

Outcome of and prognostic indicators for dogs and cats with pneumoperitoneum and no history of penetrating trauma: 54 cases (1988–2002)

Jennifer A. Smelstoys, VMD; Garrett J. Davis, DVM, DACVS; Amy E. Learn, VMD; Frances F. Shofer, PhD; Dorothy Cimino Brown, DVM, DACVS

Objective—To determine the outcome of and prognostic indicators for dogs and cats with pneumoperitoneum and no history of penetrating trauma.

Design—Retrospective study.

Animals—43 dogs and 11 cats.

Procedure—Medical records of dogs and cats with radiographic evidence of pneumoperitoneum and no history of penetrating trauma were reviewed. Information collected included signalment, previous medical problems, initial complaint, duration of illness, physical examination findings, radiographic findings, laboratory abnormalities, abdominocentesis results, bacterial culture results, concurrent diseases, hospitalization time, and outcome. Abdominal radiographs were reviewed, and radiographic severity of pneumoperitoneum was classified. For those animals that underwent exploratory laparotomy, time from admission to surgery and results of histologic examination of biopsy specimens were recorded.

Results—24 (44%) animals survived and were discharged from the hospital, but none of the variables examined was associated with whether animals survived. Rupture of the gastrointestinal tract was the cause of pneumoperitoneum in 40 animals. However, cause and location of gastrointestinal tract rupture was not associated with whether animals survived. Twenty-three of 40 (58%) animals that underwent exploratory laparotomy survived, compared with only 1 of 14 animals that did not undergo surgery.

Conclusions and Clinical Relevance—Results suggest that pneumoperitoneum in dogs and cats without any history of penetrating trauma is most commonly associated with rupture of the gastrointestinal tract and requires immediate surgical intervention. Even when appropriate treatment is instituted, the short-term prognosis is only fair. (*J Am Vet Med Assoc* 2004;225:251–255)

Pneumoperitoneum is defined as free gas within the peritoneal cavity. Most often, pneumoperitoneum in dogs and cats is a result of abdominal surgery or penetrating trauma.^{1,2} However, a number of conditions not associated with surgery or penetrating trauma have also been identified as possible causes of pneu-

moperitoneum in dogs and cats, including intra-abdominal infection with gas-forming organisms,³ gas leakage from a ruptured hollow viscus,^{4,9} and transmural migration of gas through the wall of the stomach or intestine as a result of distension.¹⁰ Idiopathic, spontaneous pneumoperitoneum has also been reported.^{11,12}

In general, detection of pneumoperitoneum in conjunction with clinical signs of abdominal disease is considered an indication for exploratory surgery. To our knowledge, however, no studies describing the outcome of a series of dogs and cats with pneumoperitoneum that was not associated with penetrating trauma have been published. Therefore, the purpose of the study reported here was to determine outcome of and prognostic indicators for dogs and cats with pneumoperitoneum that was not associated with penetrating trauma.

Criterion for Selection of Cases

The medical records database of the Matthew J. Ryan Veterinary Hospital of the University of Pennsylvania was searched for records of dogs and cats examined between 1988 to 2002 in which a radiographic diagnosis of pneumoperitoneum was made. Dogs and cats with a history of penetrating abdominal trauma, abdominal surgery, or abdominocentesis prior to radiography were excluded from the study.

Procedures

Data collected from the medical records included signalment, previous medical problems, initial complaint, duration of illness, physical examination findings, radiographic findings, results of laboratory testing, abdominocentesis results, bacterial culture results, concurrent diseases, diagnoses, hospitalization time, and short-term outcome (ie, whether the animal survived and was discharged from the hospital). For those animals that underwent exploratory laparotomy, time from admission to surgery, surgical findings, and results of histologic examination of biopsy specimens obtained at the time of surgery were recorded.

All available radiographs were reviewed, and radiographic severity of pneumoperitoneum was classified as mild, moderate, or severe. Mild pneumoperitoneum was defined as free air evident in a single isolated area of the abdomen (**Figure 1**). Moderate pneumoperitoneum was defined as free air evident in multiple areas but not seen diffusely throughout the abdomen (**Figure 2**). Severe pneumoperitoneum was defined as free air seen diffusely throughout the abdomen (**Figures 3 and 4**).

From the Department of Clinical Studies, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA 19104-6010.

Drs. Davis and Learn's present address is Red Bank Veterinary Hospital, 210 Newman Springs Rd, Red Bank, NJ 07701.

Address correspondence to Dr. Smelstoys.

