

Exocrine Pancreatic Disease in Cats

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Diseases of the feline exocrine pancreas are difficult to diagnose and treat. Although the cat appears to be susceptible to the same spectrum of pancreatic diseases as the dog, that is, acute and chronic pancreatitis, exocrine insufficiency, and pancreatic neoplasia, these disorders are much more difficult to recognize clinically in cats than in dogs. In a recent review of pancreatic diseases in cats, 1027 cases were diagnosed in a population of 180,640 cats (0.57%) incidence. Thirty eight per cent of these 1027 cats had pancreatitis, 25 per cent had pancreatic neoplasia and 1 per cent had exocrine pancreatic insufficiency. Others have estimated the incidence of pancreatic diseases in cats to be between 1.5 and 35/1000 cat accessions. At the University of Pennsylvania the incidence of fatal acute pancreatitis was 1 in every 600 new feline admissions (0.16% incidence). Based on necropsy identified lesions, the incidence of pancreatic disease in cats is 1.3%, a figure that is close to that in dogs at 1.5%. Other less common diagnoses that involve the feline pancreas include nodular hyperplasia, pancreatic bladder, pancreatic fluke infestation, pancreatic pseudocysts, and pancreatic abscess. In most published reports of feline pancreatic diseases the diagnosis was established at exploratory surgery (rarely) or on the necropsy table (most often). This trend is slowly changing as new diagnostic modalities become available for diagnosing pancreatic diseases in cats.

INFLAMMATORY PANCREATIC DISEASE

Inflammatory pancreatic disease may be characterized as acute or chronic, but this is more appropriate for pathologic studies and is not often clinically relevant. On a clinical basis, it is impossible to differentiate these two classes of pancreatitis without histologic confirmation. Recent reports have differentiated a particularly severe form of acute pancreatitis into two distinct diseases based on histologic characteristics. These are: acute pancreatic necrosis and suppurative pancreatitis. The authors excluded the most common form of pancreatitis in cats, chronic non-suppurative pancreatitis, from their discussion since most cats with this form of the disease have silent or very mild clinical signs. On a clinical basis, acute pancreatic necrosis and suppurative pancreatitis are indistinguishable and are treated similarly. For the purposes of this discussion I will consider all forms of feline pancreatitis that produce severe clinical signs and have similar diagnostic and therapeutic approaches as acute pancreatitis.

Etiopathogenesis

The etiopathogenesis of feline pancreatitis is poorly understood. Evaluation of published cases points to a number of recognized etiologic associations: (1) coexisting cholangitis/cholangiohepatitis (2) coexisting hepatic lipidosis, (3) pancreatic trauma (4) pancreatic involvement with toxoplasmosis, and feline Herpes virus infections, (5) FIP, and (6) pancreatic fluke infestations.

Biliary tract disease has been documented to coexist with pancreatitis in many reported cases of feline pancreatitis. Some investigators consider cholangitis to be frequently, if not always present in cases of chronic interstitial pancreatitis. It is presumed that ascending bacterial infections of both the common bile duct and major pancreatic duct occur simultaneously. Since the major pancreatic duct and common bile duct enter the duodenum at a common papilla, this is at least possible. Culture of bile has only been reported in two cases. Cultures were negative in one cat that had received

systemic antibiotics prior to culture and positive in a second case (*Escherichia coli*) that had not had prior antibiotic therapy. It is also possible that cholangiohepatitis precedes the onset of pancreatitis and may be responsible for its initiation. Retrograde lymph flow may occur from the extrahepatic biliary system into pancreatic lymphatics, carrying bile salts to the pancreas, bile salts being capable of initiating acute pancreatitis

A recent association has been made between the presence of idiopathic hepatic lipidosis (IHL) and pancreatitis. One study of cats with IHL found 38% had coexisting histologic evidence for acute pancreatitis. Since signs of IHL and pancreatitis are similar, and both have a high mortality, clinicians should pursue diagnostic efforts to identify pancreatitis in cats with IHL who fail to improve during early phases of their illness.

The pancreatic trematode, *Eurytrema procyonis*, has been identified within the pancreatic ducts of cats from a number of areas around the United States (New Jersey, Kentucky, Missouri, and the Ohio River Valley). Chronic infestations lead to severe pathologic changes, both microscopically and functionally, within the pancreas. Severe ductular and acinar fibrosis occur. Clinical signs relative to pancreatitis or exocrine insufficiency have not been reported, however. The cat liver fluke, *Amphimerus pseudofelineus*, has been associated with chronic cholangitis and chronic pancreatitis (pancreatic cirrhosis) in a cat. Flukes were identified within hepatic and pancreatic cysts.

Several reports of traumatic acute pancreatitis in cats have appeared. All reported cases have been uniformly fatal, having a clinical course similar to hemorrhagic pancreatitis in dogs. A number of unique radiographic features are present and are discussed further below.

