

Feline Infectious Peritonitis/Feline Coronavirus (FIP/FCoV)

Feline infectious peritonitis (FIP) is a complex and inevitably fatal disease whose mode of transmission and infection is still not entirely understood. While cases are rare and outbreaks are rarer still, shelters should have a plan in place to respond to cases and monitor for elevated rates of disease. This information sheet provides a basic overview of this disease and presents some ideas to consider when you face FIP in your shelter.

Feline Coronavirus is not the same coronavirus that is the cause of COVID-19 illness in humans. For more information on COVID-19 [click here](#).

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Background

Feline infectious peritonitis (FIP) is one of the most common infectious causes of death in younger cats. It arises as a mutation of feline coronavirus (FCoV) and leads to a fatal systemic disease that progresses over weeks to months. The FIP form of FCoV is distinct from the enteric form of FCoV that occurs in most cats. The virulent virus type that leads to FIP is referred to as FIPV. Although infection with FCoV is very common in shelters and other densely housed feline populations, the occurrence of FIPV is generally low.

In a study of cats adopted from an open-intake shelter where cats were only in the environment relatively briefly, the rate of FIP was less than 0.6%. So, in shelters we typically expect the numbers of FIP cats to be less than 1%, and any rate higher than 1% is a cause for concern. The

low incidence of disease is fortunate as the disease's fatality is devastating and its control is nearly impossible: vaccination against FCoV is unreliable, diagnosis is rarely straightforward, and disease transmission and development follows an unpredictable course.

While FCoV is highly contagious and found to be endemic in many multiple cat populations, FIPV is not thought to be transmitted via direct contact between cats. FIP instead develops as a result of [multiple factors](#). Despite this, outbreaks involving increased mortality due to FIP can occur in groups of unrelated cats in shelters or catteries and pose challenges for disease control.

Disease course and transmission of FCoV/FIP

FCoV is shed extensively in the feces of infected cats and is readily spread by fomite transmission. Viral shedding may begin within just a few days of infection, and antibody titers will develop within 7-14 days. Most often no clinical signs of FCoV infection are seen; mild diarrhea or respiratory signs may occur but will generally be indistinguishable from other common illnesses in feline populations. Although most cats eventually resolve their infection, some cats are chronic shedders and can shed the virus intermittently without clinical signs. In order to consider cats negative shedders, five negative samples obtained at one-month intervals are required. While this may be done in closed breeding colonies, this is rarely if ever practical or indicated in a shelter.

FIP results from the distinctive occurrence of a mutation of FCoV within a genetically susceptible cat with a particular immune response. This mutated virus is cell-associated and thus is not commonly transmitted directly from one cat to another. Disease generally develops within a few weeks to 18 months after infection with FCoV and conversion to FIPV, often following a stressor such as rehoming or spay/neuter surgery.

The incidence of disease is bimodal, occurring most commonly in cats younger than 18 months and older than 12 years of age. There is a genetic component that contributes to the risk of developing FIP, thus littermates of kittens that have developed FIP are at increased risk. Unfortunately, there is no way to predict, out of a group of FCoV seropositive cats at risk for FIP, which ones are most likely to develop the disease.

Recognition and Diagnosis of FIP

A positive diagnosis of FIP can be difficult to make, particularly in the absence of characteristic clinical signs, including most classically, effusion

in the chest or abdomen. Diagnosis is generally made based on a combination of signalment, clinical signs, blood work and specific tests.

The predominant signalment is a cat less than three years of age, particularly between 4 and 16 months of age. The most common signs of FIP in young cats include a cyclic fever that is not responsive to antibiotics, lethargy, unexplained weight loss and failure to grow. Common laboratory abnormalities (see Table 1) include hyperproteinemia (mainly hyperglobulinemia), leukocytosis characterized by neutrophilia and lymphopenia, and anemia. Hyperproteinemia is a consistent finding in cats with or without effusion. Serum albumin:globulin ratio can be more useful than globulin measurement alone and most useful in ruling out disease rather than supporting disease in populations with low FIP prevalence. A cat with an albumin:globulin ratio of 0.6 or more is highly unlikely to have FIP. Cats with FIP are often icteric with a corresponding hyperbilirubinemia and hyperbilirubinuria caused by red blood cell destruction. Kidney or liver failure may occur depending on whether these organs are affected by granulomatous nodules resulting in abnormal renal and hepatic chemistry values.

