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CHAPTER 33

# Diseases of the Small Intestines

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## CONGENITAL/DEVELOPMENTAL DISORDERS

See Table 33-1.

## INFECTIOUS DISEASES

### Viral Infections

#### Definition and Causes

I. A number of viruses are implicated as enteric pathogens in dogs and cats, especially in puppies and kittens <6 months of age.
II. Primary intestinal viruses in dogs include canine parvoviruses (CPV-1, CPV-2), canine coronavirus (CCV), distemper virus, and rotavirus.
   A. Astrovirus, enterovirus, herpesvirus, and parainfluenza viruses have been identified in feces, but their pathogenicity is unknown (Greene, 2006).
   B. Both CPV-2a and CPV-2b are responsible for most illness, with CPV-2b as the most common isolate in the United States and Japan, and CPV-2a as the most common isolate in the Far East (Greene, 2006).
III. The primary intestinal viruses in cats include parvovirus (panleukopenia), coronavirus (enteric or feline infectious peritonitis [FIP] virus), rotavirus, and astrovirus.
   A. Feline immunodeficiency virus (FIV) and feline leukemia virus (FeLV) may cause enteric signs as part of the overall infection.
   B. Other viruses have been identified in feline feces, including torovirus-like particles, reovirus, calicivirus, and picornavirus-like particles, but their significance is unknown (Greene, 2006).

#### Pathophysiology

I. Viral infections cause disease by invading the enterocytes lining the intestinal villi or crypts, in most instances from oronasal exposure to contaminated feces.
II. CPV-2 is highly contagious, because the organism is extremely resistant in the environment.
   A. It may persist on the dog's hair coat, caretaker clothing, or floors for >5 months; it is resistant to normal disinfectants.
   B. Only sodium hypochlorite (common household bleach) is known to be consistently effective.
III. The severity of clinical signs is highly variable.
   A. Villous cell damage (e.g., coronavirus or rotavirus infection) is well tolerated (less severe clinical signs), because affected enterocytes are soon replaced.
   B. Viral infections causing crypt cell damage or destruction (e.g., CPV-2 infection) result in severe clinical signs.
      1. Normal enterocyte proliferation is completely disrupted from destruction of crypt cells.
      2. Massive loss of villous absorptive and barrier functions occur, predisposing to ascending infections, endotoxemia, and severe fluid and electrolyte losses.

#### Clinical Signs

I. Canine parvovirus (CPV-2b)
   A. Infection can cause inapparent or subclinical infection or may result in acute, fatal disease.
   B. Lethargy , anorexia, depression, dehydration, vomiting, and diarrhea are the most common signs.
      1. The most severe clinical signs are seen in dogs <4 months of age because of their lack of protective immunity and increased number of rapidly dividing cells.
      2. The clinical course ranges from 4 to 7 days.
   C. Diarrhea is often profuse and hemorrhagic, and vomiting may be intractable.
   D. Fever and leucopenia are common initially, but hypothermia, disseminated intravascular coagulation (DIC), and endotoxic shock occur terminally with septicemia, which may develop within 48 hours in a fulminant infection.
   E. Certain breeds have increased susceptibility, including the rottweiler, Doberman pinscher, American pit bull terrier, German shepherd dog, Labrador retriever, and Alaskan sled dog breeds.
   F. Most adult dogs infected with parvovirus have subclinical disease.
   G. Puppies infected in utero or perinatally (<8 weeks) can develop myocarditis that may progress to cardiomyopathy and sudden death.
   H. Other complications include thrombosis (from DIC), erythema multiforme, hypoglycemia, and septicemia.
II. Canine coronavirus
   A. Infection is via the fecal-oral route, signs are uncommon in adult dogs, and they are generally mild and self-limiting in weanling puppies.

## TABLE 33-1

### Congenital and Developmental Disorders

| DISORDER | DEFINITION AND CAUSE | CLINICAL SIGNS | DIAGNOSIS | TREATMENT |
|---|---|---|---|---|
| Intestinal atresia | Congenital agenesis of a segment of intestine<br>Occurs in the small intestine in dogs and in the large intestine in cats<br>Three types of atresia have been reported (Guilford et al., 1996):<br>*Membrane atresia:* normal intestine with a luminal membrane that prevents normal flow of ingesta<br>*Cord atresia*: two segments of intestine connected by tissue<br>*Blind end atresia*: two segments of intestine not connected together | High neonatal mortality from inability to digest or process milk or other ingesta<br>Failure to thrive, poor growth, and death are most common in puppies<br>Kittens may develop enlarged abdomens and vomiting owing to colonic obstruction | Clinical signs and signalment are suggestive<br>Definitive diagnosis is by documentation of the anomaly (from imaging studies, at surgery or postmortem) | Treatment is removal of the affected segment of bowel by intestinal resection and anastomosis<br>In kittens, a subtotal colectomy may be required if a significant segment of the large intestine is involved |
| Intestinal diverticulum | Rare condition in both dogs and cats<br>Most commonly seen in the jejunum in dogs | Many cases are subclinical<br>Clinical signs are nonspecific, including vomiting, diarrhea, weight loss, or inappetence and occur from diverticulitis or diverticular perforation or obstruction | Imaging studies, such as contrast radiographs or ultrasonography, may identify the abnormal structure<br>Definitive diagnosis is made by visualizing the defect (at surgery) | Resection and anastomosis of the affected segment of the intestine are curative<br>In animals not exhibiting any clinical signs, the best approach is often benign neglect |
| Selective cobalamin malabsorption | Selective inability in the giant schnauzer, border collie, and shar-pei to absorb cobalamin (vitamin $B_{12}$) (Fyfe et al., 1989; Guilford et al., 1996)<br>Inherited in giant schnauzers as an autosomal recessive trait<br>Results in a defect in the ileal receptor for the cobalamin and intrinsic factor complex, called *cubulin* (Fyfe et al., 1989) | Inappetence and failure to thrive (poor weight gain and lethargy)<br>Clinical signs occur after weaning, at 6-12 weeks of age in giant schnauzers, and often later in border collies and shar-peis | Signalment and history are suggestive<br>Definitive diagnosis is made by finding an extremely low serum cobalamin concentration (normal is 6.7-17.4 μg/L)<br>Dyserythropoiesis is evident by 8-16 weeks of age, with development of a nonregenerative, normochromic normocytic anemia (PCV 27%-31%) by 20-22 weeks of age<br>Abnormal granulopoiesis and low neutrophil numbers may also be seen | Parenteral cyanocobalamin (0.25-1.0 mg SC, IM weekly for 4 weeks, then every 3-6 mo indefinitely)<br>Response is rapid<br>Appetite returns in 24-48 hours, reticulocytosis occurs in 3-4 days, and methylmalonic aciduria stops within 1 week<br>Reevaluate cobalamin levels every 3-6 months<br>Neuter affected dogs |

*PCV*, Packed cell volume.

## TABLE 33-1

### Congenital and Developmental Disorders—*cont'd*

| DISORDER | DEFINITION AND CAUSE | CLINICAL SIGNS | DIAGNOSIS | TREATMENT |
|---|---|---|---|---|
| | Defect is not defined in either the border collie or shar-pei | | Cobalamin deficiency leads to reduced activity of two enzymes important in energy (succinyl CoA) and amino acid synthesis (methionine), which results in the development of methylmalonic aciduria (Fyfe et al., 1989) | |
| Short bowel syndrome | Rare condition in both dogs and cats<br>Lack of development of a major segment of the small intestine (Guilford et al., 1996; Simpson and Hall, 2000)<br>Acquired short bowel syndrome is more common and is from surgical removal of a large segment of bowel<br>Dogs are able to compensate if 30-40 cm of small intestine are present; cats require 18-20 cm of small bowel for adequate function | Appropriate historical and clinical signs in a young puppy or kitten are suggestive of a congenital defect<br>Clinical signs include a failure to gain weight or weight loss; poor body or coat condition; and chronic, small bowel diarrhea with characteristics of severe malabsorption (steatorrhea, abnormal color, etc.) | Definitive diagnosis is made from imaging studies (e.g., contrast radiographs) showing the abnormally short bowel | There is no specific therapy for short bowel syndrome<br>Compensation can occur if enough of the bowel remains; these animals have soft or semi-formed feces and are able to maintain body weight<br>Feed highly digestible diets to maximize digestion of food and minimize the amount of feces produced |
| Gluten enteropathy of Irish setter | Autosomal recessive disorder linked to the MHC genes *MQA* and *DQB* in affected dogs (Garden et al., 2000)<br>Disease causes a progressive loss of villous height and increased numbers of goblet cells and intraepithelial lymphocytes<br>Wheat gluten may also have direct toxic effects on the intestinal mucosa of affected dogs | Inappetence, poor growth (stunted or small stature), and chronic diarrhea are the most common signs<br>Diarrhea usually starts in puppies immediately postweaning (4-6 weeks of age)<br>Signs may include semiformed feces or severe, liquid and explosive small bowel diarrhea | Typical history and clinical signs in a young Irish setter are suggestive<br>Affected dogs may have abnormal sugar permeability tests, decreased serum folate (normal serum cobalamin), and negative duodenal juice culture (e.g., no evidence of bacterial overgrowth)<br>Intestinal biopsy reveals vilous atrophy and increased numbers of intraepithelial lymphocytes (distinguish from IBD)<br>A presumptive diagnosis is based on the resolution of clinical signs after the withdrawal of dietary gluten | Only diets that contain no wheat products are fed to Irish setters with this problem<br>Affected dogs will be normal within 4-6 weeks of the diet change<br>Neuter affected dogs |

*CoA*, Coenzyme A; *MHC,* major histocompatibility complex; *IBD*, inflammatory bowel disease.

*Continued*

## TABLE 33-1

### Congenital and Developmental Disorders—*cont'd*

| DISORDER | DEFINITION AND CAUSE | CLINICAL SIGNS | DIAGNOSIS | TREATMENT |
|---|---|---|---|---|
| | | | A definitive diagnosis is confirmed when the clinical signs return on challenge with gluten | |
| Enteropathy of soft-coated wheaten terriers | Immunological defect that results in a protein-losing enteropathy and nephropathy of unknown cause or inheritance (Vaden et al., 2000)<br>The pathogenic cause of the protein-losing enteropathy is unknown, but wheat gluten does not appear to be the trigger | Typical signs include vomiting, diarrhea, and weight loss (which may be severe)<br>Affected dogs are young, and the most severely affected may die before the age of 5 years<br>In severely hypoproteinemic dogs, ascites and peripheral edema may be observed<br>Dogs that survive the initial insults often develop renal insufficiency secondary to the chronic protein-losing glomerulopathy | This enteropathy is characterized by the presence of IBD with varying morphological characteristics, but lymphocytes and plasma cells often predominate<br>Intestinal protein loss occurs from IBD, lymphangiectasia, or both, and may be detected by measuring fecal $\alpha_1$-protease inhibitor levels<br>Protein-losing nephropathy occurs secondary to the chronic inflammatory disease in the intestines<br>Intestinal biopsy is necessary to confirm the presence of IBD and lymphangiectasia<br>There is no definitive test for this specific enteropathy other than finding the concurrent GI and renal protein loss in this breed | Treatment of affected dogs is symptomatic, using immunosuppressive doses of prednisolone (2-4 mg/kg/day PO) as for IBD; antibiotics as needed for control of small intestinal bacterial overgrowth; and a low-fat, highly digestible diet to minimize malabsorption and diarrhea<br>Neuter affected dogs |
| Immunoproliferative small intestinal disease of basenjis | Disease results in the development of chronic diarrhea, gastropathy, and hypergammaglobulinemia in young basenjis (Breitschwerdt et al., 1984)<br>Mode of inheritance is still undetermined | Chronic, intractable diarrhea and emaciation are the most common signs<br>Some dogs will have concurrent vomiting from hypergastrinemia and mucosal hyperplasia<br>Young basenjis may have severe fulminating disease, while adult dogs often have chronic, intermittent diarrhea with acute exacerbations | Confirmation of the diagnosis is by finding lymphoplasmacytic IBD, hypertrophic gastropathy, and concurrent protein-losing enteropathy (hypoalbuminemia, elevated fecal $\alpha_1$-protease inhibitor levels) in a young basenji | Treatment of basenjis with severe immunoproliferative enteropathy is generally unsuccessful<br>In less severely affected dogs, aggressive treatment of IBD is helpful<br>Novel antigen diets may also be helpful<br>Neuter affected dogs |

*GI*, Gastrointestinal.

B. Neonatal puppies have the most severe clinical signs (vomiting, diarrhea, anorexia), and are often concurrently infected with other viruses, intestinal parasites, or bacteria (e.g., salmonellosis, campylobacteriosis), and are housed in crowded, stressful living conditions, with poor hygiene and nutrition.
C. Fever and bloody diarrhea are very uncommon in puppies with coronavirus enteritis alone, and death from diarrheal disease is very uncommon, except in situations where dehydration or acidosis is untreated.
D. The virus is not as stable in the environment as parvoviruses nor as resistant to disinfectants, so appropriate kennel hygiene is highly beneficial.

III. Canine distemper virus
A. Explosive diarrhea with vomiting, dehydration, and depression may occur before onset of central nervous system signs.
B. The most common clinical signs are lethargy, anorexia, fever, and upper respiratory tract infection, which may be followed by mild gastrointestinal (GI) signs.

IV. Canine rotavirus
A. Rotavirus infections are common enteric pathogens in dogs that are transmitted by the fecal-oral route, but rarely cause more than mild, mucoid to watery diarrhea.
B. Very young puppies (<2 weeks) may develop a fever or more severe signs.

