

## **Canine Parvovirus Infection**

by Elizabeth A. Coney DVM

*Parvo* - the word strikes fear into the heart of every dog lover.

In 1978, a devastating new disease of nearly endemic proportions emerged and swept through the dog world. From foxhound packs to indoor pets, stricken dogs fell acutely ill with severe hemorrhagic gastroenteritis, sepsis, myocarditis. The disease spread quickly throughout whole kennels and all age groups, and the fatality rate was high.

The causative agent was isolated, identified and named: Canine Parvovirus Type-2 (CPV-2). Within 3 years of the initial outbreak, the first vaccine was developed and placed into general use.

Fortunately, much has changed since 1978. A great deal is now known about canine parvovirus, many dogs are successfully treated and survive parvovirus infection, and appropriate vaccination can prevent this disease. However, some confusion and misinformation still exists within the dog world regarding how parvovirus is spread, how CPV infects dogs, how CPV may be diagnosed, and the role of vaccination in the prevention of this deadly viral disease.

### **What is canine parvovirus?**

Canine parvovirus is a single-stranded, unenveloped DNA virus. It is closely related to other known parvoviruses, such as feline panleukopenia virus and mink enteritis virus.

The originally identified CPV-2 has changed antigenically since first discovery. The original virus is now virtually extinct in the canine population, replaced by the variants CPV-2a and CPV-2b. While these variants appear more virulent, with higher mortality rates, they have remained genetically stable and unchanged since 1984.

CPV is one of the most resistant viruses known, able to survive in the environment for months to years, and unaffected by sunlight, drying, and most disinfectants. The only effective disinfectant for CPV is common household bleach (sodium hypochlorite).

### **Transmission from dog to dog**

CPV is simply and easily spread via the fecal-oral route: an infected dog sheds CPV in the feces, and another dog picks up the virus into the oropharynx via the mouth or nose.

For example, an infected dog defecates in the park. Rains wash away most of the fecal material, but the virus remains. A week later, your 10-week old puppy walks through that area, and eats some grass or licks it's feet, ingesting CPV. Most dog owners are aware that inanimate objects such as shoes and toys can also carry CPV from an infected area into a kennel or home. Dog owners should realize CPV is probably present in the environment nearly anywhere dogs frequent - parks, dog show venues, feed stores, the veterinary clinic dog-walking area.

### **Infection and viral replication**

After oral ingestion, CPV begins to replicate in local lymph nodes. Although inapparent and unrealized by the dog's owner, over the next day or two the virus is spreading via the lymphatic

system throughout the entire body. CPV then infects and localizes within the rapidly-dividing body cells needed to support viral growth - particularly those of the intestinal lining and bone marrow stem cells. The rapidly-dividing intestinal cells are quickly destroyed as the virus multiplies within the cells.

Now, 3-4 days post-infection, the first clinical signs of depression, lethargy, vomiting, collapse, bloody diarrhea and/or dehydration appear. The severely damaged intestinal lining allows the normal gut bacteria to enter the bloodstream, where it doesn't belong, causing systemic bacterial infection (sepsis, endotoxic shock).

Viral shedding in the feces and contamination of the environment begins with the onset of diarrhea and overt clinical signs, and can continue 8-12 days past the initial infection. No "carrier state" has been established, so once viral shedding stops the infected dog can safely be placed back in the general environment.

## **Diagnosis**

All that is bloody diarrhea is not parvovirus. Rapid, definitive diagnosis of CPV infection, even in the severely ill puppy suffering hemorrhagic diarrhea and vomiting, is not always easy. Other conditions may have clinical signs similar to CPV infection, including gastrointestinal parasites, coronavirus, foreign body ingestion (toys, bones), other gastrointestinal bacterial infections (such as salmonella, campylobacter), toxin and garbage ingestion, intestinal intussusception or hemorrhagic gastroenteritis from unknown cause. Thus other causes of hemorrhagic diarrhea and vomiting must be investigated and eliminated.