Acute interstitial pancreatitis is considered common in cases of systemic toxoplasmosis in cats. A 1-year-old cat developed chronic pancreatitis and obstructive jaundice associated with pancreatic infiltration by toxoplasma organisms. The diagnosis was made at necropsy.

Feline Herpes virus was isolated from two kittens at necropsy, both of which had evidence for necrotizing pancreatitis. Herpes virus was cultured from the pancreas and intranuclear viral inclusions were identified from one of the kittens. The primary clinical signs in these kittens were related to respiratory abnormalities, not gastrointestinal.

Unlike dogs, cats do not appear to be predisposed to the development of pancreatitis in association with high fat meals or the administration of drugs, particularly glucocorticoids. In addition, there does not appear to be an association between obesity and the onset of pancreatitis in cats as there is in dogs. In spite of the afore mentioned known causes for feline pancreatitis, in the majority of cases, a cause is never identified.

The pathogenesis of pancreatitis in cats is generally much less severe than in dogs and is rarely a cause for death of the animal except for cats with acute pancreatic necrosis or suppurative pancreatitis. Mortality is also high in the rare cases of traumatic pancreatitis. In animals with cholangitis/cholangiohepatitis diagnostic efforts generally focus on the hepatic component and the pancreatitis remains relatively benign clinically unless common bile duct compromise occurs. In those cases, surgery is necessary to relieve the extrahepatic obstruction caused by chronic pancreatic fibrosis. In most cats with chronic pancreatitis, the diagnosis is established at necropsy and the pancreatitis generally remains subclinical.

A significant number of cats develop diabetes mellitus secondary to extensive islet cell destruction during the inflammatory process. Approximately 20 percent of diabetic cats in my own practice show evidence of chronic pancreatitis at necropsy.

Clinical signs of active pancreatitis are rarely present, however, with this chronic form of the disease.

Clinical Findings

Establishing a diagnosis of acute pancreatitis in cats requires considerable clinical acumen, thorough case histories, complete physical examinations, extensive laboratory and radiographic evaluations, and a good deal of intuition. Cats with this more severe form of pancreatitis have a wide age range, from 3 weeks to 16 years. Males equal females in frequency. Siamese cats appear to be over represented in some studies, but the majority are domestic short haired cats. Most are indoor cats and they generally are fed commercial brands of cat food. Obesity is present in 22% of the cats, while 57% are underweight. This contrasts with dogs in which obesity predisposes to more severe forms of pancreatitis. The clinical course is three days or less in 38% of cases of acute pancreatitis.

Clinical signs are very non-specific. . Most have vague histories of lethargy and anorexia and then present for acute deterioration and have a rapid decline in spite of aggressive therapeutic attempts. Lethargy (100%), anorexia (97%), dehydration (92%) and hypothermia (68%) are the most frequent observations. Less often observed clinical signs include vomiting (35%), abdominal pain (25%), palpable cranial abdominal mass (23%), weight loss (23%), jaundice (23%), dyspnea (20%), diarrhea (15%), ataxia (15%), fever (7%), and polydipsia/polyuria (7%). Jaundice is present in cases with coexisting cholangiohepatitis or lipidosis and in some cats with chronic pancreatitis and fibrosis that obstructs the common bile duct. Pleural effusions are an uncommon finding and may result in muffled heart sounds on auscultation and dyspnea. Peritoneal effusions are identified during physical exam or following radiographic evaluations infrequently. Polydipsia and polyuria are secondary to coexisting diabetes mellitus or renal failure. Hepatomegaly may be palpable in cats with coexisting lipidosis or cholangiohepatitis.

A rare clinical finding associated with chronic pancreatitis is systemic lipodystrophy. Cats present with multiple subcutaneous nodules that may drain an oily fluid out the skin. Disseminated areas of fat necrosis are responsible for this manifestation.

Laboratory and Radiographic Findings

Laboratory and radiographic evaluations of cats with inflammatory pancreatic disease are supportive of the diagnosis but except for serum feline trypsin-like-immunoreactivity (fTLI), have little diagnostic specificity. Hematologic findings may identify a neutrophilia (30%), and anemia is found in (26%). The hematocrit tends to progressively decline as the disease progresses. Hepatic abnormalities include > ALT (68%), > ALP (50%), > total bilirubin (64%), and > cholesterol (64%). Hyperglycemia is common (64%), as is glucosuria (60%). Ketoacidosis is present in 20% of cats with acute pancreatitis. In diabetic cats whose insulin requirements decline or cease entirely, chronic pancreatitis should be suspected. Mild flareups of pancreatitis may transiently impair the cats' insulin responsiveness leading to relapse of insulin dependent diabetes.