V. Feline panleukopenia virus
A. Fever, anorexia, severe diarrhea, and intractable vomiting are common in young, unvaccinated kittens, with the highest morbidity and mortality occurring between 3 and 5 months of age.
B. In adult cats or in kittens from a well-vaccinated queen, anorexia, lethargy, and mild GI signs may occur, but usually the infection is self-limiting and subclinical.
C. Clinical disease is rare in vaccinated cats and in kittens born to vaccinated queens.
D. Unvaccinated kittens with peracute infection have a high morbidity and mortality rate from severe leukopenia and anemia, and may be found dehydrated, hypothermic, and comatose within 12 hours of onset.

VI. Feline enteric coronavirus (FEC) and FIP virus
A. Infections with enteric coronavirus are most often subclinical, especially in adult cats, but may cause mild, self-limiting diarrhea and fever in young or immunocompromised cats.
B. Clinically apparent FEC infections are most common in kittens 4 to 12 weeks of age.
C. FEC is nearly ubiquitous, especially in colonies, and inapparent infection is common.
D. Clinical signs in cats infected with FIP virus are variable (see Chapter 112).
1. FIP granulomas of the GI tract are known to occur in 10% to 20% of cases and cause chronic, intermittent to persistent small or large bowel diarrhea (Harvey et al., 1996).
2. The lesions may be large enough to be palpable (mass effect), but in many cases are only detected by ultrasonography or exploratory surgery.

VII. Feline leukemia virus
A. In cats that develop alimentary lymphosarcoma, signs of bowel obstruction (anorexia, vomiting, diarrhea, weight loss) or malabsorption (diarrhea, weight loss) may be observed.
B. A panleukopenia-like syndrome (small bowel diarrhea, weight loss) is also occasionally observed.

VIII. Feline immunodeficiency virus
A. The most common GI signs are anorexia, emaciation, and chronic diarrhea, which are secondary to villous atrophy and granulomatous inflammation in the intestinal tract.
B. In some cats, diarrhea may be chronic and intermittent, and not result in weight loss; however, in immunocompromised cats, diarrhea may be very severe and associated with high mortality.

## Diagnosis

I. Hematological changes in viral infections
A. Parvoviruses of dogs and cats cause severe leukopenia (primarily neutropenia), and remaining neutrophils may have toxic changes.
1. Cats are also usually anemic (mild, nonregenerative) and thrombocytopenic.
2. Both dogs and cats exhibit a neutrophilia during the recovery phase.
B. Distemper virus in dogs causes leukopenia from lymphopenia.
1. Blood smears may show reactive lymphocytes and occasionally viral inclusion bodies in red blood cells (RBCs) or neutrophils.
2. Thrombocytopenia may also occur, but varies in intensity.
C. CCV, FEC, rotavirus, and other enteric viruses do not usually cause significant changes in the hemogram.
D. FIP is usually associated with a nonregenerative anemia, leukopenia or leukocytosis (with a left shift), and increased serum globulins.

II. Diagnostic tests for viral infection
A. Immunological assays (e.g., commercial enzyme-linked immunosorbent assay [ELISA] for antigen or antibody) are available for detection of parvovirus (antigen), CCV (antibody), FeLV (antigen), rotavirus (antigen, outside of the United States), and FIV (antibody).
1. The tests have a high degree of sensitivity (low false negatives) and specificity (low false positives).
2. Following vaccination with a modified live vaccine for parvovirus, some fecal shedding of virus occurs up to a week and is detected on fecal ELISA assay.
3. The most common reason for a false-negative parvovirus ELISA is testing before active shedding has started or after the brief period of shedding has stopped (10 to 12 days postinfection).
B. Serology for viral infections is useful if the antigen is available for detection (e.g., present in the tissue assayed), and often requires acute and convalescent serum samples.

1. The sensitivity and specificity of serological assays are low or moderate.
2. The presence of large amounts of immunoglobulin M suggests a recent or active infection.
3. A positive hemaglutination titer (HA) present in dog or cat after ≥3 days of clinical illness is diagnostic of CPV-2b or feline panleukopenia infection.
4. FEC can only be confirmed with immunohistochemical or immunofluorescent staining of gut biopsies (Giordano et al., 2005).
5. Definitive diagnosis of FIP requires histopathology, with clinical diagnosis primarily one of exclusion.

C. Viral isolation is rarely used because sample quality is extremely important, and both susceptible cell culture systems and antiserum against the virus must be available.
D. CCV and FEC do not grow well in tissue or cell culture systems.
E. Electron microscopic detection of viral particles in feces rapidly confirms the presence of virus, but requires specialized equipment and a high concentration of virus.
F. Applied molecular diagnostics are increasingly important in the detection of viral infections.
   1. The two most common methods are immunoblotting (Western blot) and polymerase chain reaction (PCR) testing.
   2. The sensitivity and specificity of these methods are very high and allow detection of preclinical disease.
   3. They require only a small quantity of sample for detection of the virus.
   4. They require specialized equipment and time and are not yet used for routine diagnosis except in cases where ELISA or virus isolation is not available or diagnostic (e.g., FIP).
   5. Detection of FIP messenger ribonucleic acid (mRNA) via PCR in circulating monocytes or in macrophages in effusions is a highly promising new technique.
G. Tissue biopsy, necropsy, and light microscopy are diagnostic in most cases of canine distemper, feline panleukopenia, canine parvovirus, and FIP.

## Differential Diagnosis

I. Nonspecific enteritis, including dietary indiscretion or dietary intolerance
II. Bacterial or parasitic enteropathies
III. Toxin-induced intestinal disease
IV. GI obstruction: foreign bodies, intussusception, masses
V. Acute pancreatitis, hepatitis, or other extra-GI inflammatory disease

## Treatment

I. In mild cases, supportive care provided on an outpatient basis is adequate.
   A. Withhold food for 24 to 48 hours and provide water in small, frequent quantities or as ice cubes.
      1. Oral hydration solutions *(Enterolyte, Rebound)* may be given instead of water.
      2. The goal of oral fluid therapy is to provide at least 40 to 60 mL/kg/day.
   B. Once vomiting resolves, food is reintroduced as small quantities of a bland, highly digestible diet.
      1. Examples for dogs include low-fat chicken or turkey with rice or potato, or commercial diets (e.g., Hill's i/d, Purina Veterinary Diets EN, Royal Canin Low Fat, Eukanuba Low Residue).
      2. In cats, low-fat intestinal diets may not be palatable enough, so recovery diets (e.g., Hill's a/d) or canned maintenance foods are also offered.
      3. Enteral nutrition is essential for recovery of enterocytes (especially in parvoviral infections) and return of normal gut motility patterns, so is reintroduced as soon as possible.
      4. In some cases, feeding a liquid diet through a nasoesophageal tube may be necessary.
   C. Do not withhold food for >3 days without further nutritional or fluid support, especially in cats (to prevent the risk of hepatic lipidosis) or young kittens and puppies.
   D. Once vomiting or diarrhea resolves, reintroduce the regular diet over a period of 3 to 7 days.
II. Parenteral fluid therapy is required for dogs and cats that are dehydrated, have severe vomiting or diarrhea, or are anorectic for >3 days.
   A. Lactated Ringer's solution or Normosol-R is given at a rate of 40 to 60 mL/kg/day IV, SC, with additional fluids to correct dehydration and replacing ongoing losses.
   B. Potassium chloride (20 to 40 mEq/L) is added to the fluids if anorexia, vomiting, and diarrhea are severe, or if hypokalemia is present.
   C. Replacement of magnesium sulfate may also be required if serum concentrations of magnesium are low.
   D. In animals with low serum magnesium and hypokalemia, serum potassium does not return to normal until magnesium levels are corrected.
   E. Hypoglycemia is a potential complication of severe enteritis in young animals, and requires addition of dextrose to the fluids after the animal is rehydrated.
   F. IV nutrition (premade amino acid solutions with dextrose or parenteral solutions formulated by a nutritionist and compounded by a pharmacist) may be indicated in dogs or cats that are unwilling or unable to eat after 3 to 4 days of illness.
   G. Anorectic animals, especially cats, become deficient in B vitamins, so add a multiple B-complex solution (5 to 10 mL/L) to the IV fluids or give SC SID.
   H. Acid-base disorders are common, but the type and severity vary.
      1. Fluid therapy and resolution of vomiting and diarrhea resolve most of these abnormalities.
      2. Specific therapy is recommended only in severe, life-threatening cases when blood gas analysis is performed.
   I. Hetastarch or plasma therapy is indicated in dogs with severe hypovolemia, endotoxemia, or severe hypoalbuminemia (<1.5 g/dL).

J. SC fluid therapy may be sufficient in animals with only moderate clinical signs.

III. Isolate affected dogs or cats from other animals to prevent spread of infection.
   A. Meticulous hygiene, both of personnel and the hospital cages and runs, is essential to prevent spread of viral infection.
   B. Instruct owners to properly dispose of all fecal material to reduce environmental contamination.
   C. Parvoviruses and coronaviruses are very hardy and can survive for long periods in the environment, but sodium hypochlorite *(Clorox)* and some newer disinfecting agents will kill these viruses.

IV. Antibiotics are rarely necessary in mild cases of viral enteritis.
   A. In animals with severe or hemorrhagic gastroenteritis, especially with leukopenia, use parenteral antibiotics to prevent septicemia.
      1. Some puppies with parvovirus infection have asymptomatic bacteruria, suggesting antibacterial therapy is essential.
      2. Four-quadrant therapy protects against gram-negative and gram-positive aerobic and anaerobic bacterial septicemia.
      3. Utilize ampicillin 11 to 22 mg/kg IV, IM TID to QID and amikacin 6 to 8 mg/kg IV SID, or enrofloxacin 2.5 to 5 mg/kg IV, IM BID.
   B. In dogs with suspected septicemia or endotoxemia, more aggressive antibiotic therapy may be necessary.
      1. Cefoxitin 15 to 30 mg/kg IV, IM TID to QID
      2. Timentin 40 to 50 mg/kg IV TID to QID
      3. Imipenem 2 to 7 mg/kg IV, IM TID

V. Antiemetic therapy is indicated for severe vomiting.
   A. Prochlorperazine 0.25 to 0.5 mg/kg IM BID to TID in the dog and 0.125 mg/kg IM BID in the cat
   B. Metoclopramide 0.2 to 0.5 mg/kg SC, IM, IV BID to QID or as a constant rate infusion of 0.01 to 0.02 mg/kg/hr IV
   C. Chlorpromazine 0.05 mg/kg IV TID to QID or 1 to 2 mg/kg SC TID to QID in the dog
   D. Dolasetron 0.3 to 0.6 mg/kg SC SID to TID
   E. Ondansetron 0.1 to 0.2 mg/kg SC TID in the dog

VI. Other supportive therapy includes the following:
   A. IV immune globulin can be administered to severely neutropenic dogs with parvovirus infection, but it is expensive and difficult to obtain.
   B. Recombinant granulocyte colony-stimulating factor may be given to increased neutrophil counts; however, it may not affect morbidity or survival (Cohn et al., 1999).
   C. Motility-modifying agents or antidiarrheals are not recommended in acute, infectious gastroenteritis, and are given only to dogs with mild diarrhea.
   D. In cats with FIP, corticosteroids are recommended to maintain appetite and reduce the granulomas associated with the dry form of the disease, but their effectiveness has not been proven.
   E. Antiviral therapy has not been shown to improve survival in FIP or CPV infections and may be associated with significant side effects.
   F. Anecdotally, oseltamixir phosphate *(Tomiflu)* may be beneficial in dogs when given at 2 mg/kg PO BID for 5 days, especially if administered within 24 to 48 hours of onset of signs.

### Monitoring of Animal

I. Frequently assess hospitalized animals for hydration status, response to therapy, and complications such as septic shock, DIC, or intussusception.

II. Daily monitoring includes determining body weight, performing a complete physical examination, and monitoring packed cell volume (PCV), total solids, blood glucose, and electrolytes.

III. The prognosis for most dogs and cats with viral enteritis is good if aggressive supportive care is initiated early, neutropenia is not associated with sepsis, and secondary complications are mild.

IV. The prognosis is more guarded for very young animals, animals with concurrent infections, or for cats with FeLV, FIV, or FIP infections.

V. All potentially exposed animals are vaccinated or revaccinated if their vaccine status is questionable.

VI. Disinfection of the premises with bleach reduces the risk of transmitting viruses to other animals.

## Bacterial Infections

### Definition and Causes

I. *Escherichia coli* is part of the normal bacterial flora of the ileum and colon.
   A. Documentation of pathogenic *E. coli* as the cause of intestinal infection is very difficult because many strains are found in clinically healthy dogs and cats (Greene, 2006; Marks and Kather 2003).
   B. Strains of *E. coli* that may cause diarrhea include enteropathogenic, enterotoxigenic, enterohemorrhagic, necrotoxigenic, enteroaggregative, or enteroinvasive (Greene, 2006).
   C. The best way to distinguish pathogenic *E. coli* from nonpathogens is the use of assays for specific toxin genes or molecular typing (Pass et al., 2000).

II. *Salmonella* spp. are frequently isolated from feces of normal dogs (1% to 36%) and cats (1% to 18%); however, their actual prevalence may be much higher in animals fed raw meat diets (Greene, 2006).
   A. *Salmonella typhimurium* is the most important pathogen in small animals (McDonough and Simpson, 1996; Greene, 2006).
   B. The risk factors for clinical disease include age (puppies and kittens <1 year), immunosuppression or stress from hospitalization, malnutrition, neoplasia, coinfection with FeLV or FIV, diabetes mellitus, and immunosuppressive therapy.
   C. Most cats that develop clinical disease are bacteremic, are systemically ill, and also have GI signs.
   D. Most dogs and cats infected with *Salmonella* spp. have transient or subclinical infections, and <10% became severely ill or die (Greene, 2006).

