Chapter 56

Acute Gastroenteritis and Enteritis

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"When the Humour falls upon the intestines, it produces a Diarrhea with a sense of heat, and sometimes a Griping...and sometimes with hot stools...so that most of the nutricious juices run off that way, which greatly wastes and sinks the patient."
Williams Hillary 1759, Observations on Changes of the Air

CLINICAL IMPORTANCE

Acute gastroenteritis (enteritis often accompanied by acute gastritis; called gastroenteritis) is one of the most common illnesses of dogs and cats. A number of infectious, toxic and dietary factors can trigger the sudden onset of diarrhea with or without vomiting (Table 55-1). This chapter addresses the diagnosis and management of dogs and cats with an acute onset of diarrhea with or without vomiting.

PATIENT ASSESSMENT

History and Physical Examination

Patients are usually presented for the sudden onset of diarrhea, vomiting or both. In many cases, the owner will report that the pet acts depressed and has a poor appetite. The number and character of the defecations should be assessed. Large fluid stools are typical of small bowel disorders. Melenic or hemorrhagic stools may indicate a potentially life-threatening disorder (**Table 56-1**).

The dietary history is critical. Food-induced diarrhea is relatively common; therefore, a recent change to a moist high-fat or meat-based food may be the source of the patient's diarrhea.[a,b] Often, it is possible to elicit a history of dietary indiscretion, feeding table foods over a holiday or access to garbage, carrion or abrasive materials. Cats that hunt birds may have been exposed to *Salmonella* spp. and dogs eating raw salmon are at risk for salmon poisoning (Scott, 1988; Hibler and Greene, 1986).

Feeding uncooked meat in homemade foods and racing greyhound rations is linked to bacterial enteritis (Chapter 11). Greyhound rations often contain raw ground beef and have been identified as fomites for salmonellosis and colibacillosis (Chengappa et al, 1993; Stone et al, 1993; Morley et al, 2006). Incorporation of raw poultry in foods has been linked to campylobacteriosis and salmonellosis (Davenport, 1989) (Chapter 11).

Other husbandry issues are also important. Records of vacci-

Table 56-1. Clinical signs associated with life-threatening acute gastroenteritis.

Abdominal pain	Fecal leukocytes
Dehydration	Fever
Depression	Melena or hematochezia

nations and anthelmintic treatments should be reviewed. Questions should be asked about the health of other pets and people in the household. A positive answer to these questions raises the likelihood that an infectious organism was involved.

Often, affected dogs and cats are depressed and dehydrated. Typically, the diarrhea is most consistent with small bowel disease (Table 55-4). Occasionally, patients may present with signs reflective of small and large bowel involvement. Abdominal discomfort may be recognized on palpation. Patients should be carefully evaluated for evidence of septic shock. Animals exhibiting systemic signs of illness such as fever and congested mucous membranes in addition to gastrointestinal (GI) signs should be treated more aggressively.

Laboratory and Other Clinical Information

Because there are many potential causes of acute gastroenteritis and enteritis, achieving a definitive diagnosis can be difficult. It is more important to determine whether the patient's condition is self-limiting or if it is potentially life-threatening. This decision, based on historical and physical findings, is critical. **Table 56-1** lists factors that suggest a potentially life-threatening condition. Cases of a serious nature should be pursued aggressively with the use of hematology, serum biochemistry profiles, urinalyses and fecal examinations for parasites and other infectious pathogens. Abdominal films or GI contrast radiographs are recommended to rule out obstruction. Self-limiting cases are usually approached more conservatively. Diagnostics are often limited to assessment of hydration status (i.e., packed cell volume, total protein concentration and body weight) and thorough examination of feces for evidence of parasites, bacterial pathogens (e.g., spores of *Clostridium* spp.), viruses (e.g., fecal ELISA for parvovirus) and enterotoxins (e.g., *C. difficile* fecal ELISA) (Chouicha and Marks, 2006).

Risk Factors

Risk factors for acute gastroenteritis and enteritis include age, breed, immune status and environment. Young animals are more susceptible to a variety of infectious pathogens including parasites, viruses and bacteria (De Santis-Kerr et al, 2006). Hemorrhagic gastroenteritis is reported most commonly in miniature schnauzers, dachshunds, toy poodles and other toy and small dogs (Guilford and Strombeck, 1996). Rottweilers, American pit bull terriers and Doberman pinschers appear to be at increased risk for parvoviral enteritis (Mantione and Otto, 2005; Houston et al, 1996).

Several canine breeds (e.g., Chinese Shar-Pei, German shepherd dog, beagle) may have IgA deficiency; therefore, these dogs may be more susceptible to develop a number of GI conditions, including giardiasis and small intestinal bacterial overgrowth (Table 55-1) (Batt et al, 1991; Whitbread et al, 1984). Likewise, immunocompromised animals are at risk for contracting viral and bacterial enteritides. For example, an outbreak of *C. difficile*-associated enteritis was reported in hospitalized dogs (Weese and Armstrong, 2003). Several conditions including cancer, diabetes mellitus, feline leukemia and feline immunodeficiency virus infections may result in deranged immune function.

Environment also plays an important role in exposure to pathogens. Dogs and cats kept in unsanitary or overcrowded conditions are much more likely to develop infectious enteropathies (De Santis-Kerr, 2006). In addition, animals kept in poorly controlled environments have higher risk for exposure to high-fat table foods, garbage containing spoiled food and toxins. Dogs in particular eat indiscriminately. Consumption of rotten garbage, decomposing carrion or abrasive materials (e.g., hair, bones, rocks, plastic, aluminum foil) can result in severe enteritis. Poor husbandry practices including inadequate parasite control and vaccination programs and overcrowding put pets at risk for acute gastroenteritis and enteritis.