Table 1 – Laboratory findings and interpretation when considering FIP as a possible diagnosis

Laboratory Findings	Interpretation
Mild non-regenerative anemia, leukocytosis characterized by neutrophilia, lymphopenia	Can be seen with FIP, but not specific. Not seen in every cat with FIP.
Hyperproteinemia/hyperglobulinemia	Common with FIP, but other diseases can also cause. Not present in all cats with FIP.
Albumin:globulin ratio	Ratio greater than 0.6 is possible but uncommon in cats with FIP.
Elevated ALT, ALP, BUN, Creatinine	Can be seen with FIP, but not specific. Not seen in every cat with FIP.

None of these laboratory abnormalities are present in all cats with FIP and there are many other conditions that can lead to any of these findings; therefore, FIP cannot be definitely diagnosed or ruled out based on these bloodwork tests alone. There are additional tests that can aid in the diagnosis (see Table 2 for a summary), but definitive diagnosis is only accomplished by direct visualization of feline corona virus within macrophages in effusion fluid, or in tissue or necropsy samples. These more invasive tests may not be feasible in some patients or financially practical in a shelter.

Coronavirus titers:

Feline coronavirus titers may be used as an adjunct to diagnosis, however these titers only indicate whether a cat has been exposed to the near-ubiquitous FCoV. There are no titer tests specific for FIPV. If the titer is negative at <1:25, it is likely the cat is truly negative and does not have FIP. It is important to remember that not all laboratories test down to such a low dilution, and a negative titer at higher dilutions (e.g. 1:400) is not meaningful. Very high titers (>1:1,600) are suggestive of FIP, however most cats with FIP do not have titers this high. Rising titers are less informative than they would be for other diseases, because cats with benign FCoV and those with FIPV both cycle up and down in titer level. This is particularly likely in a shelter cat, who can be presumed to have suffered a recent onslaught of viral exposure. Occasionally, cats with advanced disease are seronegative due to severe immunosuppression. *Diagnosis of FIP, or risk for developing FIP, should never be made based on titers alone.*

Characteristic effusion:

Wet FIP can often be diagnosed with reasonable confidence based on the presence of a clear to yellow high protein exudate that contains a low number of nucleated cells (protein levels > 3.5 g/dl, low cellularity of < 5000 cells per microliter). Protein content can be readily assessed in-house using a refractometer. High protein and fibrin content make FIP exudate characteristically viscous, an egg-white consistency that often exhibits threading.

The Rivalta Test can be done in-house to further assess suspicious fluid: a test tube is filled with distilled water and one drop of 98% (glacial) acetic acid is added (this can be obtained from chemical supply companies) and the solution is mixed. One drop of effusion is added and watched carefully: if the drop disappears, the test is negative. If the drop retains its shape, the test is positive. A negative test is more powerful in ruling out disease than a positive test is in supporting FIP diagnosis. It is important to remember that other rule outs for an exudate in the abdomen are all serious conditions, and therefore in a shelter it may be reasonable to euthanize cats based on a strong suspicion of an untreatable condition rather than investing resources on further testing.

Suspicious effusion can be analyzed for antibodies to FCoV; however, the presence of FCoV antibodies and the magnitude of the titer do not strongly correlate with diagnosing FIP. Studies focused on localizing antibodies in CSF are contradictory, and CSF should not be used in order to determine a diagnosis.

Visualization of FCoV Antigen by Immunostaining:

FCoV antigen immunostaining detects virus-infected macrophages in the tissue or in effusion via immunocytochemistry or immunohistochemistry; a biopsy is needed in order to make an evaluation of affected tissue. Studies have shown that only FIP positive cats will have antigen positive tests. Care must be taken to ensure that the test is performed properly and interpreted correctly. False negatives occur regularly with low infected cellularity or when the virus has been bound by antibody complexes.