Hypoglycemia is a prominent laboratory finding in the cats in which suppurative pancreatitis is diagnosed at necropsy.

Renal failure is generally mild when present, and is infrequently identified in cats with acute pancreatitis. Hypokalemia is common (56%).

Hypocalcemia can be identified in as many as 45% of cats with acute pancreatitis. It is generally mild and associated with low normal or low serum albumin concentrations (relative hypocalcemia). However, in some cases it can be severe (< 7 mg/dl). Since other causes for hypocalcemia are rare in cats, finding this electrolyte abnormality in a cat with non specific signs of illness may direct you to think of pancreatitis.

Lipemia is uncommon in cats with pancreatitis, being identified in 10% of cases.

Amylase and lipase evaluations are nearly always non-diagnostic for pancreatitis in cats and cannot be recommended as diagnostic tests for this feline disease. Amylase values also increase in cats with renal failure and since renal failure may coexist with pancreatitis, elevations most likely reflect compromised renal function not the presence of pancreatitis. Nearly all cases of confirmed acute pancreatitis in which amylase or lipase values were run, have been normal.

Recently, an assay for feline trypsin-like-immunoreactivity has been validated for use in the cat. This test is very useful for diagnosing exocrine pancreatic insufficiency (EPI) and will be discussed later for that purpose. However, initial evaluations in cats suspected of having acute pancreatitis support its value in this disease as well. The assay detects the presence of trypsin and other similar proteins released from the pancreas into the blood stream as a normal process. Serum concentrations of fTLI decrease in EPI and, conversely, they should increase during inflammation of the pancreas as intrapancreatic enzymes are liberated into the circulation. Normal values are 17-49 µg/L by RIA and 12-82 µg/l by a newer elisa assay. In a report of 12 cats with confirmed acute pancreatitis, mean fTLI values were 100 µg/L and ranged from 14 to 540 µg/L. These values were significantly above controls and values obtained in cats with other illnesses. A recent publication has expanded our knowledge of feline TLI assays in terms of sensitivity and specificity. The sensitivity of this assay for detecting the presence of pancreatitis in cats is 86% while the specificity is 89%. Some authors recommend a cut off of 100 mg/l by Elisa assay to increase specificity but it will decrease the sensitivity of the test. Samples can be sent for analysis to: Gastrointestinal Function Test Laboratory, c/o Dr. David Williams, College of Veterinary Medicine, Texas A & M University, College Station Texas, 77843-4474. Phone (409) 862-2861, Fax (409) 862-2864. Current costs for the fTLI sample is \$20.00 and requires 0.5 ml of serum (6 hr fasting sample).

In cases where abdominal effusions are identified following palpation, survey radiographs or ultrasound, abdominocentesis yields a serosanguinous fluid characteristic of a sterile exudate.

Abdominal and thoracic radiographs may be of value in the diagnosis of pancreatitis. The normal pancreas is not radiographically visible. In pancreatitis, displacement of adjacent organs in the upper right quadrant of the abdomen may occur. Additional radiographic abnormalities include blurring of visceral outlines and a mottled flaky density confined to the ventral mesogastrium. Slow spreading of inflammation to involve the entire ventral abdomen may occur. Dorsal or dorsomedial displacement of the duodenum and corrugation and spasticity of the duodenal wall are findings considered nearly pathognomonic for traumatic pancreatitis in cats. Pleural effusions are occasionally seen in cats with severe pancreatitis. Ultrasound evaluations of the abdomen will identify cranial abdominal soft tissue masses in the region of the pancreas and increased peritoneal fluid in some cats. The pancreas is generally characterized as

hypoechoic, a dilated pancreatic duct may be seen and peripancreatic fat is often noted to be hyperechoic. If bile duct obstruction is present, it too can be identified via ultrasound. Ultrasound has low sensitivity for detecting pancreatitis, identifying changes compatible with the disease in approximately 40% of cats. If lesions are identified via ultrasound, however, it's specificity is 100%.

The clinical and pathologic changes in experimentally induced feline pancreatitis have been described. Depression, fever, rare vomiting (a single episode in two of six cats), and mild tachycardia were the only clinically significant abnormalities. Abdominal discomfort and palpable cranial abdominal masses were detected in all cats. Abdominal ultrasound detected increased soft tissue and fluid echodensities in the pancreatic and peripancreatic region. Survey abdominal radiographs in two cats detected a cranial abdominal mass and loss of abdominal detail.

