Neurological and ocular FIP

Niels C. Pedersen, DVM PhD
Distinguished Professor Emeritus
UC Davis, Center for Companion Animal Health
Updated February 10, 2023

Background

What is FIP? - FIP is caused by a common and a largely innocuous enteric coronavirus, like those causing colds in humans and diarrhea in foals, calves, and poultry. Most cats are infected with the feline enteric coronavirus (FECV) at about 9 weeks of age and may be reinfected numerous times before reaching 3 years of age, when cycles of infection become less frequent. Specific mutations that allow FECV to escape the cells lining the lower intestine and infect the most basic cell of the immune system, the macrophage, will occur in about 10% of infections. However, this macrophage infection is eliminated in all but 0.3-1.4% of cats. Predisposing conditions that lead to disease in this small proportion of cats involve young age, genetic susceptibility, sex, overcrowding, poor nutrition, and a number of stressful environmental events. The initial site of disease is in the lymphoid tissue in the lower small intestine, cecum, and proximal colon. Infected macrophages leave these initial disease sites and migrate locally and in the bloodstream to small veins in the linings of the peritoneal cavity, the uveal tract of the eye, the ependyma and meninges of the brain and spine. Disease signs manifest within days, several weeks, sometimes months, and rarely a year or more. The form of disease that is manifested is referred to simply as wet (effusive) or dry (non-effusive). These two forms are easily distinguishable, although there may also be transition forms between the two. Some cats may present with signs of dry FIP but later develop wet FIP, or vice versa. Overall, about two-thirds of cats will present with wet FIP and one-third with dry FIP. The duration of illness to death, usually from euthanasia, in the past was only a matter of days or weeks. Less than 5% of diseased cats, mainly those with milder forms of dry FIP, will survive longer than one year with the best symptomatic care.

FIP manifestations and forms

Clinical manifestations of FIP- The clinical manifestations of wet (Table 1) and dry (Table 2) FIP vary according to the site(s) of in the body where infected macrophages end up and cause inflammation. The intensity and character of the inflammation is responsible for the disease form. Wet FIP is the more acute and severe form of FIP and is characterized by accumulation of inflammatory fluid either in the abdominal cavity and/or chest cavity. Involvement of the central nervous system (CNS) and eyes is relatively uncommon in the wet form of FIP (Table 1). The dry form of FIP is characterized, not by diffuse inflammation and fluid effusion, but rather by less numerous and more tumor-like lesions (i.e., granulomas) in organs (e. g., kidney, cecum, colon, liver, lung, lymph nodes) within the abdominal or thoracic cavities, or in the eyes and brain (Table 2). Whereas the brain and/or eyes are only involved in 9% of the wet cases, neurological and-or ocular disease is seen as the main presenting clinical sign in 70% of cats with dry FIP. 2

Table 1. Variability in clinical signs of effusive (wet) FIP from cats necropsied at UC Davis

Signs referable to - % affected.
Peritoneal cavity – 58%
Peritoneal & pleural cavity – 22%
Pleural cavity – 11%
Peritoneal cavity, eyes - 2.8%
Peritoneal cavity, CNS* - 1.9%
Peritoneal and pleural cavity, CNS - 0.9%
Peritoneal and pleural cavity, eyes - 0.9%
Pleural cavity, CNS, eyes - 0.9%
Peritoneal cavity, CNS, eyes - 0.9%

**Central nervous system (brain, spinal cord)*

Table 2. Variability in clinical signs of non-effusive (dry) FIP from cats necropsied at UC Davis

Signs referable to - % affected.
Peritoneal cavity – 30%
CNS – 22%
Eyes – 14%
CNS & eyes – 8%
Peritoneal cavity, eyes – 7%
Peritoneal & pleural cavities – 4%
Peritoneal & pleural cavities, CNS – 3%
Peritoneal & pleural cavities, eyes – 2%
Peritoneal cavity, CNS, eyes – 2%
Pleural cavity – 1%

