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Objective—To determine signalment, diagnoses, presence of effusions in multiple sites, and outcome in cats with peritoneal effusion.

Design—Retrospective case series.

Animals—65 cats.

Procedure—Medical records from 1981 to 1997 were reviewed to obtain information on cats with peritoneal effusion identified on physical examination, radiographs, abdominal ultrasonograms, or at necropsy.

Results—Conditions most commonly associated with peritoneal effusion in cats, in order of frequency, were cardiovascular disease, neoplasia, hepatic disease, renal disease, feline infectious peritonitis, peritonitis attributable to other causes, and urinary tract trauma. Dilated cardiomyopathy (DCM) was the most common disease associated with peritoneal effusion; however, DCM was diagnosed in most of these cats before change of heart failure was found to be the primary cause of this form of cardiomyopathy in cats. Neoplasia was the most common cause after 1987. Right-sided congestive heart failure was the most commonly associated disorder in cats < 1 year old, whereas neoplastic disease was more common with increasing age. Most effusions were detected during the initial physical examination and were modified transudates. Peritoneal effusion was commonly accompanied by fluid accumulation elsewhere, particularly pleural effusion. The prognosis for a cat with abdominal effusion in this study was poor (mean survival time, 21 days; range, 1 to 360 days; median, 2.5 days).

Clinical Implications—The primary differential diagnosis for peritoneal effusion in cats is neoplastic disease in older cats and right-sided heart failure in kittens. Diseases associated with peritoneal effusion generally have poor prognoses. (J Am Vet Med Assoc 1999;214:375–381)

Peritoneal effusion is a sign of disease but is not a primary disease itself. Causes of peritoneal effusion include hypoalbuminemia, portal hypertension, obstructive or traumatic lymphatic disease, coagulopathies, trauma, peritonitis, neoplasia, and sodium and water retention such as can develop with hyperadrenocorticism, hyperreninism, or increases in concentrations of antidiuretic hormone or angiotensin II. Only single case reports and 2 small case series, one of concurrent peritoneal and pleural effusion and the other of feline hemoperitoneum, have been published. The purpose of the study reported here was to determine the signalment, results of fluid analysis, additional sites of fluid accumulation, associated disorders, and outcome in a large number of cats with peritoneal effusion.

Criteria for Selection of Cases

Medical records from 1981 to 1997 of cats with peritoneal effusion identified on physical examination, radiographs, abdominal ultrasonograms, or at necropsy at the University of Tennessee Veterinary Teaching Hospital were reviewed. Cats were included in this study if antemortem diagnostic testing had been sufficient to determine diseases associated with the effusion, or if a necropsy had been performed. Signalment, history, physical examination findings, associated disorders, cytologic analysis of peritoneal fluid, presence of other effusions or edema, time of detection of effusions, outcome, and available necropsy findings were retrieved from records. Age, sex, and breed distributions of affected cats were compared with the general hospital population of cats seen during the same period, using Yates corrected chi-square analysis.

Associated diseases were grouped into the following broad categories: cardiovascular, neoplastic, hepatic (nonneoplastic), renal (nonneoplastic, nontraumatic), urinary tract trauma, feline infectious peritonitis (FIP), and peritonitis other than FIP. Cardiovascular disease was diagnosed on the basis of results of physical examination (ie, presence of murmur, gallop rhythm, or jugular venous distention), and radiographic, echocardiographic, or necropsy findings. Echocardiographic findings of dilated, poorly contractile ventricles and dilated atria were diagnostic of dilated cardiomyopathy (DCM). Echocardiographic criteria for restrictive cardiomyopathy (RCM) included marked biatrial dilation, left ventricular fractional shortening that was within reference range or mildly decreased, LV chamber dimension that was within reference range or mildly increased, and variable right ventricular chamber dilation in the absence of shunting lesions or other identifiable defects. Necropsy findings supportive of RCM included severe biatrial dilation, right ventricular dilation, mild left ventricular dilation, and regional areas of hypertrophy. Histologically, these regions corresponded to areas of marked endomyocardial and interstitial fibrosis. Myocarditis and endocarditis were confirmed histologically, using established criteria. Neoplasia was confirmed through histologic evaluation, using specimens obtained by biopsy or at necropsy. Hepatic function tests, such as determination of total serum bile acids concentration or bromosulphalein retention, or...
Table 1—Distribution by disease category and signalment of 65 cats with peritoneal effusion

