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Authors
Hatch, Alex
Jandrey, Karl E
Tenwolde, Matt C
et al.

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Incidence of chyloabdomen diagnosis in dogs and cats and corresponding clinical signs, clinicopathologic test results, and outcomes: 53 cases (1984–2014)

Alex Hatch DVM

Karl E. Jandrey DVM

Matt C. Tenwolde DVM

Michael S. Kent DVM

From the William R. Pritchard Veterinary Medical Teaching Hospital (Hatch, Tenwolde) and Department of Surgical and Radiological Sciences (Jandrey, Kent), School of Veterinary Medicine, University of California-Davis, Davis, CA 95616. Dr. Hatch's present address is London Veterinary Specialists, 56 Belsize Lane, London, NW3 5AR, England. Dr. Tenwolde's present address is Vista Veterinary Specialists, 7425 Greenhaven Dr, Sacramento, CA 95831.

Address correspondence to Dr. Jandrey (kejandrey@ucdavis.edu).

OBJECTIVE

To determine the incidence of chyloabdomen diagnosis in cats and dogs and characterize and compare between species the corresponding clinical signs, clinicopathologic test results, and outcomes.

DESIGN

Retrospective case series.

ANIMALS

36 cats and 17 dogs in which chyloabdomen was diagnosed at a veterinary teaching hospital between 1984 and 2014.

PROCEDURES

Medical records were reviewed, and data retrieved included patient signalment; clinical signs at initial evaluation; results of physical examination, diagnostic tests, and imaging studies; and outcomes. Survival analyses, descriptive statistics, and comparisons between species were completed.

RESULTS

The incidence of chyloabdomen at the veterinary teaching hospital during the study period was 2.0 cases/100,000 admissions for cats and 2.8 cases/100,000 admissions for dogs. The mean age at diagnosis of chyloabdomen in cats was 11.3 years, compared with 6.9 years in dogs. The most common clinical signs in dogs and cats combined were lethargy (39/51 [76%]) and anorexia (37/51 [73%]), but fewer (23/53 [43%]) had abdominal distention. Chylothorax was a common comorbidity (25/53 [47%]), with malignant neoplasia being the most common underlying diagnosis (24/53 [45%]). Survival analyses included 44 patients; median survival time from diagnosis of chyloabdomen was 31 days overall, 8 days for patients with malignant neoplasia, and 73 days for patients without neoplasia.

CONCLUSIONS AND CLINICAL RELEVANCE

There were multiple causes of chyloabdomen in dogs and cats of the study, and outcome depended on underlying cause. Because of this and the rarity of chyloabdomen, a multicenter prospective study of disease progression, treatment response, and clinical outcome for dogs and cats with chyloabdomen is needed. (*J Am Vet Med Assoc* 2018;253:886–892)

Chyloabdomen is an exudative peritoneal disease characterized by an accumulation of chyle within the peritoneal cavity as a result of impaired or blocked lymphatic drainage.[1] To the authors' knowledge, no consensus exists on the ideal criteria required to diagnose chyloabdomen in dogs and cats. Rather, the diagnosis is typically made on the basis of results from cytologic evaluation of abdominal fluid samples, combined with a comparison between results from biochemical analyses of abdominal fluid and serum or plasma samples.[1]

Chylous effusions contain higher concentrations of triglycerides (usually > 100 mg/dL) and total lipids (generally > 4 g/L) than does serum.[2,3] On cytologic evaluation of abdominal fluids, Sudan staining can be performed to detect chylomicrons and thereby confirm lipid content. In addition, there is often a predominance of mononuclear cells, typically small lymphocytes. Other typical findings include the absence of bacterial organisms on cytologic evaluation as well as negative results from bacteriologic culture of the effusion. Further, chronic chylous effusions may take on more exudative cytologic features, including an increase in the number of visible macrophages, neutrophils, and other cells, although a specific cutoff is not known.