Significant hematologic abnormalities in these experimental cats were limited to mild, normocytic, normochromic regenerative anemias. No significant neutrophilia or left shift were seen. Biochemically, the serum lipase was significantly increased in all cats. Lipase concentrations were six times normal during the initial 12 to 24 hours postoperatively, but fell to three times normal for the next 2 days and were two times baseline on days 4 through 7. Interestingly, serum amylase concentrations were significantly decreased during the acute stages of illness. No significant changes occurred in ALT, SAP, or serum bilirubin concentrations. Mild hypocalcemia and hypercholesterolemia were the only other significant clinicopathologic abnormalities. Exocrine insufficiency was assessed using bentiromide. Although absorption was delayed and peak values were less postoperatively than preoperatively, the differences were not significant from baseline values.

In summary, a definitive diagnosis of pancreatitis in cats is difficult to make on the basis of clinical, biochemical, and radiographic data, and the diagnosis will in many cases be speculative, at best. In acute severe cases, abdominal ultrasound and fTLI may be your best diagnostic tests to establish a diagnosis. Exploratory surgery or necropsy findings have been the procedures used to diagnose most chronic cases. However, the findings of a palpable cranial abdominal mass in association with peritoneal fluid accumulation and transient hyperglycemia and mild hypocalcemia in vomiting, depressed, anorectic cats is strongly supportive of this diagnosis.

Therapy

Therapeutic efforts for cats with pancreatitis should be directed at reversing the etiology, when known, and at providing general supportive and symptomatic care when indicated. For cats identified as having cholangiohepatitis and chronic pancreatitis, antibiotics, with or without glucocorticoids, may bring about improvement in the hepatic disease and cause the pancreatic inflammation to subside. A liver biopsy should be performed prior to initiating antibiotic therapy, so that cultures (aerobic and anaerobic) can be taken both of hepatic tissue and of bile. If common bile duct obstruction is present due to pancreatic fibrosis, bile patency must be restored surgically.

In cats with lipidosis and coexisting pancreatitis nutritional support is of paramount importance. Mortality for cats with both diseases concurrently was 80% in one recent study while the mortality rate for cats with only IHL is generally <40%. Feeding via nasogastric intubation or gastrostomy tubes is probably contraindicated in the

face of active pancreatitis. Jejunostomy tubes or TPN support is likely to be required to save cats with this combination of diseases.

Pancreatic fluke infestations can cause significant functional alterations in the pancreas. Even though clinical signs of disease rarely exist, it is reasonable to treat affected cats to eliminate the flukes. Treatment with 30 mg/kg oral fenbendazole once daily for six consecutive days resulted in negative fecal examinations in one reported case. The drug was continued for an additional 3 days after the negative fecal exam was obtained.

Therapy for cats with chronic pancreatitis that become diabetic should be directed toward managing the diabetes. Occasionally, such cats become non-insulin dependent, presumably because as pancreatic inflammation subsides, islet cell function improves.

General supportive care is indicated for cats with more acute pancreatitis utilizing guidelines recommended for dogs. Balanced polyionic isotonic rehydrating fluids, such as lactated Ringer's solution, should be administered in volumes sufficient to meet the cat's maintenance requirements, replace any deficits, and keep pace with ongoing losses. Because hypokalemia is a common finding in cats with pancreatitis, supplementation is warranted based on the severity of the deficits. In the rare fulminant cases, whole blood transfusions (if anemia is severe), or plasma may be of benefit to replace depleted alpha-2-macroglobulins which remove circulating active proteases and to combat DIC.

Three agents, dopamine, terbutaline, and isoproterenol have been used in experimental models of feline hemorrhagic pancreatitis to modify inflammation and necrosis. All three drugs produce significantly decreased inflammation of the pancreas if given within 12 hours of the onset of disease. If given later in the course, no improvement will be noted. Dosages for dopamine are 5 µg/kg/min intravenously and administered for 6 hours. Dopamine decreases the permeability of pancreatic ducts, decreasing loss of pancreatic enzymes into the pancreatic interstitium. The beta adrenergic agonist terbutaline sulfate is given at a dosage of 10 µg/kg/hr as a constant rate infusion for 24 hours. Isoproterenol is given at 0.3 µg/kg/min, also as a constant rate infusion over 24 hours. Both the beta agonists prevent vascular and pancreatic ductal fluid extravasation into the pancreatic interstitium. Since most cats present with longer courses of disease than in these experimental models, it is doubtful that any of these three agents will be of value in clinically ill cats.

The benefit of prophylactic antibiotics in feline pancreatitis has not been confirmed. In most cases, infectious complications are not recognized. In man, antibiotics with the best spectrum against bacterial pathogens identified in pancreatitis are: clindamycin, metronidazole, tobramycin, and ciprofloxacin. Antibiotics considered slightly less effective included cefotaxime, ceftazidime, netilmicin, rifampin, and trimethoprim-sulfa. Be very cautious of using aminoglycosides if any renal compromise is present.

