canned and dry veterinary diet. The owner also provided a lactose-free milk product and chicken broth to increase the cat’s water consumption. From the ages of 4.3 to 4.8 years, the medical record indicated that the owner purchased only the dry form of the recommended diet. At the age of 4.8 years, the cat developed a second urinary tract obstruction and was evaluated by another primary care veterinarian.

After the second urinary tract obstruction, there were no further episodes of dysuria for several years. The cat’s diet during this time was unclear but, by the age of 8 years, the cat’s body weight had increased from the usual weight of approximately 4.6 to 5.1 kg (11.2 lb). However, at the age of 9 years, weight loss of 0.3 kg (0.7 lb) was noted during a routine physical examination; further loss was detected during reevaluation 2 months later, at which time the cat’s weight was 4.6 kg (BCS unknown). Results of a CBC, serum biochemical analysis, and assessment of serum total thyroxine concentration were within reference intervals. The second primary care veterinarian recommended that the cat’s diet be changed to address the weight loss and to help reduce the risk for further episodes of dysuria or urinary obstruction. This diet consisted of a wet (pouch) food and a granular diet. After the diet was changed, the cat lost more weight and had several additional episodes of dysuria and hematuria over 4 months. Treatment with piroxicam (1 mg/kg [0.45 mg/lb], PO, q 24 h for 7 days) was administered several times in an attempt to reduce the urinary tract signs, but with no improvement. The cat was referred for evaluation of the recurrent signs of dysuria and hematuria.

On physical examination, the cat (now 9 years old) weighed 4 kg (8.8 lb), with a BCS of 4 of 9 and no muscle loss. The only medication the cat was receiving was piroxicam (0.6 mg/kg [0.27 mg/lb], PO, q 24 h). Rectal temperature was 37.8°C (100.1°F), pulse rate was 180 beats/min, and respiratory rate was 42 breaths/min. No gross abnormalities were noted on physical examination. The cat was discharged from the hospital, pending the results of laboratory testing, and recommendations were made to reduce the piroxicam dosage (to 0.3 mg/kg [0.14 mg/lb], PO, q 48 h). Results of a CBC, serum biochemical analysis, and assessment of serum total thyroxine concentration were within reference intervals except for serum albumin concentration (4.3 g/dL; reference interval, 2.2 to 4.0 g/dL). Analysis of a urine sample obtained via ultrasound-guided cystocentesis revealed urine pH of 6.5 and specific gravity of 1.034, with 1+ protein (30 mg/dL) and 3+ heme; microscopic examination revealed occasional squamous cells and rare RBCs in each hpf, but RBCs were too numerous to count. Results of bacteriologic culture of another urine sample (also obtained by cystocentesis 12 days after the initial visit and urine sample) yielded Salmonella organisms (> 100,000 CFUs/mL). Antimicrobial susceptibility testing indicated that the salmonellae had intermediate susceptibility to nitrofurantoin and were susceptible to all other antimicrobials tested (amoxicillin, amoxicillin–clavulanic acid, cefovecin, cepodoxime, cefotaxime, cefazidime, cefotirax, chloramphenicol, ciprofloxacin, enrofloxacin, imipenem, marbofloxacin, piperacillin, tetracycline, ticarcillin–clavulanic acid, and sulfamethoxazole-trimethoprim).

The unusual results of bacteriologic culture of urine prompted the clinicians to check for exotic pets (particularly reptiles) in the house, of which there were none, and to obtain a complete diet history for the cat. The owner reported that the cat had been eating a wet (pouch) food (1/2 pouch, q 12 h) and a granular diet (1/4 cup, q 24 h) during the preceding 4 months. In addition, the owner had added a wet (canned) food (1/4 can, q 8 to 12 h) approximately 1 week prior in an attempt to encourage weight gain. The owner also was adding cooked chicken and cooked chicken liver (approx 1/8 cup; 3 times/mo for each) to the commercial foods. The cat also received commercial cat treats (3 or 4 treats/d), an omega-3 fatty acid supplement (approx 200 mg of eicosapentaenoic acid and 123 mg of docosahexaenoic acid, q 24 h), a probiotic (Lactobacillus acidophilus; 1/4 tsp [1.25 mL], q 24 h), and psyllium (1/4 tsp, q 24 h).

