Canine and Feline Parvovirus in Animal Shelters

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Overview

Feline panleukopenia and canine parvovirus are highly contagious viral diseases that commonly cause serious illness in cats and dogs in animal shelters. Most shelters have been affected by outbreaks of feline panleukopenia or canine parvovirus, with some resorting to temporary halting of intake and adoptions or depopulation to stop spread of disease. Every shelter is at high risk for exposure to feline and canine parvoviruses. As recently as August through October 2008, shelters in Michigan, Pennsylvania, and Ohio became very newsworthy when they temporarily closed due to panleukopenia or canine parvovirus outbreaks. Feline panleukopenia and canine parvovirus in shelters can be very costly in terms of resource allocation to manage and eradicate these viruses, animal suffering, and negative public image.

This document provides a basic overview of: 1) the properties of feline panleukopenia virus and canine parvovirus, including the new canine parvovirus 2c strain; 2) incubation times, clinical disease, duration of virus shedding, modes of transmission; 3) diagnosis; and 4) strategies for management and prevention in shelters.

Virology 101

Feline panleukopenia is caused by infection with feline parvovirus (FPV). This virus has caused massive die-offs of cats around the world since the 1800's. In addition to the commonly used term panleukopenia, FPV has also been referred to as "cat distemper" or "cat plague". Today, there are several strains of FPV circulating in cat populations worldwide, but all are closely related genetically.

Canine parvovirus (CPV-2) emerged in 1978, presumably originating from FPV through a small number of mutations that allowed the cat virus to replicate in dogs. Although the mutations provided the ability to infect dogs, CPV-2 lost the ability to infect cats. By the mid-1980's, the original CPV-2 strain was replaced by 2 new genetic variants, CPV-2a and CPV-2b, both of which continue to circulate in dogs today. The CPV-2a variant differs from the CPV-2b variant by one amino acid substitution at position 426 in the major antigenic capsid protein VP2. Despite differences in a few amino acids, CPV-2, CPV-2a, and CPV-2b are still closely related genetically. CPV-2a and CPV-2b re-acquired the ability to infect cats, and CPV-2b has been reported to cause "panleukopenia-like" disease in cats. CPV-2b is the predominant strain that infects dogs in the U.S. today.

In 2000, another genetic variant of CPV-2 was identified in dogs in Italy. This variant, designated as CPV-2c, differs from CPV-2a and CPV-2b by another single amino acid change in position 426 of the VP2 protein. Therefore, each of the 3 variants contains a different amino acid at this position in the VP2 protein. However, they are still 99% related genetically. CPV-2c appears to be widespread in Europe, and has been detected in dogs in Asia, South America, and most recently in the U.S. Two studies independently reported in 2007 the identification of CPV-2c in fecal samples from dogs with parvo-like disease in 11 states (AL, AR, AZ, CA, FL, GA, IL, KS, MO, OK, TX).[1,2] The coast-to-coast geographic distribution suggests that the new CPV-2c strain is probably widespread in the U.S. Similar to what has

already happened during the evolution of CPV, CPV-2c likely may replace CPV-2b as the predominant strain worldwide within 5 years.

More about CPV-2c

There is no evidence that CPV-2c is a more serious threat to dogs than CPV-2a or CPV-2b. CPV-2c causes the same clinical signs of vomiting, hemorrhagic diarrhea, and leukopenia. Although some believe that CPV-2c causes more severe disease and higher mortality than CPV-2b, others report that there is no difference. There are some reports of vaccinated adult dogs becoming infected with CPV-2c, but the details of the vaccination history with regard to when and how many vaccinations were administered were not provided or fully known.

Recently, a parvo outbreak due to CPV-2c was documented in 11 adult dogs housed in a breeding kennel in Italy.[3] The dogs ranged in age from 6 months to 2.5 years and had received at least 3 CPV vaccines, including boosters at 1 year and 2 years of age, prior to the outbreak. Another recent study evaluated the ability of antibodies from vaccinated dogs to block CPV-2c from infecting tissue culture cells in vitro.[4] Dogs were vaccinated with commercial CPV vaccines containing either CPV-2 or CPV-2b. Antibodies induced by these vaccines were very effective in preventing infection of tissue culture cells by CPV-2a and CPV-2b, but were not as effective in blocking CPV-2c infection of the cells.