Scientific reports of chyloabdomen in companion animals have been scant; however, various causes of chyloabdomen have been reported in dogs,[4] and neoplasia has been reported as a common cause in cats.[5] Reasons for the different causes and the variability between species remain unclear. To the authors' knowledge, there has been no recent compre-

ABBREVIATIONS

BCS	Body condition score
CI	Confidence interval

hensive report of investigation into the pathogenesis and clinical manifestations of chyloabdomen in dogs or cats. Considering the 2 veterinary reports[4,5] and information from human medicine, it appears that chyloabdomen has various causes (eg, cardiac disease, thromboembolic disease, trauma, neoplasia [most commonly lymphoma], bacterial peritonitis, pancreatitis, infectious diseases [eg, feline infectious peritonitis and tuberculosis], and iatrogenic causes [ie, surgical complications]).[1–3,6]

In humans, the incidence of chyloabdomen in the 1950s was an estimated 1 case/187,000 hospital admissions,[1] but higher incidences have since been reported (eg, 1 case/11,589 admissions in 1982[7]), and this increase was likely attributable to improvements in diagnostic capabilities.[1] To the authors' knowledge, however, information about incidence and outcomes of chyloabdomen in dogs and cats has been limited.

The purposes of the study reported here were to determine the incidence of chyloabdomen diagnosis in cats and dogs; characterize the corresponding clinical signs, clinicopathologic test results, and outcomes; and compare findings between species. We anticipated that the underlying causes of chyloabdomen would differ among patients, that clinicopathologic test results (other than a higher triglyceride concentration in abdominal effusion vs blood samples) would differ among affected animals, and that outcome would vary with underlying cause.

Materials and Methods

Case selection criteria

Electronic medical records of all dogs and cats examined at the William R. Pritchard Veterinary Medical Teaching Hospital at the University of California-Davis between January 1, 1984, and December 31, 2014, were searched to identify dogs and cats for which the terms chyle, chylous, or chylo appeared in the clinical diagnosis section of the medical record. Patients were included in the study if chyloabdomen had been diagnosed on the basis of results of abdominal fluid analyses conducted by the veterinary teaching hospital's clinical pathology laboratory and if the abdominal fluid had met at least 1 of the following criteria: total lipid concentration > 4 g/L, triglyceride concentration greater than serum triglyceride concentration, detection of chylomicrons microscopically by Sudan stain uptake, and cytologic features consistent with chylous effusion (eg, modified transudate with a predominance of noninflammatory mononuclear cells, typically lymphocytes). Dogs and cats in which chyloabdomen had been diagnosed at necropsy were also included. Patients were excluded if there was insufficient diagnostic information to ensure an accurate diagnosis or if they were not a dog or a cat.

Medical records review

Data obtained from medical records included patient signalment, clinical signs at initial evaluation, results of physical examination, presence and characteristics of abdominal fluid, results of CBC and serum biochemical analyses, results of diagnostic imaging studies, and outcome data (including necropsy findings and whether a patient died naturally or was euthanized). For patients with no follow-up data available in the medical records, the investigators contacted the referring veterinarians and owners (alone or in combination) for the information. These phone calls were completed in May 2014.

Statistical analysis

The Shapiro-Wilk test was used to assess for normality of continuous data. If data were considered normally distributed, then comparisons between dogs and cats involving continuous variables were performed with a *t* test. If data were considered nonnormally distributed, then the Mann-Whitney *U* test was used instead. Normally distributed data are reported as mean ± SD (range). Nonnormally distributed data are reported as median (range). The Fisher exact test was used for comparisons of categorical data involving ≤ 6 patients in any category; otherwise, the χ^2 test was used.

The Kaplan-Meier method was used to estimate median survival times and associated 95% CIs for patients with available follow-up data, and the log-rank test was performed to assess differences in survival time between dogs and cats and between patients with different underlying causes of chyloabdomen. Patients alive at the time of analysis or lost to follow-up were censored on the last day of contact. Results with a value of $P < 0.05$ were considered significant. Statistical analyses were performed with commercially available software.[a]

Results

Animals

Fifty-three patients with chyloabdomen (36 [68%] cats and 17 [32%] dogs) were included in the study. Of these, 52 (98%) were neutered, and the only sexually intact animal was a female Maine Coon. There was a significantly ($P = 0.02$) higher proportion of females represented in dogs (females, n = 14/17 [82%]; males, 3/17 [18%]) than was represented in cats (females, 17/36 [47%]; males, 19/36 [53%]). In addition, mean age at diagnosis of chyloabdomen was significantly ($P < 0.001$) older for cats (11.3 ± 4.2 years; range, 2.2 to 20.9 years), compared with that for dogs (6.9 ± 3.2 years; range, 2.4 to 13.9 years).

