

[Biogal Laboratories](#) and [www.catvirus.com](http://www.catvirus.com) present:

# Feline Coronavirus and Feline Infectious Peritonitis Diagnosis and Prevention

Diane D. Addie

PhD, BVMS, MRCVS

May 2020

## PART 1: FCoV AND FIP DIAGNOSIS

Feline infectious peritonitis (FIP) is caused by infection with feline coronavirus (FCoV), which is an RNA virus. There are two types of FCoV: Type I is purely feline, Type II FCoV strains arise by recombination with canine coronavirus (CCoV).<sup>Herrewegh et al 1998; Terada et al, 2014</sup>

**KEY MESSAGE: FOR FIP TO DEVELOP, FCoV INFECTION MUST OCCUR: IF YOU CAN PREVENT FCoV INFECTION, YOU PREVENT FIP.**

**FCoV transmission** is faecal-oral, primarily through sharing litter trays, and from cat litter fomites. Virus transmission is mainly indirect, not direct.

**Videos for further information on FCoV transmission (watching these films counts towards your continuing education: these films are suitable for practice waiting room monitors)**

English: <http://www.youtube.com/watch?v=rkqUjeQNEQs>

French: <http://www.youtube.com/watch?v=JrnopBFAr8A&feature=plcp>

**Virus shedding:** cats shed virus in their faeces from about 2-3 days post-infection.<sup>Kipar et al, 2006</sup> Type I FCoV shedding persists for weeks to months.<sup>Addie et al, 2001 & 2003</sup> The duration of Type II FCoV shedding is unknown, but based on experimental infections, is likely about 2 weeks.

Around 13% of cats infected with Type I FCoV become persistently infected, carrier cats.<sup>Addie & Jarrett, 2001</sup>

FCoV shedding is detected by reverse-transcriptase polymerase chain reaction (RT-PCR) testing of a faecal sample.

[The majority of cats exposed to SARS-CoV2 infected people do not get infected but in those who do, virus shedding begins 2-5 days post-exposure and the duration of SARS-CoV2 shedding by cats is 4-5 days.<sup>Halfmann et al, 2020</sup> The median duration of SARS-CoV2 shedding by humans is 18 days in respiratory secretions, 22 days in faeces.<sup>Zheng et al, 2020</sup>]

**Seroconversion** to FCoV occurs at 18-21 days post-infection.

**Initial FCoV infection of kittens can cause diarrhoea, stunting or not be detected.** In the majority of cats FCoV infection is not detected by their guardians although the trained eye will spot uneven litter sizes, stunting, or a history of diarrhoea. FCoV-associated diarrhoea ranges from minor and transient, to major, life-threatening and even fatal, <sup>Kipar *et al*, 1998</sup> especially where there are co-infections with viruses, protozoa or pathogenic bacteria.

**Key messages:**

**Most cats who become infected with FCoV do NOT develop FIP.**

**Most people who become infected with SARS-CoV2 do NOT develop severe acute respiratory syndrome.**

**FIP:** up to 10% of FCoV-infected cats develop FIP—the figure is highest when kittens, with undeveloped immune systems, become infected: 70% of FIP is in purebred cats, probably because they become infected as young kittens when maternally derived antibody wanes between 5-7 weeks.

Q: Why does FIP mostly affect young kittens but SARS-CoV2 mainly causes serious symptoms in the over-eighties with co-morbidities?

A: The answer is to do with both groups having poor immune systems relative to healthy adults, and both tending to be in densely populated spaces where they are exposed to high virus doses and stress.

**SARS-CoV2** mortality varies considerably: as with all seasonal colds and flu, it is more severe in winter months. As with influenza, the majority of deaths occurred in the very old and those with severe pre-existing conditions. At time of writing (May 2020), 98% of infections are classified as mild, and only 2% as serious. <https://www.worldometers.info/coronavirus/>

Countries where populations take hydroxychloroquine to prevent malaria had significantly fewer cases of SARS-CoV2 than northern countries; <sup>Ahmed 2020</sup> hydroxychloroquine inhibits SARS-CoV2. Hydroxychloroquine and azithromycin, if given early in SARS-CoV2 infection, prevents progression to pneumonia. <sup>Million *et al*, 2020</sup>

[Could hydroxychloroquine be used in cats with FIP? I don't know: chloroquine causes elevated ALT in cats and only extended survival of FIP cats briefly. <sup>Takano *et al*, 2013</sup>

Hydroxychloroquine is safer than chloroquine: Dr Takano in Japan is evaluating its use along with feline interferon omega to treat FIP, and in Australia Prof. Norris' group is assessing mefloquine as a possible treatment. Watch the FIP treatment page of my website, [www.catvirus.com](http://www.catvirus.com), or go on my email list, for updates.]

**SARS-CoV2 can infect cats:** Idexx conducted a study of 4,000 pets (dogs, cats, horses) and all were negative by RT-PCR. However, some cats and dogs of human COVID-19 patients have tested positive: they have mostly been asymptomatic but some cats have had respiratory signs. [https://www.avma.org/resources-tools/animal-health-and-welfare/covid-19/depth-summary-reports-naturally-acquired-sars-cov-2-infections-domestic-animals-and-farmed-or?fbclid=IwAR3FHl3wpZuy7aT0THY1cVUf\\_SsivT5iMZlitunGsd73-PX82hNBdi94-A](https://www.avma.org/resources-tools/animal-health-and-welfare/covid-19/depth-summary-reports-naturally-acquired-sars-cov-2-infections-domestic-animals-and-farmed-or?fbclid=IwAR3FHl3wpZuy7aT0THY1cVUf_SsivT5iMZlitunGsd73-PX82hNBdi94-A)

## FIP DIAGNOSIS

In many viral infections, clinical signs are a result of the virus directly damaging the target cell. However, in FIP, FCoV takes over the cell which controls the immune response: the monocyte / macrophage and an abnormal pro-inflammatory immune response is the cause

of the disease. Similarly, in SARS-CoV2 infection mortality is due to the cytokine storm, rather than virus-induced cytopathic effect, and in that respect COVID-19 resembles FIP.