<table>
<thead>
<tr>
<th>Signalment</th>
<th>Cardiac</th>
<th>Neoplasia</th>
<th>Hepatic</th>
<th>Renal</th>
<th>Urinary tract trauma</th>
<th>FIP*</th>
<th>Peritonitis</th>
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<tr>
<td>Age (y)</td>
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*FIP = feline infectious peritonitis.

demonstration of hyperammonemia, were used to confirm hepatic failure. Cytologic or histologic examination of biopsy or necropsy specimens was used to identify the underlying cause of hepatic failure. Renal disease was diagnosed on the basis of serum biochemical test results, urine specific gravity, urine protein-to-creatinine ratios, abdominal radiographs, and ultrasonograms. Contrast radiography was used to diagnose trauma to the urinary tract. Feline infectious peritonitis was confirmed by finding diffuse fibrinous serositis and surface-oriented pyogranulomatous lesions in the mesentery and parenchymal organs on histologic examination.25 Other forms of peritonitis were also confirmed histologically.

Peritoneal fluid was analyzed cytologically and cultured for aerobic and anaerobic bacteria. Descriptors, such as serosanguineous or hemorrhagic, were recorded. Pure transudates were defined as fluids having a total nucleated cell count < 1,000/μl and protein concentration < 2.5 g/dl.12 Modified transudates had a total nucleated cell count between 250 and 2,000/μl and protein concentration of 2.5 to 6.0 g/dl.12 Nonseptic exudates had a total nucleated cell count > 5,000/μl, protein concentration > 2.5 g/dl, and primarily mature neutrophils on cytologic analysis.12 Septic exudates had a total nucleated cell counts > 5,000/μl, protein concentration > 2.5 g/dl, and degenerated neutrophils and bacteria on cytologic examination.12 Chylous effusions had a total nucleated cell count and protein concentration as for a modified transudate, but also had a triglyceride concentration > 100 mg/dl.12

Presence of effusions or edema at other sites was detected during a physical examination (eg, palpation or visual observation for subcutaneous edema), on thoracic radiographs, during echocardiography, or on necropsy evaluation. Standard radiographic criteria were used to diagnose pleural effusion. Radiographic findings of patchy interstitial to alveolar infiltrates and pulmonary venous congestion were supportive of pulmonary edema. Necropsy examinations confirmed fluid accumulation at these sites.

Statistical Analysis

Associations between disease category and age, breed, results of analysis of peritoneal effusion, presence of concurrent effusions at other sites, and outcome were determined using a Yates corrected χ² analysis or a Fisher's exact test. The Fisher's exact test was used when the expected frequency of at least 1 cell in a 2 × 2 contingency table was < 5. Differences were considered significant at P < 0.05.

Results

The number of cats seen from 1981 to 1997 was 25,565. Peritoneal effusion was not prevalent in this population; it was diagnosed in approximately 3 cats/1,000 initial admissions. Of 82 cats with peritoneal effusion, 65 met the criteria for inclusion in this study. Differences in signalment and clinical signs were not found between cats included and those excluded.

Peritoneal fluid was analyzed cytologically in 45 (69%) cats, and aerobic and anaerobic bacterial cultures were performed on fluid from 12 (18%) cats. Presence of effusions or edema at other sites was detected during a physical examination, on thoracic radiographs (obtained in 46 cats), during echocardiography (performed on 13 cats), or at necropsy (performed on 44 cats).