The 36 cats were classified as domestic shorthair (n = 25 [69%]), domestic longhair (5 [14%]), and domestic medium hair (3 [8%]) as well as Abyssinian, Burmese, and Maine Coon (1 [3%] each). The 17 dogs were classified as Dachshund (n = 2 [including 1 miniature Dachshund; 12%]), Golden Retriever (2 [12%]), and Shetland Sheepdog (2 [12%]) as well as Australian Cattle Dog, Bichon Frise, Border Collie, Chow Chow, Doberman Pinscher, Great Dane, Labrador Retriever, Newfoundland, Portuguese Water Dog, Rhodesian Ridgeback, and mixed-breed dog (1 [6%]

each). The incidence of chyloabdomen diagnosis at the veterinary teaching hospital during the study period was 2.0 cases/100,000 admissions for cats and 2.8 cases/100,000 admissions for dogs.

Clinical signs

The most common clinical signs in dogs and cats combined were lethargy (39/51 [76%]) and anorexia (37/51 [73%]). On initial examination, the most common clinical signs in dogs were anorexia (12/16 [75%]), lethargy (11/16 [69%]), and vomiting (7/17 [41%]), whereas the most common clinical signs in cats were lethargy (28/35 [80%]), anorexia (26/36 [72%]), and dehydration (20/36 [56%]).

Abdominal distention was recorded for only 23 of the 53 (43%) patients (cats, 17/36 [47%]; dogs, 6/17 [35%]), and dehydration was significantly (P = 0.02) more common in cats (16/27 [59%]) than in dogs (2/11 [17%]). No other significant differences in clinical signs were identified between species.

Physical examination findings

Mean ± SD BCS (on a 9-point scale) at initial examination was 4.2 ± 2.0 (range, 1 to 8) for all patients; however, BCS was significantly (P = 0.03) lower in cats (3.8 ± 2.2; range, 1 to 8), compared with dogs (5.1 ± 1.2; range, 3 to 7). Mean ± SD rectal temperature for all patients was 38.4° ± 1.07°C (101.1° ± 1.93°F; range, 34.8° to 40.6°C [94.7° to 105°F]). Dogs had a significantly (P = 0.03) higher rectal temperature (39.0° ± 0.67°C [102.1° ± 1.21°F]; range, 37.8° to 40°C [100.1° to 104°F]), compared with cats (38.2°± 1.13°C [100.7° ± 2.04°F]; range, 34.8° to 40.6°C [94.7° to 105°F]).

Abdominal fluid analysis

Abdominal fluid triglyceride concentration was recorded for 19 of the 53 (35%) patients (cats, 11/36 [31%]; dogs, 8/17 [47%]). The median triglyceride concentration in abdominal fluid was significantly (P = 0.03) higher for cats (1,404 mg/dL; range, 41 to 7,170 mg/dL) than for dogs (155 mg/dL; range, 13 to 3,024 mg/dL). Abdominal fluid cholesterol concentration was recorded for 11 of the 53 (21%) patients (cats, 5/36 [14%]; dogs, 6/17 [35%]), and the overall mean ± SD concentration was 77.2 ± 42.93 mg/dL (range, 11 to 149 mg/dL), with no significant (P = 0.62) difference between the species. However, mean abdominal fluid total protein concentration was significantly (P = 0.01) higher in cats (4.27 ± 1.32 g/dL; range, 1.7 to 7.2 g/dL) than in dogs (3.11 ± 1.39 g/dL; range, 1.1 to 5.6 g/dL).

The presence of nondegenerate neutrophils, with or without small lymphocytes or macrophages, was a predominant cytologic feature noted on abdominal fluid sample evaluation. Also present in abdominal fluid samples were mixed populations of other cells, such as mast cells and atypical cells (eg, lymphoblasts or mesothelial cells that met criteria for malignancy).

