



# Feline Leukemia Virus in the Environment

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It has recently come to the attention of the Feline Health Center (FHC) at Cornell University that some cat owners who are caring for feline leukemia virus (FeLV) positive cats have strong but varying opinions about the survivability of FeLV in the environment. Does FeLV survive in the environment for any length of time? Is the statement “*if it dries it dies*” accurate for FeLV or other feline viruses? Let’s look at the facts.

## **Virology 101**

Viruses come in two main categories, enveloped and non-enveloped. Non-enveloped viruses consist of only nucleic acid (either DNA or RNA) and a protective protein coat, with no envelope or lipid making up the viral particle. As such, they are generally very stable and resistant to inactivation by common environmental factors and many commonly used disinfectants.

Enveloped feline viruses contain a lipoprotein layer or envelope around the nucleic acid (DNA or RNA) and viral protein core. This lipid makes these enveloped viruses more susceptible to inactivation by many chemicals and disinfectants.

The amount of virus present in tissue, secretions, or excretions is referred to as the virus titer. The titer is determined by diluting the fluid containing the virus until the virus no longer is infectious or detectable by the assay method being used. The titer is usually expressed as a log to the base 10 per milliliter of sample, so a titer of 2.0 means the sample contains 100 infectious viral particles, and a titer of 6.0 means that the sample contains a million infectious virus particles per milliliter.

The amount of virus needed to cause infection in a cat varies greatly from virus to virus, so the mere recovery of infectious virus from a contaminated surface does not necessarily mean that enough viable virus was present to cause infection in every cat that encounters that contaminated surface.

## **Dried viruses**

When viruses are secreted or discharged from a cat into the environment, they undergo drying rather rapidly, depending upon temperature, relative humidity, and the amount of organic material in which the virus is located (saliva, nasal discharge, feces, etc.). Some inactivation may

occur during the drying process, then the remaining viable dried viral particles are inactivated over time in a more or less steady rate. The more virus that is present at the beginning of the process, the longer infectious or viable virus persists in the environment. The rate of inactivation varies greatly depending upon the properties and chemical makeup of the individual viruses. For non-enveloped viruses like the feline parvovirus it is generally agreed that drying has little effect on decreasing the viability of the virus particle, and that these dried virus particles become inactivated at a very, very slow rate. Thus, these non-enveloped viruses remain infectious on contaminated surfaces for a long time – months to years.

Enveloped viruses have generally been considered to be labile virus because they are susceptible to inactivation by most disinfectants. It was thus assumed that they were also susceptible to rapid inactivation by drying and environmental factors once they are outside the host animal. However, more recent studies on a number of enveloped viruses have begun to shed a slightly different picture of how rapidly these enveloped viruses are inactivated in the environment. Some investigators now believe that the lipid in the envelope of these viruses protects them during the drying process, and thus enables these viruses to survive in the dried state longer than was previously thought. For example, Van Bueren et al. [J. Clin. Microbiol. 32(2):571-574, 1994], citing Damjanovic [J. Hosp. Infect. 10:209-211, 1987] state that: “The survival characteristics of HIV have been attributed, in part, to its lipid envelope, which resists drying and protects internal viral constituents from the deleterious effects of dehydration.” Modified live-virus (MLV) vaccines are routinely dried during production by a process called “lyophilization” or “freeze-drying.” In this process, the viable virus in liquid is rapidly frozen at an ultra low temperature, and then the frozen vaccine is dehydrated under vacuum. The dehydrated MLV virus is much less susceptible to inactivation at refrigeration or room temperature than if the virus was maintained in a liquid environment.

### **Common non-enveloped viruses of cats**

- **Feline parvovirus (FPV)**, the cause of feline panleukopenia (or feline “distemper”) is one of the most resistant viruses known, and will survive for years at room temperature, either in a liquid state in a sealed vial, or dried on a contaminated surface if it is not exposed to extreme environmental factors. Canine parvovirus (CPV) is a very close cousin of FPV, and they both share the same biochemical and environmental stability properties.
- **Feline calicivirus (FCV)** causes mild to severe respiratory disease, and some recently identified strains (VS-FCV) cause a more severe, virulent, systemic disease. FCV is very stable in the environment, but slightly less so than FPV. However, FCV is still capable of surviving for long times in the environment.