Clinical signs of FIP depend on the location and severity of vascular damage and peri-vascular pyogranulomata which is why FIP can present in so many different ways.

Cartoon video on FIP pathogenesis

<http://www.youtube.com/watch?v=6RyI2LI9R9Q&feature=related>

Due to time constraints in this webinar, diagnosis of FIP will necessarily be extremely brief and focussed on essential messages. However, on my YouTube channel, there is a series called “Does X Have FIP?” For example, “[Does Pancho Have FIP?](#)” “[Does Tommy Have FIP.](#)” These videos go into FIP diagnosis in considerable detail and count for continuing education time.

In my online FIP referral practice, people usually subscribe in order to discuss FIP treatment—I always insist that first we establish the diagnosis: 80% of cats from first opinion practices and 40% of cats from referral practices turn out to have some other condition, they do not have FIP.

*“A wrong diagnosis can be far more devastating than no diagnosis.”*

Prof. Mike Willard

Such erroneous FIP diagnoses have included toxoplasmosis, tumour, bacterial peritonitis or pleurisy, nutritional problems. One cat simply required a dental! These mis-diagnoses were sometimes made for the flimsiest of reasons: raised globulins (globulins rise in ALL infections!) or the presence of a FCoV antibody titre.

**Key message:**

**A positive FCoV antibody test does NOT equate to a diagnosis of FIP: cats sick with non-FIP conditions can be co-incidentally antibody positive for FCoV.**

**FIP confirmation in a nutshell:**

**Effusive FIP:** positive FCoV RT-PCR test on effusion

**Non-effusive FIP:** positive FCoV RT-PCR test on a mesenteric lymph node ultrasound guided fine needle aspirate

**Key message:**

**Never do a FCoV RT-PCR test on blood—even if your veterinary laboratory requests a blood sample for this test.\* Most cats with FIP will have a negative FCoV RT-PCR test on blood and 5% of healthy, or non-FIP sick cats, will be positive.**

**\*Consider changing your laboratory if they know so little about FIP as to ask for blood for FCoV RT-PCR testing.**

Although immunohistochemistry is considered the gold standard for FIP diagnosis, and is certainly what to do for a cat post mortem, it requires too invasive an intervention in the

living cat, and in practice, most clinicians accept that a positive FCoV RT-PCR test on an effusion, or—in non-effusive cases—mesenteric lymph node (MLN) fine needle aspirate (FNA), or aqueous humour, to be sufficiently diagnostic of FIP <sup>Dunbar et al, 2019</sup> to begin FIP treatment. A positive FCoV RT-PCR result on an effusion or MLN FNA is 96% specific for FIP: in my view that is sufficient evidence to begin specific FIP treatment, provided the cat ticks most of the boxes on the FIP diagnostic algorithm (free download from catvirus.com).

However, FCoV RT-PCR testing requires a wait of about one week, and you need some answers more quickly when faced with a sick cat.

**A negative FCoV antibody test can quickly and inexpensively rule out a diagnosis of FIP but only IF THE TEST IS SENSITIVE ENOUGH (see below).**

### Lab tests 101

**SENSITIVITY is the ability of the test to detect SMALL quantities of an antibody or antigen**

**SPECIFICITY is the ability of a test to detect the antibody or antigen ACCURATELY**

If you have problems remembering which way round this is, just think about people with allergies who are sensitive to trace amounts of their allergen, but may require tests to establish to what, specifically, they are allergic.

### Which FCoV antibody test is the best?

I conducted an independent trial of available FCoV antibody tests, including in-house tests and laboratories. <sup>Addie et al, 2015</sup> Companies who donated tests were given the choice of whether or not their tests should be included in the publication (i.e. the table of results below does not include results of companies who requested their results to be withheld, or who chose not to participate, e.g. Antech, Idexx).

	IFA FCoV		IFA TGEV		ELISA	Rapid Immunomigration / lateral flow		
	Biobest	VDS	EVNA	Zurich	FCoV Immuno-comb	Speed F-Corona	FASTest FIP	Anigen Rapid FCoV
<b>Sensitivity %</b>	96.1	100	96.2	100	100	92.4	84.6	64.1
<b>Specificity %</b>	100	100	97.5	83.3	100	100	100	100

Biobest Laboratories Ltd,, Penicuik, Scotland.

VDS: Veterinary Diagnostic Services, University of Glasgow Veterinary School, Scotland.

EVNA : UMR 1161-Virologie-INRA-ENVA-ANSES, Maisons-Alfort, France.

Zurich: Clinical Laboratory, Vetsuisse Faculty, University of Zurich, Switzerland

FCoV Immucombe, Biogal, Israel.

Speed F-Corona, Virbac, Nice, France.

FASTest FIP, MegaCor Diagnostik, Hoerbranz, Austria.

Anigen Rapid FCoV Ab Test Kit, Bionote Inc, Seoul, Korea.

Of all the in-house tests, the FCoV Immunocomb (Biogal) fared best in that study.<sup>Addie et al, 2015</sup> I like the Immunocomb because it doesn't require sophisticated laboratory equipment such as a plate ELISA reader; it only requires a fridge (to store the kit in) and the CombCam for reading the combs, which can be purchased from Biogal. I highly recommend you use the Biogal reader rather than trying to eyeball the results: we found poorer sensitivity and specificity in a previous study we conducted on the FCoV Immunocomb,<sup>Addie et al, 2004</sup> probably because we relied on human observation of the result grey spots.