PCR:

PCR can be used to detect viral genetic material in tissue or body fluid; there are no effective PCR tests for detecting virus in the blood. Historically, PCR testing could not distinguish between FCoV and FIPV, and results lacked clinical significance similar to FCoV titer testing. Recently, Idexx developed a RealPCR that detects a FIPV specific protein, in tissue or body fluid, that correlates well with FIP infection and can be used as a confirmatory diagnostic tool.

To date, there is no way to screen healthy cats for risk of developing FIP.

Table 2 – Summary of diagnostic tests and interpretation that can help aid in the diagnosis of FIP

Diagnostic Tests	Interpretation
Coronavirus Titers	In general, a positive titer only indicates exposure to FCoV, not FIPV. If the titer is negative at <1:25, it is likely the cat is truly negative for FIP. Very high titers, >1:1,600, are suggestive of FIP
Rivalta Test	A negative test indicates the fluid is a transudate and not supportive of FIP.
Visualization of FCoV within macrophages in effusion or tissue samples (by immunohistochemistry)	Diagnostic for FIP.
PCR	Positive FCoV PCR indicates exposure to coronavirus, not FIPV. Negative PCR does not rule out FIP.
IDEXX RealPCR™	Positive result in a sick cat is suggestive of FIP.

Treatment

Although once considered 100% fatal, promising anti-viral medications, including viral protease inhibitors and a viral RNA inhibitor, have demonstrated FIP remission in clinical trials. Unfortunately, these drugs are not yet approved by the Food and Drug Administration (FDA) and are not publicly available. Black market versions are appearing, but it is important to remember there is no regulation of these drugs including no verification of their authenticity or safety. This puts veterinarians in a difficult position of being aware of possible life-saving treatment but unable to recommend it. In response, cat owners have banded together through groups such as “FIP warriors” on Facebook to share knowledge and experiences.

Until these drugs are approved and legally available, FIP will remain an essentially untreatable disease in shelters. Infected cats likely pose a minimal contagious risk to others and can be cared for in “fospice” situations where resources exist and humane care can be assured. However, the inexorable course of the disease means that euthanasia is still often considered as a humane choice for clinically affected cats in shelters.

Risk Assessment

Given that FIP itself is not generally transmitted cat-to-cat and coronavirus is so commonly present in multiple cat populations without causing apparent harm, it is challenging to understand what accounts for FIP development. Although the dynamics of FIP transmission and development are poorly understood, several factors likely contribute to situations where FIP occurs with a higher-than-expected frequency:

- **Virulence of FCoV strain:** While FIP itself is not usually transmitted directly between cats, there are strains of coronavirus (“virulent coronaviruses”) that are relatively likely to mutate to FIP.
- **Exposure to high doses and/or high replication in the intestine:** Cats exposed to high doses of the virus or that have high levels of viral replication are more likely to develop FIP. Dose effect is increased by crowding and poor husbandry and sanitation. Higher rates of replication, and consequently higher doses shed into the environment, are likely to occur with stress, concurrent illness, and in kittens. Stress includes changes common for cats in shelters like surgery, vaccination or transition to a new home.
- **Age at exposure:** Cats exposed at an early age are more likely to experience infections leading to high levels of replication, shedding,

and relatively high risk of FIP. However, FIP can occur at any age; there is evidence of a secondary peak incidence in geriatric cats as a result of sub-optimal immune function. Typically, cats younger than 18 months and older than 12 years are the most at risk for development of FIP.

- **Length of exposure:** Although in one study cats were most likely to develop FIP subsequent to a first infection with FCoV, chronicity of exposure may also play a role. In laboratory studies, a second exposure in previously FCoV infected cats led to greater likelihood of FIP (antibody dependent enhancement). In a shelter study, cats that had been in a shelter for > 60 days were over 5 times as likely to be coronavirus positive as cats sheltered less than 5 days.
- **Genetic risk:** Littermates of kittens that develop FIP are at higher risk than unrelated but equivalently-exposed kittens. This is in part because of shared genetic risk, and in part due to exposure to an identical, possibly relatively virulent strain of FCoV at a relatively vulnerable time period (very early in life). Although the disease occurs in all breeds, purebred cats are more susceptible including, Abyssinians, Australian mist, Bengals, Birmans, Burmese, British shorthairs, Himalayans, ragdolls, rexes, and Scottish folds. Mothers of litters containing one or more FIP kittens may not be at an appreciably increased risk; although they may share some genetic risk factors, they may not have been exposed at a vulnerable time. However, they may be shedding a strain of FCoV that mutated in at least one kitten to FIPV.