Cardiovascular and neoplastic disorders accounted for > 50% of diseases associated with peritoneal effusion (Table 1). Hepatic disease was also common (n = 11; 17% of cats). Remaining cats had (in order of decreasing frequency) renal disease (n = 6), FIP (4), non-FIP peritonitis (4), and urinary tract trauma (3). Cardiovascular disorders resulted in right-sided congestive heart failure. Nine of 19 cats with cardiovascular disease had DCM; in 7 of these 9 cats, the diagnosis was made before 1987. Necropsy evaluations (7/9 cats) confirmed dilation of all chambers without an identifiable underlying cause. Other forms of cardiomyopathy or myocarditis were diagnosed in 7 cats, and included idiopathic RCM (n = 5) and idiopathic chronic lymphocytic (1) and acute suppurative (1) myocarditis. Two cats had congenital heart diseases (1
each with tricuspid valve dysplasia and bilateral atrio-ventricular valvar dysplasia with a ventricular septal defect), and the remaining cat had tricuspid valve endocarditis.

Neoplastic causes were diverse and included intra-abdominal carcinomas in 7 cats. Carcinomatosis was found in each of these cats. The carcinoma originated from the gastrointestinal tract at the ileocecal junction (n = 3 cats), the greater curvature of the stomach (1), the pancreas (1), and the mammary gland (1). In the remaining cat, marked anaplasia precluded determination of the site of origin. Five cats had lymphosarcomas involving intra-abdominal organs (liver, spleen, or mesentery), and 2 cats had anaplastic sarcomas distributed throughout the peritoneal cavity, for which the site of origin could not be determined because of marked anaplasia. The remaining 4 cats with neoplasia and peritoneal effusion each had an intra-abdominal mast cell tumor of the liver (n = 1) or jejunum (1), hepatic and splenic hemangiosarcoma (1), or splenic fibrosarcoma (1).

Cytologic (n = 4) or histologic (7) examination of biopsy or necropsy specimens was used to identify the underlying cause of hepatic failure in 11 cats. Five cats had severe hepatic lipidosis, 2 had cirrhosis, 2 had hepatic necrosis as a result of idiopathic severe centrilobular necrosis (1) or infection with Toxoplasma gondii (1), and 2 had lymphocytic (1) or supplicative (1) cholangiohepatitis. The cat with toxoplasmosis also had myocarditis secondary to infiltration by the organism.

Two cats had end-stage chronic renal failure, mild hypoalbuminemia, and a history of recent parenteral administration of fluids. One of these 2 cats had been given 500 ml of lactated Ringer’s solution, SC, in a 24-hour period. One cat had acute renal failure secondary to ethylene glycol intoxication. Two other cats had a protein-losing nephropathy secondary to renal amyloidosis (n = 1) or glomerulocapsularis (1) and severe hypoalbuminemia (1.4 and 1.8 g/dl; reference range, 2.5 to 4.5 g/dl). Another cat had massive recurrent peritoneal effusion after resection of a perinephric pseudocyst. Markedly dilated subcapsular lymphatics were found in this cat during necropsy.

Feline infectious peritonitis was diagnosed in 76 cats during the time period of this study; only 4 of these cats had peritoneal effusion. Other forms of peritonitis included chronic lymphocytic-plasmacytic peritonitis (n = 1 cat), chronic fibrinopurulent peritonitis (2), and necrotizing vasculitis with intestinal perforation and septic peritonitis (1). One of the 2 cats with fibrinopurulent peritonitis also had granulomatous hepatitis, whereas the second cat also had chronic-active steatitis. These 2 cats had neither pyogranulomas nor other findings consistent with FIP.

There was a significant age difference between cats with peritoneal effusion (mean ± SD: 8.8 ± 5.12 years) and the general hospital population (5.2 ± 4.7 years; P < 0.001). Forty-two cats were ≥ 6 years old. When considering disease categories, cats with neoplastic causes of peritoneal effusion were significantly older. A
breed or sex predilection was not found when comparing cats with peritoneal effusion with the general hospital population.

Historical and physical examination findings varied (Table 2). Vague signs, such as anorexia and cachexia, were most commonly observed. Twenty-seven cats were initially admitted for evaluation of abdominal distention. Abdominal distention, peritoneal effusion, or both were detected on physical examination in an additional 13 cats. Taken together, these results indicate large volume effusions in 40 of 65 cats. Peritoneal effusion was detected initially on abdominal radiographs in 19 cats and at necropsy in an additional 6 cats.

