fluid therapy, drainage of accumulated fluids, and blood transfusions, is also indicated in some cases.

## Prevention

The only way to prevent FIP in cats is to prevent FeCV infection, which can be challenging given its ubiquitous nature. This is particularly true of cats that are housed in high density (shelters, catteries). Housing cats at a density at or below three per room is recommended to minimize stresses associated with crowded living conditions. It is important to note that while FeCV is quite contagious (it is passed in the feces and saliva of infected cats and infects other cats primarily via the oral cavity), FIPV is not believed to be. Rather, FIP develops in individual cats after they are infected with FeCV and the virus undergoes mutations to become FIPV (FIPV itself is not passed in the feces). Keeping cats as healthy as possible, including preventing infection by other viruses via appropriate vaccination, is likely to decrease the likelihood of FIP. Litter boxes should be kept clean and located away from food and water dishes. Some sources have suggested that newly acquired cats and any cats that are suspected of being infected with FeCV should be separated from other cats, although the usefulness of this management strategy is debatable.

There is only one licensed FIP vaccine available, but given its questionable effectiveness, the American Association of Feline Practitioners Feline Vaccine Advisory Panel has refrained from routinely recommending this vaccine. The risks and benefits of FIP vaccination should be weighed carefully in consultation with a veterinarian.

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Dr. Whittaker is a leading expert on FIP, and his laboratory at the Cornell College of Veterinary Medicine focuses on improving our understanding of the molecular mechanism of FIP infection.

## ABOUT THE CORNELL FELINE HEALTH CENTER

The Cornell Feline Health Center's mission is to improve the health and well-being of cats worldwide. Funded solely by the generous support of our donors, we provide up-to-date and expert information to cat lovers and veterinarians, support basic and applied research in cat health, and promote the training of veterinary professionals and researchers.

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Cornell
Feline Health Center

# Feline Infectious Peritonitis (FIP):

## Symptoms, Management, and New Hope for Therapies

Cornell University
College of Veterinary Medicine

# Feline Infectious Peritonitis

Cornell Feline Health Center

Feline infectious peritonitis (FIP) is a disease of cats that is caused by certain strains of feline coronavirus.

Most strains of feline coronavirus are found in the gastrointestinal tract (referred to as feline enteric coronavirus (FeCV)), and do not cause significant disease. In between five and 10 percent of cats infected with FeCV, though, mutations of the virus can alter its biological behavior, resulting in white blood cells becoming infected with virus, spreading it through the cat's body, and causing the intense systemic inflammatory reaction that is known as FIP. When this occurs, the virus is referred to as the FIPV. Once a cat develops FIP, the disease is usually progressive and almost always fatal without therapy that has recently become available, but that has yet to be approved to treat FIP in cats by the Food and Drug Administration (FDA) (see below). It is important to note that feline coronaviruses are not the same virus that causes COVID-19 illness in people, and that they cannot be passed from infected cats to humans.

Any cat that carries FeCV can develop FIP, but younger cats are at greater risk. Approximately 70% of cases are diagnosed in cats less than 1 1/2 years of age. The most common mode of transmission of FeCV is believed to be from queens to their kittens when they are between five and eight weeks of age. Cats that are housed in high-density facilities (i.e. shelters, catteries) appear to be more susceptible to the development of FIP, as are pure bred cats, male cats, and geriatric cats, for reasons that remain unclear.

## Clinical Signs

Cats that are infected with FeCV usually show no obvious symptoms. Some may show mild upper respiratory symptoms such as sneezing, watery eyes, and nasal discharge, while others may experience mild gastrointestinal signs such as diarrhea. In most cases, these signs are self-limiting. Only a small percentage of cats that are exposed to the FeCV develop FIP, and this can occur weeks, months, or even years after initial exposure to FeCV.