### **Common enveloped viruses of cats**

- **Feline herpesvirus (FHV-1)** is the cause of “feline viral rhinotracheitis” or FVR, a common upper respiratory infection. It is a typical herpesvirus with properties similar to other animal and human herpesviruses.
- **Feline enteric coronavirus (FECV)** is a common feline coronavirus (FCoV) that infects the intestinal tract of cats with generally little or no clinical disease.
- **Feline infectious peritonitis virus (FIPV)** is a coronavirus that may produce a severe and often fatal infection of cats, feline infectious peritonitis (FIP).

- **Feline immunodeficiency virus (FIV)**, a lentivirus within the family of viruses referred to as retroviruses, produces a chronic infection of cats that may produce a depression of the immune system resulting in a number of clinical signs including secondary infections after a prolonged asymptomatic period of perhaps several years.
- **Feline leukemia virus (FeLV)**, another retrovirus but distinct from FIV, is a common and persistent infection of cats that can result in immunosuppression, lymphatic tumors, anemia, or a number of other clinical disease signs.

### **Environmental factors that affect the inactivation of virus**

There are many factors that influence how long a virus will survive in the environment.

- Concentration or quantity of virus
- Temperature
- Moisture or humidity
- Intracellular vs. extracellular (cell-free) virus
- pH
- Sunlight
- Protein concentration
- Dry or wet

### **Studies on inactivation of feline viruses**

Our laboratory studied the affect of 35 disinfectants, antiseptics, sanitizers, and detergents on FPV, FHV-1, and FCV. [Scott FW. Virucidal disinfectants and feline viruses. *Am. J. Vet. Res.* 41(3):410-414, 1980]

Our laboratory studied the viability of FHV-1 at room temperature under four conditions: liquid in sealed vials either with or without 10% serum, and dried in open Petri dishes with or without 10% serum. Samples were assayed daily for infectious virus, and a significant amount of virus (at least 10,000 infectious units of virus) was still present after 7 days in samples of all four treatment groups. In this limited study, FHV-1 survived drying and persisted for at least 7 days under normal room temperature conditions. [Scott FW, unpublished data] For years it was assumed that the enveloped FIPV and the other feline coronaviruses were quite labile and did not survive outside the cat any length of time, perhaps a matter of hours. However, studies in our laboratory on the survivability of FIPV on contaminated objects provided surprising results. Aliquots of an infectious viral preparation were dried onto Petri dishes and allowed to remain at room temperature for up to seven weeks. At varying times samples were assayed for infectious virus. There was some loss of infectivity during the drying process, but then the amount of infectious virus remained relatively constant with only a gradual decrease in viability. FIPV virus could be recovered up to seven weeks from these dried samples.

Results of studies on other parvoviruses, herpesviruses, and coronaviruses of animals were consistent with our findings. [Brown, *Am. J. Vet. Res.* 42:1033-36, 1981] I have attempted to find published controlled studies that address the survivability of FeLV in the environment, but to date I have been unable to find a creditable report in the literature. Absent such a study, what can we learn from other studies that can reasonably predict what occurs with FeLV.

Van Bueren et al. [J. Clin. Microbiol. 32(2):571-574, 1994] studied the survival of human immunodeficiency virus (HIV), the cause of human AIDS, in suspension and dried on surfaces. They looked at survival of both cell-free and cell-associated virus either suspended in serum or dried onto glass surfaces. Both cell-associated and cell-free HIV suspended in serum survived for several weeks at room temperature. Cell-free HIV that was dried onto a glass surface survived for at least seven days, while cell-associated HIV was inactivated faster than cell-free virus, but still survived up to five days. The published results of several other studies on HIV are consistent with the results obtained by Van Bueren et al.

FeLV, HIV, and FIV all belong to the same virus family, retroviruses. It is reasonable to assume that the survivability of FeLV on a contaminated surface will be similar to that of HIV—days to weeks rather than minutes to hours. There is no scientific evidence to show that the simple process of drying of FeLV immediately renders it inactive or not infectious.

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*Prepared by Fred W. Scott, D.V.M., Ph.D., Professor Emeritus of Virology/ Interim Director of the Cornell Feline Health Center, College of Veterinary Medicine, Cornell University, Ithaca, NY 14853.*

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