These findings have raised concerns about the efficacy of current CPV vaccines in providing protection against infection by CPV-2c. However, recent vaccine trials have demonstrated that currently available commercial CPV vaccines do provide protective immunity to CPV-2c. In one study,[5] beagle puppies that were free of maternal antibodies to CPV received a vaccine containing CPV-2 (Intervet) at 8 weeks and 11 weeks of age. Vaccination induced antibody titers to both the CPV-2 vaccine strain as well as to CPV-2c, but the CPV-2 titers were higher. The vaccinated puppies and non-vaccinated puppies were challenged with CPV-2c administered orally. All of the unvaccinated puppies developed clinical disease within 4 days, shed the CPV-2c virus in feces, and had 50% mortality. In contrast, none of the vaccinated puppies had clinical disease or fecal shedding of virus. In another study,[6] beagle puppies that were free of maternal antibodies to CPV received a vaccine containing CPV-2 (Continuum, Intervet) or CPV-2b (Galaxy, Schering Plough) at 12 weeks of age. The vaccinated puppies and un-vaccinated puppies were challenged 5 weeks later with a combination of CPV-2b and CPV-2c administered orally or intranasally. All of the vaccinated puppies were protected from disease while all of the unvaccinated puppies developed disease with 50% mortality. The unvaccinated puppies also shed high amounts of virus in feces, but only 2 of 18 vaccinated pups shed virus. The most recent study evaluated the efficacy of vaccines containing either CPV-2 or CPV-2b from 5 major manufacturers (Fort Dodge, Intervet, Schering Plough, Pfizer, and Merial) in providing protective immunity against CPV-2c.[7] Seronegative puppies were vaccinated with one of the 5 vaccines, then challenged 5 weeks later with CPV-2c. Seropositive adult dogs that had been vaccinated against CPV at least 3 years earlier were also challenged. All of the vaccinated puppies and adults were protected from disease. Collectively, these vaccine trials demonstrate that current commercial vaccines containing CPV-2 or CPV-2b provide protective immunity against CPV-2c, even when dogs were vaccinated 3 or more years prior to challenge.

Besides vaccine efficacy, another concern about the new CPV-2c strain is the accuracy of the commonly used ELISA diagnostic tests in detecting CPV-2c antigens in feces. These tests utilize monoclonal antibodies to detect single epitopes of CPV. To date, these tests have been shown to reliably detect CPV-2c in fecal samples from infected dogs. In fact, the only way to determine if dogs are infected with CPV-2a, CPV-2b, or CPV-2c is to perform PCR on feces and DNA sequence analysis of virus isolates. Since vaccine efficacy, diagnostic accuracy, and management strategies for CPV have not changed, there is no real advantage afforded by determining which strain has infected dogs in shelters at this time.

Although current vaccines and diagnostic kits work for the newly emerged CPV-2c strain, canine parvovirus is still evolving. It is possible that future genetic variants may be altered enough to escape protection from current vaccines and detection by available diagnostic tests.

Populations at risk

Kittens and puppies are the most susceptible to parvoviral infection due to lack of protective immunity from maternally derived antibodies or from ineffective responses to vaccination. They typically enter shelters at an age when maternal immunity has waned to a level that does not protect against infection, but still interferes with responses to vaccination. Unvaccinated adult cats and dogs are also at risk for infection, but the clinical disease may be inapparent or mild. Older cats and dogs that have spent time outdoors eventually develop immunity by natural exposure to virus in the environment. Panleukopenia outbreaks commonly occur in the summer and fall ("kitten season") when large numbers of kittens born in the spring are admitted to shelters. Since dogs are not seasonal breeders like cats, there is no apparent seasonal pattern to parvovirus outbreaks in dogs.