Food and water should be withheld during the acute vomiting state (2-3 days), as with other nonspecific gastroenteritides. Antiemetics may be needed to control fluid and electrolyte losses secondary to vomiting or diarrhea in some cats (metoclopramide 0.20-.5 mg/kg SQ q 8 h). Gradual introduction of a low fat diet is indicated once signs of vomiting subside for 24 to 48 hours. Small frequent feedings are preferable to single large meals. Enteral support for persistently anorexic cats may be provided by a surgically placed jejunostomy tube in which a highly digestible enteral diet can be

administered (Precision-LR, Sandoz). TPN or partial TPN may be needed in cats that continue to vomit after an initial 3 to 4 days of supportive care.

Pain control can be provided by administering meperidine at 1-2 mg/kg IM or SQ q 2-4 hrs, or butorphenol at 0.2-0.4 mg/kg SQ q 8hrs.

Unfortunately, there are few documented reports of cats surviving severe pancreatitis. In spite of major therapeutic efforts this disease is relentless in its progression in most cats.

EXOCRINE PANCREATIC INSUFFICIENCY

Exocrine pancreatic insufficiency (EPI) is a rare disease in cats. Few well-documented cases have been reported. Several cases have been reported in which the diagnosis was based primarily on clinical signs and/or response to therapy. In an epidemiologic study of 180,640 cats, only 1027 had evidence of pancreatic disease and of these, only 11 had a diagnosis of exocrine pancreatic insufficiency. The cat apparently has a large functional pancreatic reserve as evidenced by the severe damage that can be induced by both chronic pancreatitis and pancreatic fluke infestations without producing signs of EPI. The most common cause for EPI in cats is chronic pancreatitis. No reports of pancreatic acinar atrophy have appeared but anecdotal mention is made in one article of three cats with lesions resembling pancreatic atrophy.

Clinical Findings

Cats with EPI are generally alert and active and have tremendous appetites. They eventually develop chronic weight loss to the point of emaciation, and have high volume stool production. Stool character is loose to semiformal, rarely watery and is yellow to clay colored and malodorous. Diabetes mellitus may coexist with EPI in rare cases. An oil stained perineum may be observed. Excessive borborygmi may be noted by some owners.

Diagnostic approaches for EPI in cats have used similar techniques to those used for dogs with EPI, that is, qualitative assessment of fecal fat, protein fibers, and starch granules; fecal proteolytic activity, using x-ray film digestion or gelatin digestion; and therapeutic response, using pancreatic enzyme supplements. Since no information is available on the reliability or specificity of these evaluations in normal cats, it is difficult to assess the significance of results in cats suspected of having EPI. Affected cats have reportedly had evidence for undigested food in their stools, had increased numbers of both split and unsplit fat droplets in fecal smears stained with Sudan III, and increased starch granules in feces stained with iodine. Proteolytic activity of feces was also reported to be absent in a number of cases.

Routine laboratory work is rarely helpful. The CBC is usually normal. Chemistry abnormalities include mild increases in ALT and ALP concentrations, and mildly decreased concentrations of cholesterol and triglycerides.

The recent availability of serum feline trypsin-like immunoreactivity assay has helped to improve the diagnostic specificity of available laboratory tests. As in dogs, cats with EPI have severely depressed serum concentrations of fTLLI. Normal values are 17 to 49 µg/L and in 11 confirmed cases of feline EPI values were consistently < 8 µg/L. In addition to severely decreased fTLLI concentrations, serum cobalamin and folate concentrations are often also depressed, secondary to coexisting small intestinal

malabsorption. Cobalamin deficiency leads to severe villous atrophy, intestinal inflammation and malabsorption. Normal serum cobalamin concentrations in cats are 200-1680 ng/L and in cats with EPI these values are < 27 ng/L, implying severe vitamin B¹² deficiency. Normal serum folate concentrations for cats are 13.4-38 µg/L. FTLI, cobalamine and folate may all be obtained by sending samples for analysis to: Gastrointestinal Function Test Laboratory, c/o Dr. David Williams, College of Veterinary Medicine, Texas A & M University, College Station Texas, 77843-4474. Phone (409) 862-2861, Fax (409) 862-2864. Current costs for the fTLI, cobalamine and folate is \$35.00 and requires 1.5 ml of non-hemolyzed serum from a fasted cat (6-18 hr fast).

The signs observed in cats with EPI are quite similar to those found in cats with diffuse infiltrative small bowel disease (inflammatory and neoplastic), and hyperthyroidism. These latter diseases are much more common than documented EPI. A serum thyroxine (T₄) determination and appropriate diagnostic tests to rule out infiltrative small intestinal disease should be performed on all cats with clinical signs of EPI, so that the correct diagnosis may be made. One of the earliest case reports of feline EPI had evidence of chronic pancreatitis as well as a large thyroid adenoma present on necropsy. This cat had a partial response to therapy, similar to the response observed in hyperthyroid cats given pancreatic enzyme supplements.

