GUT BUGS: CAN WE CHANGE THEM WITH DIET?

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GUT BUGS AND THEIR INFLUENCE ON HEALTH & DISEASE

The intestinal microbiota include bacteria, fungi, and viruses. The genes expressed by the intestinal microbiota are the microbiome which plays a role in both host health and disease. Commensal microbes (i.e. symbionts) promote host health while pathogenic microbes (i.e. pathobionts) are opportunistic organisms that can harm host health. In health, these two populations of microbes are in homeostasis. The gastrointestinal microbiome is actively involved with the normal physiology of the host organism. This includes energy homeostasis, metabolism, gut health, immune function, and development. The predominant bacterial phylum in the healthy dog and cat is Firmicutes followed by Bacteroidetes in the dog and Actinobacteria in the cat. The composition of the microbiome can also vary depending on the location in the gastrointestinal tract.

The gastrointestinal microbiome can be influenced by diet, disease, medical intervention (e.g. antibiotic administration), and the environment. Changes to the intestinal microbiome that adversely affects host health are termed dysbiosis. This includes when the population of pathogens overwhelm commensal microbes or the absence of important commensals. Critical illness, for example, is associated with dysbiosis which can occur early during illness and hospitalization. Dysbiosis in this setting occurs through a variety of mechanisms including perfusion injury, antibiotic usage, gastrointestinal dysmotility, physiologic stress, and inadequate enteral nutrition. This dysbiosis may result in infectious complications and negative outcomes in these patient populations. Bacterial dysbiosis is found in dogs and cats with various gastrointestinal disorders which can vary with chronicity. The bacterial populations found in dogs with acute diarrhea differed from those with inflammatory bowel disease. Dysbiosis in dogs with acute diarrhea was further associated with an altered systemic metabolic state and decreased production of short chain fatty acids which are important for colonic health. The intestinal microbiome has also been linked to obesity in companion animals. Changes in the microbiome have been documented in both dogs and the cats suffering from obesity. This association between changes in the microbiome and obesity may be influenced by a variety of mechanisms including the state of chronic inflammation induced by obesity or an increased capacity of the microbes to extract energy from the diet. The role of the gastrointestinal microbiome and the pathophysiology of disease is not clear but evidence at this time suggests that it play an important role.

NUTRITIONAL INTERVENTIONS TO ALTER GUT BUGS

One of the primary influences on the intestinal microbiome is diet. Many veterinary studies investigate the role of dietary protein and fiber and their impact on intestinal microbes. Dietary protein concentrations influenced the populations of *Escherichia coli*, *Bifidobacterium*, and *Lactobacillus* in kittens and *Bifidobacterium* and *Clostridium perfringens* in adult cats. The ratio of protein to carbohydrate fed to kittens also influenced the fecal microbiota and was associated with metabolic effects on the host including Bifidobacteriaceae positively correlated with ghrelin concentrations and negatively correlated to blood triglycerides. Weight loss in the cat increased the abundance of Actinobacteria and decreased Bacteroidetes. The inclusion of potato fiber increased the proportion of *Faecalibacterium* and fecal short chain fatty acids suggesting it’s use as a prebiotic fiber. Clinically, diet plays an important role in the management of gastrointestinal disorders including acute diarrhea and chronic enteropathies. Dietary interventions for chronic enteropathies include highly digestible, novel/hydrolyzed protein, and fiber
enriched diet. Although studies are lacking investigating dietary effects on the microbiome in patients with chronic enteropathy, it is likely changes are occurring.

Feeding a raw meat based diet has been associated with changes in the fecal microbiome of companion animals. Significant differences were described in the fecal microbiota of cats fed a raw meat based diet of 1-3 day old chicken versus a chicken-based extruded diet. Investigators found a higher biodiversity in healthy dogs fed a raw meat based diet versus an extruded diet. These studies are limited in that differences in microbial populations cannot be attributed to the raw versus extruded nature of the diets due to different nutrient compositions. The clinical benefits of these changes are unknown and may not outweigh potential risks associated with feeding a raw meat based diet. Three of 12 cats fed a raw food diet of whole or ground 1-3 day old chicken developed clinical salmonelliosis with significant differences in their fecal microbiome including detection and increased proportions of other potentially pathogenic bacteria.

Fibers are classified based on their solubility (increased water-binding capacity to make a viscous solution), fermentation (ability of colonic microbes to produce short chain fatty acids), and prebiotic ability to support the growth and activity of health-promoting bacteria in the GI tract. Prebiotic fibers, such as inulin, fructooligosaccharides (FOS), mannaoligosaccharides (MOS), and resistant starch, are selectively fermented by commensal bacteria (i.e. Lactobacillus and Bifidobacterium spp.) in the GI tract to produce short chain fatty acids that have beneficial effects on colonic health. Butyrate is a short chain fatty acid produced by fiber fermentation. Luminal production of butyrate can have anti-inflammatory effects in the colon and increase water and electrolyte absorption. Short chain fatty acids are also used as energy for colonocytes. Dogs experimentally infected with enteropathogenic E. coli recovered from their diarrhea faster when supplemented with MOS compared to un-supplemented dogs. A meta-analysis showed that feeding prebiotics to dogs increased fecal short chain fatty acid concentrations and increased beneficial bacterial populations. Prebiotic fibers can be incorporated in to pet food for the benefit of GI health.

Probiotics are non-pathogenic, living bacteria or yeast used to correct dysbiosis in the gastrointestinal tract. Additionally, probiotics must demonstrate health effects when dosed in certain amounts for the prevention and treatment of disease. To be effective, probiotics must survive the acidic environment of the stomach, adhere and establish a population in the intestines, demonstrate activity against pathogenic microbes, and stimulate the immune system. Several studies in veterinary medicine investigate the effect of probiotics and gastrointestinal disease. Dogs with a diagnosis of inflammatory bowel disease receiving a multi-strain probiotic had decreased clinical and histological scores as well as normalization of dysbiosis. Patient populations investigated with acute diarrhea often include those in shelters, kennels, or undergoing physical exercise (i.e. sled dogs). Enterococcus faecium SF68 reduced the episodes of diarrhea in cats in a shelter setting compared to placebo. A combination probiotic containing Lactobacillus spp., Bifidobacterium spp., and Streptococcus spp. was administered to puppies with parvovirus enteritis receiving standard supportive care. Puppies receiving the probiotic had reduced clinical signs, increased lymphocyte counts, and improved survival rates when compared to the control group.

Several studies support the use of probiotics with antibiotic-associated diarrhea in veterinary medicine. In dogs, the use of yeast Saccharomyces boulardii after the onset of antibiotic associated diarrhea reduced the duration of clinical signs and returned fecal short chain fatty acids concentrations to pre-antibiotic treatment levels. Diarrhea did not occur in patients treated concurrently with antibiotics and the yeast probiotic. Cats were treated with amoxicillin-clavulanate for 7 days with or without a probiotic, Enterococcus faecium SF68, for 14 days. Fecal scores were improved in cats administered the probiotic, although no differences in microbiome diversity were found between groups. Improvement in clinical signs do not always correlate to detectable changes in the microbiome and changes to the microbiome do not always result in clinical improvement. Cats receiving a multi-strain probiotic 1 hour after clindamycin administration had reduced hyporexia and vomiting although this did not decrease antibiotic-associated diarrhea.

Although limited data exists on nutritional interventions to treat gastrointestinal dysbiosis, clinical goals can include improvement in fecal score, decreased duration and severity of clinical signs, and decreased fecal counts of pathogenic microbes.
REFERENCES