On the basis of the Salmonella-positive culture results, the Salmonella-positive urine sample (original sample) and another urine sample (second sample; also obtained by ultrasound-guided cystocentesis) collected 12 days after the Salmonella-positive urine sample was collected were submitted for aerobic bacterial culture and further identification of the microorganisms (Table 1). After the second sample was collected, treatment with amoxicillin–clavulanic acid was initiated (15.6 mg/kg [7.1 mg/lb], PO, q 12 h). Because of the concern for the safety of the owner and another cat in the household that ate the same foods, the owner was asked to collect food, fecal samples (from both cats), and environmental samples for analysis. The granular food, a commercially available diet, was suspected as a possible source because the manufacturers claim that, although the individual ingredients are cooked, the diet itself does not go through a standard cooking procedure. Dietary supplements were not evaluated for contamination. Feces were collected from the litter box. Environmental samples were collected with disposable floor sweeper cloths. All samples were shipped on dry ice to the authors’ (NJ and JSW) laboratory for analysis. In addition to the initial urine sample, salmonellae were isolated from feces of the affected cat, feces of the other household cat, and the granular food sample. Overall, 3 Salmonella serotypes were identified. Bacteria were not detected in the second urine sample obtained from the affected cat. A recommendation was made to discontinue feeding the granular food.

The cat was returned for a urinalysis and bacteriologic culture of urine 1 week after completing a 3-week period of treatment with amoxicillin–clavulanic acid. At that time, the cat had no clinical signs and was eating the moist foods well. The cat’s weight was 4 kg (8.8 lb), with a BCS of 4 of 9 with normal muscle condition. Analysis of a urine sample obtained via cystocentesis revealed urine pH of 7.0 and specific gravity of 1.052, with 2+ protein and 3+ heme; microscopic ex-
amination revealed rare leukocytes and RBCs that were too numerous to count in each hpf. Results of bacteriologic culture of urine were negative. The second primary care veterinarian continued treatment of the cat with amoxicillin–clavulanic acid for another 3 weeks. The owner noted no further pigmenturia at home. One week after completing the full 6-week period of antimicrobial treatment, repeated urinalysis and bacteriologic culture of urine were performed. The urine was brown colored and had pH of 5.0 and specific gravity of 1.038, consistent with feline lower urinary tract disease. Initially, the cat also had clinical signs consistent with infection (eg, pyuria) suggested that this cat’s urinary tract infections.3–5 Administration of prednisolone to the cat also could have contributed to changes in urine pH. In addition, the lack of cytologic changes consistent with infection (eg, pyuria) suggested that this cat’s clinical signs might have been primarily due to idioopathic cystitis with subclinical bacteriuria. Nevertheless, the presence of bacteria in the urine is still of potential relevance in a cat with underlying urinary tract disease as it could be a risk factor for development of subsequent infection. In humans, underlying urinary tract disorders, immunocompromise, and handling of reptiles have been reported as risk factors for development of Salmonella urinary tract infections.3–5 Administration of prednisolone to the cat also could have contributed to infection and is an additional consideration when prescribing corticosteroids to animals eating diets with higher risk of microbial contamination, such as RMBDs. Further, colonisation of the urinary bladder with a zoonotic pathogen is of potential public health concern, similar to concerns with fecal shedding of this bacterium.

Regardless of the role of Salmonella in the urine of the cat of this report, it is unclear. Considering that results of testing of the second urine sample (collected after obtaining the urine sample that contained Salmonella organisms but before antimicrobial treatments were administered to the cat) were negative, it is possible that there was transient bacteriuria or that the first urine sample was contaminated with fecal material during collection, despite the fact that it had been collected by means of ultrasound-guided cystocentesis. Diet changes also could contribute to changes in urine pH. In addition, the lack of cytologic changes consistent with infection (eg, pyuria) suggested that this cat’s clinical signs might have been primarily due to idiopathic cystitis with subclinical bacteriuria. Regardless, the presence of bacteria in the urine is still of potential relevance in a cat with underlying urinary tract disease as it could be a risk factor for development of subsequent infection. In humans, underlying urinary tract disorders, immunocompromise, and handling of reptiles have been reported as risk factors for development of Salmonella urinary tract infections.3–5 Administration of prednisolone to the cat also could have contributed to infection and is an additional consideration when prescribing corticosteroids to animals eating diets with higher risk of microbial contamination, such as RMBDs. Further, colonisation of the urinary bladder with a zoonotic pathogen is of potential public health concern, similar to concerns with fecal shedding of this bacterium.

### Discussion

The commercial granular diet fed to the cat of the present report may have led to shedding of salmonellae in the feces of both cats in the household and Salmonella bacteriuria in the case cat. Although the Salmonella serotype found in the cat’s urine and in the feces of both cats was different from the 2 serotypes found in the contaminated diet, this does not preclude a link with the diet. Only a small single sample of food from 1 bag was tested, and it is possible that a different Salmonella serotype (ie, the one identified in the feces) was present in the batch eaten by the cat when it first became infected. It is also possible that the cat was contaminated through another route (eg, from the other cat or from raw meat products used by the owner) or that the diet itself is not cooked.

