Chapter 55

Introduction to Small Intestinal Diseases

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"From the gut, comes the strut, and where hunger reigns, strength abstains."
Francois Rabelais

CLINICAL IMPORTANCE

Disorders of the small intestine are encountered frequently in veterinary practice. A number of acute and chronic enteropathies are recognized (**Tables 55-1** and **55-2** and **Boxes 55-1** through **55-3**) and must be distinguished from diseases of other organ systems resulting in gastrointestinal (GI) signs. Typical clinical manifestations of small intestinal disease include diarrhea, weight loss, poor body condition, vomiting, borborygmus and flatulence. **Table 55-3** lists breed-associated small intestinal disorders.

Diarrhea is defined as a change in the frequency, consistency or volume of bowel movements and stools. Diarrhea is the most common manifestation of small intestinal disease. The diarrhea associated with small intestinal conditions differs from that typically associated with large intestinal disorders (**Table 55-4**).

Chapters 56 through 60 include feeding plans for patients with small intestinal disorders. Tables in those chapters list the key nutritional factors for such patients as well as tables that include the levels of key nutritional factors of commercial foods marketed for patients with small intestinal diseases. For comparative purposes, these tables also include the recommended levels of key nutritional factors for patients with small intestinal diseases. Box 60-1 discusses the use of certain oligosaccharides in small intestinal disease.

MECHANISMS OF DIARRHEA

An understanding of normal gut physiology and the common pathophysiologic mechanisms responsible for diarrhea in companion animals allows for a rational approach to evaluation and treatment of patients with small intestinal disorders. There are four major mechanisms for diarrhea: 1) osmotic, 2) altered mucosal permeability, 3) abnormal motility and 4) secretory (Moon, 1978).

Osmotic Diarrhea

Osmotic diarrhea, also referred to as diarrhea of malabsorption, is the most common cause of diarrhea in dogs and cats (Moon,

1978). Osmotic diarrhea may occur in conjunction with other pathophysiologic processes. The presence of unabsorbed nutrients (solutes) in the bowel results in passive diffusion of water into the gut lumen (**Box 55-3**). This process continues until the osmolality of the intestinal chyme is approximately that of plasma. Osmotic diarrhea may occur as a result of maldigestion, malabsorption, administration of osmotic laxatives and overeating. Clinical manifestations of osmotic diarrhea include passage of large volumes of fluid or soft stools. Stools may appear greasy if steatorrhea is present. The diarrhea usually resolves following a 24- to 36-hour fast.

Diarrhea Due to Altered Mucosal Permeability

Altered mucosal permeability (i.e., exudative diarrhea) is another common cause of diarrhea in dogs and cats. The large or small bowel may be affected. The intestinal permeability barrier is composed of epithelial tight junctions, mucosal lymphatics and capillaries and the local immune system. Failure of any one of these components can result in diarrhea. Intestinal diseases that result in erosions, ulcerations and mucosal inflammation or infiltration are potential causes of gut permeability changes and diarrhea. Diarrhea associated with increased gut permeability may present as a protein-losing enteropathy (i.e., hypoproteinemia, hypoalbuminemia, weight loss). Fresh and/or melenic blood may be present in the stool. Fecal examination may reveal inflammatory cells. Often these diarrheas do not completely resolve if food is withheld.

Diarrhea Due to Abnormal GI Motility

Diarrhea may be associated with deranged intestinal motility. It is often difficult to determine whether abnormal GI motility is a primary entity or a consequence of another disorder. In general, deranged intestinal motility is not a common cause of small bowel diarrhea in dogs and cats. The most common motility

Table 55-1. Potential causes of acute small bowel diarrhea in dogs and cats.