Positive detection of parovirus in the feces, using in-clinic fecal swab tests (Enzyme-Linked-Immunosorbant-Assay, or ELISA) is accurate and diagnostic. However, dogs presented early in infection, before the onset of diarrhea (and fecal viral shedding) may have falsely negative results. Dogs that have been sick for several days quickly develop antibody to CPV, and this antibody may bind the fecal CPV in the intestine, and interfere with ELISA detection. At veterinary teaching hospitals, electron microscopy can identify the virus in fecal material once fecal shedding has begun.

Serologic tests (titers) on blood serum are not always diagnostic, as dogs may have high titers to parvovirus due to previous vaccination or maternal antibodies. As antibody production against CPV is rapid, by several days post-infection CPV titers will be high. Very high titers in dogs that have been ill for several days, or titers rising quickly over time, help demonstrate CPV infection.

The complete blood count (CBC) is important. Different types of white blood cell lines are affected depending upon the stage of CPV infection. In the first few days post-infection, a low white blood cell count characterized by lymphopenia is common. A severe neutropenia can occur a few days later, at the onset of intestinal cell damage. During recovery, a high white cell count (leukocytosis) is common. Your veterinarian may want to run repeated CBC's to both assist in diagnosis and monitor progression and recovery.

Chemistry panels are necessary to determine and monitor blood glucose levels (critical in puppies), possible renal damage due to dehydration, blood protein levels, and electrolyte imbalances.

Radiology (x-rays) can help eliminate foreign body ingestion as a diagnosis. However, intestinal images of CPV infection and some of the other differential diagnosis listed initially above can be similar. Radiology may be confusing and in itself is not specifically diagnostic.

## **Treatment**

As canine parvovirus infections cannot be “cured”, infected dogs and puppies must be hospitalized and aggressively treated symptomatically and supportively while the viral infection runs its course.

CPV patients are considered highly contagious, and most veterinary facilities place infected animals in intensive-care isolation to prevent contamination of the hospital environment and spread to other patients via fomites (inanimate objects, such as a thermometer, shoes, etc.) or via personnel caring for the CPV patient. Do not be surprised if your visitation privileges are severely restricted, so that you do not inadvertently spread CPV outside of the isolation environment and the hospital.

The cornerstone of effective parvovirus treatment is careful fluid and electrolyte replacement to counter losses, dehydration, and shock caused by diarrhea and vomiting. Your veterinarian will do this by placing an intravenous (IV) catheter and administering IV fluids. Potassium (an electrolyte), dextrose and/or vitamins may be added to maintenance IV fluids. Dogs with severe loss of serum proteins due to intestinal damage may be treated with whole blood or plasma transfusions.

Antibiotics are given to help prevent or control bacterial sepsis and endotoxin release into the bloodstream. If the CPV dog is vomiting, and the intestine is damaged and unable to absorb medications given by mouth, broad-spectrum antibiotics (often a combination of an aminoglycoside and a synthetic penicillin) must be given intramuscularly or by intravenous line to counter blood infection and shock caused by intestinal bacterial and bacterial endotoxins.

Medications may be given to decrease severe vomiting. Corticosteroids may be given to combat endotoxic shock. Anti-diarrheal drugs are not commonly used, as this may increase endotoxin absorption from damaged intestines.

Most CPV-infected dogs require 3 to 7 days of intensive supportive care and careful monitoring. As soon as possible in recovery, water and then a highly-digestible, low-fat food will be re-introduced to the animal. Appropriate food helps the damaged intestine repair itself. When vomiting and diarrhea have ceased, so that the animal can maintain its own hydration through oral intake, the animal will be sent home.

Treatment of a parvovirus-infected dog is expensive, and can range from several hundred to over a thousand dollars depending upon the size of the dog and severity of infection.

Fortunately, in general, most parvovirus-infected dogs today can be successfully treated and recover if caught early and treated aggressively. Dogs that are mildly infected may recover in 1-2 days without much additional treatment; more severely affected dogs need 3-6 days of supportive treatment but will still recover.

Unfortunately, there is no way to predict at the onset of treatment which dogs will do well, and which will not. Some dogs may still acutely die within 24 hours of illness, despite treatment.

