

Public health concerns associated with feeding raw meat diets to dogs

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Food safety issues have recently gained considerable attention from the public and represent an important concern for the veterinary profession. Problems related to food contamination, however, are not unique to humans, as dogs are also susceptible to a large number of food-borne infections. Unfortunately, the safety of food intended for consumption by dogs has received limited attention.

Racing Greyhounds and sled dogs are commonly fed diets containing raw meat, and some pet owners also choose to feed uncooked meat to their pets. The risks associated with feeding raw meat to dogs are well documented, and it is imperative that veterinarians recognize these risks and convey this information to their clients and the public. The risk of food-borne illnesses in pet dogs is a major concern, but of more importance is the public health risk of zoonotic infections. For pets in contact with livestock or livestock feeds, there is the added risk of introducing or perpetuating diseases in livestock populations. The purpose of the present article is to summarize the microbiologic infections dogs may acquire through consumption of raw or undercooked meats and meat by-products. Suggestions on reducing the risks associated with these infections are provided.

Raw meat incorporated into canine diets may be derived from many sources. It may be added intentionally by the owners or acquired from hunting or scavenging. In either case, uncooked meat can be a vehicle for the transmission of microorganisms. Importantly, even meat obtained from healthy animals approved for human consumption is not sterile. Bacteria from the hide or feathers are frequently deposited on the surface of the meat at slaughter. Additional contamination can occur during evisceration, processing, and packaging. Although control measures such as carcass trimming, washing, and steam pasteurization are incorporated into processing lines to reduce pathogen load, some contaminating bacteria persist on carcasses. Some of these bacteria contribute to meat spoilage; others are pathogenic to humans and animals. Microscopic contamination or infection of meat with viral or parasitic agents in the absence of gross pathologic changes will frequently go undetected at inspection. Meat products not intended for human consumption, such as inedible tissues, condemned portions of carcasses, and entire

carcasses of condemned animals (eg, animals found to be dead, dying, disabled, or diseased at the time of slaughter), are also used for dog food.¹ Because of the inherent nature of these products and the less stringent handling requirements, compared with products approved for human consumption, these products may contain high levels of bacterial contamination.

Of the bacterial pathogens that can be found in raw meats offered to dogs, organisms of the genus *Salmonella* have received the most attention. Twenty to thirty-five percent of poultry carcasses intended for human consumption test positive for *Salmonella* organisms,^{2,3} and raw meat used for feeding dogs is even more frequently contaminated with this pathogen.⁴ Outbreaks of *Salmonella*-related gastroenteritis in dogs consuming diets containing raw meat are documented.^{5,6} In 1 study,⁶ more than half the strains of *Salmonella* spp identified in the feces of dogs could be matched to strains found in their diet. Perhaps more commonly, dogs may become subclinical carriers of *Salmonella* spp following exposure.⁷ Pet-to-person transmission of *Salmonella* spp may occur if infected pets are handled without observing proper hygienic practices. There is also a risk of humans becoming infected with *Salmonella* spp after handling contaminated meat products intended for dogs, such as bones and pigs' ears dog treats.⁸

Campylobacteriosis is the most frequently reported notifiable human enteric infection in the United States,⁹ and household contact with dogs is a significant risk factor for development of campylobacteriosis in humans.¹⁰ Campylobacteriosis can also develop in dogs, but similar to *Salmonella* infection, a large proportion of infected dogs excrete organisms in their feces yet remain clinically normal.¹¹ The routes by which dogs can become infected with *Campylobacter* spp are not precisely known; however, because most raw poultry is contaminated with *Campylobacter* spp, primarily *C jejuni*, food-borne infection is highly probable among dogs fed raw chicken.¹² The link between poultry and campylobacteriosis in dogs is strengthened by results of a serotyping study¹³ in which serovars of *Campylobacter* spp isolated from dogs with diarrhea were also isolated from poultry carcasses fed to the dogs.