Prevention

The best protection against FIP is operating within your shelter's capacity for care, practicing good husbandry with humane housing, and managing disease in the population and within individuals. These practices minimize the vulnerability of cats to pathogens, like feline coronavirus, by minimizing their exposure, infectious dose and transmission.

1. Capacity for care practices important to prevent overcrowding and decrease LOS:

- Manage population size so each cat or litter has a humane housing unit and the staff available to adequately provide care
- Minimize length of stay so each cat stays in the shelter only as long as needed to meet their needs for adoption
- Prioritize fast track animals, like kittens, through your shelter processes so their shelter stay (and disease exposure) is lowered

2. Housing and husbandry practices important to decrease stress and

minimize viral dose are:

- Humane housing units include:
 - Double-sided housing for all cats
 - Group housing is limited to adult cats >5 months and related litters
 - Each cat in group housing has a minimum of 18 square feet of floor space and their own litterbox
- No comingling of kittens or mixing of litters in the shelter or in foster
- Minimize movement of cats between different housing units
- Manage stress by providing hiding places for all cats and decreasing noise levels

3. Practices to minimize overall disease burden are:

- Intake protocols that include vaccination and dewormers
- Work with a DVM to develop treatment protocols for common shelter diseases like diarrhea and upper respiratory disease
- Have in place a robust monitoring and rounds system so sick animals are noted quickly and brought to the attention of medical staff for care

Vaccination for FCoV/FIP

There are inherent challenges to creating a truly reliable vaccine for FCoV, given that even natural infection does not convey lasting immunity. There is currently only one vaccine available for feline coronavirus, a modified live intranasal product labeled for use in cats > 16 weeks of age, which is given as a series of two vaccines 3-4 weeks apart.

Results of studies regarding the efficacy of this vaccine have been variable, some showing no efficacy and others showing limited efficacy under certain circumstances. One study showed a significantly decreased risk of FIP in cats that were seronegative for FCoV at the time of vaccination. Although there may be some benefit to giving the vaccine to cats that have never before been exposed to a multi-cat environment (and are therefore relatively likely to be seronegative), most shelter cats will have long since been exposed by the time the recommended booster vaccine can be administered. Based on this information, vaccination is not recommended by the [American Association of Feline Practitioners \(AAFP\)](#).

Cleaning and Disinfection

Fortunately, the most commonly used disinfectants will inactivate feline coronavirus. Best cleaning practices include:

- Spot-cleaning for daily cleaning and deep cleaning only between cats
- Litterbox care includes:
 - Use low-dust litter
 - Provide a scoop for each cat clean scoops between each cage, and scoop litterboxes as frequently as possible
 - Minimize contamination of floors (don't empty litter onto floor during cage cleaning)
- Change tops or gowns between groups of animals

Implications for Adoption

Siblings of FIP kittens

Siblings of kittens that have FIP have a higher risk of developing FIP. However, it is not a guarantee that a sibling will develop FIP and many will not develop the disease. If the decision is made to place these kittens for adoption, their exposure to FIP should be disclosed. These kittens likely pose little risk to resident adult cats in a household. Cats in a home experience much less stress than cats in shelters, and cats over two years of age are at even less risk of developing disease.

The risk of maintaining these kittens in a shelter is unknown. It is highly likely the kitten, even if asymptomatic, is shedding a strain of feline coronavirus that mutated to FIPV in another kitten (the FIP sibling). If the kitten is in a foster home, maintaining the kitten in the home and adopting through the foster home may be a possibility for some shelters.

Nonsibling kittens

Unrelated kittens exposed to an FIP kitten are at no greater risk of developing the disease than kittens never exposed. No special adoption disclosure is warranted.

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