The following are added risk factors for not surviving parvovirus infection: concurrent distemper, coronavirus, or gastrointestinal parasites; poor nutritional levels, stress; exposure to a high amount of CPV; severe vomiting and severe hemorrhagic diarrhea. Puppies infected at less than 8 weeks of age may still develop the myocardial form of parvovirus and die.

**Protection: how maternal antibody against CPV works**

Unlike 1978, when the entire canine population had never been exposed to CPV-2, today a large majority of the canine population as a whole has a basic level of immunity to CPV, either from vaccination or natural exposure to disease. Thus, the myocardial form of CPV, seen in the past in newborn puppies, is rare.

Most pups are now protected against immediate neonatal infection by some passive level of maternal antibody passed on to pups in the colostrum (first milk) from the dam. The dam acquires this immunity by either her past exposure to parvovirus or by vaccination.

But here's the rub: how long the protective antibody received from mom's colostrum will last in puppies varies widely. And more importantly, *levels of maternal antibody in puppies can remain high enough to interfere with effective immunization, but too low to provide protection against parvovirus.*

In dams with very high levels (titers) of maternal antibody, the antibody passed on to puppies can last up to 18 weeks of age. Pups from dams passing on low levels of maternal antibody in the colostrum may have protective antibody gone at age 6 weeks.

This is what makes "perfect" vaccination programs for puppies so difficult to determine - we cannot determine with easy accuracy when maternal antibodies have fallen low enough to ensure that active immunization with a vaccine will be effective. Vaccine companies have worked on this problem, and newer, better vaccines can overcome maternal antibodies at lower levels than ever before, providing protection more quickly than previously able.

Realize this fact, however: *no matter how well a certain vaccine can successfully overcome remaining levels of maternal antibody and successfully immunize a puppy, there will always be a short time period where maternal antibody is too low to provide protection, but high enough to interfere with any immunization.*

This is why "vaccinated" puppies can, and do, contract CPV infections. This window of susceptibility cannot be eliminated entirely.

### **When to vaccinate puppies**

For "effective" vaccination to occur, a puppy or adult dog must receive two doses of vaccine (the initial immunization and a booster), three to four weeks apart, *after* maternal antibodies have fallen to where the pup is immunizable.

Studies have shown that about 25% of pups will be immunizable at 6 weeks of age, 40% by 9 weeks, 60% by 13 weeks, 80% by 16 weeks, and more than 95% by 18 weeks of age. The trouble is, a breeder has no way of knowing where a certain litter of puppies may fall within that range.

Thus, in order to protect the most puppies within the general population, veterinarians may choose to vaccinate with a modified-live parvovirus vaccine at age 6, 9, 12, 15, and 18 weeks of age, followed by revaccination at one year of age. An overall rule, about 75% of pups can be considered successfully immunized by 12 weeks of age with this schedule.

If the dam has high titers to parvovirus (through recent disease or immunization) and her pups received that high level of passive immunity, the pups may not even be immunizable until 15 to 18 weeks of age. This is why some puppies vaccinated only at 6, 9, and 12 weeks will contract parvovirus when they are slightly older - they were vaccinated while maternal antibody was still interfering. Thus in some cases another vaccination at 6 months of age may be advisable.

An alternate schedule would be to vaccinate for CPV beginning at 6-7 weeks of age, repeating at 3-4 week intervals until the puppy is 13-14 weeks of age, followed by an additional booster at 18-20 weeks of age.

There is no reason to administer CPV vaccines closer than 3 weeks apart - the pups immune system cannot respond “faster” or “better” to vaccines given too close together.

Some dog owners feel giving vaccine every 1-2 weeks will protect the pup through the “window of vulnerability” caused by maternal antibody interference. *This does not work, and is incorrect, overuse of immunizations.* The immune system needs a certain amount of time to respond appropriately, and increasing the frequency of vaccination does not change this fact, provide greater protection, nor eliminate entirely interference from maternal antibody.

Nor is there any reason to begin CPV immunizations at 3 weeks of age. The puppy’s immune system cannot respond to immunizations appropriately at too young an age.