E. "Song bird fever" is caused by *S. typhimurium;* it is a seasonal illness that occurs in outdoor cats that prey on birds in the northeastern United States, and it manifests an acute, febrile, self-limiting gastroenteritis lasting for 2 to 7 days.

III. *Yersinia enterocolitica* and *Yersinia pseudotuberculosis* may cause a relatively mild enterocolitis, but fecal shedding of the organism may persist for weeks.
   A. *Y. enterocolitica* has been isolated from the feces of clinically normal dogs and cats, so it is probably a commensal that only rarely causes clinical disease.
   B. *Y. pseudotuberculosis* causes enteritis during cold, wet, winter months, because it replicates more effectively in cooler temperatures.

IV. *Clostridium* spp. are involved with several different intestinal diseases.
   A. *Clostridium piriformis* (Tyzzer's disease) is a rare disease that causes a chronic hemorrhagic enterocolitis with hepatic necrosis.
   B. *Clostridium difficile* is isolated in both healthy and diarrheic dogs and cats.
      1. *Clostridium* spp. produce three toxins (A, B, and C).
      2. Toxins A (enterotoxin) and B (cytotoxin) have been associated with diarrhea in dogs (Marks and Kather, 2003), but the association in cats is less well defined.
      3. Infection was thought to occur only rarely, was secondary to antibiotic use, and caused pseudomembranous colitis (Weese et al., 2001); however, outbreaks have been reported in dogs without prior antibiotic use.
   C. *C. perfringens* is part of the normal colonic flora in dogs and cats, but under conditions that allow sporulation (e.g., alkaline environment, antibiotic therapy, dietary changes, immunosuppression), enterotoxin is released, causing a watery or hemorrhagic acute to peracute diarrhea.

V. *Campylobacter jejuni* and *Campylobacter upsaliensis* are motile, microaerophilic bacteria that cause enteritis most commonly in puppies or kittens that are housed in kennel situations, or that are stressed or immunocompromised.

VI. *Helicobacter cinaedi* and *Helicobacter fennelliae* have both been cultured in feces from dogs, but whether they are a primary cause of diarrhea in immunocompetent dogs and cats is unknown.

VII. *Shigella* spp. can cause enteritis in dogs that are exposed to feces from infected hosts (primates, humans).

## Pathophysiology

I. Diarrhea caused by toxin-producing bacteria occurs from increased chloride secretion and subsequent water and electrolyte loss.
   A. Enteropathogenic *E. coli* adheres to the mucosal cells of the small intestine, causing loss of microvilli.
   B. Enterotoxigenic *E. coli* produces both heat-stable toxins that increase chloride secretion by deregulating guanylyl cyclase activity or stimulating cyclic nucleotide-independent secretion, and heat-labile toxins that alter adenylate cyclase activity, resulting in inhibition of sodium and chloride absorption, and increased secretion of chloride by crypt epithelial cells.
   C. Enterohemorrhagic *E. coli* produces verotoxins (*Shigella*-like toxins) that cause damage to the vascular endothelium, inhibit protein synthesis, and alter fluid secretion.
   D. Necrotoxigenic *E. coli* produces cytotoxic necrotizing factors that attach to the mucosal cells and cause diarrhea by invasion and destruction of the cells.

II. Invasive organisms cause enteritis by invading the bowel epithelium and causing local inflammation and mucosal disruption.
   A. Examples of organisms that are invasive include *Salmonella* spp., *Yersinia* spp., *Campylobacter* spp., and enteroinvasive *E. coli* strains.
   B. Inflammation disrupts the mucosal barrier, resulting in loss of fluids, electrolytes, and in some cases blood.
   C. Mucosal disruption can result in the development of bacteremia.

III. Inappropriate or excessive antibiotic therapy alters the normal intestinal flora and allows invasion of antibiotic-resistant strains of bacterial pathogens.

## Clinical Signs

I. Diarrhea caused by toxin-secreting bacteria is less common than that caused by invasive bacteria.
   A. Toxigenic diarrhea is usually watery, with little evidence of an inflammatory response or systemic disease.
   B. Diarrhea of this type leads rapidly to dehydration and electrolyte imbalances, but there is rarely blood, mucus, or cellular debris in the feces.

II. Invasive diarrheas are often acute, hemorrhagic, or mucoid in nature and may cause other clinical signs of illness (e.g., fever, abdominal discomfort, vomiting, anorexia).
   A. Diarrhea may result in severe gastroenteritis and fluid loss, or may affect primarily the large bowel, with signs of colitis.
   B. Animals that develop septicemia may be collapsed, hypothermic, or febrile; hypovolemic; in endotoxic shock; or have signs of DIC.
   C. Organisms that induce severe systemic clinical disease include *Salmonella* spp., enteroinvasive or enterohemorrhagic *E. coli,* and *C. piriformis.*

III. Some bacteria cause clinical syndromes with features of both invasive and toxigenic species.
   A. *Y. enterocolitica* typically causes a mild, self-limiting enterocolitis in dogs.
   B. *C. jejuni* is associated with a hemorrhagic diarrhea, but may also cause chronic colitis.
   C. Enteroadherent *E. coli* may cause a mild to severe enterocolitis with watery to hemorrhagic diarrhea.

## Diagnosis

I. Tentative diagnosis is based on typical signalment, history, and clinical signs, and is only rarely based on fecal culture.

II. Definitive diagnosis requires fecal culture, PCR detection of bacterial toxins or DNA, or demonstration of bacterial toxin in the feces.
   A. A positive fecal culture must be interpreted very cautiously, because most of the bacteria implicated in bacterial enteritis are also normal flora (e.g., *E. coli, Salmonella* spp., *Clostridium* spp., and *Campylobacter* spp.) and are found in clinically healthy animals.
   B. When submitting bacterial cultures of fecal material, submit individual samples in media appropriate for each organism suspected.
      1. Diagnosis of campylobacteriosis is best made by culture of the organism from fresh feces placed into anaerobic transport media.
      2. Diagnosis of salmonellosis is best made by culturing the organism; however, caution is advised, as *Salmonella* spp. are isolated from healthy dogs without diarrhea.
   C. The significance of culture results is based on the signalment, history, other test results for viral and parasitic agents, histopathology (if the diarrhea is chronic), and presence of toxin (if it is a toxin-secreting species).
   D. Definitive diagnosis of *C. perfringens* is difficult because detection of endospores (fecal cytology), toxin formation (by ELISA), or the gene for clostridial enterotoxin production (by PCR) are all associated with false-positive and false-negative results.
      1. Presumptive diagnosis is made by increased numbers of spores or a positive fecal enterotoxin in the presence of diarrhea.
      2. The best way to diagnose clostridial diarrhea is finding clostridial enterotoxin in feces by ELISA or PCR, in a dog with acute diarrhea (Marks and Kather, 2003).
   E. Identification of pathogenic *E. coli* requires either specific typing for known pathogenic strains or demonstration of toxin production.

III. Bacterial enteritis may occur secondary to viral infection (e.g., parvovirus).

IV. Toxin assays are available for identification of the presence of toxin in fecal material from *C. difficile, C. perfringens,* and certain *E. coli*, and are used to determine whether these organisms are responsible for the clinical signs.

V. Fecal cytology helps identify the type of enteritis (presence of inflammatory cells, type of cells, number and type of bacteria), determine its severity (presence or absence of RBCs, epithelial cells, leukocytes), and in some cases identifies the cause (e.g., seagull-shaped bacteria characteristic of *Campylobacter* or *Helicobacter* spp.).
   A. Finding *Clostridium* spp. spores (safety pin-shaped organisms) in large numbers (>5 per high-power field) is not an important consideration in the diagnosis of clostridial enterocolitis.
   B. The mere presence of spores does not indicate they are secreting toxin and causing the diarrhea (Marks and Kather, 2003).

VI. Hematological or biochemical changes may be nonspecific; however, significant leukocytosis or leukopenia is suggestive of bacterial causes.

VII. In dogs or cats with diseases of high mortality (e.g., hemorrhagic colibacillosis, salmonellosis, Tyzzer's disease), diagnosis is often based on postmortem examination.

### Differential Diagnosis

I. Viral enteritis: especially in puppies and kittens
II. Severe intestinal parasitism in puppies in and kittens
III. Toxin-induced enteritis
IV. Dietary indiscretion and other nonspecific enteritis
V. Extraintestinal causes of diarrhea

### Treatment and Monitoring

I. Supportive care is essential to replace lost fluids and electrolytes, and to correct acid-base disturbances from moderate to severe diarrhea.
   A. In animals that are not vomiting and have only mild signs, oral replacement fluid therapy is usually adequate (see Viral Infections earlier in this chapter).
   B. If vomiting is present, institute appropriate IV fluid therapy.
   C. Do not use motility-modifying agents, because removal of the bacterial toxins and inflammatory mediators is enhanced by the diarrhea.
   D. Intestinal protectants are occasionally beneficial in dogs with mild disease to decrease effects of the toxins and reduce inflammation.
      1. Consider bismuth subsalicylate *(Pepto-Bismol)* at 1 to 2 mL/kg PO TID to QID.
      2. *Pepto-Bismol* is not recommended in cats owing to the risk of salicylate toxicity.

II. Antibiotic therapy is indicated, especially if the pathogen is definitively identified; however, antibacterial therapy is controversial for animals with *Campylobacter* spp. or *Salmonella* spp. infections when there are no systemic signs of disease.
   A. Give ampicillin 10 to 22 mg/kg IM, SC, or IV TID to QID for *Salmonella* spp., or *Clostridium* spp. infections.
   B. Administer amikacin 6 to 8 mg/kg IM, IV SID alone for *Salmonella* spp., *Helicobacter* spp., *Yersinia* spp., and *Campylobacter* spp. infections, or in combination with cephalothin for systemic salmonellosis.
   C. Use trimethoprim-sulfadiazine 15 mg/kg SC, PO BID for elimination of salmonella carrier states and treatment of yersiniosis.
   D. Give erythromycin 20 mg/kg PO BID (dogs) and 10 mg/kg PO TID (cats) for *Campylobacter* spp. and *Helicobacter* spp. infections.
   E. Substitute, if necessary, newer generation macrolides, such as azithromycin (5 mg/kg PO SID) for erythromycin (fewer side effects).
   F. Clindamycin 5 to10 mg/kg PO BID may also be effective against *Clostridium* spp.
   G. Metronidazole at 5 to 15 mg/kg PO BID is used for bacterial overgrowth and clostridial enterocolitis.

H. Consider using enrofloxacin 5 to 10 mg/kg PO SID (dogs) or 2.5 to 4 mg/kg PO, SC SID (cats) for gram-negative bacterial infections (*Campylobacter* spp., *Salmonella* spp., and *E. coli*).
I. Tylosin 11 mg/kg PO BID to TID may be used for unidentified bacterial enteritis or antibiotic responsive enteritis.

III. Prevention of infection is achieved by removal of potential sources, such as wild prey or contaminated food products.
IV. Monitoring of animal is similar to that recommended under Viral Infections.

## Intestinal Parasitism

See Table 33-2.

## Mycotic and Algal Diseases

### Definition

I. Mycotic and algal diseases are uncommon in dogs, except in regions where the organism is endemic (e.g., histoplasmosis, phycomycosis), and are rare in cats.
II. They tend to be opportunistic and occur primarily in dogs that are immunocompromised from malnutrition, infection, neoplasia, or drugs, or in dogs with abnormal gut microflora.

### Causes

I. *Histoplasma capsulatum*
A. Infection occurs primarily in the Missouri, Mississippi, and Ohio river valleys; southeastern Texas; and the Gulf Coast region (Greene, 2006).
B. Dogs are more likely to develop GI histoplasmosis alone.
C. Cats with GI signs generally have a systemic infection.
II. Miscellaneous infections
A. These include *Pythium insidiosum, Lagenidium* spp., other Zygomycetes, and *Prototheca zopfii* (Grooters, 2003).
B. *P. insidiosum* is a water-borne pathogen belonging to the class Oomycetes that causes cutaneous or GI disease in tropical or subtropical regions.
C. Pythiosis is more common in dogs than in cats and causes only cutaneous infections in cats.
D. Lagenidiosis is primarily observed in dogs and is associated with cutaneous disease unless it becomes disseminated and systemic signs develop.
E. The primary zygomycosis associated with GI disease in dogs or cats is mucormycosis caused by *Mucor* spp., *Rhizopus* spp., or *Absidia* spp.
F. *Prototheca zopfii* is a blue-green algae capable of causing GI and other organ disease in dogs.
III. *Candida albicans:* opportunistic infection
IV. *Aspergillus* spp.
A. GI involvement is part of disseminated disease.
B. It is a rare disease and is more common in dogs (especially German shepherd dogs) than in cats.