The less good sensitivity results of the in-house lateral flow / rapid immunomigration tests in our study could have been partly due to the fact that mostly effusions were used, rather than plasma or serum: virus in the effusion may have bound available antibody rendering it unable to bind with viral antigen in the test kits.

**Recommendation: perform in-house FCoV antibody tests on plasma or serum, rather than on effusion or whole blood.**

### IN USING THE FIP DIAGNOSIS ALGORITHM, DON'T BE TEMPTED TO SKIP THE CAT'S HISTORY STAGE

**Key message: for FIP to develop, a cat must become infected with FCoV.**

I have diagnostic flowcharts for effusive and non-effusive FIP, as well as for FCoV diarrhoea and for using FCoV antibody and RT-PCR tests on the [www.catvirus.com](http://www.catvirus.com) website on the [Downloads](#) page. I know it's time consuming to take a thorough history, so I have made printable question sheets that your clients can fill in in the waiting room: that is also available to download from the website. In the webinar, I gave an example of this Step 1 of the algorithm saving the life of a cat who had been diagnosed as having an FIP pyogranuloma in the brain: the cat was a teenage, ex-street cat living in a household with no other cats—he had had no opportunity to become infected with FCoV and his guardians realised that from Step 1 of the algorithm and questioned the diagnosis. The diagnosis (made in a UK vet school referral clinic) was wrong; the FCoV antibody titre had been a false positive. Following correct diagnosis, the cat was put onto chemotherapy, instead of being subject to painful GS-441524 injections for 12 weeks.

**Key message: for FIP to develop, a cat must have had the opportunity to become infected with FCoV.**

Most cats who develop FIP do so within the first 18 months post-infection, by 36 months post-infection, there is only a 5% chance of FIP developing.<sup>Addie et al, 1995</sup> Therefore, it is not only important to establish that a cat could have become infected, but also if the opportunity was within the previous 3 years.

**[5 minute break for questions: note, all questions will be answered in a document uploaded to the Biogal website.]**

## PART 2: PREVENTING FIP

**Key message: if you prevent FCoV infection, you prevent FIP.**

### FULLER’S EARTH BASED CAT LITTERS CAN REDUCE BUT NOT ABROGATE FCoV TRANSMISSION

We found that bentonite-based (Fuller’s earth) cat litters abrogated FCoV transmission *in vitro* (i.e. in cell culture) but studies in two multicat households with endemic FCoV showed that virus transmission was reduced, but not abrogated. <sup>Addie et al, 2020</sup> Dr Elsey’s Cat Attract cat litter performed the best. Lack of tracking is an important quality in minimising FCoV transmission.

**Video on the cat litter study:**  
<https://www.bitchute.com/video/JnxhgvQqo9Xq/>  
<https://youtu.be/eEkOFXh8Xd4>  
 Open source paper:  
<https://journals.sagepub.com/doi/full/10.1177/1098612X19848167>

### A FOUR TO SEVEN DAY COURSE OF MUTIAN PILLS STOPS FCoV SHEDDING

The percentage of cats shedding FCoV at any one time is very low in the general population, but can be very high in multicat environments such as rescue shelters, boarding and breeding catteries.

We heard about cat breeders who were experimenting with anti-virals in an attempt to stop FCoV shedding amongst their cats, sometimes with disastrous consequences for the cat. Following her discovery that Mutian could stop FCoV shedding, Ragdoll breeder, Sheryl Curran, who had a scientific training, approached me for advice about how to eradicate the virus from her cats. For years, Sheryl had been following my advice about keeping cats in small groups, testing them annually for FCoV antibodies, and she had managed to reduce the number of FCoV shedders in her household, but she was unfortunate in having quite a number of FCoV carrier cats. About 13% of cats who get infected with FCoV-infected become chronic persistently-infected virus shedders. <sup>Addie & Jarrett, 2001</sup> I requested that Sheryl keep note of the drug dosages she was using, and take faecal samples from her cats daily which we tested by quantitative real-time reverse-transcriptase PCR (RT-qPCR), which detects FCoV RNA, to monitor virus shedding. In our study, 2mg/kg of Mutian stopped 8 of 10 cats shedding FCoV; therefore the dose was increased to 4mg/kg. <sup>Addie et al, 2020</sup> (See table below for quantity of the active anti-viral, Mutian Xraphconn, in each capsule.)

**Dose of Mutian to stop FCoV shedding:** 4mg/kg for 4-7 days. For an average-sized cat of 4 to 5 kg, two Mutian 200 capsules (Nantong Biotechnology, China) given for 4-7 days stops FCoV shedding. In our study, 4 of 29 cats required a repeated course of Mutian to ensure clearance of the virus, <sup>Addie et al, 2020</sup> therefore although a four day course of Mutian stopped most cats shedding virus, it could be prudent to use it for 5-7 days.

	<b>Actual Mutian Xraphconn content</b>	<b>Dose for stopping FCoV shedding or treating effusive FIP*</b>
Mutian 200	10mg	1 capsule/2 kg sid
Mutian 100	5mg	1 capsule/1 kg sid
Mutian 50	2.5mg	1 capsule/0.5 kg sid

\* For treating non-effusive FIP with intra-ocular presentation use 1.5 times the normal dose, and for neurological FIP use twice this dose, until haematological and biochemical values return to normal. Monitor biochemistry (especially ALT, SDMA) and urine SG in cats on long term high dose treatment.