Shiga toxic *Escherichia coli* (STEC) strains, many of which are able to cause disease in humans and animals, are routinely isolated from fresh ground hamburger.^{14,15} *Escherichia coli* O157, an emerging human pathogen, has been identified in dog feces.¹⁶ Illness occurs in Greyhounds fed raw meat containing high concentrations of this pathogen.¹⁷

Yersinia enterocolitica, another Enterobacteriaceae,

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can frequently be isolated from raw meat, especially pork. Depending upon the hygienic conditions during slaughter, packaging, and storage, as much as 89% of commercially available raw meats may be contaminated with this organism.¹⁸ Pathogenic serotypes of *Y enterocolitica* are shared between humans and dogs,¹⁹ and as with *Salmonella* spp and *Campylobacter* spp, dogs may be subclinically infected with *Y enterocolitica* serotypes that are pathogenic to humans.²⁰ Conversely, dogs may develop enteritis when infected with other serotypes.²¹ Household transmission of this pathogen from dogs to people has been documented.²²

Numerous other bacterial pathogens, including *Listeria monocytogenes* and *Clostridium perfringens*, may also cause illness in dogs. *Listeria monocytogenes* has been reported as a cause of abortion in a bitch that consumed raw meat products thought to be contaminated with the organism.²³ Handling of infected aborted tissues in the absence of appropriate hygiene measures would undoubtedly put handlers at risk of infection. Although the exact relationship between *C perfringens* infection and gastroenteritis in dogs is not clear, numerous cases of *C perfringens*-associated enteritis in dogs have been reported in the veterinary literature.^{24,25}

In addition to these food-borne bacterial agents, several other bacteria pose a direct risk to pets, even though there is little or no known risk of secondary transmission to humans from pets. Dogs are susceptible to the neurologic effects of *C botulinum* toxin, and some packaged foods, such as bacon, are capable of supporting growth of *C botulinum* and toxin production.²⁶ If these foods are not fully cooked to destroy the toxin prior to feeding, disease may ensue. Dogs are also susceptible to illness caused by *Staphylococcus aureus* and *Bacillus cereus*.^{27,28} These toxin-producing organisms can be found in raw meat and commercially prepared foods and may proliferate and produce toxins if the food is allowed to incubate before feeding. Many idiopathic digestive upsets of dogs may be related to bacterial growth in moist foods put out for dogs and left for many hours before they are eaten.

Several additional bacterial agents can, under special circumstances, be transmitted to dogs in raw meat. For instance, consumption of meat from animals with anthrax could result in infection with *B anthracis*.²⁹ Although anthrax is uncommon in domestic livestock in North America, it does occasionally occur, and the disease is relatively common in wildlife and livestock in focal regions in other countries.^{30,31} *Francisella tularensis* is endemic in rabbits and aquatic mammals, such as muskrats and beavers, in North America, and dogs that consume raw meat from infected sources are at risk of developing tularemia.³²

Dogs can become infected with *Mycobacterium bovis* and *M tuberculosis* following consumption of infected organ meat from infected livestock. Although these agents have been eradicated from domestic livestock, some wildlife reservoirs remain, and in parts of the world, notably Africa, infection of domestic livestock is relatively common.^{33,34} Although transmission of these organisms from dogs to people has not been reported, it is thought that transmission from dogs to

cattle may contribute to maintenance of the disease in areas where it is endemic.³⁵ Carcasses contaminated with *Burkholderia (Pseudomonas) pseudomallei*, the agent that causes melioidosis, can serve as a source of infection if ingested by dogs.³⁶ Meat from horses with glanders can be a source of *Burkholderia (Pseudomonas) mallei*, and dogs are moderately susceptible to infection with this organism.³⁷

A few viruses that pose a risk to dogs may also be present in raw meat. Pseudorabies (Aujeszky's disease) reportedly developed in dogs fed lungs from a herd of pigs with a high prevalence of this disease.³⁸ The dog is a dead-end host for this viral infection, and transmission from dogs to humans is not reported. On the other hand, rabies may be transmitted via ingestion,³⁹ and rabid dogs are a serious health risk to owners and the general public.