Clinicopathologic findings

Complete blood counts were available for 46 of the 53 (87%) patients (cats, 31/36 [86%]; dogs, 15/17 [88%]). Overall, no characteristic hematologic feature predominated the results. There were only minimal derangements from reference intervals, except in cats with mild anemia (16/31 [52%]), mild neutrophilia (21/31 [68%]), or band neutrophils (9/31 [29%]). Median Hct for cats was 27% (range, 15% to 42%; reference interval, 30% to 50%), and median neutrophil count was 14,030 neutrophils/µL (range, 5,650 to 35,800 neutrophils/µL; reference interval, 2,000 to 9,000 neutrophils/µL).

Results of serum biochemical analyses were available for 45 of the 53 (85%) patients (cats, 30/36 [83%]; dogs 15/17 [88%]). Overall, there was no characteristic feature of the biochemical analyses results that predominated, and median serum triglyceride concentration for each species was within reference intervals. However, for cats, median serum sodium concentration (148.0 mmol/L; range, 124 to 158 mmol/L; reference interval, 151 to 158 mmol/L) and mean serum chloride concentration (113.1 ± 6.0 mmol/L; reference interval, 117 to 126 mmol/L) were slightly lower than respective lower reference limits. Similarly, mean serum total protein concentration was slightly lower than the lower reference limit for dogs (5.13 ± 1.0 g/dL; range, 3 to 6.90 g/dL; reference interval, 5.40 to 7.60 g/dL) and cats (5.70 ± 0.9 g/dL; range, 3.30 to 7.20 g/dL; reference interval, 6.60 to 8.40 g/dL). Overall, dogs also had mild hypoalbuminemia, with mean ± SD serum albumin concentration of 2.46 ± 0.5 g/dL (range, 1.70 to 3.30 g/dL; reference interval, 3.00 to 4.60 g/dL). Azotemia was not recorded for any patient. However, 18 of 29 [62%] cats had hyperglycemia (median serum glucose concentration, 133 mg/dL; range, 54 to 291 mg/dL; reference interval, 63 to 118 mg/dL) and slight hyperbilirubinemia (median serum total bilirubin concentration, 0.2 mg/dL; range, 0 to 2.9 mg/dL; reference interval, 0 to 0.20 mg/dL).

Comorbidities

No significant differences were identified between the species in regard to the proportion of patients with various comorbidities, including chylothorax (n = 25/53 [47%]; cats, 16/36 [44%]; dogs 9/17 [53%]; P = 0.56), malignant neoplasia in general (24 [45%]; cats, 19/36 [53%]; dogs, 5/17 [29%]; P = 0.21) or disseminated carcinomatosis specifically (7 [13%]; cats, 6/36 [17%]; dogs, 1/17 [6%]; P = 0.41), cardiac disease (13 [24.5%]; cats, 11/36 [31%]; dogs, 2/17 [12%]; P = 0.18), lymphangiectasia (8 [15%]; cats, 4/36 [11%]; dogs, 4/17 [24%]; P = 0.25), or pancreatitis (5 [9%]; cats, 1/36 [3%]; dogs, 4/17 [24%]; P = 0.053).

Follow-up information was available for 15 of the 24 (63%) patients with malignant neoplasia, and carcinoma had been diagnosed in 8 of these patients on the basis of necropsy results (n = 6) or abdominal fluid cytologic analysis in which features of malignancy were identified (2). A pattern in the type or anatomic location (eg, bladder, great vessels, intestine, and diffuse carcinomatosis) of carcinoma diagnosed was not detected.

Of the other forms of malignant neoplasia, hemangiosarcoma had been diagnosed in 2 of the 15 (13%) patients, one with intestines affected and the other with spleen and lung affected. Sarcoma of undetermined origin was diagnosed in 1 patient (an 8-year-old castrated male domestic shorthair cat) at necropsy on the basis of 2 affected intestinal lymph nodes, but the primary site of the neoplasia was not confirmed. This sarcoma was presumed to have caused obstruction to the thoracic duct, resulting in chyloabdomen; however, chylothorax was not present in this patient. A lymphoid form of cancer (lymphoma or leukemia) was diagnosed in 3 patients, and 1 of these died of jejunal mass perforation. In addition, a presumptive diagnosis of neoplasia in a cat was made on the basis of pulmonary nodules evident on thoracic radiographs. Follow-up information indicated that this cat later died of respiratory arrest at home. Neoplasia, predominantly carcinoma, had been diagnosed in the remaining 9 patients while alive; however, causes of death for these patients were unclear because most were lost to follow-up or had medical records that were purged.