The blood-to-brain and blood-to-eye barriers

Background- The eye and central nervous system (CNS) are protected from harmful substances/agents by blood-to-eye and blood-to-brain barriers. These barriers have great evolutionary significance because they protect both brain and ocular functions from the effects of systemic toxins and infectious agents. Such barriers evolved over millions of years by positive selection for the fittest. The blood-to-brain barrier in cats will exclude around 80% of most drugs, while the blood-to-eye barrier excludes about 70%. Therefore, if a given dose of drug such as GS-441524 achieves an effective blood (plasma) level of 10 µM, the levels in the brain (cerebrospinal fluid) will be only 2 µM and the level in the eye (aqueous humor) only 3 µM. There are several other aspects of these two blood barriers that need to be considered. First, their efficiency at excluding unwanted substances and agents varies between individuals. Second, the efficiency of this barrier will decrease in inflamed tissues and increase as inflammation subsides. This is good in the early stages of disease but bad for treatment in the final stages when the inflammation is gone and only the virus is left. Thirdly, there is no simple, safe, or effective means to decrease these barriers and the only way to increase drug levels in brain or eyes is to increase their levels in blood plasma by giving a higher dosage orally or parenterally.

How these barriers effect the forms of FIP- Paradoxically, the ocular and neurological forms of FIP are also a result of these same barriers, but in this case of neurological and/o ocular FIP, the impediment is to the entry of antibodies and immune lymphocytes. The phenomenon of neurological disease following a common systemic virus infection is well known in humans and animals. The prime example is polio-encephalomyelitis in people and canine distemper in dogs. The polio virus is a common enteric pathogen and usually causes an inapparent or mild intestinal infection. However, in some people the virus also escapes to the brain and spinal cord. People mount a vigorous systemic immune response to the polio virus, which is highly effective in eliminating the virus in parts of the body except for the nervous system, where the blood-to-brain barrier limits is an impediment to immunity. These unfortunate people will develop the classical neurologic form of the infection. A similar phenomenon occurs with canine distemper. The canine distemper virus, which is closely related to the human measles virus, causes an acute respiratory infection in young dogs that manifests 7-14 days after exposure and lasts for a week or two. Most of these dogs will completely recover, but a proportion will develop neurological disease three or more weeks later. This highly fatal secondary form of canine distemper is caused by virus that escaped into the brain and spinal cord during the respiratory phase of infection and is shielded from the host's immune system by the blood-to-brain barrier.

The compartmentalization of disease between CNS and other parts of the body may also explain why blood tests are less likely to be abnormal in cats presenting with primary neurological disease or that have relapsed to these forms either during or after treatment for non-neurological FIP. It appears that inflammation within privileged sites like the CNS are less likely to evoke a systemic inflammatory response and to cause significant changes in hematology, increases in total protein and globulin, and decreases in albumin and A:G ratio.

Preliminary diagnosis of ocular and neurological FIP

Preliminary diagnosis -. Ocular and neurological disease is much less common in cats with wet than dry FIP (Tables 1, 2). They also occur in primary and secondary forms. Primary disease accounts for about one-third of dry FIP cases (Table 2) and lesions outside of the eyes and central nervous system (CNS) are either not present or not readily discernible. Secondary neurological and ocular forms of FIP have become much more common as a result of antiviral drug treatment and occur either during the course of initial treatment for the common extra-ocular/CNS forms, or in the form of a relapse during the 12 week post-treatment observation period.

The initial suspicion of neurological and/or ocular FIP is based on the age, origin and presenting clinical signs. FIP occurs mainly in cats under 7 years of age, three-fourths under 3 years and with the highest incidence between 16 weeks and 1-1/2 years. Common presenting signs with both ocular and neurological FIP were retarded growth in kittens and adolescent cats, weight loss in adults and vague signs of ill-health often associated with fever.

The diagnosis of FIP, especially the dry form, is assumed to be difficult. However, a preliminary diagnosis is relatively easy to make given the stereotypic signalment, clinical histories, and physical findings and the rarity of confusing diseases in the highest FIP risk group. The neurological and/or ocular forms of FIP can be confused with feline systemic toxoplasmosis, which is why so many cats with these forms of FIP are tested for toxoplasmosis and treated with Clindamycin. However, systemic toxoplasmosis is an exceedingly rare disease of cats, especially when compared to FIP. FIP can be easily differentiated by a cat’s origin (cattery, foster/rescue, shelter), signalment (age, gender,

breed), and basic blood test results. Deep fungal infections (coccidioidomycosis, blastomycosis, histoplasmosis) can cause ocular, and sometimes neurological signs, similar FIP but are still uncommon even in their endemic regions. Lymphoma may also be a differential diagnosis for dry FIP, but this disease is usually sporadic and in older cats. Several congenital disorders may also present with progressive neurological signs but these are mainly in younger cats and not associated with the inflammatory manifestations of infectious diseases such as FIP, toxoplasmosis, or the deep mycoses.