## Key messages

- **it is essential to do a post-treatment faecal RT-PCR test** to ensure that all of the cats are fully negative; otherwise a single missed cat will re-infect the other cats: FCoV is extremely contagious.
- **make sure faecal samples DO NOT have cat litter on them** or that could inhibit the PCR test leading to a **false negative result**.
- **use a laboratory that reports virus quantity and CONTROLS FOR FAECAL PCR INHIBITORS.**<sup>1</sup>

Remember that Mutian is not legal in all countries and consult your professional body for advice about its use. In the UK, the RCVS advised me not to buy Mutian myself, but that monitoring and advising on cats being treated with it would not be problematic with our governing body. I've been advised that the situation in France is similar.

## ADDRESSING CONCERNS THAT USING ANTI-VIRALS TO STOP FCoV SHEDDING COULD LEAD TO VIRAL DRUG RESISTANCE

[This section is not part of the webinar unless a question arises: it is included for your information only.]

First: using anti-virals at too low a dose, or too short a duration could theoretically lead to viral resistance to the drug; therefore the purpose of our observational study was to define a drug dose and duration of one popularly used anti-coronavirus drug so that proper guidelines would exist to discourage experimental, improper, use of the drug. The fact is that cat breeders all over the world were already experimenting themselves with various anti-virals Pedersen *et al*, 2018 & 2019 online since the publication of the Pedersen anti-viral papers, which were open access.

Secondly, drug-resistant mutations are more likely to occur where there is a higher virus load and/or where the anti-viral has to be used for a long time, and cats who have FIP have much higher virus loads and require many weeks of treatment, compared with cats who basically mainly have FCoV infection of the gastro-intestinal tract. By preventing FIP, we are reducing the amount of anti-viral that is going to be used within the riskiest group for resistant viruses emerging.

Third: treating in-contact cats of cats who have FIP prevents re-infection of the FIP recovered cat and likely prevents at least some of the in-contact cats developing FIP, reducing overall drug use. For the same amount of drug for each cat being treated for FIP for 12 weeks, at least 12 asymptomatic FCoV-infected cats can be treated and prevented from developing FIP.

Fourth: it is erroneous to call a FCoV-infected cat without FIP a “healthy” cat, even in cats without FIP, this virus has adverse effects—we have seen weight gain in cats that we thought were asymptomatic FCoV-infected cats once we got rid of the virus; often their

---

<sup>1</sup> This will likely mean using [Veterinary Diagnostic Services](#) (VDS), Glasgow, Scotland, UK. VDS receive samples from all over the world.

guardians and sometimes even their vets hadn't realised that those cats were seriously underweight.

Fifth: over 90 cats have now received Mutian to stop FCoV shedding and we have not encountered drug resistance.

### **DECREASING FCoV ANTIBODY TITRES CONFIRM RECOVERY FROM FCoV INFECTION OR FIP**

I believe that eliminating FCoV infection, especially in breeding catteries, will prevent a significant amount of FIP development, but one reviewer of our paper pointed out that I had not actually proven that to be the case! They were right. Therefore I am keeping in contact with the cat guardians and if their cats have leftover blood from any samples taken for any reason, I request a FCoV antibody test on the samples. It would not be ethical to request bloods to be taken specifically for this purpose, so at present I do not have enough data on this to prove or disprove my hypothesis. FCoV titres are falling in 3 asymptomatic FCoV-infected cats who were in the same household as a cat with FIP and were treated to prevent his re-infection and 3 other cats in another household are now seronegative for FCoV antibodies. Prevention of re-infection of a FIP-recovered cat is the main reason for people using Mutian to stop FCoV shedding; other reasons include treatment of FCoV-associated diarrhoea, and to prevent infection of kittens in breeding catteries.

For a FCoV antibody titre to persist in a cat, antigenic stimulation needs to be occurring somewhere in the body, therefore when a cat's FCoV antibody titre decreases, it is reasonable to suppose that virus has been cleared from his or her body (unless of course the cat is on some kind of immunosuppressive treatment such as prednisolone, which will artificially cause the FCoV titre to decrease).

One thing is certain, that kittens born into FCoV-free breeding catteries are far less likely to develop FIP than kittens born into catteries with endemic FCoV, and if they go to a home with no other cats, they won't be exposed to FCoV.

Sheryl Curran was the first UK cat breeder to eliminate FCoV from her household using Mutian capsules. She proudly shared photographs of the first litter of FCoV-negative Ragdoll kittens born into her FCoV-free cattery. To reduce her concerns about what could happen if her kittens encounter FCoV in their new homes she obtained a special permit to import the FIP vaccine, Felocell FIP (Zoetis), to try to give them protection in their new homes.

### **THE TRUTH ABOUT THE FIP VACCINE: FELOCELL FIP (ZOETIS)**

There won't be time in the webinar to talk about the vaccine in detail, but I have made a video about it:

For more information on the FIP vaccine, please watch my video: *The truth about the FIP vaccine*: [www.bitchute.com/video/v06NRacWVie8/](http://www.bitchute.com/video/v06NRacWVie8/)

Felocell FIP is an intra-nasal temperature-sensitive vaccine which must be given at at least 16 weeks of age in order to be effective. The second dose should be given 3 weeks later. Unfortunately, by 16 weeks of age, most purebred kittens are already infected, which means that the vaccine is of limited use in the largest demographic of FIP victims: young pedigree cats. It also means that it probably won't work in shelter kittens, although it will protect many adult cats going into shelters.



An independent placebo-controlled study <sup>Fehr et al, 1997</sup> showed that the vaccine was effective in FCoV naïve cats, but if the cat was already viraemic with feline coronavirus, the vaccine was unable to protect the cat, since its mechanism of action is to elicit local immunity in the nares and oropharynx, which is where cats are most likely to first encounter infection.

Now that two UK cat breeders have become FCoV-free, there is interest in vaccinating kittens who are born into these households to protect them from FIP in their new homes.