Dietary	Infectious agents	Miscellaneous	Toxin or drug induced
Dietary indiscretion	Bacteria	Hemorrhagic gastroenteritis	Chemotherapeutic agents
Foreign bodies	*Bacillus* spp.		Digoxin
Garbage toxicity	*Campylobacter* spp.		Heavy metals
Raw meat consumption	*Clostridium* spp.		Laxatives (magnesium oxide, lactulose)
	Escherichia coli		Nonsteroidal antiinflammatory drugs
	Salmonella spp.		
	Staphylococcus spp.		
	Yersinia spp.		
	Parasites		
	Helminths (roundworms, hookworms, *Strongyloides* spp.)		
	Protozoa (*Giardia* spp., *Isospora* spp., *Cryptosporidium* spp.)		
	Rickettsia		
	Salmon poisoning		
	Viruses		
	Canine distemper		
	Coronavirus		
	Panleukopenia		
	Parvovirus		
	Rotavirus		

Table 55-2. Potential causes of chronic small bowel diarrhea in dogs and cats.

Dietary	Infectious agents	Inflammatory bowel disease	Miscellaneous	Neoplasia
Adverse reactions to food	Algae	Eosinophilic gastroenteritis	Juvenile diarrhea of cats	APUD cell tumors
Food allergy (hypersensitivity)	Protothecosis	Lymphocytic enteritis	Lymphangiectasia	Lymphosarcoma
Lactose intolerance	Bacteria	Lymphoplasmacytic enteritis		Mast cell tumor
	Campylobacter spp.	Regional enteritis		
	Mycobacterium spp.	Suppurative gastroenteritis		
	Salmonellosis			
	Small intestinal bacterial overgrowth			
	Fungi			
	Histoplasmosis			
	Pythiosis			
	Zygomycosis			
	Parasites			
	Helminths (roundworms, hookworms)			
	Protozoa (*Isospora* spp., *Giardia lamblia*, *Cyrptosporidium* spp.)			
	Viruses			
	Coronavirus			
	Feline immunodeficiency virus			
	Feline infectious peritonitis			
	Feline leukemia virus			

Key: APUD = amine precursor uptake and decarboxylation.

derangement is rapid intestinal transit associated with a decreased frequency of rhythmic segmental contractions, also termed ileus. The reduction in segmental contractions results in a "pipe" effect with little resistance to ingesta flow. Ileus may occur in conjunction with infiltrative diseases, severe abdominal pain, parvoviral enteritis or may develop postoperatively. In many cases, iatrogenic ileus complicates the management of patients treated inappropriately with anticholinergic agents. Increased frequency of peristaltic contractions is probably not an important cause of diarrhea in dogs and cats. However, it may play a role in the irritable bowel syndrome. A reduction in peristaltic or interdigestive motility may result in small intestinal bacterial overgrowth. Response to dietary manipulation is variable.

Secretory Diarrhea

Secretory diarrhea is relatively uncommon in companion animals vs. people (cholera is the prototypical example) and food animal species. Crypt epithelial cells produce intestinal fluid, whereas enterocytes lining the villous tips are responsible for absorption. Normally, absorption exceeds intestinal secretion. Most secretagogue effects are mediated via a second messenger (e.g., cyclic AMP, cyclic GMP, calmodulin). Secretagogues include GI hormones, bacterial enterotoxins, certain pharmacologic agents, deconjugated bile acids and hydroxy fatty acids. Clinical manifestations of secretory diarrhea are often extreme. Patients have large volumes of fluid diarrhea and often become dehydrated rapidly. Generally, fasting is not successful in alleviating clinical signs.

Table 55-3. Breed-associated small intestinal disorders.

Eosinophilic gastroenteritis	German shepherd dog Irish setter
Hemorrhagic gastroenteritis	Dachshund Miniature poodle Miniature schnauzer
Immunoproliferative small intestinal disease	Basenji Ludenhund
Intestinal adenocarcinoma	Siamese cat
Lymphoplasmacytic enteritis	German shepherd dog Chinese Shar-Pei Soft-coated wheaten terrier Domestic shorthair cat
Parvoviral enteritis	American pit bull terrier Doberman pinscher Rottweiler Labrador retriever (black)
Small intestinal bacterial overgrowth	German shepherd dog Beagle
Lymphangiectasia*	Yorkshire terrier Golden retriever Dachshund Basenji (IPSID) Ludenhund (IPSID)
Wheat-sensitive enteropathy	Irish setter

Key: IPSID = immunoproliferative small intestinal disease.
*Soft-coated wheaten terriers may be affected by a protein-losing enteropathy that may occur in conjunction with a protein-losing nephropathy.