### Pathophysiology

I. *H. capsulatum* is a dimorphic fungus, having both infective and tissue stages.
A. The free-living mycelial stages (macroconidia and microconidia) live in the soil and are the source of infection.
B. Once in the body, microconidia are converted into the yeast form in the tissues, are then engulfed by macrophages, and initiate intracellular replication.
II. Pythiosis is the most clinically important miscellaneous organism.
A. *Pythium* spp. differ from true fungi in producing motile, flagellate zoospores, and having cell walls that contain cellulose, no chitin, and very little ergosterol.
B. The infective stage is released into warm water environments and likely causes infection by encysting in the GI mucosa.
C. Pythiosis causes granulomatous inflammatory lesions that may form masses and obstruct the GI tract, or may cause diffuse infiltrative granulomatous enteritis.
D. Lesions are most frequently observed in the stomach and duodenum, but may involve any segment of the small intestine, with the ileocolic junction another common location.
III. *Lagenidium* spp. infections typically cause cutaneous or subcutaneous draining nodules in dogs, but the disease may disseminate to other body systems.
IV. *Candida* spp. invade and proliferate in the GI tract following prolonged antibiotic therapy, or when the normal GI flora are altered by disease or dysfunction.
V. Disseminated aspergillosis may infiltrate the small intestine, but only when there is severe immunodeficiency or immunosuppression.

### Clinical Signs

I. Histoplasmosis
A. Chronic weight loss, anorexia, and large bowel diarrhea (tenesmus, hematochezia, mucus, urgency) are the most common clinical signs in dogs with primary GI histoplasmosis.
B. With small intestinal involvement, the diarrhea is either profuse and watery or bloody.
C. With systemic involvement, fever, lymphadenopathy, hepatomegaly, splenomegaly, icterus, anemia, ascites, cough, and dyspnea are often observed.
D. Histoplasmosis is more common in young (<4 years) dogs and cats.
II. Miscellaneous fungal/algal infections
A. Signs include weight loss, anorexia, vomiting, and diarrhea, which are often associated with a palpable abdominal mass.
B. Infections are more common in male, large-breed dogs living in tropical or subtropical regions.
C. Cutaneous forms of pythiosis are less common than GI forms in dogs, but skin disease is more common in cats.
D. Signs of systemic illness can occur with pythiosis, but only after development of intestinal obstruction or perforation.

## TABLE 33-2

### Small Intestinal Parasitism

| PARASITE | CLINICAL FEATURES | DIAGNOSIS | TREATMENT |
|---|---|---|---|
| **Nematodes** | | | |
| Ascarids<br>Dogs:<br>*Toxocara canis*<br>*Toxascaris leonina*<br>Cats:<br>*Toxocara cati*<br>*Toxascaris leonina* | *T. canis* is the most important nematode of public health significance (visceral larval migrans)<br>Clinical signs from migration: coughing, ill thrift, pneumonitis<br>Clinical signs from mucosal dysfunction: malabsorption, weight loss, retarded growth, diarrhea, poor hair coat, enterocolitis<br>Puppies are infected in utero (transplacental), postpartum (transmammary), and by fecal–oral route<br>Feline ascarids do not cross placenta or mammary gland | Fecal flotation with salt or sugar solutions | Pyrantel pamoate<br>Dogs: 1 mL/10 lb (5 kg) PO<br>Cats: 1 mL/5 lb (2.5 kg) PO<br>Fenbendazole 50 mg/kg PO SID × 3 days<br>Milbemycin<br>Drontal Plus: dogs<br>Drontal: cats<br>Selamectin: cats only<br>Puppies are treated prophylactically every 2-3 wk, until >6 wk old, then as needed<br>Prepatent period is 4-6 wk |
| Hookworms<br>Dogs:<br>*Ancylostoma caninum*<br>*Ancylostoma braziliense*<br>Cats:<br>*Ancylostoma tubeforme*<br>*Ancylostoma braziliense*<br>*Uncinaria stenocephale* | *A. caninum* is the most important hookworm of public health significance (cutaneous larva migrans)<br>Voracious blood-sucking ability causes severe life-threatening anemia in young puppies<br>Diarrhea is the most common sign; may be blood-tinged<br>Iron deficiency anemia in adults | Fecal flotation with salt or sugar solutions | See Ascarids<br>Prepatent period is 2-3 wk |
| *Strongyloides*<br>Dogs:<br>*S. stercoralis*<br>Cats:<br>*S. tumefaciens* | Most common in young dogs from kennel or shelter environments<br>Clinical signs include vomiting or diarrhea, coughing, lethargy, and respiratory distress<br>*Strongyloides* spp. are a public health risk as the larvae are infectious | Baermann exam is best to detect larvae<br>Direct visualization of worms in emesis | Fenbendazole 50 mg/kg PO SID × 3 days<br>Ivermectin 200-300 μg/kg PO |
| Whipworms<br>Dogs:<br>*Trichuris vulpis* | Whipworm infections are most common in urban environments from persistent fecal contamination and reinfection<br>Enterocolitis (large bowel diarrhea) | Fecal flotation with sugar or zinc sulfate solution is best<br>Eggs are shed intermittently, so multiple fecal examinations may be required | Fenbendazole 50 mg/kg PO SID × 3 days<br>Drontal Plus: dogs<br>Milbemycin<br>Ivermectin 200-300 μg/kg PO<br>Prepatent period is 3 mo |
| **Coccidia** | | | |
| *Cystisospora* spp.<br>*Cryptosporidium* spp.<br>*Toxoplasma* spp.<br>Others: *Hammondia* spp., *Sarcocystis* spp., *Besnoitia* spp., *etc.* | *Cystisospora* spp. are not highly pathogenic; inapparent infections common; mucoid, foul-smelling diarrhea in young kittens or puppies<br>Cryptosporidia may cause chronic, severe diarrhea and ill thrift in puppies, kittens, and immunocompromised adults | Fecal flotation is best, using salt or sugar solution<br>*Cryptosporidium* spp. are extremely small (3-4 μm) and require both special stains and high-power microscopy for visualization<br>Fecal ELISA is available for detection of cryptosporidia | Animals with asymptomatic *Cystisospora* spp. infections do not require treatment<br>Sulfadimethoxine 55 mg/kg PO once, then 27.5 mg/kg PO SID × 14 days<br>Sulfamethazine 100 mg/kg PO once, then 50 mg/kg PO BID × 14 days |

*Continued*

## TABLE 33-2

### Small Intestinal Parasitism—*cont'd*

| PARASITE | CLINICAL FEATURES | DIAGNOSIS | TREATMENT |
|---|---|---|---|
| | Cryptosporidia are not host specific like most coccidia, thus are zoonotic, especially to immunocompromised humans<br>*Toxoplasma* spp.: see Chapter 116 | *Toxoplasma* spp. oocysts are also extremely small and rarely seen on fecal flotation examinations.<br>Toxoplasmosis is diagnosed by measuring serum IgM and IgG levels | For *Cryptosporidium* spp.: paromomycin 125-165 mg/kg PO BID × 5 days<br>For toxoplasmosis: clindamycin 10-25 mg/kg PO BID × 14 days |
| **Protozoa** | | | |
| *Giardia lamblia*<br>*Entamoeba histolytica*<br>*Balantidium coli* | *Giardia* spp. infections are characterized by acute or chronic small bowel diarrhea, weight loss, and protein-losing enteropathy<br>Subclinical infections are common<br>Zoonotic, both by direct contact with feces, but also via fomites, as cysts are highly resistant to disruption<br>*Entamoeba* spp. and *Balantidium* spp. are rare, but cause signs of enterocolitis | Zinc sulfate flotation is the most effective concentration method for detection<br>Testing of three separate fecal samples increases the sensitivity from 65% to 96%<br>Trophozoites may be observed on direct saline smears of feces, but the sensitivity is low<br>Fecal ELISA for detection of *Giardia* spp. antigen has a 93% sensitivity, but the specificity is lower than zinc sulfate flotation | Metronidazole 25-50 mg/kg PO SID × 5 days (dogs); 10 mg/kg PO BID (cats)<br>Fenbendazole 50 mg/kg PO × 7 days<br>Furazolidone (cats) 4 mg/kg PO BID × 7 days<br>Drontal Plus: dogs<br>*Giardia* spp. in cats: give Drontal Plus at 2 small dog tablets PO SID × 5 days |
| **Trichomonads** | | | |
| *Pentatrichomonas hominis* | Healthy dogs and cats may be carriers<br>Animals with diarrhea found to have *Pentatrichomonas* spp. may have other intestinal diseases or immunodeficiency | Direct examination of feces<br>Special stains may be needed to differentiate from *Giardia* spp. | No effective treatment has been identified |
| *Tritrichomonas foetus* | Healthy cats or young kittens with foul, pasty diarrhea<br>Often associated with anal hyperemia<br>No vomiting or anorexia | Direct examination of feces (least sensitive)<br>Culture of organism<br>PCR for organism | Self-elimiting in some cats after several months<br>Ronidazole 10-30 mg/kg PO BID × 14 days; can be neurotoxic |
| **Cestodes** | | | |
| Tapeworms<br>Dogs:<br>*Dipylidium caninum*<br>*Taenia pisiformis*<br>Cats:<br>*Dipylidium caninum*<br>*Taenia taeniaeformis* | Rarely associated with clinical abnormalities<br>May observe proglottid segments on perineum<br>Severe infestation may result in unthriftiness | Proglottid segments seen on perineum or in litter box<br>Oocysts may occasionally be seen on fecal flotation | Epsiprantel 5 mg/kg PO once (dog); 2.5 mg/kg PO once (cat)<br>Praziquantel 5-7.5 mg/kg PO once (dog); 5 mg/kg PO once (cat) |

*ELISA,* Enzyme-linked immunosorbent assay; *IgM,* immunoglobulin M; *IgG,* immunoglobulin G; *PCR,* polymerase chain reaction.

E. *Lagenidium* spp. and Zygomycetes infections only cause GI signs when they become disseminated.

III. Candidiasis and aspergillosis
   A. They cause chronic, nonhealing ulcerative lesions of the mucosa that result in diarrhea in dogs.
   B. Systemic involvement is more common with aspergillosis, producing clinical signs of anorexia, weight loss, fever, weakness, vomiting, uveitis, and neurological dysfunction.

## Diagnosis

I. Histoplasmosis
   A. Definitive diagnosis is made by cytological or histological identification of organisms in macrophages from infected tissues.
   B. Serology is not recommended because of a high percentage of false-positive and false-negative results.

II. *Pythium* spp., *Lagenidium* spp., and others
   A. Definitive diagnosis is made by identification of the organisms (poorly septate and branching fungal hyphae) on histopathologic examination of affected tissues (endoscopic or surgically obtained biopsies).
   B. An ELISA is available for use in dogs and cats, and it has very high sensitivity and specificity.
      1. It can be used before more invasive diagnostics are undertaken.
      2. It is also useful to guide the duration of therapy and detect recurrences (Grooters, 2003).
   C. No consistent laboratory or imaging abnormalities occur.

III. Aspergillosis and candidiasis
   A. Definitive diagnosis is achieved by identification of organisms in cytological or histological specimens from affected tissues.
   B. Serology for aspergillosis includes an agar gel immunodiffusion (AGID) assay or ELISA; however, false negatives are common, and a positive test does not rule out other concurrent diseases, which are common in dogs with aspergillosis.
   C. Both organisms can be cultured from the affected tissue, but must be done with extreme caution as the organisms can be infective to laboratory personnel.

## Differential Diagnosis

I. Inflammatory bowel disease (IBD)
II. Intestinal neoplasia
III. Protein-losing enteropathies (PLE)
IV. Obstructive intestinal diseases: intussusception, foreign body
V. Other diffuse enteropathies causing malabsorption

## Treatment

I. Histoplasmosis
   A. The drug of choice is itraconazole administered for ≥4 to 6 months or 1 month beyond resolution of clinical signs (Greene, 2006).
      1. Dose in dogs: 10 mg/kg PO SID or divided BID
      2. Dose in cats: 5 to 10 mg/kg PO SID; liquid form preferred as it is well absorbed
   B. Some animals require treatment for 9 to 12 months, and long-term treatment beyond that is occasionally necessary.
   C. If treatment is stopped prematurely, relapses are common.
   D. Alternatives to itraconazole include amphotericin B or fluconazole (see Chapter 111).
   E. Ketoconazole is less effective against histoplasma organisms and has greater toxicity.
   F. Antibiotics or other supportive care may be required in severe cases.
   G. In cats, anorexia may warrant insertion of a feeding tube.

II. Pythiosis and other miscellaneous fungal or algal infections
   A. Wide and complete surgical excision is the only effective treatment and may be curative if the lesion is focal.
   B. Itraconazole, miconazole, and terbinafine have in vitro susceptibility to the organism, but their effectiveness in vivo is questionable.
      1. These drugs may prevent dissemination or local recurrence following surgical excision.
      2. Itraconazole and terbinafine used together appear to be the most effective combination, but the rate of success is still quite low.
   C. Liposome-encapsulated amphotericin B has not been shown to be effective and has greater toxicity.
   D. A new antifungal drug, caspofungin, may be much more effective against pythiosis and other oomycoses, but is extremely expensive, and dosing and safety data have not been reported in dogs.
   E. Supportive care with correction of electrolyte disturbances and dehydration is essential, especially for cases where surgery is to be performed.

III. Aspergillosis and candidiasis
   A. *Candida* spp. are susceptible to itraconazole, fluconazole, and ketoconazole.
   B. Aspergillosis can be effectively treated with itraconazole or one of the newer azoles (voriconazole) or amphotericin B; however, disseminated disease is often unresponsive because of concurrent immunocompromise.
   C. Treatment must be continued for 1 month past the resolution of signs, and correction of the underlying cause is imperative.

IV. Supportive care is very important and may include fluid therapy, nutritional support, antibiotics, control of vomiting, and good husbandry.

## Monitoring of Animal

I. The overall prognosis for fungal diseases is fair to poor, depending on the organism involved, the extent of disease, and the response to treatment.
   A. The prognosis is generally better for dogs or cats with pulmonary disease alone than for those with GI or disseminated disease.