#### **Warning: an injected SARS-CoV2 vaccine could be dangerous**

Most attempts to develop an FIP vaccine failed because of antibody dependent enhancement leading to greater mortality amongst vaccinated compared with unvaccinated cats subject to the same virus challenge. <sup>Vennema et al, 1990</sup>

The target cell for FCoV (and SARS-CoV2) is the monocyte / macrophage: antibody to the virus can enable the virus to enter the target cell, the monocyte, via the Fc receptor, and there is every reason to believe that that could also occur with a SARS-CoV2 vaccine, since it has hampered attempts to develop a vaccine to SARS-CoV1. <sup>Jaume et al, 2012; Liu et al, 2019</sup>

US vaccine manufacturers have lobbied their government to prevent them being sued in the event of vaccine side effects, which has led to a cavalier attitude to vaccine safety. One repeatedly hears Bill Gates calling for a guarantee that vaccine manufacturers not be held financially responsible for side effects induced by the SARS-CoV2 vaccines he wishes to inject into every man, woman and child on the planet. <sup>Corbett, 2020</sup> Such an experiment on the human race is dangerous and unnecessary.

This is one area where I would hope that medics would learn from veterinarians. Personally, I would not accept any injected coronavirus vaccine, although I might consider an intra-nasal one when I reach my dotage (but not before!).

### **FCoV ANTIBODY TESTING TO PREVENT FCoV INFECTION AND FIP**

A FCoV antibody titre of zero shows that the cat is not shedding virus (unless in the 3 week post-infection period prior to seroconversion). FCoV antibody testing is quicker and less expensive than RT-qPCR testing of faeces, but **to be used as an effective screen, sensitivity of the test is essential.**

Please watch a cartoon video of using FCoV antibody testing to protect one's cats: <https://youtu.be/nDy1VPiA9z8>

Also see my blog on this subject: <https://www.biogal.com/blog/how-to-avoid-fip-in-your-cat/>

Many cat breeders test annually for FeLV and FIV infection, and it would be simple for them to add FCoV antibody testing to their annual screen. FCoV-free cat breeders can remain FCoV-free by insisting that cats or kittens they intend to purchase prove that they are FCoV antibody negative. Veterinary surgeons on the Falkland (Malvinas) Islands found that the cats there were FCoV-free and insisted that imported cats be FCoV antibody negative. <sup>Addie et al, 2012</sup>

For such FCoV/FIP prevention strategies to be effective it is essential for the antibody test to be sensitive, because a false negative result could allow a FCoV shedding cat into the household or country, and for the virus to spread throughout the population.

\*\*\*\*\*

\*\*\*\*\*

### WOULD YOU LIKE TO HELP A FCoV/FIP STUDY?

We are interested in the vaccination histories of cats with and without FIP: if you would be willing to share your practice results please contact our veterinary student, David Lee, on: davidleeUGA@gmail.com

We are interested in all kinds of vaccines, not just Felocell FIP. If you have experience of using Felocell FIP, we would also be keen to hear about that.

\*\*\*\*\*

### RNA VIRUS 101: REFRESHER ON MUTATION, DELETION, INSERTION, RECOMBINATION

[This section was omitted from the webinar due to time constraints.]

RNA viruses tend to vary genetically more than do DNA viruses because the latter have a proof-reading mechanism.

**Mutation:** a change in one or many nucleotides, which may or may not lead to a change in the amino acid coded for.

**Deletion:** loss of a section of RNA or DNA. Most deletions are probably fatal (to the virus), but not always—in systemic FCoV infection, part of the 3c gene can be discarded, leading to loss of the virus's ability to replicate in the gut. <sup>Chang et al, 2010</sup> This deletion explains why around 25% of cats with FIP no longer shed virus in their faeces. <sup>Addie et al, 1996</sup>

**Insertion:** this is when a viral genome acquires novel genetic material. An example of that having been done intentionally by scientists was published in Nature Medicine, when Menachery et al, 2015 deliberately inserted genetic code into the first SARS-CoV to confer upon it the ability to infect the human angiotensin converting enzyme II (ACE2) receptor. I have been unable to establish whether or not this laboratory-created virus is the virus we know as SARS-CoV2.

**Recombination:** this is when viruses exchange genetic material. Type II FCoV is an example of this: wholly feline Type I CoVs recombine with canine coronavirus (CCoV) to make Type II FCoVs, which, because they are new to the cat population, are frequently more lethal than Type I viruses, to which the cat population may have some herd immunity. Recombination is a problem for human health, in that emerging viruses, especially influenza viruses, frequently arise from the combination of large densities of animals in industrial farms in close contact with humans, allowing for the animal pathogens to jump species. <sup>Greger 2006</sup>

\*\*\*\*\*

### USEFUL WEBSITES

**Diane Addie's FCoV/FIP, FGS, blood typing and genetic conditions website:**

[www.catvirus.com](http://www.catvirus.com)

To download the FIP/FCoV enteritis diagnosis algorithms: [www.catvirus.com/downloads](http://www.catvirus.com/downloads)

Addie's book for cat guardians: *FIP and Coronavirus*, available from Amazon:

[www.amazon.com/Feline-Infectious-Peritonitis-Coronavirus-Everything-ebook/dp/B00P8BNA0I/ref=sr](http://www.amazon.com/Feline-Infectious-Peritonitis-Coronavirus-Everything-ebook/dp/B00P8BNA0I/ref=sr)

Spanish version (1<sup>st</sup> edition, i.e. not updated): [www.amazon.com/peritonitis-infeciosa-felina-PIF-coronavirus-ebook/dp/B01MT1DTU2/](http://www.amazon.com/peritonitis-infeciosa-felina-PIF-coronavirus-ebook/dp/B01MT1DTU2/)

**Biogal website:** [www.biogal.com](http://www.biogal.com)

Queries about purchasing FCoV Immunocomb antibody test kit: email [info@biogal.com](mailto:info@biogal.com).