REFERENCE

The reference for **Chapter 55** can be found at www.markmorris.org.

Box 55-1. Small Intestinal Neoplasia.

Lymphosarcoma, adenocarcinoma and mast cell tumors are the most common intestinal tumors recognized in cats, whereas adenocarcinomas and leiomyomas are more common in dogs. Adenocarcinomas occur most commonly in the jejunum and ileum of cats and in the duodenum and colon of dogs. Lymphosarcoma arising from gut-associated lymphoid tissue is the most common extranodal form. A number of other tumor types occur, including plasma cell tumors, leiomyosarcomas, hemangiosarcomas and carcinoid tumors, but are less common.

The diffuse nature of lymphosarcomas and mast cell tumors often results in maldigestion of carbohydrates and some proteins, malabsorption and subsequent malnutrition and provides the greatest opportunity for dietary therapy.

Nutritional support is of critical importance in managing patients with intestinal neoplasia. Providing optimal nutrition helps the clinician return the patient to ideal body condition, provides some protection against the toxic side effects of antineoplastic chemotherapy and improves the patient's quality of life (Chapter 30). As with many small bowel disorders, use of highly digestible foods is recommended with nutrient levels adjusted for each patient as tolerated.

In cases of intestinal neoplasia, assisted-feeding techniques (enteral or parenteral) may be required initially to meet nutritional, fluid and electrolyte needs as the patient recovers from surgery or receives chemotherapy. In particular, early nutritional support (i.e., parenteral or enteral) in debilitated cats is very advantageous in the initial management of gastrointestinal lymphosarcoma. Parenteral administration of nutrients can be added to oral intake to fully meet the patient's requirements. Reestablishing normal intestinal function and stimulating adaptation should begin as soon as the patient tolerates oral food intake.

Multiple (i.e., six to eight) small meals per day are recommended in a form best tolerated by the patient. Occasionally, a liquid form of the food may be necessary for patients undergoing various forms of treatment.

The Bibliography for **Box 55-1** can be found at www.markmorris.org.

Box 55-2. Wheat-Sensitive (Gluten-Sensitive) Enteropathy.

Wheat-sensitive enteropathy is a chronic small bowel disorder recognized primarily in Irish setter dogs. The condition is believed to have an autosomal recessive mode of inheritance. The condition, also termed gluten-sensitive enteropathy, is comparable in some ways to celiac disease of people. The disorder results from a hypersensitivity to gliadin, a glycoprotein found in many grains including wheat, barley, rye, buckwheat and oats. Gliadin is not found in rice, corn or potatoes.

Affected dogs usually develop clinical signs by six months of age, including weight loss, failure to thrive and chronic, intermittent small bowel diarrhea. Some dogs may outgrow the condition and fail to respond to wheat-gluten exposure as adults despite being affected as young dogs. There are no consistent laboratory findings in dogs with wheat-sensitive enteropathy. The results of intestinal function tests such as D-xylose absorption and serum folate/cobalamin concentrations are often normal. Intestinal biopsy can be a useful diagnostic aid. Typical histopathologic findings include partial villous atrophy and intraepithelial lymphocyte infiltration with inflammatory infiltrates within the lamina propria.

Diagnosis of this condition is usually based on signalment, history and response to a therapeutic food trial. Clinical signs usually resolve within two to four weeks after gliadin-containing grains are eliminated from the food. Definitive diagnosis can be made if the clinical signs recrudesce upon re-exposure to gliadin-containing foods or purified gluten.

The pathogenesis of gluten- or wheat-sensitive enteropathy is not completely understood. Hypersensitivity to gliadin has been theorized to develop in dogs due to an age-related delay in expression of a brush border peptidase (i.e., aminopeptidase N) or to increased intestinal permeability. Affected Irish setters have increased serum IgA levels and circulating CD4+ lymphocytes compared to normal dogs. Compared to celiac disease in man, there is no link to major histocompatibility genes (Chapter 31).

The feeding plan includes eliminating all sources of gliadin from the diet including commercial foods, homemade foods, table foods, commercial treats, supplements and chewable medications containing wheat, barley, rye, buckwheat or oats as ingredients. The carbohydrate portion of the food should be composed of potatoes, rice or corn.