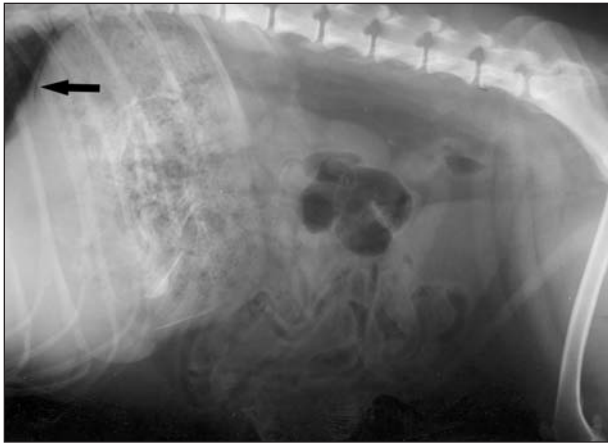


Figure 1—Lateral radiographic projection of the abdomen of a dog with mild pneumoperitoneum. Notice that only a small amount of free air is evident within the abdomen just caudal to the diaphragm (arrow).



Figure 2—Lateral radiographic projection of the abdomen of a dog with moderate pneumoperitoneum. Free air is evident in multiple areas of the abdomen but not seen diffusely throughout the abdomen. Notice how free air surrounds the uppermost kidney, making it appear more radiopaque.

Owners and referring veterinarians of animals that had been discharged from the hospital were contacted by telephone to determine long-term outcome. Information obtained included condition of the animal at the time of discharge from the hospital; complications related to surgery or pneumoperitoneum; current condition of the animal; and, for animals that had died, date and cause of death, if known.

Statistical analyses—Wilcoxon rank sum (categorical variables) and χ^2 (continuous variables) tests were used to determine whether any of the recorded variables were associated with short-term outcome (ie, discharged from the hospital vs euthanatized or died without being discharged). All analyses were performed with standard software.^a Values of $P < 0.05$ were considered significant.

Results

During the study period, pneumoperitoneum was identified in 43 dogs and 11 cats that did not have any



Figure 3—Lateral radiographic projection of the abdomen of a dog with severe pneumoperitoneum. Free air is evident diffusely throughout the abdomen. Angular air opacities represent air entrapped in the omentum. There is also an increase in serosal detail throughout the abdomen.

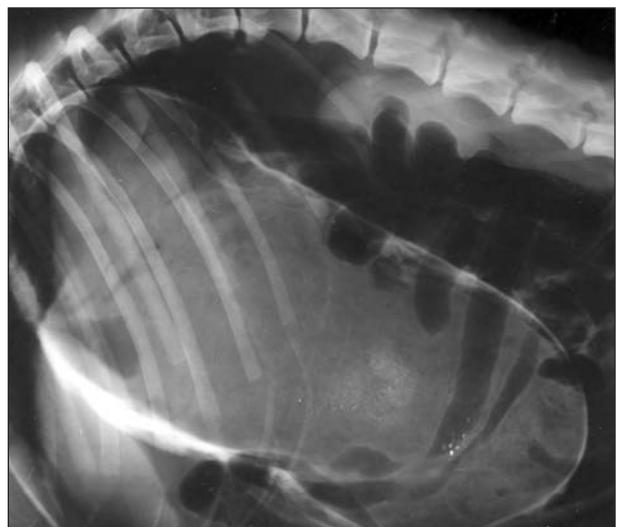


Figure 4—Lateral radiographic projection of the abdomen of a dog with severe pneumoperitoneum secondary to gastric dilatation-volvulus.

history of penetrating trauma. Twenty-four of the 54 (44%) animals, including 18 of the 43 (41%) dogs and 6 of the 11 cats, survived and were discharged from the hospital.

Mean age of the 54 animals was 7.9 years (range, 1 to 16 years). Mean age of animals that survived and were discharged (6.6 years) was not significantly ($P = 0.07$) different from mean age of animals that died or were euthanatized (8.7 years).

Seven of the 43 (16%) dogs were of mixed breeding. The remaining 36 represented 20 breeds, including German Shepherd Dog ($n = 7$ [16%]), Rottweiler (7 [16%]), Golden Retriever (3 [5%]), Saint Bernard (2 [4%]), Great Dane (2 [4%]), and 15 other breeds represented by 1 dog each. Three of the 11 cats were Persians, and 8 were domestic shorthair cats. German Shepherd Dogs, Rottweilers, Saint Bernards, and Great Danes were overrepresented, compared with the hospital population during the same period, as were Persian cats. However, breed (ie, mixed breed vs purebred) was

not associated with short-term outcome (ie, survived and discharged vs died or euthanatized). Eleven animals were sexually intact males, 18 were castrated males, 24 were spayed females, and 1 was a sexually intact female. Sex was not significantly associated with short-term outcome.