**Mutian website:** [www.Mutian.us](http://www.Mutian.us)

**University of Glasgow Veterinary Diagnostic Services Laboratory:**  
[www.gla.ac.uk/schools/vet/cad/](http://www.gla.ac.uk/schools/vet/cad/)

**SARS-CoV2 information online:**

Obviously PubMed (<https://pubmed.ncbi.nlm.nih.gov/>) is the go-to for peer-reviewed papers on COVID-19 as well as FCoV /FIP.

There is also a website which publishes papers prior to peer review: [www.medrxiv.org/](http://www.medrxiv.org/)

For latest numbers on SARS-CoV2: <https://www.worldometers.info/coronavirus/>

I recommend the YouTube channel of Dr Mike Hansen who is a thoracic specialist: ([www.youtube.com/channel/UCMSsLqxqvZsNXiOZ-VjN89A](http://www.youtube.com/channel/UCMSsLqxqvZsNXiOZ-VjN89A)).

**SARS-CoV2 in domestic animals:** [https://www.avma.org/resources-tools/animal-health-and-welfare/covid-19/depth-summary-reports-naturally-acquired-sars-cov-2-infections-domestic-animals-and-farmed-or?fbclid=IwAR3FHL3wpZuy7aTOTHY1cVUf\\_SsivT5jMZljtunGsd73-PX82hNBdi94-A](https://www.avma.org/resources-tools/animal-health-and-welfare/covid-19/depth-summary-reports-naturally-acquired-sars-cov-2-infections-domestic-animals-and-farmed-or?fbclid=IwAR3FHL3wpZuy7aTOTHY1cVUf_SsivT5jMZljtunGsd73-PX82hNBdi94-A)

**SARS-CoV2 and cats ABCD guideline:**

<http://www.abcdcatsvets.org/sars-coronavirus-2-and-cats/>

## ONLINE VIDEOS

How FCoV transmission occurs:

English: <http://www.youtube.com/watch?v=rkqUjeQNEQs>

French: <http://www.youtube.com/watch?v=JrnopBFAr8A&feature=plcp>

FIP pathogenesis: <http://www.youtube.com/watch?v=6Ryl2LI9R9Q&feature=related>

Cat litter video: <https://www.bitchute.com/video/JnxhgvQqo9Xq/>  
<https://youtu.be/eEkOFXh8Xd4>

Preventing FIP by antibody testing: <https://youtu.be/nDy1VPiA9z8>

The truth about the FIP vaccine: [www.bitchute.com/video/v06NRacWVie8/](http://www.bitchute.com/video/v06NRacWVie8/)

In protest against YouTube's censorship of many content producers, I release my videos first on Bitchute and am exploring producing my videos on freedom platforms such as Lbry and Pocketnet, at present I have only mastered uploading to Bitchute though.

**Freedom of speech is a fundamental human right which many of our ancestors died to protect.** Future generations depend upon our actions, and one method of non-violent non-cooperation with those who seek to control us is to leave their data-collecting social media such as Facebook, Google, Instagram, WhatsApp, Twitter and YouTube and to give our valuable attention time instead to platforms that endorse privacy, such as the DuckDuckGo search engine, Brave browser, MeWe, etc.

**Contact:** please do NOT try to contact me via Facebook; I am unlikely to reply to you for reasons given above. If you want to contact me, my email address is [draddie@catvirus.com](mailto:draddie@catvirus.com). If you want to refer your clients to me please direct them to the consultation packages on

the home page of catvirus.com and send me an email with your consent to contact your client (RCVS rules to which I am bound). If you would like to subscribe to my veterinary email list, email me with "Subscribe vet" as the subject.

## ACKNOWLEDGEMENTS

Enormous thanks to Dr Len Small and Dr Yotam Copelovitz of Biogal Laboratories for arranging, sponsoring, and promoting this webinar. Especially I thank them for not influencing in any way the content of the webinar or these notes. I am grateful to Dr Albert Ahn for chairing the webinar so graciously.

None of my research could have been conducted without the amazing cat guardians and their veterinary surgeons who—for over 3 decades—have provided me with material from naturally-occurring FCoV and FIP cases for my research: I will be forever indebted to them. I will also be forever indebted to Prof. Os Jarrett for being brave enough to take on a PhD student who refused to experiment on laboratory cats.

I am sincerely grateful to the catvirus.com subscribers and donors who have funded the majority of my research, and recently have supported me personally as well.