Numerous food-borne parasitic infections can affect dogs. Feeding raw fish to dogs can result in infection with a variety of organisms, including *Diphyllobothrium latum*, the fish tapeworm; *Opisthorchis tenuicollis*, a trematode that infects the bile duct, pancreatic ducts, and small intestines; *Diocotophyme renale*, the giant kidney worm; and *Nanophyetus salmincola*, the vector of *Neorickettsia helminthoeca*, the agent responsible for salmon poisoning in dogs.⁴⁰⁻⁴²

The prevalence of *Toxoplasma gondii* infection in swine intended for slaughter varies regionally. It is reportedly as high as 13% in Canada and is much higher in other countries.^{43,44} Fortunately, although dogs may become infected with *T gondii*, they are not the definitive host and, therefore, do not pass infective oocysts into the environment. On the other hand, dogs routinely fed raw meat are commonly infected with the protozoa *Sarcocystis* spp,^{45,46} and dogs that ingest infected meat may excrete sporocysts of this parasite in their feces and contaminate the environment, resulting in a hazard for livestock grazing in the same environment. When livestock ingest *Sarcocystis* spp, clinical disease resulting in considerable economic losses may ensue.⁴⁷ More recently, dogs have been identified as the definitive host of another important protozoan parasite of cattle, *Neospora caninum*.⁴⁸ Dogs become infected with *N caninum* by eating infected tissues, specifically aborted fetuses and placentas. Dogs infected with *N caninum* can develop clinical disease and shed infective oocysts in their feces; cattle become infected as a result of ingesting oocysts in pastures. In cattle, infection with *N caninum* is associated with abortion and production losses.⁴⁹

Ascarids such as *Toxocara canis* can encyst in the tissues of intermediate paratenic hosts, including sheep.⁵⁰ Dogs may become infected with *T canis* and with the raccoon ascarid, *Baylisascaris procyonis*, as a result of eating raw meat. Infected dogs can develop enteritis and shed infective eggs into the environment. Hence, the parasites may be transmitted to other dogs and other intermediate hosts, including humans. In humans, these 2 parasites cause visceral larval migrans.

Like most other carnivores, dogs are also susceptible to infection with *Trichinella spiralis*. Ingesting meat containing encysted larvae results in infection.

Undercooked pork is occasionally contaminated with infectious larvae, and undercooked walrus, seal, and bear meat is an important source of infection in some geographic regions.⁵¹ Trichinellosis in dogs has been reported occasionally, but the prevalence of this infection in dogs is probably underestimated.^{52,53}

The feeding of raw meat-containing diets to dogs that have contact with livestock poses additional important public health and economic risks associated with the possibility of infection with parasitic cestodes.⁵⁴ *Taenia hydatigena* and *T. ovis* develop in the liver or muscle of their intermediate hosts and cause cysticercosis. Lesions caused by these parasites result in condemnation of tissues at slaughter and related economic losses. These parasites are maintained in the livestock population by feeding infected meat or organs to dogs. Dogs, in turn, contaminate the environment with eggs that are infectious to livestock, the intermediate hosts. In the same manner, eggs of *Echinococcus multilocularis* and *E. granulosus* are transmitted from dogs to cattle, swine, and sheep. Furthermore, *E. multilocularis* and *E. granulosus* can be transmitted to humans through the feces of infected dogs and result in alveolar hydatid and hydatid disease, respectively.⁵⁵

To improve the health of pets and their owners, as well as to protect livestock, several recommendations for safe feeding of pets are suggested. First and foremost, never feed raw meat or fish to pets and limit access to carrion or hunting. Second, provide pet food in a clean container and dispose of uneaten food promptly. Pet foods, commercial or homemade, provide an ideal environment for bacterial proliferation. Third, practice personal hygiene when feeding and interacting with pets. This includes adequate handwashing following contact with food, feeding dishes, and feces. The value of handwashing following the handling of any potentially contaminated material cannot be understated.

A large number of commercial pet foods are available to provide excellent nutrition for dogs. Clients who wish to supplement their animal's diets with additional meat-based protein should be advised to adequately cook it before incorporating it into the feed. Because of the numerous risks outlined previously, veterinarians should not recommend the feeding of raw meat to dogs. Personal hygiene of pet owners is critical in preventing transfer of pathogens from pets to humans. Unfortunately, it is often the individuals with the lowest level of personal hygiene (eg, young children) who are most susceptible to these infectious agents. Supervising children during pet feeding and subsequent handwashing may be beneficial. Veterinary recommendation of raw meat feeding may result in serious legal ramifications.⁵⁶ On the other hand, recommending good hygienic food safety practices for pets and educating clients can advance the veterinary profession by benefiting pets, agriculture, and people.

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