Consumption of raw food diets has been associated with bacterial enteritides (Chengappa et al, 1993; Stone et al, 1993; Morley et al, 2006). Cultures of home-prepared and commercially available raw foods have demonstrated bacterial pathogens including *Salmonella* spp., *Campylobacter* spp., *Escherichia* spp. and *Yersinia* spp. (Weese, 2006; Strohmeyer et al, 2006). Dogs consuming such foods shed bacterial pathogens at a much higher rate than those consuming conventionally cooked commercial foods (Weese and Armstrong, 2006). A thorough dietary history should elicit details of potential exposure to raw meats.

Etiopathogenesis

In acute enteritis, diarrhea may occur as a result of any or all of the four mechanisms of diarrhea described in Chapter 55. Many viral organisms and cancer chemotherapeutic agents destroy intestinal villi. Consequently, diarrhea may occur due to altered gut permeability and/or osmotic mechanisms. Ileus may arise due to abdominal pain in patients with parvoviral enteritis. Finally, bacterial pathogens may elaborate enterotoxins that serve as potent secretogogues.

Small bowel atrophy begins within days in the absence of luminal stimulation. Atrophy, the small intestinal response to disuse, occurs in several species with simple stomachs, including foals (Oikawa et al, 1992), cats (Lippert et al, 1989), dogs (Remillard and Thatcher, 1989) and pigs (Schulman, 1988) and is similar morphologically. The hallmarks of small bowel atrophy are decreased villus height (about 50% in the jejunum and 25% in the ileum) with an overall reduced absorptive surface area and brush border enzyme activity (Remillard et al, 1998, 1998a; Levine et al, 1974).

Food in the lumen of the small bowel stimulates intestinal integrity (mass and function) by several mechanisms. Ingested nutrients mechanically and chemically stimulate the

Table 56-2. Key nutritional factors for dogs and cats with acute gastroenteritis or enteritis.*

Factors	Recommended levels
Sodium	0.3 to 0.5%
Chloride	0.5 to 1.3%
Potassium	0.8 to 1.1%
Fat	12 to 15% for dogs (highly digestible foods) 15 to 25% for cats (highly digestible foods) 8 to 12% for dogs (increased-fiber foods) 9 to 18% for cats (increased-fiber foods)
Energy density	4.0 to 4.5 kcal/g (16.7 to 18.8 kJ/g) (highly digestible foods) ≥3.2 kcal/g (≥13.4 kJ/g) for dogs and ≥3.4 kcal/g (≥14.2 kJ/g) for cats (increased-fiber foods)
Fiber	≤5% in highly digestible foods (mixed fiber sources are best) 7 to 15% in fiber-enhanced foods (insoluble fiber sources are best)
Digestibility	≥87% for protein and ≥90% for fat and carbohydrate (highly digestible foods) ≥80% for protein and fat and ≥90% for carbohydrate (fiber-enhanced foods)

*Nutrient levels are on a dry matter basis.

Table 56-3. Selected commercial oral rehydration solutions available for use in dogs and cats.

	Nutrient content (mEq/l)								
Products (manufacturers)	**Na**	**K**	**Cl**	**Mg**	**Ca**	**P**	**Citrate**	**ME (kcal/l)**	**Comments**
Electramine (Life Science Products)	69.8	15.4	69.7	–	–	–	–	–	Contains glycine
Enfamil Enfalyte (Mead Johnson)	50	25	45	–	–	–	34	126	mOsm/l = 167
Pedialyte Solution unflavored (Abbott Nutrition)	45	20	35	–	–	–	30	100	mOsm/l = 250-270
Rebound OES (Virbac)	52.2-65.2	20.5-25.6	10-20	–	–	–	–	253	–

Key: mEq/l = milliequivalents per liter, Na = sodium, K = potassium, Cl = chloride, Mg = magnesium, Ca = calcium, P = phosphorus, ME = metabolizable energy.

intestine, increasing intestinal secretory and endocrine activity. The type and amount of ingested nutrients mechanically alter the mucosal cell mass by affecting the rate of stem cell division and the rate of mucosal cell renewal. Gastric, duodenal and pancreato-biliary secretions, which normally accompany eating, digestion and absorption, promote mucosal structure and function (Yamada, 1985; Castillo et al, 1990). Refeeding the atrophied small bowel should consider altered function. Limited enteral feeding of milk (i.e., 2 ml/kg body weight, per os, twice daily) to piglets, providing only 10% of the resting energy requirement, resulted in significantly greater jejunal lactase and sucrase activities with taller villi and deeper crypts vs. findings in animals fed nothing per os (Remillard et al, 1998).

Glutamine is the preferred fuel for enterocytes. Glutamine is a conditionally essential amino acid necessary during intestinal recovery to stimulate enterocyte-DNA synthesis and increase enterocyte mucosal mass (Windmueller and Spaeth, 1974). In dogs, there is an increased intestinal requirement for glutamine during the immediate postoperative phase (i.e., less than seven days postsurgery). Glutamine uptake returns to normal later during the recovery phase (i.e., more than 10 days postsurgery) (Souba et al, 1990, 1987).

Key Nutritional Factors

Table 56-2 lists key nutritional factors for patients with acute gastroenteritis or enteritis, which are discussed in detail below.

Water

Water is the most important nutrient for patients with acute diarrhea with or without vomiting because of the potential for life-threatening dehydration due to excessive fluid loss and inability of the patient to replace those losses. Moderate to severe dehydration should be corrected with appropriate parenteral fluid therapy rather than using the oral route. Intraosseous fluid administration may be used in patients with limited venous access, but the subcutaneous route is not recommended in moderate to severely dehydrated patients.