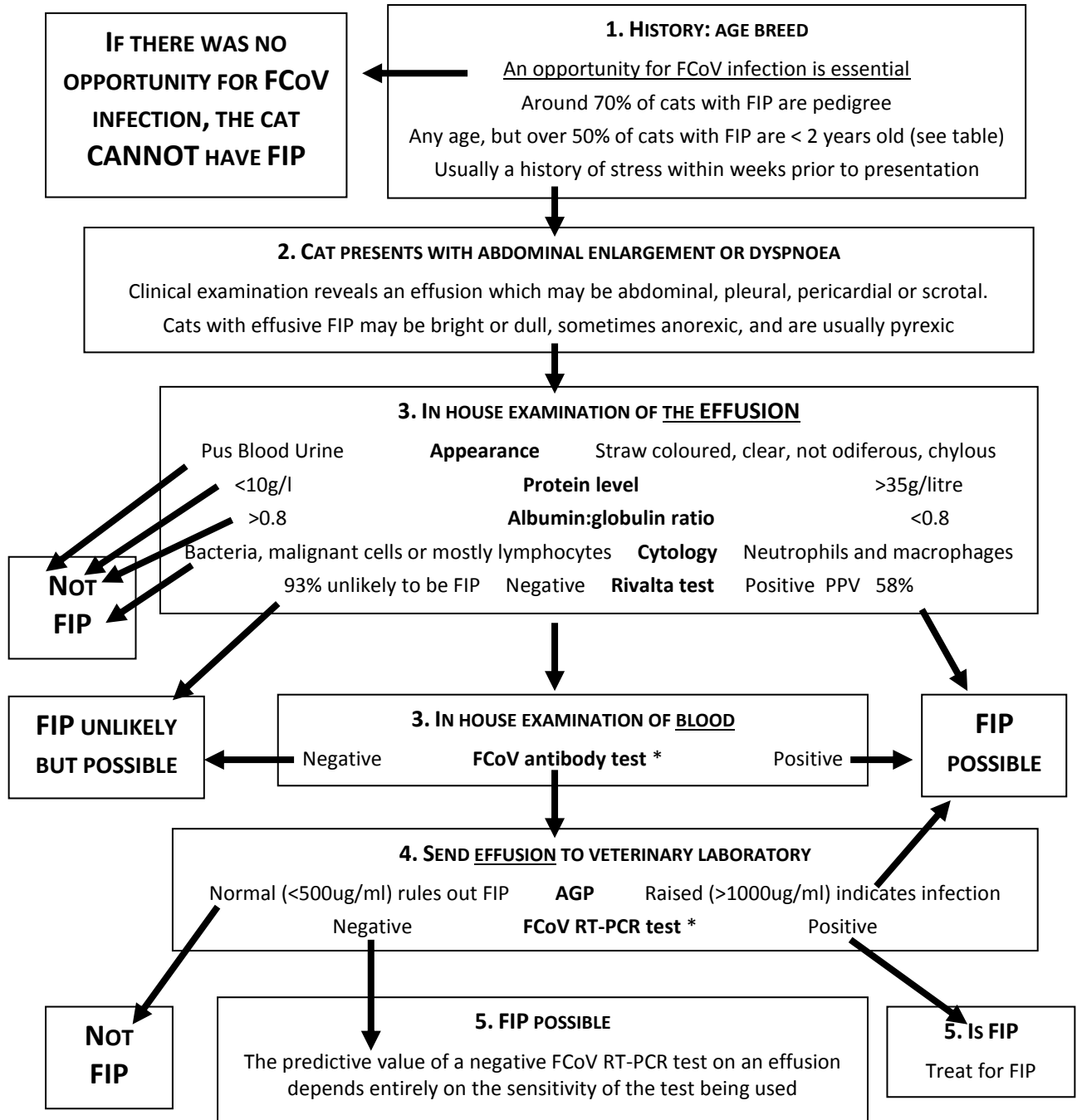
## REFERENCES

- Addie DD, Toth S, Murray GD, Jarrett O. 1995. The risk of feline infectious peritonitis in cats naturally infected with feline coronavirus. *Am. J. Vet. Res.* **56** 4 429-434.
- Addie DD, Toth S, Herrewegh AAPM, Jarrett O. 1996. Feline coronavirus in the intestinal contents of cats with feline infectious peritonitis. *The Veterinary Record.* **139** 522-523.
- Addie, D.D., and Jarrett, J.O. 2001. Use of a reverse-transcriptase polymerase chain reaction for monitoring feline coronavirus shedding by healthy cats. *Vet. Rec.* 148:649-653.
- Addie D.D, Schaap I.A.T, Nicolson L, Jarrett O. 2003. Persistence and transmission of natural type I feline coronavirus infection. *J. Gen. Virol.* 84 (10): 2735-2744.
- Addie D.D, McLachlan SA, Golder M., Ramsay I, Jarrett O. 2004. Evaluation of an in-practice test for feline coronavirus antibodies. *Journal of Feline Medicine and Surgery.* **6** 2 63-68
- Addie DD, McDonald M, Audhuy S, Burr P, Hollins J, Kovacic R, Lutz H, Luxton Z, Mazar S, Meli M. 2012. Quarantine protects Falkland Islands (Malvinas) Cats from Feline Coronavirus Infection. *J Feline Med Surg.* 14 2 171-176.
- Addie DD, le Poder S, Burr P, Decaro N, Graham E, Hofmann-Lehmann R, Jarrett O, McDonald M, Meli ML. 2015. Utility of feline coronavirus antibody tests. *J Feline Med Surg* 17(2):152-62.
- Addie DD, Boucraut-Baralon C, Egberink H, Frymus T, Gruffydd-Jones T, Hartmann K, Horzinek MC, Hosie MJ, Lloret A, Lutz H, Marsilio F, Pennisi MG, Radford AD, Thiry E, Truyen U, Möstl K; European Advisory Board on Cat Diseases. 2015. Disinfectant choices in veterinary practices, shelters and households: ABCD guidelines on safe and effective disinfection for feline environments. *J Feline Med Surg.* 17(7):594-605.
- Addie D, Houe L, Maitland K, Passantino G, Decaro N. 2020. [Effect of cat litters on feline coronavirus infection of cell culture and cats.](#) *J Feline Med Surg.* 22(4):350-357.
- Addie DD. Curran S, Bellini F, Crowe B, Sheehan E, Ukrainchuk L, Decaro N. 2020. Oral Mutian® X stopped faecal feline coronavirus shedding by naturally infected cats. *Res. Vet. Sci.* 130:222-229.. doi: 10.1016/j.rvsc.2020.02.012.
- Ahmed AE. Incidence of coronavirus disease (COVID-19) and countries affected by malarial infections. *Travel Med Infect Dis.* 2020 Apr 22 : 101693. doi: 10.1016/j.tmaid.2020.101693
- Astruc, Lionel. 2019. L'art de la fausse générosité: La fondation Bill et Melinda Gates. Dandelion press. Currently out of print, so watch this interview with him (English subtitles): <https://www.youtube.com/watch?v=Dqzt6yAmdDE>