B. Dogs with diffuse GI pythiosis or other oomycoses have a very guarded to poor prognosis.

II. Therapy must be given for a long time (≥4 to 6 months) in animals with GI disease, and early withdrawal results in a relapse of the clinical disease.

III. A number of other adverse effects of drug administration must also be monitored (see Chapter 111).

IV. Response to treatment is monitored by assessment of body weight, return of appetite, and resolution of clinical and biochemical abnormalities.

## CANINE HEMORRHAGIC GASTROENTERITIS

### Definition and Cause

I. Hemorrhagic gastroenteritis (HGE) is a peracute, hemorrhagic diarrhea of dogs that is accompanied by hemoconcentration and an acute onset of vomiting.

II. The etiology is unknown, but it may be an enterotoxemia from *E. coli* or *Clostridium* spp. (Marks and Kather, 2003).

### Pathophysiology

I. A dramatic increase in small intestinal vascular and mucosal permeability may be responsible for the rapid loss of blood, protein, and fluids from the GI tract.

II. The syndrome may represent a hypersensitivity or immunological reaction to bacteria or bacterial toxins.

### Clinical Signs

I. Signalment is as follows:
   A. HGE is most frequently seen in small-breed dogs, with the miniature schnauzer, poodle, bichon frisé, dachshund, sheltie, and Cavalier King Charles spaniel overrepresented.
   B. HGE is most common in young dogs (2 to 4 years), and there is classically no known exposure to different foods, garbage, or other inciting causes.

II. The clinical signs are peracute and severe, resulting in rapid development of severe hypovolemia and shock.

III. The typical signs include hematochezia, melena, depression, acute onset of anorexia, vomiting (may have hematemesis), abdominal pain, and occasionally fever.

IV. Endotoxic shock occurs in severely affected dogs, as evidenced by hyperemic mucous membranes, slow capillary refill time, hypothermia, generalized weakness, or collapse.

### Diagnosis

I. There is no definitive diagnostic test for this syndrome.

II. Presumptive diagnosis is based on the characteristic signalment, history, and clinical signs in a previously healthy dog.

III. Dogs have marked hemoconcentration (PCV=50% to 80%), but the total protein is often normal or low (despite the severe dehydration).
   A. Other hematological and biochemical parameters are usually normal.
   B. The white blood cell count may show a stress leukogram, neutropenia, or neutrophils with toxic changes; however, in most cases the condition is too peracute for these changes to occur.

IV. Tests for viral and bacterial enteric pathogens and fecal evaluations for parasites are negative.

V. Radiography of the abdomen is often unremarkable with the exception of ileus, which may be marked.

VI. Coagulation tests are normal unless the dog is in severe endotoxic shock, and then evidence of DIC may be present.

### Differential Diagnosis

I. Parvoviral enteritis

II. Bacterial enteritis, especially *Salmonella* spp., *Clostridium* spp., or hemorrhagic *E. coli*

III. Intestinal obstruction: intussusception, foreign body, volvulus, neoplasia, fungal granuloma

IV. Other causes of hypovolemic or endotoxic shock resulting in hemorrhagic diarrhea

V. Coagulopathies: warfarin toxicity, DIC

### Treatment

I. Aggressive treatment of fluid and electrolyte derangements is the most important aspect of initial treatment.
   A. Start IV fluid therapy with isotonic, polyionic crystalloid solutions (Normosol-R, lactated Ringer's) at 60 to 90 mL/kg in the first hour in severely hypovolemic, shocky dogs.
      1. Once the dog is stabilized, fluids are modified to match the ongoing losses.
      2. In many dogs, the best approach is the placement of a central venous catheter to allow measurement of central venous pressure (CVP) during the replacement and maintenance phases of fluid therapy.
   B. In dogs that are severely hypoproteinemic (total protein [TP] <4.0 mg/dL, albumin <2.0 mg/dL), colloid therapy (hetastarch 10 to 20 mL/kg IV) or plasma is preferred to prevent fluid overload, edema formation, and further deteri-oration of the clinical condition.
   C. Electrolyte losses are often severe.
      1. Potassium supplementation (20 to 40 mEq/L) is usually the most critical.
      2. Magnesium and phosphorus (owing to metabolic acidosis and blood loss) must also be monitored.

II. Antibiotic therapy is very important because bacterial translocation via deranged mucosal permeability and shock are common complications.
   A. Four-quadrant therapy is recommended to provide protection against aerobic, anaerobic, gram-positive, and gram-negative bacteria (see doses in Viral Infections).
      1. Ampicillin and amikacin
      2. Ampicillin and enrofloxacin
      3. Cefoxitin or other second- or third-generation cephalosporins
      4. Imipenem or Timentin
   B. Antibiotic therapy is continued for 3 to 5 days beyond the cessation of clinical signs.

III. The use of corticosteroids in dogs with shock is controversial and not recommended for this condition.

IV. Treatment of vomiting is indicated, with drugs such as metoclopramide, prochlorperazine, ondansetron, or dolasetron.
V. Consider ranitidine, famotidine or omeprazole if the vomiting is severe, or blood is present in the vomitus.
VI. Treatment of diarrhea with antidiarrheal agents (loperamide, diphenoxylate, or *Pepto-Bismol*) is not recommended.
VII. A short-term fast (1 to 3 days) is indicated, at least until the vomiting is controlled.
   A. Do not fast dogs for long periods, because the gut requires food to repair itself.
   B. When ready, offer small amounts of a canned, highly digestible, low-fat, low-fiber food.

### Monitoring of Animal

I. Monitor serum electrolytes, PCV, and total solids BID to QID initially, depending on the severity of the abnormalities.
II. In very small or toy breeds, blood glucose is also assessed.
III. The rate of fluid administration is monitored by assessing CVP, urine output, PCV, TP, and body weight.
IV. The prognosis is good if the dog is not severely hypoproteinemic and aggressive supportive care is administered.
   A. In most cases, dogs begin to recover in 2 to 3 days.
   B. In dogs with severe hypoproteinemia or with secondary complications, the prognosis is more guarded.
   C. Dogs that do not respond to therapy in 2 to 3 days must be reevaluated, because it is likely that the diagnosis is incorrect or that other complications have developed (e.g., intussusception, endotoxemia, sepsis, DIC).
V. The mortality rate is very high in dogs that are not treated aggressively.

## DISORDERS OF MALABSORPTION

### Definition

I. Malabsorption or malassimilation is a disorder that results in a primary failure of absorption (e.g., lymphangiectasia, small intestinal disease affecting mucosal transport), and is distinguished from maldigestion caused by failure of digestive processes (e.g., exocrine pancreatic insufficiency, brush border enzyme deficiency).
II. The distinction between maldigestion and malabsorption is artificial because both are inextricably linked; therefore malabsorption is often used as a general term for either defective digestion or absorption.

### Causes and Pathophysiology

I. The causes of malabsorption are separated by the site where the primary abnormality occurs.
   A. Examples are luminal, mucosal, or hemolymphatic (postmucosal) disorders (Simpson and Hall, 2000).
   B. No matter the cause or site, the end result is decreased nutrient absorption from the small intestine.
II. Luminal causes of malabsorption include the following:
   A. Motility disorders: hyperthyroidism
   B. Inactivation of enzymes: gastric hyperacidity, Zollinger-Ellison syndrome
   C. Lack of digestive enzymes: exocrine pancreatic insufficiency
   D. Deficiency of bile salts: cholestatic liver disease, obstruction of common bile duct, or loss of bile salts as a result of ileal disease
   E. Bacterial overgrowth in the small intestine resulting in cobalamin deficiency, deconjugation of bile salts, and impairment of intestinal mucosal function
III. Mucosal causes include the following disorders:
   A. Deficiencies of mucosal (brush border) enzymes: trehalase deficiency in cats, lactose deficiency
   B. Disturbances in uptake of luminal substrate across the mucosa from congenital lack of transport protein: intrinsic factor receptor absence
   C. Severe mucosal disease: IBD, neoplasia, etc.
   D. Defects in enterocytes resulting in abnormal transport: villous atrophy, abetalipoproteinemia, inflammatory or infectious diseases affecting enterocytes
IV. There is often considerable overlap between the classes of disorders.
V. Some of the more important individual causes of malabsorption include the following:
   A. Inflammatory bowel diseases: lymphocytic plasmacytic enteritis, eosinophilic enteritis, granulomatous enteritis, etc.
   B. Neoplasia: lymphosarcoma, leiomyosarcoma, adenocarcinoma, etc.
   C. Chronic infectious enteropathies: histoplasmosis, giardiasis, pythiosis, small intestinal bacterial overgrowth
   D. Villous atrophy: idiopathic, secondary to IBD, etc.
   E. Dietary hypersensitivity: dietary allergy, wheat-sensitive enteropathy, dietary intolerance
   F. Short bowel syndrome: congenital or secondary to massive bowel resection
   G. Lymphangiectasia: primary, secondary to other intestinal disease
   H. Idiopathic PLE

### Clinical Signs

I. Signs of intestinal malabsorption are varied in both severity and presentation, and range from mild diarrhea or weight loss to severe diarrhea, weight loss, abnormal appetite, and edema or ascites from hypoproteinemia.
II. Diarrhea is the most consistent abnormality.
   A. Occasional soft feces to severe watery diarrhea
   B. Hematochezia and/or melena with severe inflammatory diseases
   C. Light or gray fecal color with maldigestion or a lack of bile salts
III. Weight loss may be the only clinical sign in some cases, and it can be significant.
IV. Other variable clinical signs include alterations in appetite, abdominal discomfort, depression, increased intestinal gas production (borborygmus, belching, flatus), or vomiting.
V. Severe lymphangiectasia may result in edema or ascites from severe hypoproteinemia from PLE, and may rarely be associated with a chylous effusion in the abdomen or thorax.

VI. Protein and fat malnutrition may result in poor skin and hair coat.
VII. Increased risk of bleeding may occur with severe malabsorption and vitamin K deficiency or with loss of clotting proteins secondary to intestinal protein loss.

## Diagnosis

I. Rule out extraintestinal causes of diarrhea and weight loss (complete blood count, biochemistry profile, urinalysis), and assess of thyroid, adrenal, and liver function.
   A. Hematological findings are nonspecific, but may include lymphopenia, eosinophilia, neutrophilia, or anemia of chronic disease.
   B. Serum biochemistry profile results are often nonspecific.
      1. With severe malabsorptive disease, hypocholesterolemia, hypoproteinemia, and hypoalbuminemia indicate PLE.
      2. Cats or dogs with IBD may have elevations of liver enzymes and/or hyperglobulinemia.
      3. Electrolyte concentrations are variable, depending on the degree and severity of diarrhea, but hypokalemia is common with severe small bowel diarrhea.
      4. Hypomagnesemia, hypochloremia, and hyponatremia can also occur.
      5. Hypocalcemia (true or pseudo) is a common finding in dogs with PLE from lymphangiectasia (Kimmel et al., 2000).
      6. Serum bile acid concentrations may be increased from concurrent hepatic disease, or may be falsely low owing to deconjugation and loss of bile salts in the GI tract.
II. Fecal examinations are essential.
   A. Perform multiple fecal flotations (more than three) using different flotation media (salt, sugar, zinc sulfate [$ZnSO_4$]), and different methods (direct examination, cytology of fecal smears, Baermann's).
      1. *Giardia* spp. are best detected using a minimum of three $ZnSO_4$ flotations, sugar flotation, or ELISA for giardial antigen.
      2. Diarrhea caused by clostridial overgrowth and enterotoxin production is suggested by finding enterotoxin in the feces using an ELISA assay (Marks and Kather, 2003).
      3. *Cryptosporidia* spp. are difficult to identify because their extremely small oocysts require special microscopy, so an assay for the toxin is the best diagnostic approach.
      4. Fecal cytology may also be useful in identification of *Campylobacter* spp., *Tritrichomonas* spp., *Histoplasma* spp., and other enteric pathogens.
   B. Fecal cultures are important if specific bacterial pathogens are suspected; however, cultures should be followed by PCR assays.
   C. Fecal $\alpha_1$-protease inhibitor assay detects fecal protein loss in dogs with PLE.
      1. This protein is not affected by intestinal or bacterial degradative processes, but is similar in size to albumin and is lost into the lumen if there is intestinal protein leakage.
      2. The assay has been validated in dogs but not in cats, and requires obtaining three separate, defecated fecal samples.
      3. Send samples directly to the Gastrointestinal Laboratory at Texas A&M University for processing using special collection kits provided.
      4. The assay can be falsely elevated in animals with parasites and other GI disturbances, and from collection problems.
   D. Other fecal tests (fecal fat, proteolytic activity, occult blood) are nonspecific, insensitive, and not recommended.
III. Other serum tests may be helpful in identifying intestinal, pancreatic, or hepatic disease associated with malabsorption.
   A. Trypsin-like immunoreactivity (TLI)
      1. The TLI assay is a species-specific assay for the pancreatic acinar cell enzymes, trypsinogen and trypsin.
      2. Normal serum TLI of dogs is 5.2 to 35 μg/L and of cats is 12 to 82 μg/L.
      3. Serum TLI is unaffected by small intestinal disease, but is markedly low in dogs or cats with exocrine pancreatic insufficiency.
      4. Elevated levels correlate poorly in dogs and only moderately well in cats with acute pancreatitis.
      5. Serum is collected following a fast for 6 to 12 hours.
   B. Serum vitamin concentrations (folate and cobalamin)
      1. Decreased levels of folate occur with severe proximal or diffuse small intestinal disease.
      2. Increased folate levels are observed in animals on parenteral supplementation, and in dogs with exocrine pancreatic insufficiency or with antibiotic responsive enteritis.
      3. Increased levels of folate are also present in hemolyzed blood samples from leakage of the vitamin from RBCs.
      4. A cobalamin deficiency reflects ileal disease, exocrine pancreatic insufficiency, or may occur in the presence of antibiotic responsive enteritis (dogs).
      5. Elevated levels of cobalamin have unknown clinical significance, but may occur with excess parenteral supplementation.
      6. Assays for both cobalamin and folate must be validated and normal values established for each species.
         a. Samples are collected after a 6- to 12-hour fast and stored in darkness, because cobalamin is light sensitive.
         b. Because serum vitamin concentrations can be low in animals with both exocrine pancreatic insufficiency and small intestinal disease, simultaneous serum TLI assay is recommended.
      7. Cats may be more susceptible to cobalamin deficiency because of their increased need for cobalamin.
   C. Measurements of intestinal permeability

1. Tests of intestinal permeability are used to noninvasively determine the presence of intestinal mucosal damage from gluten enteropathy, acute gastroenteritis, IBD, neoplasia, and other diseases.
2. The standard test uses the probe $^{51}$Cr-labeled EDTA; however, the marker is not suitable for use in private clinical practice or many referral practices.
3. Other tests use two sugars, one disaccharide (cellobiose, lactulose) and one monosaccharide (mannitol, rhamnose) to determine intestinal permeability by measuring the amount excreted in urine and expression of the results as a ratio.