Therapy

Specific therapy for feline EPI is based on recommendations given for dogs. Pancreatic enzyme supplements are added to the diet to aid digestion. Dosages are basically empirical, but 1 teaspoon of pancreatin powder (Viokase-V) per 10 kg of body weight is mixed in the food. High-protein low-fat, low fiber diets may decrease steatorrhea. Low fiber diets are recommended as fiber may decrease availability of pancreatic enzymes. Clinical responses in reported cases have been variable, although compressed tablets were used in some cases. Tablets are less effective than powdered products in dogs with EPI; this is likely true for cats as well. Some cats refuse to eat their food when powdered pancreatic enzymes are added. Raw pancreas from cows or pigs may be used as an alternative to commercial powdered products. The glands may be frozen for months and enzyme activity maintained. It has been recommended to feed cats 1 to 3 oz (30 to 90 g) of chopped raw pancreas in each meal. The quantity can gradually be reduced to the least amount needed to maintain weight on the cat (variable).

Because of combined cobalamin deficiency in most cats with EPI, it should be supplemented if serum concentrations are low. Initial recommendations are to give 100-150 µg SQ weekly until serum concentrations normalize. Then injections are given monthly, and then bimonthly and eventually only administered every 6 months. Secondary bacterial overgrowth may also be present and cats may benefit from a trial course of metronidazole therapy (10 mg/kg/os once daily). Cats that fail to respond to enzyme replacement and cobalamin therapy may have primary small intestinal diseases and will need to be pursued further diagnostically.

The prognosis for cats with EPI is generally good for recovery, but therapy will be life long.

PANCREATIC NEOPLASIA

Tumors of the feline pancreas arise primarily from the epithelial tissue. The most important clinically are pancreatic adenocarcinomas. Islet cell carcinomas and gastrinomas also occur, but are rare.

Malignant neoplasms of the pancreas are uncommon in cats. Estimates on their frequency of occurrence are 1.1 to 1.8 percent of all feline cancers. Relative rates for nonendocrine pancreatic tumors are reported as 12.6/100,000 patient-years

Pancreatic Adenocarcinoma

Pancreatic adenocarcinomas arise from both ductular and acinar tissues, with ductular origin tumors predominating. The mean age at the time of diagnosis is 12 years, with cats over 15 years of age at progressively increased risk. No breed or sex predisposition for this tumor are known to exist. Pancreatic adenocarcinomas are highly malignant, and widespread metastases often exist prior to diagnosis (81% of cats). The most frequent sites for metastases are the regional lymphatics, liver, duodenum, peripancreatic fat, omentum, and peritoneal cavity. Lung metastases and widespread peritoneal involvement (carcinomatosis) also occur.

Clinical signs are nonspecific. The most common signs are depression, anorexia, weight loss, and vomiting. Occasionally, polydipsia, diarrhea, and abdominal distention are reported. These signs are similar to those seen with pancreatitis. On physical examination, fever, palpable cranial abdominal masses, ascites, or jaundice may be detected. Two cats were recently reported with diffuse generalized alopecia, primarily effecting the ventrum, limbs and face who had diffuse pancreatic adenocarcinoma. This syndrome has been termed pancreatic paraneoplastic alopecia.

A definitive antemortum diagnosis usually requires exploratory surgery. Most reported cases have died or been euthanized with a diagnosis made on necropsy examination. Biochemical evaluations may reflect hepatic disease caused by metastases. Obstructive jaundice due to tumor compression of the common bile duct can occur. Radiographs of cats with adenocarcinomas can be similar to those of cats with acute pancreatitis. Ultrasound is helpful in identifying pancreatic masses or evidence for regional metastases to abdominal viscera. Abdominocentesis may be helpful in identifying the cause of illness as neoplastic, but rarely establishes the site of tumor origin. In many cats no cancer cells are detected in the effusion.

The prognosis for cats with pancreatic adenocarcinoma is invariably poor because of the tendency for metastases to exist prior to diagnosis and their poor response to chemotherapy or radiation therapy. Occasional cases in man have responded to 5-fluorouracil (5-FU). If solitary cancers are identified, surgical extirpation is indicated.

Pancreatic Adenoma/Hyperplasia

Small, solitary, or multifocal nodules are often observed in the pancreases of aged cats as incidental findings. Solitary nodules that are well encapsulated and not associated with adjacent pancreatic atrophy or inflammation distinguish the adenoma from hyperplastic nodules. Distinguishing between these two benign lesions is primarily academic, since they are not associated with clinical signs.

Malignant Foregut Carcinoid

A single report of malignant foregut carcinoid in a 9-year-old castrated male domestic shorthair cat has appeared. Carcinoids are rare tumors arising from enterochromaffin cells in the pancreas. These tumors are highly malignant and have clinical signs similar to those of pancreatic adenocarcinomas of acinar origin.