Oral fluid therapy is typically reserved for non-vomiting patients with minor fluid deficits or to supply maintenance fluid requirements. Oral rehydration solutions have been used commonly in people and food production animals with acute diarrhea. Oral rehydration solutions have also been advocated for use in dogs and cats (Zenger and Willard, 1989). Oral rehydration solutions contain glucose, amino acids and electrolytes in addition to water. The physiologic basis for these solutions is the coupled transport of sodium and glucose and other active-

ly transported small organic molecules (Avery and Snyder, 1990). The maximum uptake of water and electrolytes occurs when the ratio of glucose to sodium approaches 1:1 (Avery and Snyder, 1990). An oral rehydration solution containing rice carbohydrate-based glucose polymers developed by the World Health Organization has been licensed for the small animal market (**Table 56-3**). Such solutions are most useful in secretory diarrheas, which are uncommon in small animals. However, oral rehydration solutions can be useful as an alternate fluid source, if readily consumed by the patient.

Electrolytes: Sodium, Chloride and Potassium

The electrolyte composition of intestinal (and gastric) secretions differs from that of extracellular fluids; therefore, loss of intestinal (and gastric) secretions may result in systemic electrolyte abnormalities. Dogs and cats with diarrhea and vomiting may have low, normal or high serum sodium, potassium and chloride concentrations. The derangement that predominates in a particular animal depends on the severity of the disease, nutritional status, site of the disease process, etc. For these reasons, serum electrolyte concentrations are helpful in tailoring the fluid therapy and nutritional management. Mild hypokalemia, hypochloremia and either hypernatremia or hyponatremia are the electrolyte abnormalities most commonly associated with acute diarrhea and vomiting.

Depletion of total body potassium is a predictable consequence of severe or chronic GI disease because the potassium concentration of gastric and intestinal secretions is high. Hypokalemia in association with GI disease will be particularly profound if losses are not matched by sufficient intake of dietary potassium.

Electrolyte disorders should be corrected initially with appropriate parenteral fluid and electrolyte therapy. Foods for patients with acute gastroenteritis should contain levels of sodium, chloride and potassium above the minimum allowances for normal dogs and cats. Recommended levels of these nutrients for dogs and cats are 0.30 to 0.5% dry matter (DM) sodium, 0.5 to 1.3% DM chloride and 0.8 to 1.1% DM potassium.

Fat and Energy Density

In comparison to processes involved with other macronutrients, fat digestion and absorption are relatively complex and may be disrupted in patients with GI disease. Ingestion of a fatty meal decreases gastroesophageal tone, slows gastric emptying and is a potent stimulus for pancreatic secretion.

On the other hand, dietary fat is a concentrated source of calories; higher fat foods allow smaller amounts of food to be ingested to meet the patient's daily energy requirement (DER). This is an important consideration in many patients because limiting the amount of food entering the GI tract helps control clinical signs. Fat also improves the palatability of food, which is important in patients with nausea.

For these reasons, foods for patients with acute gastroenteritis and many other GI diseases should contain moderate amounts of fat. Recommended dietary DM fat levels are 12 to 15% for dogs and 15 to 25% for cats. Dietary fat within these ranges should ensure the energy density of the food falls between 4.0 to 4.5 kcal/g (16.7 to 18.8 kJ/g) DM, thus providing sufficient energy with small amounts of food. Foods with higher energy densities may help restore or maintain body weight and condition in patients but would require higher dietary fat levels. Increased levels of dietary fat delay gastric emptying and therefore should usually be avoided. When feeding foods with increased fiber, the food's DM fat content will typically be lower (eight to 12% for dogs and nine to 18% for cats), as will energy density. Energy densities for these foods should be at least 3.2 kcal/g (13.4 kJ/g) DM for dogs and at least 3.4 kcal/g (14.2 kJ/g) DM for cats.

Fiber

Although dietary fiber predominantly affects the large bowel of dogs and cats, fiber can also affect gastric, small intestinal and pancreatic structure and function. Effects of dietary fiber include: 1) modifying gastric emptying, 2) normalizing intestinal motility and intestinal transport rate, 3) buffering toxins in the GI lumen, 4) binding or holding excess water, 5) supporting growth of normal GI microflora, 6) buffering gastric acid and 7) altering viscosity of GI luminal contents. Dietary fiber also adds indigestible bulk and decreases the DM digestibility of the food.

Various types and levels of dietary fiber have been advocated for patients with acute gastroenteritis. The traditional approach is to recommend low-fiber foods (≤5% DM mixed fiber) that are highly digestible and provide "low residue" in the GI tract. Mixed fibers include beet pulp, brans (rice, wheat or oat), pea, soy fibers, soy hulls and mixtures of soluble and insoluble fibers. Insoluble fibers include purified cellulose and peanut hulls. Soluble fiber sources include fruit pectins, guar gums and psyllium.

Another approach used by one of the authors (RLR) is to use foods containing insoluble fiber sources at levels between 7 to 15% DM. Each of these strategies can be successful in managing selected patients with acute gastroenteritis and enteritis.

Digestibility

The term "highly digestible" is not defined in a regulatory sense. However, the term has generally been reserved for products with protein digestibility ≥87%, and fat and carbohydrate digestibility ≥90%. Fiber-enhanced foods will typically have somewhat lower protein and fat digestibilities but carbohydrate should be about the same. Digestibility targets for fiber-enhanced foods are at least 80% for protein and fat and 90% or above for carbohydrate. The average digestibility coefficients for popular commercial dog and cat foods are 78 to 81%, 77 to 85% and 69 to 79% for crude protein, crude fat and digestible (soluble) carbohydrate, respectively (Kendall et al, 1982; Kendall, 1981). Veterinary therapeutic foods formulated for patients with GI disease usually contain meat and carbohydrate sources that have been highly refined to increase digestibility. Meat ingredients in many therapeutic foods are usually composed of muscle and organ sources rather than meat and bone meals. Typical meat/animal source ingredients in commercial GI foods include egg, cottage cheese, chicken,