Ocular FIP signs- Ocular disease occurs as a sole or primary presenting sign in about one-third of cats with dry FIP and in association with extra-ocular lesions in two thirds of cases (Table 2). Ocular disease is an uncommon manifestation in cats presenting initially with wet FIP (Table 1). The initial clinical manifestation is unilateral or bilateral anterior uveitis manifested by change in iris color, cloudiness, and flocculant debris in the anterior chamber, keratic precipitates on the back side of the cornea, and anisocoria. Retinitis is an accompanying feature in a proportion of cats and manifested by focal tapetal hyporeflectivity associated with local inflammation, and microhemorhage of retinal vessels. Less than one-third of cats with ocular FIP will also manifest vague or definite neurological signs (Table 2). Glaucoma, unilateral or bilateral, and panopthalmlitis occur in some cases and may result in enucleation.

Neurological FIP signs- The same prodromal signs associated with FIP occur in cats that manifest neurological disease, but include vague signs of dementia, aggressive behavior, compulsive licking at inanimate objects and other cats, reluctance to jump, spontaneous muscle twitching, abnormal swallowing motions, and occasionally seizures. Later signs include posterior ataxia, physical and auditory hyperesthesia, hyperreflexia, and cerebellar-vestibular signs (crossed-extensor reflex, loss of conscious proprioception), seizures, and increasing incoordination and dementia. Signs of spinal involvement often include fecal and/or urinary incontinence, paralysis of tail and hindlegs, pain over lower back. Catastrophic decerebrate signs have also been associated with sudden and severe herniation of the brain into the spinal cord.

Confirmatory tests for ocular and neurological FIP

Background- A definitive diagnosis of FIP is by identifying the presence of viral antigen or RNA within macrophages within typical effusions or lesions by PCR or immunohistochemistry (IHC). A definitive diagnosis can be a difficult and expensive process in many cats and PCR/IHC may be falsely negative in up to 30% of specimens. However, it is not necessary in most cases to meet this level of proof. A strong collection of historical, physical, and less direct laboratory abnormalities can suffice to establish a diagnosis.

Laboratory signs -A diagnosis of ocular and neurological FIP can usually be made with linking characteristic changes in cerebrospinal fluid (CSF) and aqueous humor (high protein, high cells, neutrophils, lymphocytes, macrophages), with suggestive abnormalities in history, physical exam, CBC, serum chemistry panel, or MRI. Total protein concentration is often increased (mean, 9.4 g/L; median, 3.6 g/L; range, 0.85–28.8 g/L) as is the total nucleated cell count (mean, 196/μL; median, 171/μL; range, 15–479/μL). Neutrophils are the dominant inflammatory cell in most cats, while lymphocytes and a mixture of neutrophils and lymphocytes are observed in a smaller proportion. 5

MRI is a useful tool for diagnosis of neurologic FIP, particularly in combination common signalment/history, typical clinical signs, and CSF analysis. Three distinct clinical syndromes have been identified MRI findings were described in 24 cats with necropsy confirmed neurological FIP (Rissi DR, JVDI, 2018,30:392–399): 1) T3-L3 myelopathy, 2) central vestibular syndrome, and 3) multifocal CNS disease. MRI abnormalities including meningeal contrast enhancement, ependymal contrast enhancement, ventriculomegaly, syringomyelia, and foramen magnum herniation were detected in all cases. 15 cases and consisted of hydrocephalus (10 cases), cerebellar herniation through the foramen magnum (6 cases), cerebral swelling with flattening of gyri (2 cases), and accumulation of fibrin within ventricles (2 cases) or leptomeninges (1 case). Histologically, 3 main distinct distributions of neuropathologic changes were observed, namely periventricular encephalitis (12 cases), rhombencephalitis (8 cases), and diffuse leptomeningitis with superficial encephalitis (6 cases).