Gastrinoma

A 12-year-old spayed female domestic shorthair cat was evaluated because of a 2-year history of hematemesis. necropsy identified two duodenal ulcers and a pancreatic islet tumor with metastases to the liver. Serum gastrin concentrations were extremely elevated (1,000 pg/ml, normal less than 150 pg/ml). Tumor cells stained positive for gastrin and glucagon. The syndrome seen in this cat is analogous to the Zollinger-Ellison syndrome in humans. Gastrin-secreting non-beta-cell islet tumors of the pancreas cause excessive hydrochloric acid secretion by the stomach. Peptic esophagitis and gastric or duodenal ulcers are often present. Therapy used in human patients involves tumor resection, if possible. When metastases are present, gastrectomy and cimetidine, an H₂-receptor antagonist, are used. The cimetidine dose that may be tried in cats is 2.5 to 5.0 mg/kg every 12 hours.

PANCREATIC CYSTS/PANCREATIC BLADDER

On rare occasions, cats will develop cystic dilations of the pancreatic duct, referred to as pancreatic bladder. Clinical signs are usually absent, but large cysts may occasionally compromise bile flow and induce jaundice. They also can be identified during abdominal palpation or following abdominal radiographs or ultrasonography. A definitive diagnosis requires exploratory surgery. Reconstruction of the sacculated duct is the best therapeutic option if there are clinical signs.

SELECTED REFERENCES

1. Strombeck D: Small Animal Gastroenterology (1st ed.), Stonegate, Davis, 1979
2. Kelly DF, Baggott DG, Gaskill CJ: Jaundice in the cat associated with inflammation of the biliary tract and pancreas. *J Small Anim Pract* 16:163, 1975
3. Owens JM, Drazner FH, Gilbertson SR: Pancreatic disease in the cat. *J Amer Anim. Hosp Assoc* 11:83, 1975
4. Garvey MS, Zawie DA: Feline pancreatic disease. *Vet Clin North Am, Small Anim Pract* 14:1231, 1984
5. Duffell S: Some aspects of pancreatic disease in the cat. *J Small Anim Pract* 16:365, 1975
6. Anderson NV, Strafuss AC: Pancreatic disease in dogs and cats. *J Amer Vet Med Assoc* 159:885, 1971
7. Macy DW: Feline Pancreatitis, in Kirk RW (ed): *Current Veterinary Therapy-Small Animal Practice*. Vol 10. W. B. Saunders, Philadelphia, 1989
8. Schaer M, Holloway S: Diagnosing acute pancreatitis in the cat. *Vet Med*.86:782, 1991
9. Hirsch VM, Doige CE: Suppurative cholangitis in cats. *J Amer Vet Med Assoc* 182:1223, 1983
10. Sheldon WG: Pancreatic flukes (*Eurytrema procyonis*) in domestic cats. *J Amer Vet Med Assoc* 148:251, 1966
11. Roudebush P, Schmidt DA: Fenbendazole for treatment of pancreatic fluke infection in cats. *J Amer Vet Med Assoc* 180:545, 1982