The most common initial complaints were lethargy (n = 24 [44%]), vomiting (23 [42%]), signs of abdominal discomfort and distension (20 [37%]), anorexia (19 [35%]), and retching (7 [13%]). Less frequent complaints included diarrhea, collapse, tarry stools, rectal prolapse, and ataxia.

Twelve (22%) animals had a clinically important medical history. This included 3 animals that had undergone surgical correction of gastric dilatation-volvulus several months to a year prior to the diagnosis of pneumoperitoneum, 2 animals that had undergone exploratory surgery for removal of gastrointestinal tract foreign bodies several months to a year earlier, 3 animals in which an unrelated neoplasm had been identified, 2 animals with diabetes mellitus, 1 cat for which results of FeLV testing were positive, and 1 animal with idiopathic epilepsy. Whether animals had a clinically important medical history was not significantly associated with short-term outcome.

Duration of illness prior to examination ranged from 30 minutes to 6 weeks (median, 1.5 days). Twenty-six (48%) animals were examined within 1 day of the onset of initial signs. Duration of illness for animals that survived to discharge was not significantly different from duration of illness for animals that died or were euthanatized. Physical examination findings included signs of abdominal pain and distension (n = 36 [67%]), pale mucous membranes (20 [37%]), increased respiratory rate and effort (16 [30%]), palpably poor femoral pulses (14 [26%]), heart murmur (8 [15%]), cachexia (6 [11%]), and recumbency (6 [11%]). Fifteen (28%) animals had rectal temperatures > 38.9°C (102°F), and 4 (7%) had rectal temperatures < 37.2°C (99°F). No individual clinical sign was more or less likely to be present in animals that survived and were discharged, compared with animals that died or were euthanatized.

Although pneumoperitoneum had been diagnosed in all 54 animals on the basis of radiographic abnormalities, radiographs from only 40 animals were available for review. On the basis of radiographic abnormalities, pneumoperitoneum was classified as mild in 10 of these 40 (25%) animals, moderate in 10 (25%), and severe in 20 (50%). Other abdominal radiographic abnormalities included poor abdominal detail (n = 22 [55%]), gastric dilatation-volvulus (10 [25%]), dilatation of the stomach without torsion (8 [20%]), and dilatation of the small intestine (8 [20%]). Other less common radiographic abnormalities included gastrointestinal tract foreign bodies, obstructive bowel pattern, diaphragmatic hernia, fractures, large sternal lymph nodes, pleural effusion, and abdominal mass effect. Neither radiographic severity of pneumoperitoneum nor whether animals had radiographic abnormalities other than pneumoperitoneum was significantly associated with short-term outcome.

In all 54 animals, PCV and blood total solids and glucose concentrations were measured. A CBC and

serum biochemical profile was performed in 47 animals, and a coagulation profile was performed in 23 animals. Serum biochemical abnormalities included high hepatic enzyme activities (n = 27 [50%]), azotemia (19 [35%]), hypoglycemia (10 [19%]), and hyperglycemia (6 [11%]). Hematologic abnormalities included high WBC count (n = 22 [41%]), low WBC count (2 [4%]), and anemia (12 [22%]). Coagulation abnormalities included prolonged clotting times (n = 11 [20%]) and thrombocytopenia (8 [15%]).

Abdominocentesis was performed in 17 of the 54 animals after abdominal radiographs were obtained; fluid that was obtained was submitted for cytologic analysis. Eight of the 17 animals had inflammatory exudates, and 2 had hemorrhagic effusions. In the remaining 7 animals, the exudate was considered septic.

Forty animals underwent exploratory laparotomy, of which 23 (58%) survived and were discharged from the hospital. Six of the 17 animals that did not survive were euthanatized at the time of surgery at the owner's request because of the extent of disease and perceived poor prognosis. The other 11 survived the immediate postoperative period and were euthanatized or died without being discharged from the hospital. One of the 14 animals that did not undergo surgical exploration survived and was discharged. The other 13 animals that did not undergo surgery died or were euthanatized at the owner's request because of the extent of disease and perceived poor prognosis.