In one study, the most useful antemortem indicator of neurologic FIP was a positive IgG anti-coronavirus antibody titer in the CSF. Cats with CSF antibody titers of 1:640 or greater were found only in cats with FIP and were always positive by RT-PCR. Initial studies indicated that CSF antibody was produced, at least in part, within the CNS. However, antibody was detected only in cats with serum titers of 1:4,096 to 1:16,384 in another study and researchers concluded that CSF antibodies were passively acquired. In another attempt to measure local CNS antibody production in cats with FIP, an albumin quotient and IgG index were measured to determine whether proteins in the CSF were of blood or local origin. Neither the albumin quotient nor IgG index identified a pattern consistent with intrathecal IgG synthesis in cats with the CNS form of FIP. In conclusion, it seems that coronavirus antibodies enter the CSF at high levels when they are also at high levels in the serum. Indeed, serum coronavirus antibody titers by IFA in cats with ocular and neurological FIP tend to be among the highest for any form of FIP.

PCR, when done on CSF and aqueous humor with higher protein and cell counts, is highly sensitive and specific for ocular and neurological FIP. It is recommended, however, that only the PCR test targeting the FCoV 7b gene be used and not the less sensitive PCR for FIPV specific mutations in the S gene. The FCoV 7b gene is often used for PCR because it is the most abundant viral transcript and most likely to be detected. The FCoV M gene has also been targeted in some PCRs, as it is highly conserved across all isolates, but transcripts are less abundant than for the 7b gene. Immunohistochemistry on cells collected from spinal fluid is equally sensitive and specific to PCR on samples with higher protein and cell counts. Antigen is localized specifically to macrophage appearing cells.

The rapid response of FIP to GS-441524 is being used more frequently as a confirmatory test. However, this should only be used when other evidence is strong, but no simpler or less expensive means are available to aid the diagnosis.

Treatment of ocular and neurological forms of FIP

Viral specific inhibitors- Inhibition of viral genes regulating specific stages of infection and replication have become the mainstays of treatment for chronic RNA virus infections of humans such as HIV and hepatitis C virus. At this time, two classes of antiviral drugs have proven effective against FIP. The first class consist of inhibitors of RNA synthesis and include the nucleoside analogues GS-441524 (the active ingredient of Remdesvir) and EIDD-2801 (Molnupiravir). The second class of drugs consist of viral protease inhibitors such as GC376 (a prodrug of GC373) and

Nirmatrelvir (prodrug of a nitrile modification of GC373). Protease inhibitors are much less efficient at crossing the blood to brain or blood to eye barriers than the nucleoside analogs and are the not advised for treatment of neurological or ocular FIP.

GS-441524 treatment- GS-441524 has become the drug of choice for treatment of cats with all forms of FIP, and injectable (SC) and oral forms are available from the unapproved Chinese market. However, oral absorption is less than 50% efficient compared to injection, thus requiring a dosage of oral GS-441524 twice as high. Suppliers of oral GS-441524 hardly ever divulge the actual concentration of GS-441524 in one of their tablets or capsules, but rather label them as what they believe to be an equivalent injectable dose. The efficiency of absorption of oral GS also has an upward limit, making it more difficult to achieve the higher blood levels needed to get sufficient levels of drug into the brain and eyes. Therefore, if poor results are obtained in cats with ocular and neurological disease even at high equivalent dosages of oral GS-441524, injectable GS-441524 should be substituted before contemplating a change to a drug like molnupiravir.

The starting dosage for cats with wet or dry FIP and no ocular or neurological disease signs is 4-6 mg/kg, subcutaneously (SC), daily for 12 weeks, with the younger and wet cases tending to go toward the lower end and the dry cases toward the higher end. Cats with ocular lesions and no neurological signs start at 8 mg/kg daily for 12 weeks. Cats with neurological signs start at 10 mg/kg, daily for 12 weeks. If cats with wet or dry FIP at the beginning develop ocular or neurological signs they go to the appropriate ocular or neurological dosage. The GS dosage be adjusted weekly to account for weight gains. Weight gain can be tremendous in many of these cats, either because they are so wasted at the start or that they their growth has been stunted. Failure to gain a good amount of weight during treatment is considered an unfavorable sign. The starting dosage is not changed unless there is significant reasons to do so, such as failure to grow or for abnormal blood test values to improve, poor activity levels, poor improvement in coat and flesh, or change in disease form to include ocular or neurological signs. If there are good reasons to increase the dosage, it should always be from +2 to +5 mg/kg daily depending on degree of remaining abnormalities and for a minimum of 4 weeks. If 4 weeks extends the 12-week treatment time, the treatment time is extended to accommodate. One should expect a positive response to any increase in the dosage and a failure to see improvement indicates that the dosage is still not high enough, drug resistance is occurring, the brand of GS is not what it should be, the cat does not have FIP, or there are other diseases confusing the treatment.