12. Rothenbacher H, Lindquist WD: Liver cirrhosis and pancreatitis in a cat infected with *Amphimerus pseudofelineus*. J Amer Vet Med Assoc 143:1099, 1962
13. Fox JH, Mosley JG, Vogler GA et al: Pancreatic function in domestic cats with pancreatic fluke infection. J Amer Vet Med Assoc.178:58, 1981
14. Schaer MS: A clinicopathologic survey of acute pancreatitis in thirty dogs and five cats. J Amer Anim Hosp Assoc 15:681, 1979
15. Suter PF, Olsen SE: Traumatic hemorrhagic pancreatitis in the cat. J Amer Vet Radiol Soc 10:4, 1969
16. Ruwitch J, Bonertz HE, Carlson RE: Clinical aspects of pancreatic disease of dogs and cats. J Amer Vet Med Assoc 145:21, 1964
17. Smart ME, Downey RS, Stockdale PHG: Toxoplasmosis in a cat associated with cholangitis and progressive pancreatitis. Canadian Vet J 14:313, 1973
18. Jubb KVF, Dennedy PC, Palmer N: Pathology of Domestic Animals (3rd ed.). Academic Press, Orlando,1985
19. Van Pelt CS, Crandell RA: Pancreatitis associated with a feline herpes virus infection. Compan Anim Pract 1:7, 1987
20. Weiner S, Gramatica L: Role of the lymphatic system in the pathogenesis of inflammatory disease of the biliary tree and pancreas. Amer J Surg 119:55, 1970
21. Ryan CP, Howard EB: Systemic lipodystrophy associated with pancreatitis in a cat. Feline Pract 11:31, 1981
22. Grumbein SL: Chronic pancreatitis in a cat. Feline Pract 11:23, 1981
23. Schaer MS: A clinicopathologic survey of acute pancreatitis in thirty dogs and five cats. J Amer. Anim Hosp Assoc 15:681, 1979
24. Lulich JD, Osborne CA, O'Brien TD, Polzin DJ: Feline renal failure: questions, answers, questions. Compendium Cont Educ for Practicing Veterinarian 14:157, 1992
25. Kitchell BE, Strombeck DR, Cullin J et al: Clinical and pathologic changes in experimentally induced acute pancreatitis in cats. Amer J Vet Res 47:1170, 1986
26. Bradley EL: Antibiotics in acute pancreatitis: current status and future directions. Amer J Surg 158:472, 1989
27. Carakostas M, Kennedy G, Kittleson M et al: Malignant foregut carcinoid in a domestic cat. Vet Pathol 16:607, 1979
28. Holzworth J, Coffin DL: Pancreatic insufficiency and diabetes mellitus in a cat. Cornell Vet 43:502, 1953
29. Tangner CW, Turrell JM, Hobson HP: Complications associated with proximal duodenal resection and cholecystoduodenostomy in two cats. Vet Surg 11:60, 1982
30. Hoskins JD, Turk JR, Turk MA: Feline pancreatic insufficiency. Vet Med Small Anim.Clin 77:1745, 1982
31. Perry LA, Williams, DA, Pidgeon, GL and Boosinger, TR: Exocrine pancreatic insufficiency with associated coagulopathy in a cat. J Amer Anim Hosp Assoc 27:109, 1991
32. Watson DL, Church DB, Middleton DJ, Rothwell TLW: Weight loss in cats which eat well. J Small Anim Pract 22:473, 1981
33. Sheridan V: Pancreatic deficiency in the cat. Vet Rec 96:229, 1975
34. Priester W: Data from eleven United States and Canadian colleges of veterinary medicine on pancreatic carcinoma in domestic animals. Cancer Res 34:1372, 1974
35. Kircher D, Nielsen S: Tumors of the pancreas. Bull World Health Assoc 53:195, 1976
36. Moulton J: Tumors of the pancreas, liver, gallbladder and mesothelium, in Moulton, J (ed): Tumors in Domestic Animals, University of California Press, Berkeley, 1978,
37. Noxon JO: Fever of unknown origin in a cat. Feline Pract 11:8, 1981
38. Middleston DJ: Duodenal ulceration associated with a gastrin secreting pancreatic tumor in a cat. J Amer Vet Med Assoc 183:461, 1983
39. Wolff A: An unusual unidentified abdominal mass in a cat. Vet Med 74:162, 1979
40. Perry, LA, et al: Exocrine pancreatic insufficiency with associated coagulopathy in a cat. J Am Anim Hosp Assoc 27:109, 1991.
41. Hill, RC, et al: Acute necrotizing pancreatitis and acute suppurative pancreatitis in the cat. A retrospective study of 40 cases (1976-1989). J Vet Int Med 7:25, 1993.
42. Bruner, JM, et al: High feline trypsin-like immunoreactivity in a cat with pancreatitis and hepatic lipidosis. JAVMA 210:1757, 1997.

43. Steiner, and Willieams, DA: Feline pancreatitis. *Cont Ed for Pract Vet.* 19:590, 1997.
44. Harvey, MH, et al: Treatment of acute pancreatitis with b-adrenergic agonist drugs. *Surgery* 102:229, 1987.
45. Karanjia, ND, et al: Dopamine in models of alcoholic acute pancreatitis. *Gut* 35:547, 1994.
46. Simpson, KW, et al: Ante mortem diagnosis of pancreatitis in four cats. *J Sm Anim Pract* 35:93, 1994.
47. Steiner, JM, and Williams DA. Validation of a radioimmunoassay for feline trypsin like immunoreactivity (FTLI) and serum cobalamin and folate concentrations in cats with exocrine pancreatic insufficiency (EPI) *J Vet Int Med* 193, 1995.
48. Parent, C, et al: Serum trypsin-like immunoreactivity, amylase and lipase in the diagnosis of feline acute pancreatitis. *J Vet Int Med* 9: 194, 1995.
49. Akol, KG, et al: Acute pancreatitis in cats with hepatic lipidosis. *J Vet Int Med* 7:205, 1993.
50. Steiner, JM, and Williams DA: Feline exocrine pancreatic disorders: Insufficiency, neoplasia and uncommon conditions. *Cont Ed for Pract Vet* 19:836, 1997
51. Steiner, JM and Williams, DA: *The GI Lab Newsletter*, August, 1999, published by Texas A & M University College of Veterinary Medicine