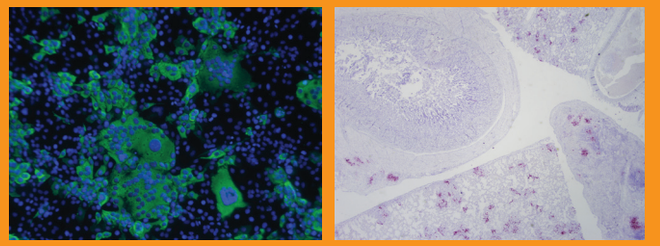
There are two major forms of FIP, an effusive ("wet") form and a noneffusive ("dry") form. Regardless of which form they ultimately develop, cats infected with FIPV usually first develop nonspecific signs of disease such as loss of appetite, weight loss, depression, and fever. It is also important to note that cases of the effusive form of FIP can evolve into the non-effusive form and vice-versa.

Signs of the noneffusive form, which may include the non-specific signs listed above as well as neurologic signs including seizures and ataxia (abnormal or uncoordinated movements), usually develop more slowly than those of the effusive form.

Signs of the effusive form of FIP usually progress relatively rapidly and include development of the above-mentioned non-specific signs combined with the accumulation of fluid in body cavities, including the abdomen and the thorax (chest cavity). Affected cats may develop a pot-bellied appearance due to fluid accumulation in the abdomen, and if the fluid accumulation is excessive, it may become difficult for a cat to breathe.

## Diagnosis

Unfortunately, there is currently no definitive test available to diagnose FIP. While antibody levels (titers) to coronavirus can be measured, they cannot distinguish between exposure to FeCV and FIPV. A positive result means only that a cat has been exposed to coronavirus, but not necessarily to FIPV. In spite of this limitation, however, young cats that experience a fever that is not responsive to antibiotics and that have high coronavirus titers are often presumptively diagnosed with FIP. This is particularly true if characteristic fluid (yellow tinged with a high protein and white blood cell concentration) begins to accumulate within body cavities. A healthy cat with a high coronavirus titer (i.e. many antibodies against coronavirus), however, is not necessarily more likely to develop FIP or be a carrier of an FIPV than a cat with a low titer. In cats with suppressed immune systems, FIPV infections may not cause elevated coronavirus titers due to an inability of the immune system to produce sufficient antibodies against the virus.



*Photos supplied by Dr. Gary Whittaker*
Left: Cell culture adapted feline coronavirus infection in epithelial cells in culture. Green = virus infection, Blue = cell nuclei.
Right: Detection of viral RNA in pathology tissue sample from FIP infected cat.

Other available tests can detect the presence of the virus itself. One of these tests, called the immunoperoxidase test, can detect viral proteins in virus-infected white blood cells in tissue, but a biopsy of affected tissue is necessary for evaluation. Another, called the immunofluorescence test, can detect viral proteins in virus-infected white blood cells in tissue or body fluids. More recently, a technology called polymerase chain reaction (PCR) has been used to detect viral genetic material in tissue or body fluid. Although these tests can be useful, none of them is 100% accurate, and each suffers from its own limitations that may lead to false negative or false positive results.

## Treatment

Until recently, FIP was considered to be a non-treatable disease. While there are still some uncertainties regarding the long-term effectiveness of recently-identified antiviral drugs to treat FIP (most importantly regarding their effectiveness in treating the non-effusive form), studies in both the laboratory and in cats with naturally occurring FIP suggest that a drug referred to as GS-441524 may prove to be an effective treatment option for (minimally) the effusive form of FIP. While some cases of the non-effusive form of FIP responded to GS-441524 therapy in these trials, these responses were not as favorable as those seen in cases of the effusive form. This drug is currently not FDA-approved, however, and while there are a number of sources offering it for sale, anecdotal reports suggest that the products being provided by some of these sources vary widely in both accuracy of reported drug concentration and purity.
It is very important to discuss the risks, benefits, and evolving acquisition and regulatory issues with your veterinarian if you are considering therapy with GS-441524. Supportive care, including