Clinical features

The primary route of exposure to parvoviruses is nasal or oral contamination with virus-containing feces. The incubation period from time of exposure to onset of clinical disease ranges from 2 to 14 days, but typically is 5 to 7 days. Because the disease may be difficult for the shelter to detect during the incubation period, apparently healthy animals with parvo may be adopted out only to become ill a few days later in their new home.

Both FPV and CPV infect rapidly dividing cells in the intestinal tract, lymphoid tissues, and bone marrow. Resulting clinical signs include a sudden onset of fever, vomiting, diarrhea, dehydration, hypovolemic shock, panleukopenia, and death from shock or sepsis. The clinical signs can be worsened by concurrent infections with internal parasites and protozoa (coccidia), other viruses, bacteria, and STRESS induced by the shelter environment. The mortality rate can approach 90% in kittens and puppies that are not treated aggressively with supportive therapies. Parvovirus can have a higher mortality rate in shelter puppies and kittens despite early or aggressive therapy because of concurrent debilitation, parasitism and stress. Adult cats and dogs may have subclinical infection or mild transient diarrhea.

The most common cause of sudden death in kittens and cats in shelters is FPV! Both age groups can progress in hours to a moribund state without having any gastrotintestinal signs.

Parvovirus shedding in feces starts within 4 days of exposure, so that infected dogs and cats in the incubation period are already contagious prior to onset of clinical signs. Virus shedding continues for 14 days, so that animals recovered after a week of illness are still contagious to other animals. Animals with subclinical infection or transient symptoms also shed infectious virus in feces.

Transmission of parvoviruses occurs by direct contact with an infected animal or feces, by contact with contaminated fomites (cage or kennel surfaces, hands, clothing, food/water bowls, toys, litterboxes), and even by rodents and insects! The infected animal is covered with virus from head to toes, including the fur. Cats and dogs that recover from parvo should be bathed before allowed contact with other animals.

Diagnosis

Not all cases of vomiting or diarrhea in juveniles and adults are due to CPV or FPV, especially in animals that are debilitated, parasitized, co-infected with other pathogens, and stressed from entering the shelter environment.

Therefore, parvovirus infection cannot be diagnosed based on the age of the dog or cat and the clinical signs. Since other diseases mimic parvo, diagnostic testing should be performed on all dogs and cats with compatible clinical signs instead of making a decision on a guess, especially if animals suspected of having parvo are euthanized.

The point of care test kits (IDEXX, Agen, Synbiotics) for detection of parvovirus antigens in feces are a rapid and cost-effective diagnostic tool for dogs and cats in shelters suspected of having parvo. All animals with compatible clinical signs should be immediately tested in order to start proper containment strategies. False negative results can occur due to intermittent virus shedding very early or late in the course of disease, and also may occur more frequently in cats. Test results are most accurate if the test is performed within 5 days of onset of clinical signs. Negative tests should be repeated another day on any cat or dog suspected to have parvo based on clinical presentation. Although it is a common practice, there is no compelling medical reason to use the parvovirus test kits for routine screening of all dogs and cats in the shelter that don't have compatible clinical signs or known exposure – resources would be better allocated for control and preventive strategies.

Recent vaccination with modified-live parvovirus vaccines sometimes results in transient fecal shedding of vaccine virus that causes false-positive reactions on the parvo tests. Documentation of this phenomenon in dogs is scant. In a recent study,[8] kittens were vaccinated once with one of 8 commercial vaccines containing modified-live FPV or killed FPV, then their feces were tested daily for 14 days with 3 different commercial tests for detection of CPV (IDEXX, Agen, Synbiotics). For all tests combined, 20% of the kittens had at least one positive test result during the first 2 weeks postvaccination. Only 1 kitten was positive using the IDEXX test, compared to 4 kittens tested with Agen, and 13 kittens tested with the Synbiotics test. Most of the reactions were weak positive on all 3 tests. Thus, vaccine interference with parvovirus diagnostic testing is low, especially when the IDEXX SNAP test is used. A strong positive test result in combination with compatible clinical signs or known contact with virus is unlikely to be due to vaccination.