Thirteen of the 53 (25%) patients (2 dogs and 11 cats) had cardiac disease, which directly contributed to death for 4 patients. Of the 2 dogs with cardiac disease, 1 was euthanized because of progressive myxomatous mitral valve disease with atrial fibrillation, right-sided heart failure, and bicavitary effusion (ie, chyloabdomen and chylothorax), and the other dog (a 5-year-old spayed female Dachshund) was euthanized during an exploratory laparotomy because of chyloabdomen, lymphangiectasia (later also confirmed on necropsy), and concurrent myocardial steatitis. Eleven cats had cardiac disease that was recorded as restrictive or constrictive pericarditis (n = 2), right-sided congestive heart failure (2), dilated cardiomyopathy (1), hypertrophic cardiomyopathy (2), pericardial effusion (1), tricuspid regurgitation (1), and right atrial enlargement of unknown cause (1). The classification of cardiac disease in 1 cat was not clear from the medical record.

Of the 8 patients with lymphangiectasia, 2 had been euthanized (15 and 214 days after diagnosis) because of the progression of their lymphangiectasia and chyloabdomen, whereas 2 others had been euthanized (20 and 1,988 days after diagnosis) because of progression of inflammatory bowel disease. In addition, 2 of the patients with pancreatitis had concurrent lymphangiectasia.

Chyloabdomen was not attributed to trauma or congenital disease in any of the patients. Further, chyloabdomen could not be attributed wholly to 1 underlying cause because of the presence of multiple pathological conditions in most patients. For example, dilated cardiomyopathy, pancreatic mass, hyperthyroidism, and biliary cystadenomas were diagnosed antemortem in 1 cat, then on the basis of necropsy results, diffuse cryptococcal meningitis, extensive pyogranulomatous pneumonia, and severe fibrosis of both kidneys were also diagnosed in this same cat. The cause of sudden death in this cat was attributed to cryptococcal meningitis compounded by heart failure.

Survival analysis

One patient (a cat) in which the underlying cause (pancreatitis) of chyloabdomen had been resolved survived to the end of the study period. The rest of the patients (n = 52) had been euthanized (33/53 [62%]), died of unknown causes (11 [21%]), or had a natural death (8 [15%]). Forty-four of the 53 (83%) patients (cats, 28/36 [78%]; dogs, 16/17 [94%]) had follow-up information recorded in the medical record (n = 26) or obtained through conversations with owners or referring veterinarians (18), and these patients were included in analysis of survival time from the point at which chyloabdomen was diagnosed. Median time from hospital discharge to follow-up data collection was 28.5 days (range, 1 to 4,178 days). The overall median survival time for all patients was 31 days (range, 0 to 4,178 days; 95% CI, 15 to 69 days; **Figure 1**). Median survival time for cats was 25 days (range, 0 to 2,118 days; 95% CI, 9 to 37 days) and for dogs was 73 days (range, 3 to 4,178 days; 95% CI, 15 to 1,592 days); however, the difference between species was not significant (*P* = 0.09). Median survival time after diagnosis of chyloabdomen was significantly (*P* < 0.001) shorter for patients with neoplasia (8 days; range, 0 to 83 days; 95% CI, 4 to 25 days; n = 18/44 [41%]), compared with that for patients without neoplasia (73 days; range, 0 to 4,178 days; 95% CI, 31 to 214 days; 26/44 [59%]).

Median survival time was not significantly (*P* = 0.63) different between the 5 patients with pancreatitis (median, 73 days; range, 3 to 145 days; 95% CI, 3 days to unknown [upper limit not reached]), compared with the 39 patients without pancreatitis (median, 31 days; range, 0 to 4,178 days; 95% CI, 14 to 64 days). Survival times for 4 patients with pancreatitis that were known to have died ranged from 3 to 145 days after diagnosis, whereas the remaining 1 patient with pancreatitis was still alive at the end of the study period, having survived > 1 year after diagnosis. Additionally, median survival times were not significantly different for 7 patients with lymphangiectasia (23 days; range, 15 to 214 days; 95% CI, 2 to 176 days), compared with 37 patients without lymphangiectasia (32 days; range, 0 to 4,178 days; 95% CI, 16 to 73 days; *P* = 0.42); 11 patients with cardiac disease (64 days; range, 0 to 2,118 days; 95% CI, 8 to 86 days), compared with 33 patients without cardiac disease (26 days; range, 0 to 4,178 days; 95% CI, 13 to 73 days; *P* = 0.85); or 20 patients with chylothorax (22 days; range, 0 to 2,118 days; 95% CI, 13 to 73 days), compared with 24 patients