Table 56-4. Key nutritional factors in selected highly digestible commercial veterinary therapeutic foods marketed for dogs with acute gastroenteritis or acute enteritis.*

Dry foods	Na (%)	Cl (%)	K (%)	Fat (%)	Energy density (kcal/g)	Fiber (%)**	Protein digestibility (%)	Fat digestibility (%)	Carbohydrate digestibility (%)	Ingredient comments
Recommended levels	**0.3-0.5**	**0.5-1.3**	**0.8-1.1**	**12-15**	**4.0-4.5**	**≤5**	**≥87**	**≥90**	**≥90**	**–**
Hill's Prescription Diet i/d Canine	0.45	1.04	0.92	14.1	4.2	2.7	92	93	94	–
Iams Veterinary Formula Intestinal Low-Residue	0.35	0.66	0.90	10.7	3.8	2.1	na	na	na	FOS, MOS prebiotics
Medi-Cal Gastro Formula	0.5	na	0.8	13.9	na	1.9	na	na	na	OS prebiotic, *Bacillus subtilis* dried fermentation extract
Purina Veterinary Diets EN GastroENteric Formula	0.6	0.85	0.66	12.6	4.2	1.5	84.5	91.4	94.4	MCT
Royal Canin Veterinary Diet Digestive Low Fat LF 20	0.49	1.10	0.88	6.6	3.7	2.3	na	na	na	FOS, MOS prebiotics
Royal Canin Veterinary Diet Intestinal HE 28	0.55	0.99	0.88	22.0	4.5	1.6	na	na	na	FOS, MOS prebiotics

Moist foods	Na (%)	Cl (%)	K (%)	Fat (%)	Energy density (kcal/g)	Fiber (%)**	Protein digestibility (%)	Fat digestibility (%)	Carbohydrate digestibility (%)	Ingredient comments
Recommended levels	**0.3-0.5**	**0.5-1.3**	**0.8-1.1**	**12-15**	**4.0-4.5**	**≤5**	**≥87**	**≥90**	**≥90**	**–**
Hill's Prescription Diet i/d Canine	0.44	1.22	0.95	14.9	4.4	1.0	88	94	93	–
Iams Veterinary Formula Intestinal Low-Residue	0.53	0.84	0.84	13.2	4.6	3.9	na	na	na	–
Medi-Cal Gastro Formula	0.6	na	0.6	11.7	na	1.0	na	na	na	FOS prebiotic
Purina Veterinary Diets EN GastroENteric Formula	0.37	0.78	0.61	13.8	4.0	0.9	85.1	95.6	92.2	MCT
Royal Canin Veterinary Diet Digestive Low Fat LF	0.39	1.06	0.74	6.9	4.0	3.0	na	na	na	–
Royal Canin Veterinary Diet Intestinal HE	0.57	0.92	0.80	11.8	4.3	1.4	na	na	na	Inulin prebiotic

Key: Na = sodium, Cl = chloride, K = potassium, fiber = crude fiber, na = information not available from manufacturer, FOS = fructooligosaccharide, MOS = mannanoligosaccharide, MCT = medium-chain triglyceride.
*Nutrients expressed on a dry matter basis. To convert kcal to kJ, multiply kcal by 4.184.
**Mixed fiber sources are best in highly digestible foods (see text).

low-ash poultry by-product meal and ground beef.

Carbohydrates make up the largest non-water fraction (i.e., 60 to 80% DM) of commercial and homemade foods formulated for managing patients with GI diseases. In pet foods, carbohydrate digestibility is influenced by source and processing. Dogs digest most properly cooked starches very well including corn, rice, barley and wheat (Walker et al, 1994; Bissett et al, 1998). Other starches (e.g., potato and tapioca) are less digestible, especially when inadequately cooked (Wolter, 1993; Schunemann et al, 1994; Baker and Czarnecki-Maulden, 1991; Kienzle, 1993; Morris et al, 1977). Cats, despite their obligate carnivorous nature, also efficiently digest carbohydrates. However, the opinion of some clinicians is that cats with small bowel disorders are less tolerant of dietary carbohydrate than dogs with similar causes of malassimilation (Buddington et al, 1991; Kienzle, 1993; Sherding, 1989; Washabau et al, 1986). More recently, a feeding trial in cats with diarrhea demonstrated no difference in response to foods containing moderate carbohydrate levels (31.7% DM) or low levels (15% DM) (Laflamme and Long, 2004).

A link has been established between particle size and carbohydrate digestibility in moist foods (Bissett et al, 1997). These findings support chopping or grinding carbohydrate ingredients (e.g., rice, corn, etc.) before they are incorporated into moist foods. These findings are probably not applicable to extruded dry products because the extrusion process allows for a more complete cook than the canning process. Studies have demonstrated almost complete ileal carbohydrate digestibility in normal dogs consuming extruded grains (Harmon et al, 1999).