For animals that underwent exploratory laparotomy, time from admission to the hospital to surgery ranged from 1 hour to 3 days. Twenty-eight of the 40 (70%) animals underwent surgery within 12 hours after admission to the hospital, 7 (18%) underwent surgery between 12 and 24 hours after admission to the hospital, and 5 (12%) underwent surgery > 24 hours after admission to the hospital. Time from admission to surgery for animals that survived to discharge was not significantly different from the time from admission to surgery for those animals that died or were euthanatized.

Biopsy specimens were collected at the time of surgery from 22 animals. Histologic examination revealed gastrointestinal tract inflammation, ulceration, necrosis, and perforation in 13 of the 22 animals. In addition, 2 animals had lymphosarcoma, 2 had extensive granulation tissue within the gastrointestinal tract, 1 had necrotizing colitis, 1 had a cecal leiomyosarcoma that had ruptured, and 1 had a gastric carcinoma that had ruptured. In the remaining 2 animals, histologic examination of biopsy specimens did not reveal any abnormalities.

In 25 animals, a sample of peritoneal fluid was submitted for aerobic and anaerobic bacterial culture. Samples were obtained by means of abdominocentesis, direct swab of the abdominal cavity at the time of surgery, or both. Multiple organisms were obtained from 14 of the 25 (56%) animals, and a single organism was obtained from 7 (28%). In the remaining 4 (16%) animals, bacterial culture of peritoneal fluid did not yield any growth. Organisms commonly isolated included *Clostridium* spp (n = 9), *Enterococcus* spp (9), *Escherichia coli* (7), *Proteus* spp (3), and *Enterobacter* spp (2).

Rupture of the gastrointestinal tract was identified as the underlying cause of the pneumoperitoneum in 40 of the 54 (74%) animals. Gastrointestinal tract rupture was a result of gastric dilatation-volvulus in 13 animals, a gastric or small intestinal perforating ulcer in 7, gastric or small intestinal neoplasia in 6, and a perforating small intestinal foreign body in 5. The stomach was ruptured as a result of blunt trauma in 4 animals, and the colon was perforated in 5. Causes of colonic perforation included pelvic fracture, blunt trauma as a result of being hit by a car, megacolon and colonic stricture, and severe segmental necrotizing colitis.

Transmural migration of gas across vascularly compromised stomach or intestine was believed to be the cause of pneumoperitoneum in 4 of the 54 (7%) animals. None of these dogs had an obvious rupture of the gastrointestinal tract; 3 had gastric dilatation-volvulus, and 1 had mesenteric volvulus.

Other causes of pneumoperitoneum included splenic abscess in 1 animal, liver abscess in 1, and clostridial peritonitis in 1. The cause of pneumoperitoneum was not determined in the remaining 7 animals; these animals did not undergo surgery or necropsy.

Overall, pneumoperitoneum was attributed to compromise or rupture of the stomach in 26 animals, to compromise or rupture of the small intestine in 13, and to rupture of the colon in 5. Location of gastrointestinal tract compromise or rupture was not significantly associated with short-term outcome.

In 10 animals, concurrent diseases unrelated to the development of pneumoperitoneum were found at surgery or necropsy, including lymphosarcoma in 3 animals and hemangiosarcoma, gastric carcinoma, endocrine carcinoma, megacolon, pancreatitis, rectal prolapse, and leiomyosarcoma in 1 animal each.

Total hospitalization time for all animals ranged from < 1 day to 10 days (mean, 3.1 days; median, 2.8 days). Total hospitalization time for those animals that survived to discharge ranged from 1 to 10 days (mean, 5 days).

Information on long-term outcome was available for 8 of the 24 animals that were discharged from the hospital. Survival time for these 8 animals ranged from 6 days to > 3 years (median, 210 days). Causes of death included severe acute fibrinosuppurative peritonitis, focal esophageal perforation, and aspiration pneumonia. These animals all died within 3 weeks of discharge from the hospital. One animal died of lymphosarcoma 6 months later. Four animals had no necropsy performed; however, because survival times for these animals ranged from 180 to 1,095 days, the cause of death was thought to be unrelated to the cause of pneumoperitoneum.