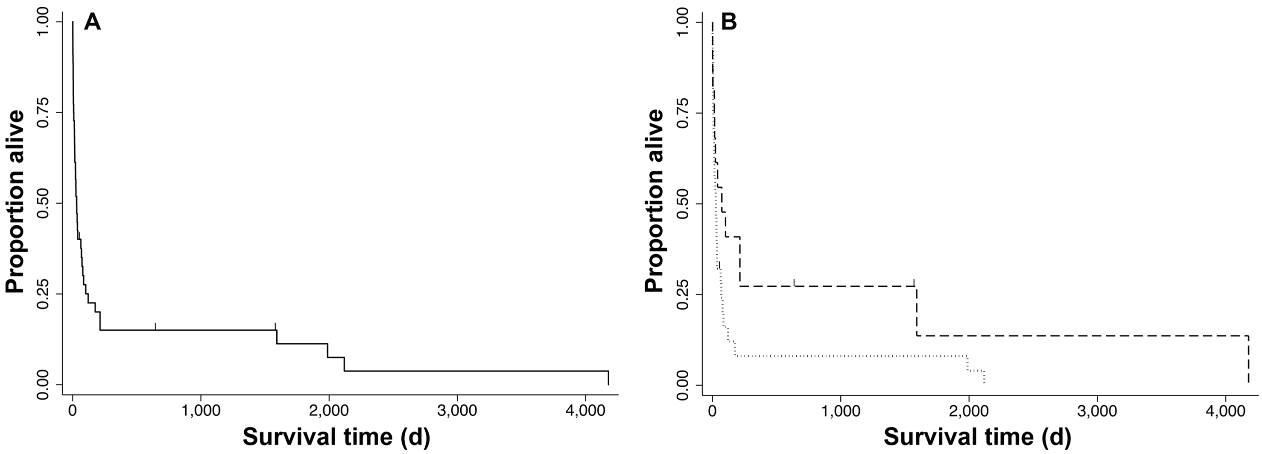

Figure 1—Kaplan-Meier plot of survival times after diagnosis of chyloabdomen for all 44 patients (A) and by species (B) for 28 cats (dotted line) and 16 dogs (dashed line) that were evaluated at a veterinary teaching hospital between January 1, 1984, and December 31, 2014, and for which follow-up information was available. There was no significant difference between species. Tick marks indicate censored patients (cats, n = 1; dogs, 2).

without chylothorax (31 days; range, 0 to 4,178 days; 95% CI, 8 to 102 days; $P = 0.35$).

Discussion

To the authors' knowledge, the present study was the largest reported case series of dogs and cats with chyloabdomen, and the findings supported that chyloabdomen was rare, often caused by neoplasia, and usually associated with a grave prognosis. Chyloabdomen in dogs was more common in females than in males, but in cats was fairly equally distributed between the sexes. It was unclear why female dogs were referred for evaluation of chyloabdomen more commonly than were male dogs. Interestingly, no evidence was obtained to support a breed predilection for chyloabdomen, whereas for chylothorax, the Afghan Hound (because of the breed's association with lung lobe torsion) and the Siamese cat are overrepresented.[5] The mean age of patients in the present study was as expected, given the high incidence of concurrent neoplasia and acquired conditions (eg, cardiac disease).

Clinical signs at initial examination were often nonspecific (eg, lethargy and anorexia); however, chylothorax was diagnosed in 47% of patients in the present study, a finding that was not surprising, given the close anatomic relationship between the lymphatic vessels and the cisterna chyli. This finding also suggested that lymphatic obstruction is often multifocal and that bicavitary effusion could be common in dogs and cats with chyloabdomen. Interestingly, abdominal distention was present in only 43% of patients.