The peritoneal effusion was a modified transudate in 24 cats, a pure transudate in 11 cats, a nonseptic exudate in 5 cats, chyle in 3 cats, and septic exudate in 2 cats (Table 3). Cats with cardiovascular and neoplastic diseases had effusions that were primarily modified transudates, whereas 6 of 9 cats with nonneoplastic hepatic disease had effusions that were pure transudates. Definitive identification of neoplastic cells was made in only 3 of the 13 effusions analyzed from cats that were found to have intra-abdominal neoplasia. Eleven of these effusions were serosanguineous. Microorganisms were not isolated from 12 specimens that were tested. Cytologic confirmation of septic exudative effusions was made in 2 cats, but culture results could not be found. One of these 2 cats developed an intestinal perforation secondary to a transmural intestinal adenocarcinoma, whereas the other cat had necrotizing vasculitis and enterocolitis that led to a perforation.

Four of 5 cats with a nonseptic exudative peritoneal effusion had FIP. Chylous peritoneal effusion was associated with right-sided congestive heart failure secondary to severe tricuspid dysplasia, chronic fibroinopurulent peritonitis of undetermined origin, and mast cell tumor of the liver. Serosanguineous effusion was reported most commonly in cats with intra-abdominal neoplasia (5 cats with carcinomas and 1 cat with an anaplastic sarcoma). Other causes of serosanguineous effusion included tears in the urinary tract (n = 2 cats), FIP (2), and necrotizing vasculitis with intestinal perforation and peritonitis (1).

Pleural effusion, pericardial effusion, subcutaneous edema, or pulmonary edema was found in 38 cats (Table 4). Various combinations of pleural effusion, pericardial effusion, subcutaneous edema, and pulmonary edema were detected in 16 of these cats. Concurrent pleural effusion was seen most commonly (32 cats), whereas subcutaneous edema, pericardial effusion, and pulmonary edema were present in decreasing frequency. Pulmonary edema and pericardial effusion were, in general, of small volume and were detected at necropsy. Cardiovascular diseases were significantly more likely to result in peritoneal and pleural effusions than were other causes (P < 0.001). Twenty-seven cats had no fluid accumulation other than peritoneal effusion.

Information on outcome was available for 56 cats. Mean survival was 21 days (range, 1 to 350 days; median, 2.5 days). Fifty-four cats died or were euthanized within 1 year of diagnosis; 39 of these were euthanized within the first week and 10 were euthanized within 7 weeks of diagnosis. Death or euthanasia of these cats was directly related to diseases associated with their peritoneal effusion. Of the 9 cats lost to follow-up evaluation, 3 had trauma to the urinary tract that had been repaired, 1 had hepatic lipidosis that had substantially improved, 1 had FIP, 2 had intra-abdominal carcinomas, 1 had widespread hemangiosarcoma, and 1 had RCM with congestive heart failure.

**Discussion**

Diseases associated with peritoneal effusion in dogs and cats are diverse, but include the same major disease categories as were found in this study. The spectrum of primary diseases found was intriguing, particularly when one considers important discoveries made during the time period that was studied. For example, peritoneal effusion was caused by a cardiac disease in 19 (29%) cats, of which 9 had DCM. Dilated cardiomyopathy was diagnosed before 1987 in 7 of these 9 cats, which was the year that taurine deficiency was documented as a major cause of DCM in cats. From 1981 through 1987, 43% of cats with peritoneal effusion had a primary cardiac disorder, whereas after 1987, only 19% had cardiac disease. Taurine supplementation of commercial cat foods is believed to account for the marked decrease in the number of cats with DCM.

The overall prevalence of intra-abdominal neoplasia (28%; 18 cats) was slightly less than that of cardiovascular disease. In the past decade, however, intra-abdominal neoplasms rather than cardiovascular disorders have been most commonly associated with peritoneal effusion. Other diseases associated with peritoneal effusion in cats were uncommon. Thus, on the basis of results of our study on this population of cats, a cat with peritoneal effusion today would most likely have (in descending order of likelihood) neoplasia, car-
diac disease, hepatic disease, or renal disease. Less likely differential diagnoses would include peritonitis of undetermined cause, FIP, and trauma to the urinary tract.