In general, dietary fat is more digestible than digestible carbohydrates and protein. Depending on the fat source, the ap-

Table 56-5. Key nutritional factors in selected fiber-enhanced commercial veterinary therapeutic foods marketed for dogs with acute gastroenteritis or acute enteritis.*

Dry foods	Na (%)	Cl (%)	K (%)	Fat (%)	Energy density (kcal/g)	Fiber (%)**	Protein digestibility (%)	Fat digestibility (%)	Carbohydrate digestibility (%)	Primary sources of fiber**
Recommended levels	**0.3-0.5**	**0.5-1.3**	**0.8-1.1**	**8-12**	**≥3.2**	**7-15**	**≥80**	**≥80**	**≥90**	**–**
Hill's Prescription Diet w/d Canine	0.22	0.46	0.70	8.8	3.3	16.4	84	92	95	Cellulose, soybean mill run, beet pulp
Medi-Cal Fibre Formula	0.3	na	1.0	10.6	na	14.3	na	na	na	Tomato pomace, rice hulls, oat hulls, flax meal, apple pomace
Purina Veterinary Diets DCO Dual Fiber Control	0.34	0.82	0.70	12.4	3.7	7.6	79.9	80.4	90.6	Beet pulp, pea fiber
Purina Veterinary Diets OM Overweight Management Formula	0.31	0.97	0.83	7.2	2.9	10.3	81.9	78.9	72.3	Soybean hulls, pea fiber, cellulose
Royal Canin Veterinary Diet Calorie Control CC 26 High Fiber	0.33	0.77	0.90	10.4	3.1	17.6	na	na	na	Cellulose, pea fiber, rice hulls, beet pulp, psyllium husk
Royal Canin Veterinary Diet Diabetic HF 18	0.27	0.88	0.88	9.9	3.3	12.1	na	na	na	Cellulose, rice hulls, guar gum

Moist foods	Na (%)	Cl (%)	K (%)	Fat (%)	Energy density (kcal/g)	Fiber (%)**	Protein digestibility (%)	Fat digestibility (%)	Carbohydrate digestibility (%)	Primary sources of fiber**
Recommended levels	**0.3-0.5**	**0.5-1.3**	**0.8-1.1**	**8-12**	**≥3.2**	**7-15**	**≥80**	**≥80**	**≥90**	**–**
Hill's Prescription Diet w/d Canine	0.24	0.76	0.64	12.7	3.6	12.4	88	90	92	Cellulose
Medi-Cal Fibre Formula	0.5	na	0.7	9.1	na	15.0	na	na	na	Tomato pomace, guar gum, flax meal, carrageenan
Purina Veterinary Diets OM Overweight Management Formula	0.28	0.51	1.06	8.4	2.5	19.2	80.9	89.8	62.9	Pea fiber, beet pulp, carrageenan
Royal Canin Veterinary Diet Calorie Control CC 26 High Fiber	0.53	0.70	0.82	12.5	3.6	8.8	na	na	na	Tomato pomace, guar gum, flax meal, carrageenan

Key: Na = sodium, Cl = chloride, K = potassium, fiber = crude fiber, na = information not available from manufacturer.
*Nutrients expressed on a dry matter basis. To convert kcal to kJ, multiply kcal by 4.184.
**Insoluble fiber sources are best in fiber-enhanced foods (see text).

parent digestibility of fat by dogs can vary from approximately 81 to 95%; fats with higher levels of unsaturated fatty acids are more digestible (NRC, 2006). The apparent digestibility of dietary fat by cats is between 85 to 99%. Fat digestibility also depends on saturation of constituent fatty acids and age of cats. Older cats and kittens have lower fat digestibility (NRC, 2006). Digestibility of protein, carbohydrates and fat in foods for patients with acute GI disease should be high because normal digestion and absorption of nutrients are often compromised. Moderate amounts of fiber decrease the DM digestibility of the overall food; however, digestibility of the non-fiber macronutrients is usually unaffected (Harmon et al, 1999).

Other Nutritional Factors

Glutamine

The amino acid, glutamine, is considered a conditionally essential nutrient for pets with severe GI disorders. As the preferred energy substrate for enterocytes, glutamine is necessary for maintaining gut mucosal integrity (Windmueller and Spaeth, 1974, 1978). Commercial and homemade pet foods containing meat ingredients provide glutamine. Unfortunately, an analytical method for determining glutamine levels in foods is not widely available, making selection of foods based on glutamine content impractical (Kuhn et al, 1996). Glutamine intake can be increased by orally administering a 2% solution of glutamine in water; 0.5 g of glutamine per kg body weight should be provided daily. Many pets will readily consume a glutamine solution, or these solutions can be administered by dose syringe or indwelling feeding tubes. Such glutamine dosing regimens have been used for treating canine patients with parvoviral enteritis. Alternatively, commercial liquid or moist homogenized enteral foods (Chapter 25) enhanced with glutamine may be offered.

Table 56-6. Key nutritional factors in selected highly digestible commercial veterinary therapeutic foods marketed for cats with acute gastroenteritis or acute enteritis.*

Dry foods	Na (%)	Cl (%)	K (%)	Fat (%)	Energy density (kcal/g)	Fiber (%)**	Protein digestibility (%)	Fat digestibility (%)	Carbohydrate digestibility (%)	Ingredient comments
Recommended levels	**0.3-0.5**	**0.5-1.3**	**0.8-1.1**	**15-25**	**4.0-4.5**	**≤5**	**≥87**	**≥90**	**≥90**	**–**
Hill's Prescription Diet i/d Feline	0.37	1.11	1.07	20.2	4.3	2.8	88	92	90	–
Iams Veterinary Formula Intestinal Low-Residue	0.25	0.63	0.66	13.7	3.9	1.8	na	na	na	FOS, MOS prebiotics
Medi-Cal HYPOallergenic/ Gastro	0.4	na	0.8	11.5	na	3.1	na	na	na	FOS prebiotic, *Bacillus subtilis* dried fermentation extract
Purina Veterinary Diets EN GastroENteric	0.64	0.58	0.99	18.4	4.4	1.3	94.0	93.1	79.7	–
Royal Canin Veterinary Diet Intestinal HE 30	0.65	0.97	0.97	23.7	4.4	5.8	na	na	na	FOS, MOS prebiotics

