Nutritional Management of Gastrointestinal Tract Diseases of Dogs and Cats¹

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ABSTRACT Pharmaceutical agents are often given inappropriate precedence in the treatment of gastrointestinal tract diseases. Nutrients have marked influences on the gastrointestinal tract and manipulation of the diet provides clinicians with a powerful therapeutic strategy to be used alone or concurrently with drug therapy. During acute gastroenteritis a change from the animal's regular food to a diet containing novel protein sources minimizes the likelihood of acquired food allergies to the staple protein components of the diet. "Feeding through" diarrhea, a method used in human infants, has limited applicability in dogs and cats. The ideal diet for chronic small bowel-type diarrhea is highly digestible, gluten-free, hypoallergenic, isosmolar, low in fat and low in lactose. Dietary protein requirements increase in protein-losing enteropathy. Dietary fat is kept to a minimum during gastrointestinal dysfunction because malabsorbed fatty acids and bile acids cause secretory diarrhea. In diseases of the small bowel, it is traditional to use low fiber diets. This recommendation needs revision because the binding and gelling properties of fiber are of potential benefit in the treatment of small bowel diarrhea. High fiber diets are useful in most large bowel diseases. The specific fiber type used markedly influences the clinical result. *J. Nutr.* 124: 2663S-2669S, 1994.

INDEXING KEY WORDS:

- gastrointestinal • disease • nutrition • dog
- cat

Pharmaceutical agents are often given inappropriate precedence in the treatment of gastrointestinal tract diseases. Drug therapy without appropriate nutritional management is likely to result in at best delayed resolution of signs and at worst exacerbation of the disorder. Many gastrointestinal diseases can be (and should be) managed by dietary therapy only. Dietary modification provides the clinician with a powerful tool for the treatment of gastrointestinal diseases because of the numerous effects of nutrients on the bowel (Table 1). This paper makes pragmatic recommendations on the nutritional management of selected gas-

trointestinal problems of dogs and cats. Because there have been few studies to determine the nutritional requirements of dogs and cats with gastrointestinal tract disorders, the recommendations have been based predominantly on clinical experience and known pathophysiologic mechanisms. Therefore they should be regarded as preliminary.

Dysphagia

The symptomatic management of dysphagia includes altering the texture of the diet and feeding from an elevated receptacle. Abnormal motility of the pharynx and/or esophagus sometimes causes great difficulty in swallowing solid boluses of food, although the swallowing of liquids or gruels is little affected. Occasionally, the opposite is true, perhaps because solid food provides sufficient sensory stimulus to initiate the swallowing reflex in those animals with an esophageal or vagal sensory deficit. Nutritional management is thus largely by trial and error, although dogs with megaesophagus generally swallow liquid diets better than solid food. Many dysphagic patients have to be fed through gastrostomy tubes.

Acute gastroenteritis

Standard dietary recommendations for dogs and cats with acute gastroenteritis include fasting for 12-48 h, followed by feeding small quantities of a "bland" diet fed three to four times per day for 3-7 d. These dietary recommendations have stood the test of time but are based more on common sense than scientific investigations. Fasting the animal for a short period provides bowel "rest". This has traditionally been considered of prime importance in the treatment of most gas-

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TABLE 1
Influence of diet on the GI tract¹

Diet may contain
Toxic food additives
Allergenic proteins
Antigenic proteins
Diet may correct
Nutritional deficiencies
Diet may alter
Cell renewal rate
Motility
Absorption
Secretion of mucus, acid and enzymes
Bacterial flora
Luminal ammonia content
Colonic volatile fatty acid content

¹Modified from Strombeck, D. R. and Guildford, W. G. (1990), used with permission.

trointestinal problems, although it has been recently challenged in the treatment of diarrhea (see below). In problems of acute onset, bowel rest is accomplished by completely restricting the oral intake of food.