D. d-Xylose absorption test
1. It has a very low sensitivity for small intestinal disease.
2. It is impractical and cumbersome to perform in most clinical settings and is not recommended.

E. Tests for antibiotic responsive enteritis (previously referred to as *small intestinal bacterial overgrowth*)
1. Increased serum folate and decreased serum cobalamin levels are suggestive but not specific for the problem.
2. Serum unconjugated bile acids increase 10 to 20 times in affected dogs, but an assay is not yet commercially available.
3. At this time, the best diagnostic test is culture of intestinal contents to quantitate bacterial numbers, and isolate known or potential pathogens.
   a. Recent evidence indicates that this method is inadequate for identification of bacterial numbers and species in the intestinal tract (Suchodolski et al., 2005).
   b. DNA technology may be the most reliable and accurate means of identifying and enumerating the wide variety of bacterial species colonizing the intestinal tract, but is only available at research laboratories.

IV. Imaging studies are indicated, but may give nonspecific results and are used to rule out other diseases.
A. Survey abdominal radiography is often normal.
B. Upper GI contrast studies may reveal foreign bodies, masses, intestinal obstruction or intussusception, and gastric or intestinal ulcers (see Chapter 4).
C. Abdominal ultrasonography is used to detect changes in echogenicity of abdominal organs and bowel thickness or irregularities, for identifying lymphadenopathy or other intraabdominal masses, and for obtaining biopsies and aspirates.

V. Endoscopic examination permits direct visualization of the mucosa and provides an opportunity to obtain multiple samples for cytology, biopsy, and culture.
A. In animals with weight loss or chronic diarrhea, samples for biopsy are obtained from multiple sites (stomach, duodenum, ileum, colon).
B. Properly obtained biopsies include submucosa and intact mucosa in the proper orientation (i.e., carefully uncurled and lying flat on a biopsy sponge to maintain orientation).
C. In some cases, endoscopic biopsies may not be sufficient for diagnosis (e.g., focal disease in jejunum unreachable by the endoscope, serosal disease, edematous changes), and full-thickness biopsies may be required.
D. Cytological examination of endoscopically obtained tissue can often be used to make a rapid diagnosis of inflammatory changes present in the mucosa (Jergens, 2003).

VI. Histological examination is essential to document villous atrophy and other architectural changes; verify that lymphatic dilatation is consistent with lymphangiectasia; and confirm neoplastic, inflammatory, or other infiltrative diseases.

VII. Intestinal samples can also be submitted for specialized assays, including analysis for marker enzymes (e.g., lactase, alkaline phosphatase) or cell surface markers cluster differentiation (CD; e.g., CD4, CD8) to help distinguish neoplastic from inflammatory infiltrates.

## Differential Diagnosis

I. Exocrine pancreatic insufficiency
II. Hepatopathy resulting in reduced bile production or bile flow
III. Endocrinopathies
A. Hyperthyroidism in cats
B. Diabetes mellitus
C. Hypoadrenocorticism
IV. Dietary intolerance or sensitivity
V. Severe parasitism: heterobilharziasis, giardiasis
VI. Other enteric pathogens: protothecosis, pythiosis

## Treatment

I. Specific therapy is directed at correcting or controlling the underlying cause.
A. Exocrine pancreatic insufficiency: see Chapter 36
B. IBD: see the following section
C. PLE and lymphangiectasia: see Protein-Losing Enteropathies
D. Neoplasia: see the following section
E. Parasitic, bacterial, or fungal enteropathies: see earlier
F. Dietary sensitivity: see Chapters 85 and 122
G. Antibiotic responsive enteropathy
1. Antibiotic therapy is most effective if based on culture of intestinal fluid.
2. Antibiotics commonly used for empirical treatment in dogs are as follows:
   a. Tetracycline 10 to 20 mg/kg PO TID for 21 to 28 days
   b. Tylosin 40 to 80 mg/kg PO SID to BID in food
   c. Metronidazole 5 to 15 mg/kg PO BID
   d. Trimethoprim-sulfadiazine 15 mg/kg PO BID
   e. Enrofloxacin 2.5 to 10 mg/kg PO SID to BID

II. General supportive care of malabsorptive diseases involves many options.
A. Feed a highly digestible, low-fat, novel or hydrolyzed protein, low-fiber, or an elemental diet in small quantities.

1. In general, fat is the limiting ingredient, so selection of a diet containing the lowest fat is essential.
2. The lowest fat, highest digestible diet is Royal Canin Low Fat (1.95 g/100 kcal fat).
3. The next lowest diets are Purina Veterinary Diets EN (2.8 g/100 kcal) and Eukanuba Low Residue (2.5 g/100 kcal).
4. In dogs with severe malabsorptive disease, commercially available diets may be inadequate, so homemade novel protein, ultra-low fat diets are needed.

B. Parenteral nutrition is required initially if PLE is severe or until the bowel has time to develop adaptive processes.
C. In dogs with severe PLE and ascites or edema, colloid therapy with hetastarch (5 to 20 mL/kg IV) is helpful.
D. Antibiotic therapy is used to control overgrowth of bacteria.
E. Parenteral vitamin supplementation may be indicated.
1. Cobalamin 250 µg SC, IM weekly or 1 mg SC every 2 weeks for 1 to 3 months
2. Folic acid 1 to 5 mg PO, SC weekly for 1 month
3. Thiamine 10 mg/kg SC, IM SID for 3 to 4 days
4. Tocopherol 100 to 500 IU IM, PO SID with food
5. Vitamin $K_1$ 2 mg/kg PO SID

F. In animals with IBD or lymphangiectasia, antiinflammatory or immunosuppressive therapy with steroids is indicated (see IBD).
G. Histamine$_2$-receptor blockers or proton pump inhibitors are used to control gastric hypersecretion and prevent ulcer development.
1. Ranitidine 0.5 to 1 mg/kg PO, SC SID to BID
2. Famotidine 0.5 to 1 mg/kg PO, SC SID
3. Omeprazole 0.5 mg/kg PO SID

H. Cholestyramine 200 to 300 mg/kg PO BID is administered in dogs to bind bile acids.
I. Loperamide 0.08 mg/kg PO BID to TID is used in dogs for persistent diarrhea not from infectious causes.
J. Special therapy of fungal infection (histoplasmosis) is described earlier.

### Monitoring of Animal

I. Warn owners that many cases of malabsorption do not respond immediately to therapy, may require some trial-and-error dietary regimens to achieve a full response, or may not be responsive to therapy at all.
II. Frequent reevaluation is necessary to assess response to therapy, and to make adjustments in the diagnostic and therapeutic approach.
A. Reassessment provides new information when the diagnosis is not apparent on the initial evaluation.
B. Reevaluate serum biochemical and vitamin levels to determine if the therapy has been appropriate.

## DIETARY SENSITIVITY AND INTOLERANCE

See Chapters 85 and 122.

## INFLAMMATORY BOWEL DISEASES

### Definition

I. Eosinophilic enterocolitis is characterized by increased numbers of eosinophils in the stomach, small intestine, or colon.
II. Lymphocytic plasmacytic enteritis (LPE) is characterized by infiltration of the bowel with lymphocytes and plasma cells, and can affect the stomach, small intestine, colon, or all of them.
III. Granulomatous enteritis is characterized by infiltration of macrophages or histiocytes in the lamina propria, and is more common in the distal small intestine and colon of boxers.
IV. Neutrophilic enteritis is characterized by infiltration of neutrophils, may occur at any location in the small or large intestine, and is uncommon in idiopathic IBD.

### Causes

I. The etiology of eosinophilic enteritis is unknown, but proposed causes include parasitic infestation, dietary hypersensitivity, and idiopathic disease.
II. Many different causes of intestinal infiltration of lymphocytes and plasma cells exist.
A. Dietary sensitivity
B. Parasitism
C. Bacterial toxins
D. Neoplasia
E. Idiopathic disease
III. Basenjis have a severe, hereditary form of lymphoplasmatic enteropathy (see Table 33-1).
IV. Soft-coated wheaten terriers have a familial PLE that is characterized by severe LPE, lymphangiectasia, and hypoproteinemia; may also be associated with a concurrent PLE; and is most likely an immune-mediated disease with a genetic basis (see Table 33-1).
V. A gluten (wheat)-sensitive enteropathy occurs in Irish setters as an autosomal recessive trait, and is characterized by intestinal infiltration of lymphocytes and plasma cells.
VI. No etiological agent or cause is known for granulomatous or neutrophilic enteritis, or for idiopathic LPE.

### Pathophysiology

I. The presence of increased eosinophils, lymphocytes, or plasma cells is likely an immune response to the presence of antigen.
II. If the inflammatory response is significant, it may result in malabsorption owing to changes in the absorptive surface (villous blunting or fusion, crypt abscesses, or fibrosis), lymphatic obstruction, or exudation of protein from the inflammatory effects on epithelial cell function.
III. Eosinophils are chemotactic for other cells, including mast cells, and may result in a local type I hypersensitivity or delayed hypersensitivity reaction to antigens presented to the GI mucosa.
IV. Although the exact etiology of LPE is unknown, an aberrant immune response to luminal antigen (bacterial, parasitic, dietary) is presumed to be the triggering event.

A. Once the mucosa is infiltrated with inflammatory cells, mediators (C-reactive protein, cytokines) are released and trigger the pathogenic effects observed.
B. Intestinal inflammation may be mild or severe, but the effects of the inflammatory changes in the mucosa include malabsorption, vomiting, diarrhea, weight loss, hypoproteinemia, or more widespread effects, such as cholangiohepatitis or pancreatitis.

### Clinical Signs

I. Anorexia, weight loss, vomiting, and diarrhea are common signs.
II. Diarrhea may be small bowel, large bowel, or a combination.
III. Enterocolitis is common in cats with eosinophilic IBD.
IV. Melena or hematochezia is observed more frequently with eosinophilic enteritis than with LPE.
V. Doberman pinschers, boxers, and German shepherd dogs may be predisposed to eosinophilic IBD.
VI. Thickened bowel loops may be palpable in cats with severe LPE.
VII. Severe IBD may be associated with concurrent ascites, coagulopathies, cholangiohepatitis, thromboembolic disease, and nephropathies.
VIII. Histiocytic enterocolitis in boxers causes severe hematochezia and large-bowel diarrhea.

### Diagnosis

I. See the diagnostic approach for Disorders of Malabsorption.
II. There are no specific hematological or biochemical abnormalities.
  A. Occasionally, neutrophilia or eosinophilia are observed.
  B. In cats, if eosinophilia is significant, hypereosinophilic syndrome (HES) must be considered.
  C. Dogs with severe eosinophilic enteritis are more likely to have significant anemia or hypoproteinemia (from gastroduodenal ulceration or mucosal bleeding).
  D. In LPE, nonregenerative anemia (from chronic inflammation or intestinal blood loss) and mild thrombocytopenia are relatively common changes.
  E. There are no pathognomic changes in serum biochemistries, but abnormalities include hypoproteinemia, hypoalbuminemia, hyperglobulinemia, elevations in liver enzyme concentrations, and electrolyte abnormalities.
III. Fecal examinations are essential for eliminating endoparasites and protozoal infections.
IV. Serum folate and cobalamin concentrations are important indicators of the severity of mucosal disease.
  A. Subnormal folate concentrations occur in proximal disease, whereas low concentrations of cobalamin (vitamin $B_{12}$) are associated with distal small bowel disease.
  B. Although not diagnostic for IBD, they indicate the need for further evaluation (biopsy) and supplementation.
V. Diagnostic imaging is important to document disease outside the GI tract, further define the extent of intestinal disease, and identify changes compatible IBD, such as mesenteric lymphadenopathy, thickened bowel loops, and concurrent pancreatic inflammation or liver changes (occasionally in cats).
VI. Definitive diagnosis of IBD requires biopsy of the affected bowel.
  A. Biopsy may be obtained via endoscopy or laparotomy.
  B. Surgical biopsies are indicated if there is multiple organ involvement, if endoscopic biopsies are nondiagnostic, or if the disease is distal.
  C. Classic findings in IBD are increased numbers of inflammatory cells infiltrating the lamina propria and submucosal tissues of the intestine in association with changes of mucosal architecture.
  D. Severe IBD is associated with villous blunting, mucosal ulceration, and other severe mucosal irregularities, which may include lymphangiectasia.