Necropsies should be performed on animals with unexplained deaths, particularly when there are unusual numbers of deaths of puppies and kittens in the shelter, foster homes, or adoptive homes. This is especially important for sudden death of adult cats and kittens during "kitten season". Feces and intestinal mucosal scrapings obtained during necropsy can be tested with the parvovirus antigen diagnostic tests.

Management

The most effective management strategy for limiting transmission of CPV or FPV in the shelter is the prompt removal of sick dogs and cats with positive test results. These animals should be housed in an isolation room if treatment is being considered. The decision to treat CPV or FPV should be carefully considered based on shelter resources, including whether there is an appropriate isolation room, enough staff to dedicate to treatment, costs for aggressive supportive treatment 1 to 2 weeks, and costs of personal protection equipment (PPE) which must be worn by staff in contact with the sick animals to maintain strict isolation conditions. The most important consideration is whether the shelter can manage treatment without contaminating the entire facility and putting healthy animals at risk, resulting in an outbreak forcing temporary closure and potential depopulation. If this is not possible, then sick animals should be removed from the facility for treatment or euthanized to relieve suffering and curtail disease transmission.

Since sick animals shed infectious virus before onset of clinical disease, all others exposed to the sick animals either by direct contact or fomite contact should be quarantined from the general population for 14 days with twice daily monitoring for appearance of clinical signs. If clinical signs occur, the animal should be immediately tested and removed if positive to help reduce the infectious dose of virus in the environment. Staff caring for the quarantined population should wear PPE (hair cover, gown, gloves, booties). Use of footbaths in lieu of disposable foot covering is not as effective because the entire shoe could be contaminated, not just the soles. Handling of dogs and cats in

quarantine should be minimized. Staff should always care for healthy animals first, then quarantined animals, then sick animals in isolation.

In some situations, the numbers of exposed but asymptomatic dogs or cats in quarantine may comprise almost the entire population. An alternative to holding all the animals for 2 weeks is to test them for protective antibody titers to parvovirus. This involves submission of serum samples to a diagnostic lab that performs parvovirus antibody testing and has a defined minimum titer required for protection (Univ. of Wisconsin and Cornell Univ.). Asymptomatic animals with protective antibody titers may be safely removed to adoption IF they also have a negative parvovirus fecal test.

Cleaning and disinfection

Parvoviruses are very durable, can persist in the environment for years, and are resistant to inactivation by quaternary ammonium disinfectants, including Roccal, Parvosol, Triple Two, Broadside, and A33. Only 2 disinfectants kill parvoviruses – bleach and Trifectant (potassium peroxymonosulfate). For optimum killing activity, environmental surfaces contaminated with feces, urine, vomit, blood, and other organic material must first be cleaned with a detergent before applying the bleach or Trifectant solution. The minimum required contact time for bleach or Trifectant is 10 minutes. Air drying is preferred if possible, but if the animal needs to be returned to the same run or cage, the area should be rinsed after the 10 min contact time, then dried using a squeegee or towel. Moisture favors the survival of pathogens.

A 5% solution of household bleach (½ cup per gallon water) should be prepared fresh daily and stored in an opaque container since light exposure inactivates it. Trifectant solution should be prepared according to manufacturer instructions - it is not inactivated by light and is less corrosive to metal and skin than bleach. For both disinfectants, more is *not* better! The more concentrated the solutions, the more irritating and damaging to skin, eyes, and the respiratory tract of animals and staff.

The “move down one” concept should be followed for cleaning and disinfection of dog runs.
Cats should kept in the same cage during their stay in the shelter, and their cages “spot cleaned” on a daily basis with replacement of soiled bedding and litterpans. If the cat must be removed for thorough cleaning and disinfection of the cage, it should be placed in its own carrier that is not shared with other cats, and carriers should also be cleaned and disinfected after use. Plastic carriers are particularly difficult to clean and disinfect unless taken apart. Many instances of exposure to FPV have occurred by improper disinfection of carriers used for multiple animals All cats, whether healthy or not, should be handled with gloves that are changed between cats.