A bland diet is defined as being without coarse and spicy foods. Most canned commercial food could, therefore, be thought of as bland. One theoretical justification for not feeding a vomiting dog or cat its usual diet is the observation in humans that acquired food allergies to proteins eaten during acute gastroenteritis can delay recovery (Gryboski 1991, Iyngkaran et al. 1978). There is clinical and gastroscopic food sensitivity testing evidence to suggest that the same phenomenon also occurs in the cat and dog. Acquired food allergies to novel protein sources temporarily introduced into a vomiting animal's diet (such as chicken or cottage cheese) are not as problematical as acquired sensitivity to a dietary staple such as beef.

Gastric diseases

Little information is available on suitable diets for inflammatory or ulcerative gastric diseases. Most authorities recommend a bland diet even though there is little evidence to support the recommendation (Pemberton et al. 1988). Milk, which was recommended in the past as a buffering/coating agent, fell from favor because of concern about the stimulation of gastric acid secretion by the calcium and protein in milk (Pemberton et al. 1988). However, interest in milk feeding is now undergoing a resurgence because of evidence that intragastric administration of lipid emulsions improves the hydrophobicity of the gastric mucosal barrier (Lichtenberger 1993). Frequent small feedings may provide relief of clinical signs but have not been shown to hasten healing of the mucosa (Pemberton et al. 1988). Symptomatic relief is afforded by small meals because they produce minimal gastric dis-

tension (distension of the inflamed stomach causes nausea and vomiting). Liquidizing the diet will hasten gastric emptying, reducing gastric acid secretion. Minimizing the protein content of the food may also reduce gastric acid secretion.

High fiber diets have been traditionally considered contraindicated in gastric disease because of the abrasive effects of fiber on the gastric mucosa. The buffering action of insoluble fiber and its acceleration of gastric emptying may, however, one day be proven to be valuable (Vahouny 1987). Conversely, in gastric dumping syndromes the addition of gel-forming fibers that slow gastric emptying (such as 3% wt/vol psyllium) may prove advantageous (Eastwood 1992, Repas et al. 1991, Russell and Bass 1985).

Nutritional management of delayed gastric emptying has limited effectiveness. Vagotomy accelerates the emptying of fluids but decreases the emptying of solids, implying that emptying disorders resulting from neuropathies (such as dysautonomia or diabetic neuropathy) may be ameliorated by feeding liquid diets. Emptying is delayed by the use of hyperosmolar and high fat foods. Therefore, in the first few days of therapy, liquid diets should be diluted to isoosmolality and should contain little fat. Unfortunately, foods such as this often have insufficient energy density to maintain animals for prolonged periods.

Acute "small bowel" diarrhea

The traditional dietary therapy of acute diarrhea is similar to that described above for acute gastroenteritis. Dogs and cats with acute diarrhea are usually held off food for 12–48 h and then offered a bland, low fat diet fed frequently and in small quantities for 3–7 d. Foodstuffs containing large amounts of lactose, such as milk, are kept to a minimum because brush-border lactase concentrations show individual variation in dogs and cats but are normally low and are reduced further when the bowel is diseased. As a result lactose is poorly tolerated by most dogs and cats, resulting in soft feces or liquid diarrhea. (Morris et al. 1977, Muhlum et al. 1989).

Recently, the long-held belief in the value of bowel rest for the treatment of diarrhea has been challenged by the concepts of food-based oral rehydration therapy and feeding through diarrhea. Food-based oral rehydration therapy differs from feeding through diarrhea primarily in the amount of nutrients provided.

Oral rehydration therapy using inorganic salts, dextrose and amino acids has been successfully practiced for many years in humans, production animals and dogs. It has recently become apparent that the addition of small quantities of cereals, such as rice, to the solutions enhances salt and water absorption and provides slightly more energy than standard oral rehydration solutions (Snyder et al. 1990). The glucose and peptides in rice furnish organic substrates for fluid

and electrolyte pumps without markedly increasing dietary osmolality (Armstrong 1987, Carpenter et al. 1988, Patra et al. 1982, Powell 1987). Furthermore, at least in some studies, food-based oral rehydration solutions reduce stool volume and shorten the course of diarrhea in comparison to glucose-based solutions (Lebenthal 1990, Molla et al. 1989, Snyder et al. 1990). It is possible that similar solutions, fed through nasogastric tubes or per os, may be of value in the short-term symptomatic treatment of cats and dogs with acute diarrhea.