Affected dogs should be fed to meet their daily energy requirement. Young growing dogs should be fed foods suitable for growth, whereas young adult and mature adult dogs should receive foods suitable for their lifestage and lifestyle.

The Bibliography for **Box 55-2** can be found at www.markmorris.org.

Box 55-3. Disaccharide Intolerance.

Lactose intolerance is the most common carbohydrate intolerance in people and possibly in dogs and cats. Lactose intolerance results from a relative or absolute deficiency of the enzyme lactase. If brush border lactase fails to hydrolyze lactose into galactose and glucose, the unabsorbed sugar will induce an osmotic diarrhea when it reaches the colon. In addition, colonic bacteria ferment lactose, producing volatile fatty acids, hydrogen and carbon dioxide, resulting in flatulence and pain.

The intestinal brush border mucosa and the disaccharidase enzymes that it contains (i.e., lactase, sucrase, maltase and α-dextrinase) are often lost due to enteritis from any cause. These enzymes are essential for digestion of disaccharides (i.e., lactose, sucrose, maltose and α-dextrins) and subsequent absorption of their constituent monosaccharides. As mentioned above, unabsorbed disaccharides result in a colonic osmotic diarrhea.

Often, one to two weeks are needed to fully restore intestinal lactase and sucrase brush border disaccharidase activity after the cause for their loss is corrected. Diarrhea may, therefore, occur during this period with the ingestion of carbohydrates requiring disaccharidase digestion. For example, jejunal and ileal lactase and sucrase activity were significantly less in piglets fed nothing per os; however, maltase activity in the jejunum and ileum was not different from that of enterally fed piglets after four weeks. Therefore, during and for several days after a diarrheic episode, foods containing maltodextrins should be fed but not those containing lactose and sucrose.

Inadequate intestinal disaccharidase activity is also the mechanism responsible for causing diarrhea after excessive milk consumption. Puppies and kittens normally have small but adequate amounts of intestinal lactase. After weaning age, lactase decreases to about 10% of peak activity in dogs and cats, and continued consumption of milk does not alter the decline in lactase activity. Diarrhea occurs if more lactose is consumed than the animal can digest. Bitch's milk contains only 3.1% lactose and queen's milk 4.2% vs. cow's and goat's milk (4.5 to 5%) as fed. This difference explains why puppies and kittens commonly have diarrhea when given cow's or goat's milk as a milk replacer.

Healthy adult dogs and cats may also develop diarrhea when fed milk. Adult dogs and cats have low levels of brush border lactase activity compared with levels present in pre-weaning animals and levels of other disaccharidases. Most newborn mammals have negligible maltase and sucrase activities, which develop during the first few weeks of life; however, lactase activity is high at birth and decreases with age. In one study, dogs developed diarrhea while consuming more than 1 g of lactose/kg body weight, an amount equivalent to about 20 ml milk/kg body weight or three-fourths cup of milk for a 10-kg dog. Thus, milk-based enteral diets and milk drinks for dogs and cats are commonly treated with enzymes (β-galactosidase) to hydrolyze lactase. However, this increases the osmolality of the product, which may cause diarrhea.

Altered intestinal disaccharidase activity also is hypothesized to be one of the factors responsible for diarrhea subsequent to rapid change in foods and feeding methods. Lactase and sucrase are food-inducible enzymes, whereas, maltase is not. Several days are required for intestinal disaccharidase enzyme activity to respond to a change in dietary carbohydrates.

The Bibliography for **Box 55-3** can be found at www.markmorris.org.

Table 55-4. Characteristics of small and large bowel diarrhea.

Characteristics	Small bowel	Large bowel
Blood in feces	Melena	Hematochezia
Fecal quality	Loose, watery, “cow-pie”	Loose to semi-formed, “jelly-like”
Fecal volume	Large quantities	Small quantities
Frequency of defecation	Normal to slightly increased	Increased
Malaise	May be present	Rare
Mucus in feces	Usually absent	Usually present
Steatorrhea	May be present	Absent
Tenesmus	Absent	Usually present
Urgency	Absent	Usually present
Vomiting	May be present	Absent
Weight loss	May be present	Rare