Discussion

In the present study, rupture of the gastrointestinal tract was the most common underlying cause in dogs and cats with pneumoperitoneum that was not associated with penetrating trauma, with gastrointestinal tract rupture identified in 40 of 54 animals. This finding supports the recommendation that immediate surgical intervention is warranted in most animals with pneumoperitoneum. A definitive cause of the pneu-

moperitoneum was identified in 39 of the 40 animals that underwent exploratory laparotomy, and in all 39, it was considered unlikely that the condition would have resolved without surgical intervention. By comparison, between 5% and 15% of human patients with pneumoperitoneum do not have gastrointestinal tract perforation and do not require surgical management.¹³

One animal in the present study that did not undergo surgery did survive long enough to be discharged from the hospital. This suggests that in some dogs and cats with pneumoperitoneum that is not associated with penetrating trauma, surgery may not be necessary and that in dogs and cats with pneumoperitoneum that is not associated with penetrating trauma, nonsurgical causes should be considered, especially if the animal has minimal signs of abdominal pain and distension and does not have a fever or leukocytosis. Nevertheless, our findings suggest that this is an unusual situation. In addition, the animal in the present study that was discharged without undergoing surgery was lost to follow-up. Therefore, we do not know whether this animal survived. As a result, we suggest that exploratory laparotomy be considered for all dogs and cats with pneumoperitoneum that do not have a history of penetrating trauma.

In the present study, location of compromise or rupture of the gastrointestinal tract (ie, stomach vs small intestine vs colon) was not significantly associated with short-term outcome (ie, discharged from the hospital vs died or euthanatized without being discharged). Because of the bacterial flora of the colon, one might assume that perforation of the colon would be associated with a worse prognosis than perforation of the stomach or small intestine. However, all 5 animals in the present study with pneumoperitoneum secondary to colonic perforation survived long enough to be discharged from the hospital.

Sixteen dogs in the present study had pneumoperitoneum secondary to gastric dilatation-volvulus. Gastric dilatation-volvulus can be diagnosed by means of radiography, but in dogs and cats with pneumoperitoneum related to other causes (eg, ulceration and neoplasia), the underlying cause is often not obvious on the radiographs. Because ultrasonography of the abdominal organs is often difficult or impossible in animals with pneumoperitoneum, the underlying cause can often not be determined prior to surgical exploration. This can be frustrating for owners, particularly owners of older animals, who may find it difficult to make the decision to pursue surgery without knowing the cause and likely prognosis. In the present study, animals that died or were euthanatized were not significantly older than animals that survived. However, the *P* value was close to the cutoff for significance, suggesting that a significant difference might have been found if more animals had been included.

Thirteen animals in the present study did not undergo surgery and died or were euthanatized at the owner's request on the basis of extent of disease and perceived poor prognosis. All of these animals received initial treatment to stabilize their condition at the time of admission. One of the limitations of retrospective studies such as the present one is that the owner's rea-

sons for electing euthanasia are often not recorded in the medical record. Thus, it is often unclear from the review of medical records whether the decision was based on the perceived prognosis or a failure to respond to initial treatment. Nevertheless, surgical exploration was offered to all owners of animals in the present study.

Concurrent disease was not found to be a prognostic indicator in the present study. In many instances, concurrent disease was not identified until after results of histologic examination of biopsy or necropsy specimens were obtained. Because of this, these animals were no more likely to be euthanatized during surgery than were animals without concurrent diseases.

German Shepherd Dogs, Rottweilers, Saint Bernards, and Great Danes were overrepresented in the present study, compared with the hospital population during the study period. This may be attributable in part to the fact that large-breed, deep-chested dogs more commonly develop gastric dilatation-volvulus than do dogs of other breeds. In addition, Rottweilers may have been overrepresented because of their increased risk of perforating gastrointestinal tract ulceration.⁶

Overall, we found the short-term prognosis for dogs and cats with pneumoperitoneum that was not associated with penetrating trauma to be only fair, in that only 24 of the 54 (44%) survived and were discharged from the hospital. The prognosis was slightly better for those animals that underwent exploratory surgery, in that 23 of these 40 (58%) animals survived and were discharged.

Information on long-term follow-up for animals included in the present study was limited. Two of the 8 animals for which follow-up information was available died within a week after discharge, and in both, the cause of death may have been related to the initial pneumoperitoneum or a surgical complication. One died of severe peritonitis, and the other had a focal esophageal tear. The remaining 6 animals for which follow-up information was available died of causes likely unrelated to the initial pneumoperitoneum.

Identifying small amounts of free gas on abdominal radiographs from dogs and cats can be difficult. Because of this, mild pneumoperitoneum may have

been missed in some animals examined during the study period, and these animals would not have been included in the present study.

Results of the present study suggest that identification of pneumoperitoneum in dogs and cats without any history of penetrating trauma warrants immediate surgical intervention. The underlying cause of the pneumoperitoneum did not seem to be associated with outcome; however, the short-term prognosis was only fair. A larger study is needed to determine long-term outcome of animals that survive the initial treatment and postoperative period.

^aSAS statistical software, version 8.0, SAS Institute Inc, Cary, NC.

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