Moist foods	Na (%)	Cl (%)	K (%)	Fat (%)	Energy density (kcal/g)	Fiber (%)**	Protein digestibility (%)	Fat digestibility (%)	Carbohydrate digestibility (%)	Ingredient comments
Recommended levels	**0.3-0.5**	**0.5-1.3**	**0.8-1.1**	**15-25**	**4.0-4.5**	**≤5**	**≥87**	**≥90**	**≥90**	**–**
Hill's Prescription Diet i/d Feline	0.33	1.18	1.06	24.1	4.2	2.4	91	89	91	–
Iams Veterinary Formula Intestinal Low-Residue	0.40	0.69	0.93	11.7	4.0	3.7	na	na	na	FOS prebiotic
Medi-Cal HYPOallergenic/Gastro	0.7	na	1.1	35.9	na	1.2	na	na	na	FOS prebiotic
Medi-Cal Sensitivity CR	1.1	na	1.1	35.1	na	2.5	na	na	na	–

Key: Na = sodium, Cl = chloride, K = potassium, fiber = crude fiber, na = information not available from manufacturer, FOS = fructooligosaccharide, MOS = mannanoligosaccharide.
*Nutrients expressed on a dry matter basis. To convert kcal to kJ, multiply kcal by 4.184.
**Mixed fiber sources are best in highly digestible foods (see text).

Acid Load

Acidemia is common in pets with diarrhea because fluid secreted in the caudal small intestine and large intestine contains bicarbonate concentrations higher than those in plasma and sodium in excess of chloride ions. The acidosis is compounded in some patients by development of hypovolemia (i.e., severe dehydration). Severe acid-base disorders are best corrected with appropriate parenteral fluid therapy. Foods for patients with acute diarrhea accompanied by vomiting should also avoid excess dietary acid load and preferably contain buffering salts (e.g., potassium gluconate and calcium carbonate). Ideally, foods that normally produce a urinary pH greater than 6.8 should be selected.

FEEDING PLAN

The first objective in managing acute gastroenteritis or enteritis should be to correct dehydration and electrolyte, glucose and acid-base imbalances, if present. Colloidal solutions or plasma transfusions may be necessary for those patients with hypoalbuminemia (Buriko and Otto, 2007). The dietary goals are to provide a food that meets the patient's nutrient requirements and allows normalization of intestinal motility and function. Medical therapy may include antibiotics, antidiarrheals, antiemetics, nonsteroidal antiinflammatory agents (e.g., flunixin meglumine), anti-endotoxin sera, analgesics, interferon and anthelmintics.

Assess and Select the Food

Levels of the key nutritional factors should be evaluated in foods currently fed to patients with acute gastroenteritis or enteritis and compared with recommended levels. Information from this aspect of assessment is essential for making any changes to foods currently provided. Changing to a more appropriate food is indicated if key nutritional factors in the current food do not match recommended levels.

There are several plausible dietary strategies for managing small bowel diarrhea after a 24- to 36-hour fast and they may be attempted in any order. The traditional approach is to first feed a highly digestible, low-residue food with moderate levels of fat. Small amounts of soluble or mixed fiber sources may be included in such foods. Including low levels of fiber does not usually impair digestibility or increase fecal volume. This approach can be accomplished by feeding commercial veterinary therapeutic

Table 56-7. Key nutritional factors in selected fiber-enhanced commercial veterinary therapeutic foods marketed for cats with acute gastroenteritis or acute enteritis.*

Dry foods	Na (%)	Cl (%)	K (%)	Fat (%)	Energy density (kcal/g)	Fiber (%)**	Protein digestibility (%)	Fat digestibility (%)	Carbohydrate digestibility (%)	Primary sources of fiber**
Recommended levels	**0.3-0.5**	**0.5-1.3**	**0.8-1.1**	**9-18**	**≥3.4**	**7-15**	**≥80**	**≥80**	**≥90**	**–**
Hill's Prescription Diet w/d Feline	0.30	0.84	0.84	9.8	3.5	7.6	90	87	86	Cellulose
Hill's Prescription Diet w/d with Chicken Feline	0.35	0.82	0.80	9.9	3.5	7.6	91	85	94	Cellulose
Medi-Cal Fibre Formula	0.5	na	0.9	12.2	na	14.9	na	na	na	Pea fiber, beet pulp, flax meal
Purina Veterinary Diets OM Overweight Management	0.57	0.84	0.89	8.5	3.6	5.6	91.1	87.7	66.8	Oat fiber, cellulose
Royal Canin Veterinary Diet Calorie Control CC 29 High Fiber	0.51	0.92	0.88	10.2	3.3	14.0	na	na	na	Cellulose, pea fiber, rice hulls, beet pulp, psyllium
Moist foods	**Na (%)**	**Cl (%)**	**K (%)**	**Fat (%)**	**Energy density (kcal/g)**	**Fiber (%)****	**Protein digestibility (%)**	**Fat digestibility (%)**	**Carbohydrate digestibility (%)**	**Primary sources of fiber****
Recommended levels	**0.3-0.5**	**0.5-1.3**	**0.8-1.1**	**9-18**	**≥3.4**	**7-15**	**≥80**	**≥80**	**≥90**	**–**
Hill's Prescription Diet w/d with Chicken Feline	0.38	0.89	0.89	16.6	3.5	10.6	92	na	na	Cellulose, oat fiber, guar gum, locust bean gum, carrageenan
Medi-Cal Fibre Formula	0.4	na	0.8	17.1	na	16.7	na	na	na	Pea fiber, flax meal, guar gum
Purina Veterinary Diets OM Overweight Management	0.31	0.93	0.91	14.6	3.9	10.2	87.3	88.6	84	Pea fiber, oat fiber, guar gum
Royal Canin Veterinary Diet Calorie Control CC High Fiber	0.38	0.51	0.77	21.3	4.1	7.7	na	na	na	Cellulose, guar gum, flaxseed

Key: Na = sodium, Cl = chloride, K = potassium, fiber = crude fiber, na = information not available from manufacturer.
*Nutrients expressed on a dry matter basis. To convert kcal to kJ, multiply kcal by 4.184.
**Insoluble fiber sources are best in fiber-enhanced foods (see text).

foods formulated for GI disease (**Tables 56-4** and **56-5** for dogs and **56-6** and **56-7** for cats) or properly prepared homemade foods (Chapter 10). Foods for puppies and kittens with GI disease should also meet requirements for growth.