### Table 1—Salmonella serotypes identified in samples from a cat with Salmonella bacteriuria being fed a contaminated granular diet (cat 1), along with samples from another cat in the household (cat 2) and related environmental samples.

<table>
<thead>
<tr>
<th>Source Sample</th>
<th>No. of Salmonella isolates</th>
<th>Salmonella serotypes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat 1 Urine (original sample)</td>
<td>2</td>
<td>I-ROUGH-O,g,m,s-</td>
</tr>
<tr>
<td>Cat 1 Urine (second sample)</td>
<td>3</td>
<td>I-ROUGH-O,g,m,s-</td>
</tr>
<tr>
<td>Cat 2 Feces</td>
<td>2</td>
<td>I-ROUGH-O,g,m,s-</td>
</tr>
<tr>
<td>Food 1 Uncooked food</td>
<td>3</td>
<td>Salmonella Johannesburg (n = 2)</td>
</tr>
<tr>
<td>Food 2 Wet (canned)</td>
<td>0</td>
<td>Negative</td>
</tr>
<tr>
<td>Food 3 Wet (pouch)</td>
<td>0</td>
<td>Negative</td>
</tr>
<tr>
<td>Treat Cat treat</td>
<td>0</td>
<td>Negative</td>
</tr>
<tr>
<td>Environment Cat 1’s food bowl</td>
<td>0</td>
<td>Negative</td>
</tr>
<tr>
<td>Environment Floor around food bowl</td>
<td>0</td>
<td>Negative</td>
</tr>
<tr>
<td>Environment Food preparation area</td>
<td>0</td>
<td>Negative</td>
</tr>
</tbody>
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Dietary supplements were not evaluated for contamination. Urine samples were collected via ultrasound-guided cystocentesis. Fecal samples were collected from the litter box. Environmental samples were collected with disposable floor cleaner cloths. All samples were shipped on dry ice to a laboratory for analysis.

*This sample was collected before the cat received antimicrobial treatment.
the cat had at least 2 episodes of struvite crystalluria; thus, a diet that promoted acidic and dilute urine was recommended. For idiopathic cystitis and, potentially, for other forms of feline lower urinary tract disease, environmental modification also appears to be beneficial. Recommendations for environmental modification were made after the Salmonella bacteriuria in this cat was treated.

Independent of concerns about Salmonella organisms in the urine in the cat of the present report, the presence of salmonellae in the feces of both cats raises both animal and public health concerns. No information is available on the contamination rates of commercial granular diets such as the one in this report, but data on the public health risks of RMBDs are increasing. A variety of pathogens, such as Salmonella spp., Escherichia coli O157:H7, Campylobacter jejuni, and Toxoplasma gondii can be present in raw meat intended for human consumption or used in commercial or home-prepared RMBDs. The ability of these pathogens to survive in different conditions varies, but many are not completely destroyed by freezing and freeze-drying; therefore, both home-prepared and commercially available RMBDs are at risk for contamination. Studies of commercially available RMBDs have revealed prevalence rates for contamination with salmonellae ranging from 21% to 48% (compared with 0% of dry food samples tested in 1 study). Less information is available for home-prepared RMBD, but 1 study found Salmonella-positive culture results for 8 of 10 home-prepared RMBDs.

Published reports of dogs and cats with Salmonella infections attributable to consumption of contaminated raw meat, including reports of dogs and cats that died of Salmonella-related sepsis, should dispel the popular notion among some RMBD enthusiasts that dogs and cats are not affected by salmonellosis. Even though the contaminated diet in the case described in this report was not raw, the fact that it did not go through standard cooking procedures rendered it at higher risk for microbial contamination than most commercial wet (eg, canned and pouch) or dry extruded foods. Standard industrial cooking procedures, such as extrusion and canning, as well as rigorous quality control measures help to reduce the risk for contamination in cooked commercial foods, but commercial dry extruded foods also can become contaminated with Salmonella spp and other pathogens. There has been a relatively low rate of recalls of commercially available RMBDs in the past (5 in 2013), but in the last 12 months, there have been 8 separate recalls of RMBD with > 25 individual products affected by salmonella or Listeria (with additional recalls of treats and chews contaminated by these organisms). However, the fact that the recall rate does not mirror study reports indicating high contamination rates may be because consumers or veterinarians do not associate illnesses with potential contamination, because the market share for commercially available RMBDs is more limited than for dry extruded and moist cooked diets, or because RMBD manufacturers may not routinely test their diets.

Contamination of the environment caused by shedding of organisms in the feces of animals eating contaminated diets also could be a risk factor for human infection. Between 3% and 50% of dogs fed RMBDs shed Salmonella organisms in their feces. Forty-four percent of dogs eating contaminated commercially available RMBDs in 1 study shed Salmonella organisms in their feces and continued to shed for up to 7 days. In the case described in the present report, both cats in the household were shedding Salmonella organisms in their feces. Although Salmonella was the focus of this case report, there also is risk of infection with other organisms among humans who might be exposed to pets eating diets contaminated with L monocytogenes, Yersinia enterocolitica 0:O:3, Clostridium spp, or T gondii.