Cleaning followed by disinfection with bleach or Trifectant should be performed not just during CPV or FPV outbreaks, but on a daily basis for all animal housing areas, food and water bowls, litterpans, animal transport vehicles, transport cages, and hallways to reduce the risk for environmental transmission of any infectious disease. Food/water bowls and litterpans should not be cleaned in the same sinks. In addition, they should be made of stainless steel instead of plastic because scratched plastic is difficult to fully disinfect. Consider using disposable litterpans in cages housing cats quarantined due to exposure to FPV.

Mop buckets should not be used for cleaning and disinfection of kennel runs. High pressure hoses and power washers should also not be used in kennels unless all dogs are removed, because the force sprays feces on all surfaces and can even aerosolize fecal matter. Cleaning and disinfection supplies should be dedicated to each room and not removed for use in other areas in order to minimize cross contamination.

While foster homes are generally a safer and less stressful environment for puppies and kittens, they have porous surfaces that are difficult to disinfect with bleach or Trifectant after contamination with parvovirus. It is very risky to send susceptible puppies and kittens to foster homes with a previous history of parvovirus.

It is also very risky to let puppies or kittens co-mingle in exercise areas and playpens containing wood, plastic, or dirt that can't be effectively disinfected.

Prevention

Vaccination of all dogs and cats on intake is the cornerstone for prevention of parvoviral transmission in shelters. All dogs and cats 4 weeks of age and older should receive a vaccine containing modified-live parvovirus on intake, regardless of intake status (stray, owner surrender, rabies quarantine, cruelty case, pregnant, lactating, injured, ill). A delay of even a day can significantly increase the risk for infection. All puppies and kittens should be re-vaccinated every 2 weeks while in the shelter until they are at least 4 months old.[9-10] Restricting vaccinations to adoptable animals only creates a large pool of susceptible animals that can make parvovirus infections an endemic problem which eventually affects all animals. The only possible exceptions to the vaccination on intake rule include dogs and cats that will be euthanized shortly after intake. For animals that were not vaccinated *before* exposure, vaccination *after* exposure will have little no effect on the outcome.

Vaccines containing modified-live parvovirus for dogs or cats are one of the most effective vaccines for reliably inducing protective immunity very quickly. Vaccine trials have proven many times that feline and canine modified-live parvovirus vaccines induce protective immunity within 3 days if there is no interference by maternally derived immunity. The potential for maternally derived antibodies to interfere with vaccination in puppies and kittens <4 months old is the reason they should be re-vaccinated every 2 weeks to successfully induce protective antibody titers. Modified-live parvovirus vaccines administered intranasally or subcutaneously are far superior to vaccines containing killed virus.

Another strategy to reduce risk for parvoviral outbreaks is to segregate juvenile animals from adults. Puppies and kittens should not be housed with adults. Puppies or kittens can be housed together using a planned co-mingling approach. In this approach, littermates can be housed together in very small groups (2-3 per group), and unrelated puppies or kittens that were already living together before admission can also be housed together. Dogs and cats should be housed in separate areas because CPV-2b has the potential to infect cats and cause panleukopenia.

In addition to vaccination, another strategy to prevent parvovirus infection is to move puppies and kittens from the shelter into foster situations as soon as possible after intake, as long as the foster homes do not have a history of housing parvovirus-infected animals in the past. Vaccination should be repeated every 2 weeks for puppies and kittens in foster care.

In combination with vaccination on entry and segregation of age groups, another key strategy is the daily cleaning of all areas followed by disinfection with bleach or Trifectant. Puppies and kittens should be cared for before adult animals, and healthy animals should be cared for before sick or exposed animals.

Finally, all efforts to reduce stress should be pursued. The most effective way to reduce stress on animals and staff in the shelter is to prevent crowding by practicing population management and planned co-mingling principles. Limiting run and cage occupancy to 1-2 compatible animals each results in less stress and substantially reduces risk for infectious disease.

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Valuable Resources

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