As mentioned above, dietary fiber content may be increased to normalize intestinal motility, water balance and GI microflora. Fiber has several physiologic characteristics that are beneficial in managing small bowel diarrhea. Moderate amounts of fiber (7 to 15% DM) add indigestible bulk, which buffers toxins, holds excess water and, perhaps more important, provides intraluminal stimuli to reestablish the coordinated actions of hormones, neurons, smooth muscles, enzyme delivery, digestion and absorption. Fiber normalizes transit time through the small bowel, which means fiber slows a hypermotile state, but also improves a hypomotile state to reestablish normal peristaltic action. **Tables 56-5** (dogs) and **56-7** (cats) list selected fiber-enhanced commercial veterinary therapeutic foods.

For cases in which protracted small bowel disuse (i.e., three to five days) is expected, a third strategy may be used. This involves providing early enteral nutrition intermittently by the oral route or continuously by a nasoesophageal tube. This strategy of feeding through vomiting and diarrhea rather than providing a period of bowel rest has been studied prospectively in dogs with parvoviral enteritis (Will et al, 2005; Mohr et al, 2003). The combination of an orally administered highly digestible food (previously incubated with pancreatic enzymes) every eight hours plus total parenteral feeding was compared to total parenteral feeding alone (Will et al, 2005). Dogs in the combined therapy group had a lower mortality rate than those receiving total parenteral nutrition alone, but the intermittent oral administration of food was complicated by marked nausea and vomiting in 90% of patients. The effect of early enteral nutrition using a polymeric enteral food administered continuously by a nasoesophageal tube was evaluated in dogs with parvoviral enteritis as compared to dogs held NPO (nothing per os) (Mohr et al, 2003). Early enteral nutrition resulted in a more rapid clinical improvement including increased body weight, resolution of vomiting and diarrhea and a lower mortality rate. The precise mechanisms responsible for these benefits are unknown but may include reduced protein/calorie mal-

nutrition, more rapid intestinal villous recovery, enhanced integrity of epithelial tight junctions, normalization of intestinal microflora and enhanced gut immunity (Mohr et al, 2003; Will et al, 2005).

For dogs held NPO for acute gastroenteritis, reintroduction to oral feeding may be accomplished by offering small amounts of a highly digestible food formulated for GI disease. Alternatively, initially feeding small amounts of a monomeric liquid food containing maltodextrins and glutamine may ease the transition to other foods (Chapter 25). Feeding puppies recovering from parvoviral enteritis a monomeric, iso-osmotic liquid food containing maltodextrins (no lactose) plus glutamine reduces nausea and vomiting, and subsequently eases the transition to feeding other commercial veterinary therapeutic foods.[c]

Assess and Determine the Feeding Method

A thorough assessment should include verification of the feeding method currently used. Items to consider include feeding frequency, amount fed, how the food is offered, access to other food and who feeds the pet. All of this information should have been gathered when the history of the patient was obtained. If the animal has a normal body condition score (2.5/5 to 3.5/5), the amount of food previously fed (energy basis) was probably appropriate.

Withholding oral intake of food and water for 24 to 48 hours is the first step in the feeding method for dogs and cats with acute gastroenteritis or enteritis. After this period, patients should be offered small amounts of water or ice cubes every few hours. If water is well tolerated, small amounts of food can be offered several times (i.e., six to eight times) a day. If the pet can eat food without episodes of diarrhea or vomiting, the amount fed can be increased over three to four days until the patient is receiving its estimated DER in two to three meals per day. During this period, if the patient begins to vomit, food should be withdrawn and offered again after several hours. As discussed above, continuous feeding can be used to deliver early enteral nutrition or monomeric liquid foods can be offered.

Persistent vomiting in some cases of parvoviral enteritis may complicate refeeding; some puppies develop gastroparesis and may require prokinetic drugs to facilitate feeding. In such cases, intravenous infusion of metoclopramide (at a rate of 1.0 mg/kg body weight/day) is recommended. Alternatively, metoclopramide can be administered to well-hydrated patients subcutaneously or intramuscularly at a dose of 0.5 mg/kg body weight q8h. Some patients may require partial parenteral or total parenteral feeding (Chapter 26).

REASSESSMENT

The prognosis for recovery in most cases of acute gastroenteritis and enteritis is good. Body weight should be recorded daily until recovery is complete. Changes in body weight from day to day usually reflect changes in hydration status rather than loss or gain of body tissue. Further diagnostic testing is warranted if severe diarrhea or vomiting persists. Acute worsening of clinical signs especially when accompanied by abdominal pain in a young dog with gastroenteritis may be a result of intestinal intussusception (Patsikas et al, 2003; Rallis et al, 2000). In such cases, abdominal radiography and/or ultrasonography are indicated.

Dogs and cats presenting with multiple or recurrent episodes of small bowel diarrhea require further diagnostic workup and, most probably, a combination of dietary and medical therapies. Parasitic causes, however, should be ruled out or treated empirically before pursuing further diagnostics. The diagnostic approach to patients with chronic small bowel diarrhea is beyond the scope of this book; readers are referred to internal medicine and gastroenterology texts for more information.

ENDNOTES

a. Davenport DJ. Unpublished data. 1996.
b. Remillard RL. Personal observation. 1998.
c. Remillard RL. Personal experience. 1998.

REFERENCES

The references for **Chapter 56** can be found at www.markmorris.org.