It was surprising that peritoneal effusion was rarely associated with FIP. One possible explanation is that there were few cats with FIP seen at this institution. However, during the time period of this study, FIP was diagnosed in 76 cats, of which only 4 (5%) had abdominal effusion. It is possible that a disproportionate number of cats with noneffusive FIP were seen, because the veterinary teaching hospital is a referral center. Cats with effusive FIP, which is more easily diagnosed, may not be referred to a university hospital. It would be interesting to examine records from large primary care facilities to determine if the incidence of FIP as a cause for peritoneal effusion would be as low as was found in our study.

Of the neoplastic causes for peritoneal effusion, carcinomatosis was most common (7/18 cats with neoplasms). Carcinomas typically arose from the gastrointestinal tract, pancreas, or mammary gland. Mast cell tumor, granular lymphoma, mesothelioma, and luteoma are causes of peritoneal effusion reported in cats.8,17,23 Lymphoma and intra-abdominal mast cell tumors were found in cats in our study.

Forty-five percent of cats with primary hepatic disorders had idiopathic hepatic lipidosis, which was unexpected because ascites is uncommon with this disease. Cats with idiopathic hepatic lipidosis and peritoneal effusion were hyperalbuminemic (0.5 to 1.8 g/dl) and had recently been treated with fluids. We hypothesize that decreased oncotic pressure and administration of additional fluids to increase hydrostatic pressure resulted in peritoneal effusion in these cats. Cirrhosis, a cause of peritoneal effusion in dogs and cats,30 was found in only 2 cats in this study. Cholangiohepatitis was found in 2 cats and has been associated with peritoneal effusion.28

Pancreatitis was not associated with peritoneal effusion in cats in our study, although it is a cause of peritoneal effusion in dogs and cats.11,35 In acute severe pancreatitis, effusion results from exudation of fluid from the surface of the inflamed pancreas or peritoneum.6,35 Pancreatitis is a difficult antemortem diagnosis in cats.1,32 However, most cats of this study were necropsied, and pancreatitis was not found.

Forty-two percent of owners complained during initial history-taking that their cat had abdominal distention, which would indicate that the peritoneal effusion was of substantial volume. This was confirmed by the fact that effusion was detected on physical examination in 40 (62%) cats admitted. Other historical and physical examination findings were not suggestive of peritoneal effusion, but rather, reflected associated diseases.

Several physical examination findings had unexpectedly low incidences. A heart murmur, for example, was found in only 7 of 19 cats with peritoneal effusion attributable to right-sided congestive heart failure. A gallop rhythm was found in 6 cats. The incidence of a heart murmur in cats with cardiac disease may have been low, because many cats with DCM in this study were admitted moribund, and a murmur would be less evident or absent if blood flow was decreased, as in cardiogenic shock. Another reason clinicians may have missed a murmur was because they did not auscult the right hemithorax in those cats that had exclusively right-sided heart disease. On the basis of findings of this study, therefore, failure to detect a heart murmur or gallop rhythm in a cat with abdominal effusion does not eliminate underlying cardiac disease.

Dyspnea was a common historical and physical examination finding in cats with peritoneal effusion and primary cardiac disease. Thirteen of 19 cats with cardiac disease were dyspneic on initial examination, compared with only 1 cat each with neoplastic or hepatic disorders, and 3 of 17 cats with other associated diseases.

Icterus was a good indicator of hepatic disease but was uncommon even in cats with primary hepatopathies. Five of 7 cats with peritoneal effusion that were icteric on initial examination had an underlying nonneoplastic hepatic disease. However, only 5 of 11 cats with nonneoplastic hepatic causes of effusion had visible signs of icterus. One cat with icterus had hepatic lymphosarcoma. Hepatomegaly was a less reliable physical examination finding of hepatic disease (Table 2). Cachexia was found in less than a third of the cats in this study and was not indicative of any particular disease category. Although often considered to be associated with intra-abdominal neoplasia, cachexia was found in only 7 of 18 cats. Cachexia was also uncommonly associated with primary cardiac or hepatic disorders, but was found in only 7 of 17 cats with abdominal effusion as a result of peritonitis (attributable to FIP or other causes), renal disease, or urinary tract trauma.