The urinary and fecal shedding of salmonellae in the cat of the present report was likely the result of consumption of a contaminated diet, and this fact emphasizes the importance of obtaining a complete diet history for every veterinary patient at every clinic visit, as recommended by the American Animal Hospital Association Nutrition Assessment Guidelines and the World Small Animal Veterinary Association Guidelines. This can be readily accomplished with standard diet history forms that can be provided to the owner prior to the appointment. Information from the diet history can have diagnostic importance; information that has relevance would be, for example, a diet including chicken jerky treats fed to a dog that has signs of acute kidney injury; an RMBD or raw meat–based treats fed to an animal with gastrointestinal tract signs, sepsis, or urinary tract infection; a vegetarian diet fed to a cat with dyspnea; or an unbalanced home-cooked diet fed to a young dog with lameness. A diet history also can help to determine whether the current diet is optimal for maintaining health (eg, whether it is complete and balanced and whether the animal is being fed a diet appropriate for its life stage) or managing medical conditions. In addition, diet history can help to identify dietary components that will need to be addressed in the overall care of the animal (eg, foods used for administering medications, excessive calories from treats, excessive sodium or phosphorus from table foods, or dietary supplements).

In addition to these issues, a diet history also is important to assess adherence to nutritional recommendations. In the case described in the present report, the owner expressed concerns about the veterinary diet that had been recommended very early during the cat’s medical care and had asked about more natural options. Such inquiries can open a conversation about the owner’s concerns regarding commercial pet food and provide an opportunity to dispel the many myths and misconceptions regarding commercial diets. By the time of the referral evaluation of the cat, there was a great deal of frustration and confusion regarding its diet on the part of the owner. Ensuring adherence with dietary recommendations requires good communication skills. These include 2-way communication, engaging and empathizing with the owner, and assessing the owner’s readiness for change. In addition, when recommendations are made, they need to be clear and simple, include options, and address potential barriers. Finally, it is critical to follow up to identify problems or concerns. Good adherence not only is beneficial for...
the outcome of the patient, but also has been shown to increase client satisfaction.69

Although much additional research is needed to understand the full extent of risks of Salmonella infection for animals eating contaminated diets and treats, the case described in this report has illustrated a potential health consequence not commonly associated with Salmonella-contaminated pet food. For this cat, it was hypothesized that ingestion of a Salmonella-contaminated commercial granular cat food led to colonization of the gastrointestinal tract and subsequent Salmonella bacteriuria. Microbial contamination can occur in any food, but it is more likely in RMDBs or diets that do not undergo a standard cooking procedure. Recently, the FDA initiated an investigation of microbial contamination in RMDB.47 Also, veterinary health-care teams should be aware that there is wide variation in quality-control procedures among manufacturers of commercially available foods (regardless of whether they are raw, dry extruded, or moist). Summaries of recommendations for manufacturers have been previously published.6,64 If a diet history reveals that owners are feeding a commercially available or home-prepared RMDB (or raw dried or freeze-dried pet treats) or a diet that has not undergone a standard cooking procedure, those owners should be counseled on the health risks to themselves and their pets as a result of this feeding strategy.

References


29. JAVMA, Vol 247, No. 5, September 1, 2015 Scientific Reports 529
Characteristics of canine platelet-rich plasma prepared with five commercially available systems

Samuel P. Franklin et al

Objective—To characterize platelet-rich plasma (PRP) products obtained from canine blood by use of a variety of commercially available devices.

Sample—Blood samples from 15 dogs between 18 months and 9 years of age with no concurrent disease, except for osteoarthritis in some dogs.

Procedures—PRP products were produced from blood obtained from each of the 15 dogs by use of each of 5 commercially available PRP-concentrating systems. Complete blood counts were performed on each whole blood sample and PRP product. The degree of platelet, leukocyte, and erythrocyte concentration or reduction for PRP, compared with results for the whole blood sample, was quantified for each dog and summarized for each concentrating system.

Results—The various PRP-concentrating systems differed substantially in the amount of blood processed, method of PRP production, amount of PRP produced, and platelet, leukocyte, and erythrocyte concentrations or reductions for PRP relative to results for whole blood.

Conclusions and Clinical Relevance—The characteristics of PRP products differed considerably. Investigators evaluating the efficacy of PRPs need to specify the characteristics of the product they are assessing. Clinicians should be aware of the data (or lack of data) supporting use of a particular PRP for a specific medical condition. (Am J Vet Res 2015;76:822–827)