Feeding through diarrhea (with sufficient solid or semisolid food to satisfy the approximate energy requirements) has recently proven beneficial in infants with acute diarrhea. Feeding through diarrhea maintains greater mucosal barrier integrity and helps minimize malnutrition, usually without prolonging the duration of diarrhea (Isolauri et al. 1989, Snyder et al. 1990). At first sight these observations might encourage veterinary clinicians to feed their diarrheic patients. Caution is required; however, before the tried-and-true "no food per os" recommendation is abandoned in dogs and cats with diarrhea. Most of the studies showing beneficial effects of feeding through diarrhea were performed in humans affected by secretory diarrheas because of toxigenic organisms such as cholera (Snyder et al. 1990). Feeding through was less successful in children with severe diarrhea or those with rotavirus infection (Snyder et al. 1990) that produces an osmotic diarrhea. Osmotic diarrheas because of viral infections (parvovirus, coronavirus, rotavirus, etc.) and dietary indiscretions are more common in dogs and cats than are secretory diarrheas. Furthermore, daily stooling frequency was increased in several studies of humans fed during diarrhea (Snyder et al. 1990). This may not be of major consequence to humans (provided duration of the diarrhea is not extended) but can be disastrous to the owner of a pet that is passing diarrhea in the house. Consequently, feeding through diarrhea is likely to be less successful in veterinary practice than the current recommendation of no food per os.

Chronic small bowel diarrhea

The ideal diet for chronic small bowel-type diarrhea is highly digestible, gluten-free, low in fat and lactose, hypoallergenic and not markedly hypertonic and contains generous overages of potassium and water soluble and fat soluble vitamins. Good palatability, nutritional balance and ease of preparation are also required. Controlled diets for chronic diarrhea are usually formulated as a compromise between the ideal and the realistic. The diet should incorporate the fewest ingredients possible, so that the influence of each ingredient on the patient's bowel function can be assessed. Strict adherence to a controlled diet depends on the effectiveness of client education. Owners often

incorrectly believe that minor dietary alterations are of no consequence.

Digestibility. High digestibility reduces the antigenicity of bowel content, by reducing both the amount of dietary protein absorbed intact by the mucosa and the number of bacteria and bacterial products in the bowel. Furthermore, less protein will enter the colon resulting in less colonic ammonia generation that in excess is toxic to the large bowel mucosa. High digestibility results in complete absorption in the cranial small intestine, permitting the remainder of the bowel to rest. Diets needing minimal digestion stimulate gastric, pancreatic, biliary and intestinal secretion less than regular diets.

Fat content. Restriction of dietary fat is usually necessary because fat malabsorption is common in small bowel diarrhea. The consequences of fat malabsorption include fatty acid, bile salt, vitamin and mineral malabsorption. Malabsorbed fatty acid and bile acids are hydroxylated and deconjugated, respectively, by colonic bacteria to produce potent secretagogues. The deconjugated bile acids and hydroxylated fatty acids are toxic to the colonic mucosa, inducing morphological changes, increased mucosal permeability, altered motility and secretory diarrhea (Binder and Sandle 1987).

Restriction of dietary fat is not necessary in all small intestinal motility disorders or in many cases of chronic colitis. It has been suggested that cats with diarrhea tolerate high fat diets better than high carbohydrate diets (Sherding 1989). This suggestion needs further investigation before widespread application. Low fat foods include vegetables, bread, cereals, low-fat milk products, most fish and lean meats such as boiled poultry (without skin).

Medium-chain triglycerides (MCT oil) can be used to supplement dietary fat if the low energy density of the diet is of concern. As discussed below, medium-chain triglycerides (carbon chain lengths <12) have theoretical advantages over long-chain triglycerides for the treatment of gastrointestinal disease (Maliakkal et al. 1992).