Because of the nonspecificity of clinical signs, use of point-of-care diagnostic procedures (eg, focused ultrasonography) during initial evaluations could be important to improving diagnostic efficiency and accuracy. Further, the need for diagnostic imaging with appropriate analyses of effusions in all such cases was supported by the finding that there were no distinguishing, consistent clinicopathologic test results for patients in the present study that helped establish chyloabdomen as a possible differential diagnosis.

Dehydration was found in 18 of 32 (56%) of cats, compared with only 2 of 13 (15%) dogs in the study population. This difference could have been attributable to human error or bias (eg, a potential ability of the involved clinicians to detect dehydration in cats more accurately than in dogs), or to cats being referred later in the course of disease. The latter possibility was supported by the lower mean BCS in cats, compared with that in dogs. However, one could argue the relevance of the noted dehydration because a lower BCS could have altered skin elasticity of affected cats, and the change in skin elasticity could have been interpreted as dehydration on physical examination.

The finding in the present study that cats had a higher median abdominal fluid triglyceride concentration (1,404 mg/dL), compared with dogs (155 mg/dL), mirrored those in previous reports.[8,9] However, the reason behind this species difference was not clear. One study[9] showed that pleural effusions with triglyceride concentrations > 100 mg/dL were chylous in all cases and that no effusions with triglyceride concentrations below this cutoff were chylous, yet some patients in the present study had chylous abdominal effusions with triglyceride concentrations < 100 mg/dL. The inclusion criteria for the present study did not involve a minimum cutoff for abdominal fluid triglyceride concentration; further, some patients were included on the basis of other criteria (eg, identification of chylomicrons microscopically in abdominal fluid by uptake of Sudan stain). The authors believe, given the findings of the present study, that the use of a confirmed ratio of abdominal fluid triglyceride concentration to serum or plasma triglyceride concentration > 1:1 is a better means to classify an effusion as chylous, compared with the use of a minimum concentration of triglycerides in the abdominal fluid. We also recommend that abdominal fluid analyses be performed on all patients with abdominal effusion to further characterize the nature of the abdominal fluid and confirm the diagnosis.

Electrolyte derangements in the patients of the present study were mild and noted exclusively in cats. Given the predominantly referral nature of the patient population at the veterinary teaching hospital, one could expect that some of the referring veterinarians may have therapeutically drained effusions prior to referral. If therapeutic drainage had been performed, any subsequently observed serum biochemical changes could have reflected consequent metabolic derangements (eg, hyponatremia noted in cats of the present study) or changes to acid-base status.[10]

The hypoproteinemia and hypoalbuminemia noted in patients of the present study could have had several causes, including a lack of dietary protein combined with catabolism from anorexia and cachexia as well as negative acute-phase protein responses to infection or inflammation. Unfortunately, the hypoproteinemia and hypoalbuminemia noted were nonspecific, and many patients had comorbidities that could have contributed to both.

The hyperglycemia noted in cats of the present study was likely a result of a stress response common in cats. Most cats with hyperglycemia also had mild hyperbilirubinemia, which could have been attributable to nonspecific hepatocellular swelling and inflammatory changes (as occurs in various disease states) as well as sepsis with bile leakage by hepatocytes (primarily through damaged junctions).[11]

If chyloabdomen were viewed more as a clinical manifestation of other disease, rather than as a disease itself, the prognosis would depend greatly on the underlying primary disease. Therefore, the authors believe that one should interpret the results of the survival time analysis of the present study with caution and always exercise careful clinical judgment with respect to the underlying disease processes and potential outcomes when evaluating any dog or cat with chyloabdomen.

In adult humans, the most common reported cause of chyloabdomen is abdominal malignancy, with malignant lymphoma accounting for approximately 85% of all abdominal chylous effusions.[12] Findings of the present study supported malignancy as the most common cause in cats and dogs; however, carcinoma, and not lymphoma, was more commonly associated with chyloabdomen. In actuality, malignancy could be more common in cats and dogs than suggested by the present study because a definitive diagnosis of the underlying cause of chyloabdomen may not be determined in every affected animal, especially those that die (including by euthanasia) before a diagnosis is confirmed.

Most cardiac diseases in the patients of the present study were atypical in nature (eg, restrictive pericarditis and pericardial effusion, instead of hypertrophic cardiomyopathy in cats). When identified in the present study, right-sided heart failure was considered a cause, and not just a comorbidity, of chyloabdomen in affected patients with both conditions because of ascites formation associated with right-sided heart disease.