One of the most difficult decisions is to determine when to stop treatment. Although some cats, often younger ones with wet FIP, can be cured in as little as 8 weeks and possibly sooner, the usual treatment time is 12 weeks. Some cats may even require dosage adjustments and even longer treatment periods. Critical blood values such as hematocrit, total protein, albumin and globulin levels, and absolute lymphocyte counts usually normalize in cats destined for cures at 8-10 weeks, at which time there is often an unanticipated increase in activity levels. It is believed, but not proven, that 8-10 weeks in when the cat's own immunity to the infection occurs. This is a situation that occurs with hepatitis C treatment in people, which is also a chronic RNA virus infection that often requires up to 12 weeks or more of antiviral drug treatment.

Cats with ocular disease, and no neurological involvement, have a rapid response to GS and full recovery of vision with minimal or no residual damage in as little as two weeks is expected. Cats that present with neurological abnormalities, develop neurological disease during treatment for other forms of FIP, or manifest neurological signs during the 12-week post-treatment observation period, also rapidly improve but the dosage is much higher, the treatment period often longer, and the cure

rate somewhat lower. Treatment failures in cats with neurological FIP are due either to inadequate treatment or the development of drug resistance.

Unfortunately, there is no simple blood test that will determine when a cure has occurred in cats with neurological involvement. Many cats with neurological FIP have minimal blood abnormalities, especially those with primary neurological FIP, and abnormalities are often absent by the end of treatment even when residual sites of inflammation still exist in the brain or spinal cord. Furthermore, a proportion of cats that are cured of their infection will have minor to moderately severe neurological deficits that are residual effects of earlier disease. These facts make it difficult to use either blood test results or residual neurological deficits as indicators of a cure or inadequate treatment. Although a thorough ocular exam can visibly clear an eye of active disease signs, only an MRI, preferably with cerebrospinal fluid analysis can determine the true disease status in brain and spinal cord. These procedures are expensive, not available to everyone, and may not provide definite evidence that the infection in the CNS has been eliminated.

Relapses usually involve infections that have escaped to the central nervous system (brain, spine, eyes) during treatment for wet or dry FIP not accompanied by neurological or ocular signs. The dosage of GS-441524 used to treat these forms of FIP are often insufficient to effectively overcome the blood-to-brain or blood-to-eye barriers. The blood-to-brain barrier is even more effective than the blood-to-eye barrier, which explains why eye lesions can be more easily cured than brain and/or spinal infections. Relapses that occur in the post treatment period, and that involve, eyes, brain or spine are usually retreated for at least 8 weeks at a starting daily dosage at least 5 mg/kg higher than the dosage used during the primary treatment (e.g., 10, 12, 15 mg/kg daily). Cats that cannot be cured of infection at dosages of as high as 15 mg/kg daily are likely to have developed varying degrees of resistance to GS-441524. Partial resistance may allow for control of disease signs, but not a cure, while total resistance is manifested by varying severity of clinical signs in the face of treatment.

Various modifications in the treatment have been created by different FIP treatment groups. Some groups will treat with an exceedingly high dosage of GS from the onset rather than escalating the dosage when indicated, capping off or extending the treatment with a high dosage during the last two weeks at a higher dosage on the hope that it may reduce the chances of relapse. Systemic prednisolone is often prescribed in addition to GS but should only be used temporarily to stabilize severe presenting disease. Systemic steroids will reduce inflammation but tend to mask the beneficial effects of GS and if used long enough, and at higher dosage, possibly interfere with the development of FIP immunity. It is believed that the re-establishment of FIP immunity is an important component of successful GS treatment. Therefore, some people advocate the use of interferon omega or non-specific immunostimulants to further stimulate the immune system, and some employ even different modifications. There is no evidence that capping the treatment with an extra high dosage will improve cure rates. Likewise, interferon omega and non-specific immunostimulants have no proven beneficial effects on FIP when given as sole treatments or as supplements to GS. The practice of adding another antiviral drug, GC376 viral protease inhibitor, to GS treatment in cats developing GS resistance is also emerging and needs research. Finally, it is common for owners, treatment groups, and veterinarians to add in many supplements, tonics, or injections (e.g., B12) to bolster blood levels or prevent liver or kidney disease. Such supplements are rarely necessary in cats with pure FIP disease.