CASE 56-1

Acute Diarrhea in a Young Cat

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Patient Assessment

A six-month-old intact male domestic shorthair kitten was examined for acute onset of vomiting, watery diarrhea, anorexia and lethargy. The kitten had been found as a stray two months previously and vaccination status was unknown. The kitten lived in a barn and the owners were concerned that it had been poisoned. A dog also lived in the house and there were several horses on the property. None of these animals were ill.

Physical examination revealed depression and dehydration. Excessive amounts of fluid and gas were palpable in the intestinal tract. Abdominal palpation stimulated vomiting; the vomitus was clear fluid with flecks of blood. Body weight was 2.5 kg and the kitten appeared thin (body condition score [BCS] 2/5).

Evaluation included a fecal flotation (negative), complete blood count (leukopenia) and serum biochemistry profile (normal except for changes associated with dehydration). A tentative diagnosis of panleukopenia due to feline parvovirus infection was made.

Treatment included aggressive intravenous fluid therapy to correct dehydration and systemic antibiotics. The kitten improved clinically within a few days and the leukocyte count returned to normal. The kitten began drinking water and eating small amounts of a moist homogenized recovery formula (Prescription Diet a/d Canine/Feline[a]). There was no further vomiting but diarrhea continued. The feces were no longer watery but were semi-formed and voluminous.

Assess the Food and Feeding Method

The kitten was fed a commercial dry grocery brand food formulated for growth (Purina Kitten Chow[b]). The food and water were available free choice in the barn. The kitten had access to other animal feed (commercial dry dog food, grain mixture for the horses) but had never been seen eating these foods.

Questions

1. What is the likely cause for the persistent diarrhea?
2. What are the key nutritional factors for this patient?
3. Outline a feeding plan for this kitten.

Answers and Discussion

1. Feline parvovirus infection destroys intestinal crypt cells in the jejunum and ileum. This results in shortened, blunt intestinal villi and also malabsorption. Villi will normally regrow very quickly after viremia resolves and crypt cells are reestablished. However, some cats have a prolonged recovery period with chronic enteritis and diarrhea. This may occur because villi are slow to recover or because of concurrent parasite, viral or bacterial infection. The recovery food may also contain excessive amounts of fat (29% dry matter [DM] fat) for the recovering gastrointestinal (GI) tract.
2. Key nutritional factors for patients with infectious enteritis include water, electrolytes, fat, energy, fiber and digestibility.

   Water. Water is the most important nutrient for patients with acute vomiting or diarrhea because of the potential for life-threatening dehydration due to excessive fluid loss and inability of the patient to replace losses. Oral fluid therapy is reserved for cats with minor fluid deficits or to supply maintenance fluid requirements.

   Electrolytes. Hypokalemia, hypochloremia and either hypernatremia or hyponatremia are the electrolyte abnormalities most commonly associated with acute vomiting and diarrhea. Electrolyte disorders should be corrected initially with appropriate parenteral fluid therapy. Foods for cats with acute gastroenteritis should contain levels of sodium, chloride and potassium above the minimum allowances for normal kittens and adult cats.

   Fat/energy density. Dietary fat is a concentrated source of calories; higher fat foods allow smaller amounts of food to be ingested to meet the cat's daily energy requirement (DER). This is important for many patients with GI disease because limiting the amount of food entering the GI tract helps control clinical signs. Fat also helps improve the palatability of food, which is important for patients with nausea. For these reasons, foods for cats with acute gastroenteritis should contain moderate amounts of fat (i.e., 15 to 25% DM).

   Fiber. Dietary fiber is beneficial because it: 1) modifies gastric emptying, 2) normalizes intestinal motility, 3) buffers toxins in the GI lumen, 4) binds or holds excess water, 5) supports growth of normal GI microflora, 6) buffers gastric acid and 7) alters viscosity of GI luminal contents. Cats with gastroenteritis may benefit from small amounts (i.e., crude fiber ≤5% DM) of a mixed (i.e., soluble/insoluble) fiber type in conjunction with a highly digestible food.

Digestibility. Digestibility of foods for cats with acute gastroenteritis should be high (fat and digestible carbohydrate ≥90% and protein ≥87%) because normal digestion and absorption of nutrients is often impaired.

3. Small amounts of water and food should be gradually reintroduced to the kitten. The food should reflect the nutrient profile discussed above. Veterinary therapeutic foods designed for patients with GI disease have appropriate nutrient levels and usually have high digestibility. Levels of nutrients in these products are also usually appropriate for growing cats. The DER should reflect the needs of a growing cat (i.e., at least 2.5 x resting energy requirement or 360 kcal [1.51 MJ]).

Progress Notes

Multiple fecal flotations were negative for intestinal parasites. A fecal culture was negative for bacterial pathogens. Tests for feline leukemia and feline immunodeficiency virus infection were negative. A commercial moist veterinary therapeutic food (Prescription Diet i/d Feline[a]) was mixed with the recovery food (approximately 50:50) and gradually introduced to the kitten. This food is highly digestible, contains a mixed fiber source and is formulated to meet the nutritional needs of kittens. The kitten readily ate this mixture for two days in the hospital and was sent home with the dry formula of i/d Feline (three-fourths cup daily to be increased as the cat grew and gained weight). Semi-formed feces persisted for several weeks but then gradually returned to normal. The food was changed to a commercial dry product appropriate for adult cats when the cat was neutered at nine months of age.

Endnotes

a. Hill's Pet Nutrition Inc., Topeka, KS, USA.
b. Ralston Purina Co., St. Louis, MO, USA.

Bibliography

Pollock RVH, Postorino NC. Feline panleukopenia and other enteric viral diseases. In: Sherding RG, ed. The Cat: Diseases and Clinical Management, 2nd ed. New York, NY: Churchill Livingstone, 1994; 479-487.