Osmolality. The ideal diet has a restricted osmolality to prevent excessive extracellular fluid moving into the intestine and to minimize the damage to the mucosa that can occur with such diets. High osmolality is a stimulus for gastrointestinal inflammation and can also disrupt tight junction structure (Madara and Trier 1987). Furthermore, if the constituents of the hyperosmolar diet are not readily absorbed, osmotic diarrhea will develop. Hyperosmolality is most often of concern when feeding excessive amounts of hyperosmolar liquid elemental diets that can rapidly exit into the highly permeable duodenum.

Carbohydrate source. Carbohydrate malabsorption contributes to the pathophysiology of a number of different diseases causing small bowel-type diarrhea, including exocrine pancreatic insufficiency,

"dumping" syndromes, short-bowel syndrome and inflammatory bowel disease. The consequences of carbohydrate malassimilation include osmotic diarrhea, loss of water and electrolytes (especially potassium), intestinal gaseousness, bacterial overgrowth of the small intestine, reduced small intestinal protein assimilation, acidification of colonic content and alteration of the composition of intestinal flora (Amtsberg et al. 1989, Meyer et al. 1989a, Meyer et al. 1989b, Muhlum et al. 1989, Washabau et al. 1986). For these reasons, carbohydrates included in diets for the management of gastrointestinal diseases must be highly digestible.

An ideal carbohydrate source for dogs and cats with small bowel diarrhea is rice. White rice is highly digestible and does not induce gluten enteropathy. Furthermore, there are few reported allergies to rice proteins in dogs or cats. Boiled white rice is suitable for dogs and baby rice cereals for cats. The palatability of rice baby cereals to cats can be enhanced by cooking the cereal with chicken soup or broth. Other carbohydrates that can be used include corn, potatoes or tapioca. These are all gluten-free. Potato and tapioca starches are less digestible than rice starch, however, particularly if they are poorly cooked (Schunemann et al. 1989). Corn starch is very well digested (Schunemann et al. 1989), but because corn is widely used in pet foods the prevalence of allergies to corn proteins is likely to be higher than that of rice. Pasta is another alternative, but it is not gluten-free.

The advisability of including carbohydrate in the diet of cats with diarrhea has been questioned (Sherding 1989, Washabau et al. 1986) because of concern about palatability and digestibility of carbohydrate in cats. Healthy cats do, however, digest cooked starch reasonably efficiently (Kienzle 1994, Morris et al. 1977). It is perhaps surprising that cats can efficiently digest carbohydrate given the low carbohydrate content of their ancestral diet. Footprints of this carnivorous past can be detected, however. For instance, unlike omnivorous animals, cats cannot upregulate intestinal sugar transporters when fed on high carbohydrate diets (Buddington et al. 1991). The suspicion that cats with diarrhea should be fed relatively less carbohydrate and relatively more fat (Sherding 1989, Washabau et al. 1986) requires future consideration. Certainly, for the first few weeks of treatment, there is no compelling reason to include carbohydrate in the diet of cats with diarrhea. However, in the long term, it is sensible from the economic point of view (and perhaps also for renal health) to "dilute" the dietary protein with carbohydrate.

Sudden changes to high carbohydrate diets should not be made. Large quantities of newly introduced carbohydrate in the diet may initially be inadequately digested and absorbed, until pancreatic enzyme and brush-border enzyme concentrations increase to meet the changed digestive requirements (Deren et al. 1967,

Grossman et al. 1942). This problem is minimized by feeding small meals frequently.

Protein sources. Protein used in the treatment of small bowel diarrhea should be derived from one food source and must be of high digestibility to limit potential antigenicity. A protein source not commonly included in the animal's usual diet is advantageous, because it reduces the likelihood of feeding a protein to which the animal is allergic. Furthermore, acquired allergy (resulting from abnormal food antigen presentation to the gut-associated lymphoid tissue because of gastrointestinal inflammation) to an infrequently fed protein is less significant than acquired sensitivity to a dietary staple. Suitable protein sources for dogs include cottage cheese, tofu, eggs, chicken, venison, lamb (except Australasia) and rabbit, but any other highly digestible meat not commonly included in the animal's diet is likely to be well tolerated. Cottage cheese is advantageous because it contains less lipid than eggs and meat. Cottage cheese is less palatable in cats than in dogs, but chicken, turkey, fish and liver (provided liver is not fed continuously) are readily accepted alternatives.