### Differential Diagnosis

I. Causes of chronic intestinal inflammation: *Giardia* spp., histoplasmosis, protothecosis, pathogenic bacteria, etc.
II. Dietary sensitivity or intolerance
III. Cancers of the small bowel causing LPE-like changes, especially lymphoma
IV. Other primary GI diseases, such as lymphangiectasia
V. HES in cats
  A. Infiltration of eosinophils occurs in multiple organs, including the bone marrow, spleen, liver, intestines, and lymph nodes.
  B. Signs mimic eosinophilic IBD (diarrhea, vomiting, weight loss, anorexia) and may involve other organ systems (splenomegaly, anemia, dermatologic signs).
  C. HES can be distinguished from eosinophilic leukemia by mature eosinophils instead of the immature or blast cells observed with leukemia.
  D. Response to treatment with prednisolone is poor in HES, whereas a good response is expected in eosinophilic IBD.

### Treatment

I. Hypoallergenic or novel protein diets, elimination diets, or hydrolyzed protein diets are recommended.
  A. Dietary therapy alone may result in resolution when dietary hypersensitivity is the cause of the inflammatory infiltrates.
  B. Novel, single-antigen or hydrolyzed protein diets reduce the antigenic stimulus and are recommended even when dietary hypersensitivity is ruled out.
  C. Low-residue or highly digestible diets are also alternatives, especially when a low-fat diet is required to prevent further malabsorption.
  D. If homemade diets are used in dogs, well-cooked rice, potatoes, and tapioca are highly digestible, gluten-free carbohydrate sources.
II. Administer appropriate treatment for intestinal parasitism, because it is difficult to identify all parasites with fecal examination.

A. Fenbendazole 50 mg/kg PO SID for 3 to 5 days is appropriate for most intestinal parasites of dogs and cats.
B. Pyrantel pamoate has a narrower spectrum of activity, but is safer in sick dogs or cats.
1. Cats: 10 mg/kg (1 mL/5 lb) PO once
2. Dogs: 5 mg/kg (1 mL/10 lb) PO once

III. Immunosuppressive doses of prednisone reduce the inflammatory and immunological stimulus within the GI tracts once infectious or parasitic causes are ruled out.
A. Give prednisolone 1 to 2 mg/kg PO BID for 3 to 6 weeks in dogs and 2 to 3 mg/kg PO BID in cats, then taper over several months.
B. In cats, methylprednisolone at 1 mg/kg PO BID may be more effective.
C. Some animals require long-term therapy to control the clinical disease, whereas others can be tapered to low QOD doses.
D. A few animals are eventually maintained with diet alone, but these are likely to be animals with a primary dietary sensitivity, not idiopathic eosinophilic IBD.

IV. Antibacterial therapy is generally justified in IBD since secondary overgrowth of bacteria or development of antibiotic responsive enteritis is relatively common, and because bacterial antigens are believed to be of major importance in the development of IBD.
A. Metronidazole is the preferred drug in both dogs and cats for initial therapy.
B. Tylosin may also be effective and has immunomodulatory effects (similar to metronidazole).
C. In severe cases of IBD, fluoroquinolones (enrofloxacin) may be indicated.
D. Bacterial overgrowth is not recognized in cats, but antibiotic therapy with metronidazole is often helpful in the management of IBD.

V. In animals that do not respond to steroid therapy, or have severe steroid-associated side effects, other immunosuppressive drugs may be tried.
A. Dogs: azathioprine 1 to 2.5 mg/kg PO SID to QOD; bone marrow toxicity monitored via frequent CBCs
B. Dogs: cyclosporine 5 mg/kg BID PO; efficacy variable, toxicity problematic, requires blood level monitoring
C. Cats: chlorambucil 1.5 mg/m$^2$ PO SID to QOD

### Monitoring of Animal

I. The prognosis for dogs and cats with eosinophilic IBD is good, and a positive response to therapy can be expected.
A. The more extensive the lesions and severe the disease (e.g., ulcerations, villous atrophy), the more difficult it is to achieve remission.
B. German shepherd dogs are more difficult to control and are more likely to have other concurrent GI abnormalities.

II. The prognosis for LPE varies, depending on the severity of clinical disease, histological changes, and initial response to therapy.
A. In some cases, a single course of drug therapy is all that is required to achieve an apparent cure, whereas others may require lifelong (diet and/or immunosuppressive) therapy.
B. Rarely, cats with LPE develop alimentary lymphoma.

III. In animals with familial or genetic enteropathies, the prognosis is guarded to poor (see Table 33-1).

IV. The prognosis for granulomatous and neutrophilic IBD is unpredictable, but may be guarded depending on the severity and initial response to therapy.

## PROTEIN-LOSING ENTEROPATHIES

### Definition and Causes

I. PLEs are characterized by increased loss of both small (albumin) and large (globulin) proteins into the GI tract.

II. PLE may be primary or secondary to diseases affecting the bowel (Peterson and Willard, 2003).
A. Examples of inflammatory diseases: IBD, histoplasmosis, other granulomatous diseases
B. Diseases causing villous atrophy: gluten enteropathy, severe viral enteritis, bacterial enteritides
C. Severe parasitic enteropathies in young animals
D. Giardiasis in heavily infested adult dogs
E. Chronic obstructive diseases: intussusception, neoplasia
F. Diseases causing intestinal ulceration or erosion (Table 33-3)
G. Diseases affecting the intestinal lymphatic system
1. Lymphangiectasia is characterized by dilated submucosal, subserosal, and/or mesenteric lymphatics.
2. Primary or congenital lymphangiectasia may occur.
a. Lymphangiectasia is seen in the Norwegian lundehund and small terrier breeds (e.g., Yorkshire, Maltese).
b. Even though the disease is congenital, clinical signs do not occur until lipogranulomatous lymphangitis develops, which is progressive.
3. Acquired or secondary lymphangiectasia may be idiopathic (intestinal lymphatic obstruction from an unknown cause) or may develop secondary to other diseases of the GI tract (e.g., neoplasia, IBD) that cause obstruction of the lymphatics, to thoracic duct obstruction, or to right-sided congestive heart failure.

### Pathophysiology

I. It is normal for protein to be lost into the small intestine; however, this protein is usually digested, absorbed, and reused to make new protein.

II. Loss of protein is accelerated in animals with intestinal mucosal or malabsorptive diseases, or lymphatic obstruction.

III. Hypoproteinemia occurs when the rate of GI loss of protein exceeds the liver's ability to synthesize protein.

IV. Hypoproteinemia manifests initially as hypoalbuminemia, with a subsequent reduction in plasma oncotic pressure, but eventually larger proteins are lost and hypoglobulinemia also occurs.

## TABLE 33–3

### Ulcerogenic Diseases of the Small Intestine

| CAUSES | CLINCAL SIGNS | DIAGNOSIS | TREATMENT |
|---|---|---|---|
| Neoplasia<br>Mast cell tumors and mastocytosis<br>Gastrin-secreting tumors (gastrinoma)<br>Hypergastrinemia<br>Secondary to liver disease<br>Secondary to renal disease<br>Drug induced: prolonged use of $H_2$ blockers or antacids<br>Drug induced<br>NSAIDs<br>Corticosteroids<br>Idiopathic<br>Hypovolemic shock with ischemia | Diarrhea ± gross melena<br>Vomiting with or without hematemesis<br>Weight loss, and anorexia or decreased appetite common<br>Abdominal pain in severe cases<br>Anemia in animals with chronic or severe blood loss | History and appropriate clinical signs are suggestive<br>Lab findings nonspecific but support blood loss (elevated BUN, normal creatinine, decreased total protein and albumin)<br>Liver or renal disease causing hypergastrinemia are supportive. Severe hypergastrinemia from gastrin-secreting tumor is rare, but measurement of serum gastrin is suggestive<br>The definitive diagnosis of ulcerative disease is by visualization of the mucosal defects (endoscopy, specialized imaging studies, or surgery) | Replace blood loss with whole blood if animal is in shock or in respiratory distress<br>Stop all medications that may cause ulcers<br>Decrease gastric acid secretion:<br>Omeprazole 0.5-1.0 mg/kg PO, SC SID<br>Famotidine 0.5-1 mg/kg PO, SC, or IV SID-BID<br>Ranitidine 1-4 mg/kg PO, SC BID-TID<br>Control vomiting<br>Metoclopramide 0.2-0.5 mg/kg PO, SC, or IV TID-QID<br>Prochlorperazine 0.25-0.5 mg/kg IM BID-TID<br>Ondansetron 0.5-1.0 mg/kg IM BID-TID<br>Dolasetron 0.3-0.6 mg/kg SC SID-BID<br>Provide mucosal protection with sucralfate 1 g/25 kg PO TID<br>Withhold food until vomiting is controlled for 24-48 hr<br>Institute specific treatment of primary disease |

*$H_2$*, Histamine$_2$; *NSAIDs*, nonsteroidal antiinflammatory drugs; *BUN,* blood urea nitrogen.

V. Because coagulation proteins and immunoglobulins are also lost, a dysfunction of the clotting system or abnormal immune responses may arise.

## Clinical Signs

I. The most common presenting clinical sign is weight loss.
II. Chronic diarrhea may occur, but is inconsistent and depends on the cause and duration.
III. Diarrhea may be intermittent or continuous, is usually small bowel in character, and may be associated with hematochezia.
IV. Vomiting, anorexia, and lethargy are variable, depending on the cause.
V. Severe PLE may cause peripheral edema, ascites, or pleural effusion, and may be associated with abnormal clotting (increased risk of thromboembolism).

## Diagnosis

I. Although signs of diarrhea or vomiting may not occur, most affected animals have weight loss, so an initial assessment must include a work-up for weight loss.
II. Classic abnormalities on hematology and biochemistry profiles include hypoalbuminemia, hypoglobulinemia, hypocholesterolemia, hypocalcemia (true or pseudo), hypomagnesemia, lymphopenia, and mild anemia of chronic disease.
III. Ascites is a pure transudate if it arises from pure loss of albumin, but may be a modified transudate if right heart failure is present, and in rare cases may be chylous if there is a thoracic duct lesion.
IV. Other causes of hypoproteinemia (liver disease, protein-losing nephropathy) must be excluded.
   A. Urinalysis, urine protein: creatinine ratio
   B. Measurement of serum bile acids, other assessments of liver function
   C. Analysis of any ascitic fluid to further identify a cause
   D. Fecal $\alpha_1$-protease inhibitor assay to assess the presence of GI protein loss (see Disorders of Malabsorption)
V. Also assess for other causes of GI disease (see Disorders of Malabsorption or Inflammatory Bowel Diseases).
VI. Definitive diagnosis of intestinal protein loss is supported by histological evidence of disease(s).

A. Because hypoproteinemia may decrease healing and increase the risk of leakage of biopsy sites or dehiscence of the incisions, endoscopic examination is preferred in animals with severe hypoproteinemia.
B. Some dogs with lipogranulomatous lymphangitis do not have significant mucosal abnormalities in the early stages of the disease; in these dogs, full-thickness biopsies are needed to obtain a definitive diagnosis.
C. Many animals with PLE have a normal-appearing intestinal tract at endoscopy or surgery, so it is imperative that biopsies be taken.
D. Endoscopic evaluation of a classic lymphangiectasia reveals lipid droplets on the surface or prominent, chyle (lipid)-filled villous tips.
E. In dogs with severe edema or ascites from hypoproteinemia, mucosal edema must be corrected with hetastarch before biopsy to assure that diagnostic specimens are obtained.
F. Feeding corn oil (1 tbsp) 6 to 8 hours before the endoscopic or surgical biopsy procedure results in maximum dilation of the lacteals, and may increase the likelihood of obtaining a diagnosis.

### Treatment and Monitoring

I. When identified, correct the primary cause of the enteropathy (i.e., administer immunosuppressive therapy for IBD and lipogranulomatous lymphangitis or antifungal therapy for histoplasmosis).
II. The most important aspect of dietary therapy is to feed a low-fat, highly digestible diet to minimize fat malabsorption and lymphatic leakage (Zoran, 2003).
   A. A homemade diet is often the best choice for dogs with severe PLE that have a selective appetite, because it can be formulated to include ultra-low–fat content, novel protein, and highly digestible carbohydrate sources.
      1. One example consists of no-fat cottage cheese, egg whites, or turkey breast as the protein sources, and boiled potatoes (without the skins) or well-cooked white rice as the carbohydrate sources.
      2. Initially, no other fat source is added, but eventually, a small amount of oil (corn oil) must be added to provide essential fatty acids in the diet.
   B. Commercially available, ultra-low–fat (<3 g/100 kcal fat) diets may be adequate in less severe cases.
      1. The lowest fat, commercially available diet that is not also a high-fiber diet is Royal Canin Low Fat.
      2. Hydrolyzed diets also may be well tolerated, but they are not all low in fat.
      3. Purina Veterinary Diets H/A has the lowest fat content of the commercially available hydrolyzed diets.
   C. In dogs that are unable to eat (vomiting, severe diarrhea) nutritional support via total parenteral or partial parenteral nutrition may be needed, especially in dogs that are severely cachetic and edematous.
   D. If hypoproteinemia is severe, but the animal is able to eat, low-fat elemental diets (e.g., *Vivonex*) may be used instead of or in addition to commercial diets.
III. For dogs with severe coagulation protein loss that have a coagulopathy, plasma therapy (10 to 20 mL/kg IV) can be used to provide these proteins, but it is ineffective in increasing serum protein levels.
IV. Following diagnosis and institution of appropriate therapy, reevaluate body weight, serum protein concentrations, and any biochemical abnormalities found on initial presentation.