Another common practice among breeders is giving very young puppies only “half” the normal volume of vaccination. This practice is *incorrect, and is not considered effective immunization.* Even very young or small puppies must receive the entire vaccine volume, in order to induce a response from the immune system.

Immunity from current modified-live CPV vaccinations on the market has been demonstrated to last from 1 to 3 years when administered correctly. There is no need to booster adult dog CPV vaccination more frequently than once per year, even for dogs with high known exposure to parvovirus infection opportunity.

### **The truth and some fables about CPV vaccinations**

Many vaccines able to prevent parvovirus infection exist and are extremely safe and effective.

It is recommended that *only* modified-live vaccines (MLV), rather than killed or inactivated vaccines, be used for immunization, due to the ability of the modified-live vaccine to engender quick and effective protection. Inactivated vaccines can provide protection, but do not prevent transmission of disease.

In MLV, the infectious agent (CPV) has been antigenically changed so that it does not and cannot cause disease, yet will stimulate the immune system to protect against CPV challenge.

Four to six days after administration of a modified-live CPV vaccine, some animals will experience a temporary drop in the white blood cell count. This is a good indication that the immune system has been activated and stimulated (exactly what is desired), NOT that the vaccine has immunosuppressed the animal or caused disease.

The attenuated (non-disease-causing) modified-live virus of some CPV vaccines replicates in the intestine and can be temporarily shed in the feces. Some owners mistakenly think this means the animal is shedding infective parvovirus after vaccination. This is not true. There has never been a documented case of a modified-live vaccine reverting to virulence (the disease-causing form), either in controlled vaccine studies or from field examinations of vaccinated dogs that have subsequently developed CPV infection.

### **Environmental preventive measures**

Because CPV is so stable in the environment, owners who have dogs develop parvovirus on the premises should take appropriate precautions to guard against permanent environmental contamination. Once the affected animals are removed to a veterinary facility, disinfect all premises, and disinfect or discard all items that were in contact with affected dogs.

Household bleach (sodium hypochlorite) is the only disinfectant agent that works for CPV disinfection, and it works very well. This is what veterinary clinics commonly use for disinfection. A 1 to 30 dilution of bleach to water will destroy CPV within a few minutes of sustained contact.

When cleaning a CPV kennel or area, tie disposable plastic garbage bags over shoes, wear disposable gloves on hands, and wear old clothes that can be bleached or thrown out. Place a garbage can at the entrance to the area so that all soiled clothes and protective items can be removed and thrown out when leaving the infected area, before CPV is spread throughout the property or house. Do not forget to disinfect cars and crates.

Pick up all traces of feces, vomit and food from affected areas and throw out. Towels, bedding, clothes, food bowls, shoes, etc. can be soaked in the bleach solution for 5-10 minutes, then items and soaking container washed.

Wet all surfaces that could have possibly come in contact with vomit, diarrhea, or feces (kennel floors, crates, walls) with bleach solution, leave on for 5-10 minutes, then wipe clean, throwing out or bleaching cleaning towels.

All feces and vomit should be immediately removed from the yard environment and thrown out. Bleach solution can be poured and left over areas of dirt and grass where feces or vomit were found, however achieving the sustained contact necessary to ensure killing of the virus outdoors is difficult.

It is probably better to consider the yard that a parvovirus dog was within permanently contaminated. Due to inevitable interference by maternal antibodies when immunizing puppies, it should be realized that subsequent excellent puppy vaccination programs will not be a fool-proof control method for preventing parvovirus outbreaks if the puppies are raised in a heavily contaminated environment.

Future puppy litters should have access to a different, non-contaminated outdoor area. Adult dogs with good immunity will be susceptible to large doses of virus, but effective vaccination will help prevent severe disease if contracted by adults.

## **Final questions**

**“My puppy was vaccinated, then broke with parvovirus 3-4 days later. This had to be due to the vaccine!”**

No. Neither modified-live or killed vaccines can cause parvovirus. Recall that the time from CPV infection to clinical signs averages 4-5 days. This puppy was most likely incubating CPV at the time of vaccination.