Fiber content. It is often recommended that diets for small intestinal diseases be low in residue to avoid physical trauma to the inflamed gastrointestinal tract and to minimize the presumed negative effects of fiber on small intestinal assimilation of nutrients. This recommendation is in need of reexamination, however, because there is little evidence to support the concept that fiber causes harmful physical abrasion to the intestinal mucosa, and there is accumulating evidence that many fibers (in nutritionally practical amounts) cause very little interference with the digestion of macronutrients (Lewis et al. 1994, Meyer et al. 1989a). Furthermore, on theoretical grounds, the binding and gelling properties of fiber may be beneficial in some small intestinal diseases.

Yogurt for treatment of chronic diarrhea. Yogurt is sometimes used for therapy of chronic diarrhea in the mistaken belief that the bacteria contained in the yogurt (*Lactobacillus acidophilus* or *Lactobacillus bulgaricus*) will colonize the bowel and displace unfavorable microorganisms (Molla et al. 1989). Yogurt has bacteriocidal properties in vitro but not in vivo. Orally administered bacteria in yogurt do not displace resident or pathogenic bacterial populations in normal or diseased intestines of a variety of species (Goldin et al. 1992, Gotteland et al. 1992, Kotz et al. 1992). The bacteria in yogurt are generally acid labile, limiting the numbers surviving passage through the stomach.

Yogurt and milk have approximately twice the lactose of cottage cheese (on an energy basis) (Pennington 1989). Thus, cottage cheese is the preferred milk-based substrate for the treatment of diarrhea. Interestingly, however, lactose in yogurt has greater digestibility than lactose in milk, perhaps because of the presence

of bacterial-derived beta-galactosidase (lactase) that assists digestion of lactose in yogurt (Boudraa et al. 1990).

Diets for protein-losing enteropathies

The diet of patients with protein-losing enteropathy should include additional high quality protein to make up for the increased fecal loss. Unfortunately, there is as yet no practical way to assess the amount of protein lost in the feces. As a rule of thumb, in patients with clinical evidence of debilitation from protein-losing enteropathy, protein requirements should be considered to be a minimum of 150% of basal requirements and probably nearer 200%. Tuna packed in water, skinned poultry and low-fat cottage cheese provide convenient, low-fat protein sources.

Fat is also usually restricted in protein-losing enteropathies, because of the likelihood of increasing lymph flow (lymphangiectasia) or difficult assimilation (inflammatory and infectious diseases). In spite of the reduced dietary fat content, daily energy intake must be sufficient to provide additional energy to support the formation of replacement protein. For this reason the diet is sometimes supplemented with medium-chain triglycerides (MCTs). MCTs have theoretical advantages over long-chain triglycerides (LCTs) for the treatment of gastrointestinal disease (Maliakkal et al. 1992). In contrast to LCTs, considerable amounts of MCTs are directly absorbed without the need for hydrolysis or formation of micelles. The MCT that is hydrolyzed by pancreatic lipase is hydrolyzed more completely than LCT. The medium-chain fatty acids produced by hydrolysis are minimally reesterified in the enterocyte. Instead, they are absorbed directly into the portal circulation. The small quantity of MCT that is reesterified is incorporated into chylomicrons. The amount of MCT incorporated into chylomicrons increases when the diet is high in MCTs or when MCTs are fed for prolonged periods (Swift et al. 1990). Thus, feeding of MCT oil, particularly in large quantities, is likely to increase lymph flow but not to the same degree as LCT. MCTs are most commonly used in dogs and cats to increase the energy intake of animals with lymphangiectasia. Unfortunately, the ability to supply significant quantities of energy by MCTs is hampered by their potential to cause osmotic diarrhea and inappetence. MCT oils are ketogenic and should not be given to patients with ketosis or acidosis (Alpers 1989). They are poorly metabolized in hepatic cirrhosis and may accumulate in plasma.