Molnupiravir (EIDD-2801)- Molnupiravir closely resembles GS-441524 but is a cytidine rather than adenine nucleoside analog. It is being widely used as an oral treatment for early cases of COVID-19 in

humans but has been increasingly used to treat cats with FIP over the last 1-2 years. Because of toxicities observed in cats at higher dosages, and still unknown chronic side effects, it is most often recommended for cats that have developed resistance to GS-441524 during primary treatment or relapsed with neurological/ocular signs after a high dosage treatment with GS-441524. The fact that molnupiravir has a different resistance profile than GS-441524 is fortunate.

A safe and effective dosage for molnupiravir in cats with FIP has not been established by well controlled and monitored field trials such as those conducted for GC376 and GS-441524. However, an estimated starting dosage for molnupiravir in cats with FIP was obtained from published in-vitro cell culture studies of EIDD-1931 and EIDD-2801 and other laboratory and experimental animal studies. Molnupiravir (EIDD-2801) has an EC50 of 0.4 uM/µl against FIPV in cell culture, while the EC50 of GS-441524 is around 1.0 uM/µl. Molnupiravir starts to show cellular cytotoxicity at concentrations of 400 µM or greater, while GS-441524 is without toxicity at 400 µM. They both have similar oral absorptions of around 40-50%. The current recommended starting dosage for molnupiravir in neurological and ocular FIP is 8-10 mg/kg, orally, every 12 hours for 84 days. This may need to be raised to a maximum of 15 mg/kg orally every 12 hours depending on response to treatment. Toxicities to molnupiravir as indicated by changes in complete blood counts are likely to occur at higher dosages.

Causes of treatment failure

Improper dosage adjustments- It is important to start the treatment at the appropriate dosage and closely monitor it with frequent checks of temperature, weight, and outward signs of improving health. A CBC and serum chemistry panel that includes basic protein values (total protein, albumin, globulin (TP - Albumin = globulin), and A:G should be done at least monthly. Instructions for adjusting dosage is included in the section on GS-441524 treatment. Expensive serum protein electrophoresis does not add much more useful information.

Poor quality GS-441524- GS-441524 is not approved for marketing in any country and the source is a small number of Chinese chemical companies who sell it to distributors as a pure powder. Sellers dilute it for injection or prepare oral forms for sale under their brand names. There is no independent mechanism to assure the quality of the final product that is being sold to cat owners. Nevertheless, major providers of diluted forms for injection and/or oral preparations have been surprisingly honest and some even offer limited guarantees if treatment with one of their products fails to cure the disease. However, batches sold by some providers have appeared to be adulterated and some are not at the stated concentration. This can also vary between batches, probably because of problems with sellers having intermittent problems with their supply of raw GS and difficulties in meeting owner's needs. Various FIP Warrior groups have good information on the most reliable brands.

Drug resistance- Resistance to GS-441524 can exist at the time of diagnosis, but this is uncommon. Rather, it tends to occur during treatment and is often partial at first and necessitates a higher dosage to accommodate for it. It can become total in some cats. Resistance is the biggest problem in cats with neurological disease, especially those that present with neurological disease or develop brain infections during treatment or within a few days or weeks after treatment has been completed. Many cats with partial drug resistance can be "treated" of their disease signs but will relapse as soon as the treatment is stopped, like HIV therapy. There have been cats successfully treated, partially or completely, for FIP disease signs for over a year with no cure. Resistance ultimately resistance becomes worse and disease signs worsen, the hardships of treatment on owner and cat becomes untenable, or the owner runs out of money.

GS-441524 treatment prognosis

Accurate data on GS-441524 cure rates are not yet available, but it appears that over 80% of cats with confirmed FIP can be cured. Treatment failures are due to incorrect diagnosis of FIP, inadequate treatment monitoring and dosage adjustment, complicating diseases, poor quality GS, GS resistance, or economic difficulties. The cure rate is somewhat lower in cats with neurological forms of FIP and in aged cats. Aged cats are more apt to have other chronic illnesses that either predispose cats to FIP or complicate overall health.

Cats with neurological FIP may suffer from permanent residual disease signs. This is most true for cats with spinal involvement and urinary and/or fecal incontinence or posterior paralysis. Hydrocephalus and syringomyelia are common complications of neurological FIP and they often persist to some degree even after the infection has been cured. Fortunately, most cats with neurological FIP will recover normal or near-normal function despite persistent evidence of hydrocephalus and syringomyelia.