Signalment was helpful in predicting cause of peritoneal effusion. The number of cats ≥ 6 years old was nearly twice that of cats < 6 years old. The incidence of primary cardiac disease tended to decrease with increasing age of the cat. One hundred percent of kittens, 29% of cats 1 to 5 years old, 40% of cats 6 to 9 years old, and 16% of cats > 9 years old had right-sided congestive heart failure associated with their peritoneal effusion. Conversely, the incidence of neoplasia increased with increasing age. None of the cats < 5 years old had neoplastic disease, compared with 20% of 6 to 9 year olds and 45% of cats > 9 year olds. Sex was not a useful predictor of the underlying disorder.

Most peritoneal effusions were modified transudates. Neoplasia and right-sided congestive heart failure were the most commonly identified disorders associated with a modified transudate, and accounted for two-thirds of those cases. Neoplasms in the abdominal cavity can lead to modified transudative effusion through compression of the caudal vena cava or hepatic veins, metastases to the peritoneum, tumor hemorrhage into the abdomen, and possibly the secretion of a factor that alters vascular permeability.19,30 Right-sided congestive heart failure causes hepatic venous stasis, impedes lymphatic drainage from the liver and results in a modified transudative peritoneal effusion. Pure transudates were less common. Eighty-two percent of cats with pure transudative effusion (ie, ascites) had hepatic failure or primary renal disease. Hypoalbuminemia in cats with ascites was severe,
except for 1 cat with chronic renal failure in which it was mild. This cat had been iatrogenically volume overloaded. Hypoalbuminemia results in a decreased plasma oncotic pressure and a shift in Starling’s forces to favor transudation of fluid.\textsuperscript{2,3}

Effusions in cats with FIP were always nonseptic exudates as was the effusion in 1 cat with intra-abdominal neoplasia. In the absence of an effective cell-mediated immune response, FIP virus elicits complement- and proteolytic enzyme-mediated damage to the tunica intima and media of small arteries and veins of the peritoneal and pleural serosa. In the effusive form of the disease, complement-mediated endothelial damage causes increased vascular permeability and leakage of a nonseptic exudate.\textsuperscript{2,5} Septic exudates and chylous effusions were least common. In our study, septic exudates resulted from contamination of the peritoneal cavity by contents of the gastrointestinal tract. Obstruction of lymphatic drainage, as can develop with intra-abdominal neoplasia, rupture of a lymphatic vessel, or lymphangiectasia, results in formation of the milky, triglyceride-rich effusion known as chyle.\textsuperscript{2,3} Chylous peritoneal effusion was associated with a variety of disorders, including mast cell tumor of the liver. Visceral mast cell tumors and systemic mastocytosis are causes of peritoneal effusion in cats.\textsuperscript{3}

Thirty-eight (58\%) cats in this study had fluid in sites in addition to the peritoneal cavity. Concurrent pleural effusion was seen most often. Neoplasia was the most common cause of multi-site effusions in another study\textsuperscript{6} of dogs and cats; other causes included cardiovascular disease, infectious disease, pancreatitis, and nonneoplastic liver disease. This differed from the results of our study, in which cats with concurrent peritoneal and pleural effusions had cardiac disorders (53\%), neoplasia (19\%), hepatic disease (12\%), or renal disease (12\%). Primary cardiovascular disease was also the main cause of concurrent peritoneal and pericardial effusions (7 of 9 cats), or peritoneal effusion and pulmonary edema (2 of 4 cats). Simultaneous subcutaneous edema and peritoneal effusion had diverse causes.

Overall, cats with peritoneal effusion had a poor prognosis, related to the severity of the underlying disease process. Most cats in this study died or were euthanatized within the first year of diagnosis—60% within the first week. True percentages may have been higher, but 9 cats were lost to follow-up evaluation; 4 of these were known to have a terminal disease. Euthanasia was requested as a direct result of the severity of each cat’s condition and poor prognosis for recovery. The presence of concurrent peritoneal and pleural effusions is an indicator of a poor prognosis, because there is an increased risk of death regardless of signalment or underlying disease.\textsuperscript{8} Approximately one-half of the cats in this study had multi-site effusions; outcomes in these cats confirms that effusions in multiple body cavities are a poor prognostic sign.

References