Diets for inflammatory bowel disease

The dietary therapy of inflammatory bowel disease (IBD) is similar to that recommended for chronic small bowel diarrhea. Immunosuppressive drugs (e.g., prednisone) are also usually required in the therapy of IBD.

In my experience, acquired food sensitivity (see above) to the novel protein source fed to the patient during the early stages of treatment is an important cause of relapse of IBD. To minimize the likelihood of recurrence of clinical signs because of acquired sensitivity, the dietary protein source can be changed to a second novel protein source after the first 6 wk of therapy. This diet change is made just before the lowering of the prednisone dose from the immunosuppressive to the antiinflammatory range. By this time it is hoped that the immunosuppressive therapy will have significantly reduced the gastrointestinal inflammation and thereby improved the chances that oral tolerance to the second novel dietary protein source will be maintained.

The addition of omega-3 polyunsaturated fatty acids, such as eicosapentaenoic acid (C25:5w3) and docosahexaenoic acid (C22:6w3), to the diet has been shown to alter the fatty acid and eicosanoid profiles of the gastrointestinal mucosa (Hillier et al. 1991, Vilaseca et al. 1990) and to reduce the degree of inflammation in experimental models of colitis (Vilaseca et al. 1990). Furthermore, dietary supplementation with omega-3 fatty acids has a favorable impact on endotoxemia and allergic processes (Maliakkal et al. 1992). Therefore, diets containing increased quantities of omega-3 fatty acids may prove to assist the management of canine and feline inflammatory bowel disease.

Diets for large bowel disease

Fecal incontinence is best treated with low fiber diets, whereas constipation can be prevented (but not treated) by high fiber diets. Dietary recommendations for the management of colitis are controversial. Low residue diets (Nelson et al. 1988), lamb and rice, and cottage cheese and rice have been successfully used as the sole management in many dogs. Other authors have recommended the use of fiber with some finding success with fermentable fibers such as psyllium (hemicellulose) and others preferring nonfermentable fibers such as bran (Simpson 1992). I prefer a diet containing moderate amounts of a highly digestible protein that is not included in the animal's usual diet (reduced colonic ammonia generation and low dietary antigenicity) in association with the addition of fermentable fiber such as psyllium or soy fiber. The beneficial effect of fermentable fibers (see Sunvold et al. 1994a, Sunvold et al. 1994b in this issue) probably relates to the generation of volatile fatty acids that nourish the colonic epithelium and discourage growth of pathogens. This hypothesis is supported by the observation that butyrate enemas are effective therapy for diversion colitis and distal ulcerative colitis in humans (Scheppach et al. 1992). Furthermore, the salvage of fluid and electrolytes by the colon is closely associated with the absorption of short-chain fatty acids (SCFA) (Penn and Lebenthal 1990), perhaps via SCFA-

bicarbonate and sodium-hydrogen exchange mechanisms (Eastwood 1992). In addition, butyrate and, to a lesser extent, other SCFA are the principal energy sources of colonocytes (Penn and Lebenthal 1990). These SCFA have a trophic effect on the large bowel mucosa (Sakata 1987, Reinhardt 1994). Moreover, SCFA lower luminal pH which in turn encourages proliferation of anaerobic flora and discourages the growth of pathogens including *Clostridium perfringens*, *Salmonella* and pathogenic *Escherichia coli* (Brockett and Tanner 1982, Twedt 1993).

Diets for borborygmus and flatulence

Gastrointestinal gas is produced by aerophagia or bacterial degradation of unabsorbed nutrients. Excessive gas usually results from dietary indiscretions but on occasion can herald more serious gastrointestinal disease. In human beings, diets high in soybeans, whole wheat products, bran, lactose and fats can cause gas. Similar associations appear to occur in some dogs and cats. Spoiled diets and diets high in protein or fat are particularly likely to yield odiferous gases. Milk products can cause gas in animals with lactase deficiency. The management of these problems begins with a change to a highly digestible, low fiber diet of moderate fat and protein content.

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