This is why veterinarians like to do a thorough physical exam at each puppy visit, prior to routine vaccination. Checking the temperature, the lymph nodes, palpating the abdomen and intestines can all help clue one in that the puppy may be “incubating” a potential problem at the time of vaccination. *Only puppies diagnosed as healthy should receive immunizations.*

**“I boosted my brood bitch right before she came in season, and her litter was vaccinated every 2 weeks from the time they were 6 weeks until they were 16 weeks old. But three of the litter came down with parvovirus when they were 5 months old. The vaccine didn’t work on these puppies.”**

It probably was not any problem with the vaccine. The dam, being boosted right before she was bred, probably passed on very high levels of maternal antibody to the puppies. So, the high maternal antibody level was still interfering in the puppy immunizations at age 12-15 weeks.

These puppies would have benefited from an additional immunization at age 18-20 weeks. The overimmunization early in life did not benefit them.

**“My puppy had parvovirus and recovered. Should I still vaccinate her for CPV?”**

It is thought that natural infection probably confers life-long immunity to CPV. However, vaccination is very safe, and vaccinating the dog as normal for an adult would not harm her. The levels of protection she received from her CPV infection may fall over time, leaving her susceptible in the future. An alternative procedure would be to draw annual CPV titers on her, and vaccinate her if the titer falls low and protection is suspect.

**“CPV is different now than it was when it first appeared. So dogs receiving these vaccinations are not protected against “street” or naturally-occurring virus.”**

Although antigenic changes have been documented in naturally-occurring parvovirus, this does not affect the ability of vaccinations to cross-protect dogs. Levels of protection (titers) fall over time. It is possible for an adult dog, who has not been vaccinated in several years and has been exposed to a large amount of CPV (such as a dog show) to become infected and ill. However, most adult dogs are only mildly ill for a day or two, as their immune system will quickly gear up and protect them.

**“My dog is at the vet’s being treated for parvovirus. When he comes home, when will he stop shedding virus, and when will it be safe for him to walk in the neighborhood and go to obedience class again?”**

CPV is shed in the feces of infected dogs for an average of 8-12 days after clinical infection becomes apparent, and no fecal shedding has been found after 2 weeks. Even though the dog may be home and apparently fine one week after his infection started, he still may be shedding infective virus in his feces. Keeping him at home for 3-4 weeks would provide a margin of safety to other dogs against this dog contaminating public environments.

**“I don’t use those modified-live vaccines, because it’s known that dogs will shed CPV in the feces after receiving them. Other people giving these MLV endanger my dog.”**

A dog receiving a modified-live vaccine may shed parovirus in the feces for a short time, however recall that the vaccine CPV is *NOT* pathogenic - it has been modified so that it does not cause disease. You do not need to fear fecal-shedding of dogs vaccinated with MLV products. They will not cause CPV in your dog.

**“I’m very concerned about over-vaccinating my dogs. That recommended puppy vaccine schedule is alot, and I don’t want to do it.”**

“Over-vaccination” is a valid concern. Vaccines are given to those animals at greatest risk of contracting disease. Puppies certainly fall into this category, as they are often out visiting, going to the vet, in public places, taken to dog shows and puppy obedience, etc. Pups have a high exposure risk. Additionally, puppies do not deal with the severe illness associated with CPV as well as an adult. With CPV, sick puppies dehydrate more quickly, suffer from protein loss and hypoglycemia, have a greater risk of renal damage due to dehydration, etc. versus an adult.

It is better to do a thorough job of protecting the puppy from a life-threatening CPV infection by a well-thought out puppy immunization schedule, including a booster one year later, than to expose the puppy to deadly CPV infection. Current CPV vaccines are safe and effective.

You and your vet can review the immunization schedule of the dam, and draw CPV titers on your puppy, to determine an appropriate individual immunization schedule that may be less than that “usually” given to puppies, if you have concerns.

After the age of one year, you and your vet should discuss the need for further immunizations during the adult years. The risk of serious CPV infection is less at this time, and previously-well-immunized adult dogs rarely contract severe disease. Better to decrease and adjust adult vaccinations, and not “over-immunize” at this stage of life, than to ignore puppy vaccinations when the threat of disease is greatest.

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