The authors believe that treatment of chyloabdomen should focus on correcting the underlying disease process when possible; however, supportive treatment can be provided to reduce the rate and amount of chylous effusion formed. Excessive amounts of abdominal effusion can lead to compartment syndrome, pain, and discomfort in affected animals, and intermittent therapeutic drainage could mitigate these effects. One could also consider dietary modification (eg, fat restriction) or diuretics to minimize the amount of third-space fluid accumulation. In human medicine, other treatment options such as surgery and IV or SC injections of octreotide acetate (a somatostatin analog) have achieved variable success[1]; however, there is limited evidence in the veterinary literature to support their use in animals.

The present study had several limitations and revealed opportunities for future investigation. The retrospective nature of the study design made it difficult to ascertain exact endpoints (eg, time of death or final outcome) for patients. In addition, given that chyloabdomen is a rare condition in cats and dogs, a prospective, multicenter study would be necessary and is warranted to better characterize disease progression, treatment response, and clinical outcome. Further, because no consensus definition exists for the diagnosis of chyloabdomen, we allowed for patients with ≥ 1 of the clinicopathologic variables used as inclusion criteria to substantiate diagnoses made by attending clinicians or clinical pathologists. This could have led to inappropriate inclusion of patients with no actual chyloabdomen or exclusion of patients with actual chyloabdomen. Allowing many clinicians and clinical pathologists to determine each diagnosis, rather than 1 blinded reviewer, also could have affected the number of patients qualifying for inclusion. Establishing guidelines for the diagnosis of chyloabdomen in cats and dogs was beyond the scope of the study, and additional research is needed in this regard.

Overall, results of the present study suggested that several causes of chyloabdomen exist in cats and dogs, that outcome depends on the underlying cause, and that clinicopathologic abnormalities can vary among patients. Performance of point-of-care diagnostic procedures, such as focused ultrasonography during initial evaluations, could improve diagnostic efficiency and accuracy, and treatment of chyloabdomen should focus on correcting the underlying disease process.

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Footnotes

a. Stata, version 10.0, StataCorp LLC, College Station, Tex.

References

1. Aalami OO, Allen DB, Organ CH Jr. Chylous ascites: a collective review. *Surgery* 2000;128:761–778.
2. Alleman AR. Abdominal, thoracic and pericardial effusions. *Vet Clin North Am Small Anim Pract* 2003;33:89–118.
3. Epstein SE. Exudative pleural diseases in small animals. *Vet Clin North Am Small Anim Pract* 2014;44:161–180.
4. Fossum TW, Hay WH, Boothe HW, et al. Chylous ascites in three dogs. *J Am Vet Med Assoc* 1992;200:70–76.
5. Gores BR, Berg J, Carpenter JL, et al. Chylous ascites in cats: nine cases (1978–1993). *J Am Vet Med Assoc* 1994;205:1161–1164.
6. Ludwig LL, Simpson AM, Han E. Pleural and extrapleural diseases. In: Ettinger SJ, Feldman EC, eds. *Textbook of veterinary internal medicine*. 7th ed. St Louis: Saunders Elsevier, 2010;1125–1137.
7. Press O, Press N, Kaufmann S. Evaluation and management of chylous ascites. *Arch Surg* 1967;96:358–364.
8. Fossum TW, Jacobs RM, Birchard SJ. Evaluation of cholesterol and triglyceride concentrations in differentiating chylous and nonchylous pleural effusions in dogs and cats. *J Am Vet Med Assoc* 1986;188:49–51.
9. Waddle JR, Giger U. Lipoprotein electrophoresis differentiation of chylous and nonchylous pleural effusions in dogs and cats and its correlation with pleural effusion triglyceride concentration. *Vet Clin Pathol* 1990;19:80–85.
10. Thompson MD, Carr AP. Hyponatremia and hyperkalemia associated with chylous pleural and peritoneal effusion in a cat. *Can Vet J* 2002;43:610–613.
11. Solter PF. Clinical pathology approaches to hepatic injury. *Toxicol Pathol* 2005;33:9–16.
12. Oosterbosch L, Leloup A, Verstraeten P, et al. Chylothorax and chylous ascites due to malignant lymphoma. *Acta Clin Belg* 1995;50:20–24.