## ULCEROGENIC DISEASES

See Table 33-3.

## INTESTINAL OBSTRUCTION

### Definition

I. Partial or complete obstructions of the small intestine are caused by intraluminal, intramural, or extramural lesions that slow or prevent passage of intestinal contents.
II. Functional obstruction is caused by ileus arising from neurogenic, myogenic, or humoral mechanisms.
III. Obstructions are also classified as to whether they are partial or complete, and whether they are simple or strangulated.
IV. Complete or strangulated obstructions result in a medical and surgical emergency necessitating an immediate response (see Chapter 39).

### Causes

I. Intraluminal causes include neoplasia, polyps, foreign bodies (both linear and other), and intussusception.
II. Intramural obstruction is caused by neoplasia, abscesses, granulomas, congenital stenosis and atresia, and inflammatory lesions.
III. Extramural lesions include adhesions, strangulation (mesenteric or organ volvulus), strictures (secondary to surgery), and neoplastic masses incarcerating the bowel or adjacent structures.
IV. Functional obstruction of the bowel is caused by hypomotility and ileus, which may be idiopathic or may occur secondary to infectious or inflammatory diseases (e.g., parvovirus).

### Pathophysiology

I. Obstructions in the bowel are also classified according to their location and their relative effects on fluid, electrolyte, and acid-base balance.
   A. High small intestinal obstructions of the duodenum or upper jejunum result in frequent vomiting and a rapid onset of dehydration with severe hypokalemia and metabolic acidosis.
   B. If the high obstruction is a gastric outflow obstruction, hypochloremic metabolic alkalosis is observed.
   C. Lower small intestinal obstructions are often associated with a slower onset of dehydration and vomiting, but diarrhea may be common.
      1. These cases frequently have hypokalemia, hyponatremia, hypochloremia, and metabolic acidosis.

2. Cats are more prone to develop low obstructions.

II. Another effect is alteration in normal GI motility, with subsequent alterations in bacteria and/or bacterial overgrowth, increased bacterial absorption, and development of endotoxemia and septicemia.

III. Intestinal strangulation, intussusception, or incarceration interfere with vascular integrity, resulting in segmental bowel stasis or death, and the animal is often presented in shock or a state of collapse.

IV. Partial, low obstruction or sliding intussusception may be chronic and cause intermittent clinical signs of malabsorption or small intestinal bacterial overgrowth.

## Clinical Signs

I. Signs depend on the location, severity, and amount and location of bowel affected.

II. Duration of the process and effects on bowel integrity and function, as well as bacterial translocation, are also important factors in determining the clinical signs.

III. The most common signs are vomiting, anorexia, and lethargy.

IV. Other signs may include diarrhea (especially with lower obstructions), abdominal pain (with bowel strangulation or loss of vascular integrity), and severe dehydration or collapse from hypovolemia, endotoxemia, or septicemia.

## Diagnosis

I. Compatible history, signalment, and physical examination findings are suggestive.

II. Palpation may reveal abdominal pain, a mass lesion, intestinal bunching (typical of string foreign bodies) or intussusception.

III. Laboratory findings are variable.
   A. The hemogram is often normal, but neutrophilia or neutropenia, a left shift, evidence of toxic change, and anemia of chronic disease may all be observed.
   B. The biochemical profile is used to rule out other causes of vomiting and anorexia (e.g., pancreatitis, liver disease, renal failure) and to assess electrolyte abnormalities (especially potassium, chloride, sodium, and magnesium).
   C. Prerenal azotemia or hepatic enzyme elevations are common in severely dehydrated or sick animals.

IV. Imaging studies are necessary when palpation is nondiagnostic.
   A. Plain radiography may reveal dilated loops of bowel present proximal to the obstruction, radiopaque foreign objects, intestinal pleating typical of linear foreign bodies, and/or evidence of functional obstruction (ileus of all bowel loops).
   B. Horizontal beam radiography (standing lateral) may show an interface of fluid and gas, with a complete obstruction having gas caps at different levels.
   C. Positive contrast studies can be used to identify obstructions that are partial, low, or intermittent, especially when survey films are inconclusive; however, in vomiting animals aspiration of the material can be life-threatening.
   D. Ultrasonography is used to identify partial or low obstructions, intussusceptions, and mesenteric volvulus or strangulation of bowel.

V. Exploratory laparotomy is necessary if the clinical signs or laboratory data indicate an obstruction, but imaging studies are inconclusive.
   A. Surgery is an acceptable means of confirming the diagnosis, especially if the clinical status is deteriorating in the face of no diagnosis.
   B. Intestinal volvulus, strangulation, and sliding intussusceptions are difficult to diagnose and may only be seen at surgery.

## Differential Diagnosis

I. Pancreatitis

II. Hypoadrenocorticism

III. Acute renal or hepatic failure

IV. Severe infectious or inflammatory intestinal diseases

V. Ingestion of toxins

VI. Other causes of acute abdomen (see Chapter 39)

## Treatment

I. Stabilize the animal with aggressive fluid therapy and electrolyte supplementation.
   A. Crystalloid therapy (lactated Ringer's solution, Normosol-R) is adequate in most cases, but hetastarch or other colloids are important in severely hypovolemic or shocky animals.
   B. Potassium supplementation (10 to 40 mEq/L) is essential if hypokalemia is present.

II. Parenteral broad-spectrum antibiotic therapy is initiated to combat bacterial overgrowth or translocation, and endotoxemia or septicemia (see Viral or Bacterial Infections).

III. Antiemetics may be considered to control vomiting, but some (metoclopramide) are contraindicated in animals with complete intestinal obstruction or must be used with caution (chlorpromazine) in severe hypovolemia.

IV. Aggressively treat hypoglycemia, systemic inflammatory response syndrome, and DIC arising from endotoxemia.

V. Definitive therapy is surgical intervention.
   A. A variety of surgical remedies are available, including enterotomy, resection and anastomosis, reduction of the intussusception and bowel plication, repair of hernias, and volvulus and mesenteric repair.
   B. Intestinal biopsies are obtained if there is any doubt about the possible cause of the problem.

## Monitoring of Animal

I. Careful postoperative monitoring is essential for a successful outcome, especially in those animals that are endotoxemic or septic.
   A. Monitor PCV, TP, vital signs, electrolytes, blood glucose, and fluid status (CVP, capillary refill time, body weight, urine output) closely.
   B. With significant bowel resection or disturbance, oral alimentation is initiated as soon as possible (12 to 18 hours postoperatively) to provide nutrition for the

GI tract, help prevent postoperative ileus, and provide support for recovery and healing.
C. If the animal refuses to eat or is unable to eat because of persistent vomiting, parenteral nutrition must be considered.

II. The prognosis is guarded to good, depending on the severity of the obstruction, the cause, and the presence of any complicating factors (e.g., DIC, endotoxemia, peritonitis).

## NEOPLASIA

### Definition and Causes

I. The most common malignant tumors of the small intestine in dogs and cats are adenocarcinoma and lymphosarcoma (LSA).
A. Intestinal adenocarcinoma only accounts for 1% of all tumors, so it is relatively rare.
B. Adenocarcinomas appear to be more common in the boxer, collie, poodle, West Highland white terrier, German shepherd dog, Doberman pinscher, and Siamese cats.

II. GI lymphoma is the second most common form of LSA in dogs and the most common form in cats.
A. Intestinal LSA may be of B or T cell origin or a large granular lymphocyte subtype, and the behavior of the tumor is dependent on its type.
B. There is no apparent breed predisposition in cats, but in dogs, the boxer, shar-pei, golden retriever, English springer spaniel, Doberman pinscher, Labrador retriever, and German shepherd dog appear to be predisposed.

III. Other malignant neoplasms affecting the small intestine include mast cell tumors (cats), leiomyosarcomas, and carcinoid tumors.

IV. Leiomyosarcomas are more common in large-breed dogs, especially German shepherd dogs.

V. Benign tumors of the intestinal tract include leiomyomas, polyps, fibromas, lipomas, and adenomas.

VI. The inciting cause of intestinal neoplasia is unknown; however, LSA may be observed in cats with chronic IBD or previous exposure to FeLV (most cats are FeLV negative).

### Pathophysiology

I. The etiology of small intestinal adenocarcinoma is unknown, but a genetic predisposition is likely.
A. These tumors typically cause an obstruction of the intestine because they form annular, constrictive lesions.
B. They can form in any segment of the intestine, but are most common in the distal jejunum or ileum in cats and in the colon in dogs.

II. The etiology of LSA is unknown in most cases, but IBD may be a predisposing factor.
A. LSA of the small intestine may occur as a diffuse, infiltrative lesion affecting large segments of bowel with thickening of the bowel wall, as a classic malabsorptive syndrome, or as an obstructive mass.
B. LSA in the cat may arise as a low-grade disease that grows slowly over months or years and may be difficult to distinguish from IBD.
C. LSA may occur in both dogs and cats as a rapidly advancing, high-grade malignancy.

III. Leiomyosarcomas tend to create large masses and have been more often associated with paraneoplastic hypoglycemia.

IV. Mast cell tumors (especially in cats) tend to be infiltrative.

### Clinical Signs

I. Clinical signs are dependent on the location of the lesion, the type of lesion (mass effect or infiltrative disease), the rate of development, and other effects initiated by the presence of the tumor.
A. Intestinal adenocarcinoma is often slow growing, so weight loss in the absence of other signs is a frequent finding in the early stages, which may be months.
1. Once an obstructive lesion develops, vomiting or diarrhea (with or without blood) occurs.
2. Metastasis to the liver, mesenteric lymph nodes, peritoneal cavity, other intestinal sites or lungs is common and has usually occurred by the time of diagnosis.
B. Signs of GI LSA are variable.
1. Solitary mass lesions may cause signs of an obstruction, including vomiting or diarrhea, anorexia, and weight loss.
2. Diffuse small-cell LSA may be very insidious, resulting in weight loss, signs of malabsorption or diarrhea (especially in cats), and is easily confused with IBD.
3. Dogs with LSA tend to have a more acute illness and are more likely to develop hypercalcemia.
4. Lymphoblastic LSA may develop very quickly and is often associated with severe malabsorptive disease, melena, and other GI signs.
C. Other intestinal tumors typically cause signs of obstruction (e.g., vomiting, diarrhea, anorexia, weight loss) and may result in a nonregenerative anemia of blood loss.
D. Intestinal mastocytosis of cats is more likely to be associated with intestinal blood loss than other GI tumors.

II. Clinical signs of weight loss or diarrhea in an older animal should warrant an investigation.

III. Physical examination may reveal weight loss or thin body condition (especially cats), but may be otherwise unremarkable.
A. Alternatively, diffuse intestinal thickening or intestinal or abdominal masses may be palpated.
B. In dogs or cats with diffuse abdominal carcinomatosis, ascites or peritonitis may be present.
C. Hepatosplenomegaly is also possible in dogs with diffuse, multicentric LSA.

IV. The most common clinical signs are vomiting, diarrhea, anorexia, and weight loss.

### Diagnosis

I. A compatible history, signalment, and physical examination findings are suggestive.

II. Laboratory results are often variable and nonspecific.

A. The hemogram may be normal, or a nonregenerative anemia of chronic disease or iron deficiency may be seen.
B. The biochemistry profile is used to assess albumin levels (intestinal protein loss), electrolytes (loss), or other organ system dysfunction.
C. Specific testing, to rule out pancreatitis (see Chapter 36) may be needed in some cases.
D. Abdominal radiography frequently reveals intestinal abnormalities, masses, abnormal organ position, or abnormal gas patterns.
E. Thoracic radiography is used to rule out metastatic disease.
F. Abdominal ultrasonography is also used to identify masses, abdominal lymphadenopathy, or obstructive lesions in the bowel wall.

III. Definitive diagnosis is made by histopathologic evaluation of biopsies.

### Differential Diagnosis

I. Lymphoma: IBD, chronic giardiasis, chronic pancreatitis (cats), cholangiohepatitis (cats), other infiltrative GI diseases or PLE (dogs), severe bacterial overgrowth
II. Adenocarcinoma: foreign body, intussusception, pythiosis granuloma, IBD, LSA, mast cell tumor in the cat, smooth muscle tumors
III. Other intestinal neoplasms: causes of intestinal obstruction, malabsorptive disease

### Treatment and Monitoring

I. LSA
   A. Focal LSA may be cured with complete surgical resection if margins are clean, but most LSA that is diffuse or has nodal or hepatic involvement requires chemotherapy to provide a good quality of life for a prolonged period.
   B. Specific chemotherapy depends on the type and location of LSA (see Treatment and Monitoring under Neoplasia in Chapter 31; see also Chapter 69).
II. Adenocarcinoma
   A. Surgical resection is the treatment of choice for intestinal adenocarcinoma.
   B. Recurrence is likely even with wide surgical margins, but may provide clinical remission for 6 to 12 months.
   C. Chemotherapy is generally unsuccessful.
III. Leiomyosarcoma: surgical resection may provide long-term survival (slow growing).
IV. Intestinal mast cell tumors (cats)
   A. Surgical resection is beneficial, but early metastasis is common.
   B. Chemotherapy is necessary in diffuse mastocytosis or in cats in which resection is not associated with clean margins.

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