- Barker EN, Stranieri A, Helps CR, Porter EL, Davidson AD, Day MJ, Knowles T, Kipar A, Tasker S. Limitations of using feline coronavirus spike protein gene mutations to diagnose feline infectious peritonitis. *Vet Res.* 2017 Oct 5;48(1): 60
- Chang HW, de Groot RJ, Egberink HF, Rottier PJ. 2010 Feline infectious peritonitis; insights into feline coronavirus pathobiogenesis and epidemiology based on genetic analysis of the viral 3c gene. *J Gen Virol.* 91(Pt 2):415-20
- Corbett J. 2020. Investigative journalist James Corbett has also made a series of documentaries on Bill Gates: [https://www.bitchute.com/video/wQSYdAX\\_9JY/](https://www.bitchute.com/video/wQSYdAX_9JY/) (the videos are also on YouTube, but will likely be censored and taken down shortly).
- Decaro N, Lorusso A. 2020. Novel human coronavirus (SARS-CoV-2): A lesson from animal coronaviruses. *Vet Microbiol.* 2020 May; 244: 108693.
- Dunbar D, Kwok W, Graham E, Armitage A, Irvine R, Johnston P, McDonald M, Montgomery D, Nicolson L, Robertson E, Weir W, Addie DD. 2019. Diagnosis of non-effusive feline infectious peritonitis by reverse transcriptase quantitative polymerase chain reaction from mesenteric lymph node fine needle aspirates. *J Feline Med Surg.* 21(10):910-921.
- Dye C, Helps CR, Siddell SG. 2008 Evaluation of real-time RT-PCR for the quantification of FCoV shedding in the faeces of domestic cats. *J Feline Med Surg.* 10(2):167-74.
- Erles K, Toomey C, Brooks HW, Brownlie J. 2003. Detection of a group 2 coronavirus in dogs with canine infectious respiratory disease. *Virology.* 310(2):216-23.
- Fehr D, Holznagel E, Bolla S, Hauser B., Herrewegh AAPM, Horzinek MC, Lutz H. 1997. Placebo-controlled evaluation of a modified live virus vaccine against feline infectious peritonitis: safety and efficacy under field conditions. *Vaccine* 15 (10): 1101-1109.
- Felten, S, Leutenegger, CM, Balzer, HJ, Pantchev, N, Matiasek, K, Wess, G, Egberink, H, Hartmann, K. 2017. Sensitivity and specificity of a real-time reverse transcriptase polymerase chain reaction detecting feline coronavirus mutations in effusion and serum/plasma of cats to diagnose feline infectious peritonitis. *BMC veterinary research* 13, 228.
- Gautret P, Lagier JC, Parola P, Hoang VT, Meddeb L, Sevestre J, Mailhe M, Doudier B, Aubry C, Amrane S, Seng P, Hocquart M, Eldin C, Finance J, Vieira VE, Dupont HT, Honoré S, Stein A, Million M, Colson P, La Scola B, Veit V, Jacquier A, Deharo JC, Drancourt M, Fournier PE, Rolain JM, Brouqui P, Raoult D. Clinical and microbiological effect of a combination of hydroxychloroquine and azithromycin in 80 COVID-19 patients with at least a six-day follow up: A pilot observational study. *Travel Med Infect Dis.* 2020 Apr 11:101663.
- Greger M. 2006. Bird flu: A virus of our own hatching. Lantern Books. New York, New York, USA. ISBN: 978-1590560983
- Halfmann PJ, Hatta M, Chiba S, et al. Transmission of SARS-CoV-2 in Domestic Cats [published online ahead of print, 2020 May 13]. *N Engl J Med.* 2020;10.1056/NEJMc2013400. doi:10.1056/NEJMc2013400
- Herrewegh AAPM, Mahler M., Hedrich HJ, Haagmans BL, Egberink HF., Horzinek MC., Rottier PJM, de Groot RJ. 1997. Persistence and evolution of feline coronavirus in a closed cat-breeding colony. *Virology* 234: 349-363.
- Herrewegh AAPM, Smeenk I., Horzinek MC., Rottier PJM, de Groot RJ. 1998 Feline coronavirus type II strains 79-1683 and 79-1146 originate from a double recombination between feline coronavirus type I and canine coronavirus. *J. Virol.* 72(5): 4508-4514.
- Jaume M, Yip MS, Kam YW, Cheung CY, Kien F, Roberts A, Li PH, Dutry I, Escriou N, Daeron M, Bruzzone R, Subbarao K, Peiris JS, Nal B, Altmeyer R. 2012. SARS CoV subunit vaccine: antibody-mediated neutralisation and enhancement. *Hong Kong Med J.* 2012;18 Suppl 2:31-36.
- Kipar A., Kremendahl J., Addie D.D., Leukert W., Grant C. K. Reinacher M. 1998 Fatal enteritis associated with coronavirus infection in cats. *J. Comp. Path.* 119: 1-14.
- Kipar A, Baptiste K, Barth A, Reinacher M. 2006. Natural FCoV infection: cats with FIP exhibit significantly higher viral loads than healthy infected cats. *JFMS* 8: 69-72.
- Liu L, Wei Q, Lin Q, et al. [Anti-spike IgG causes severe acute lung injury by skewing macrophage responses during acute SARS-CoV infection.](#) *JCI Insight.* 2019;4(4):e123158. doi:10.1172/jci.insight.123158

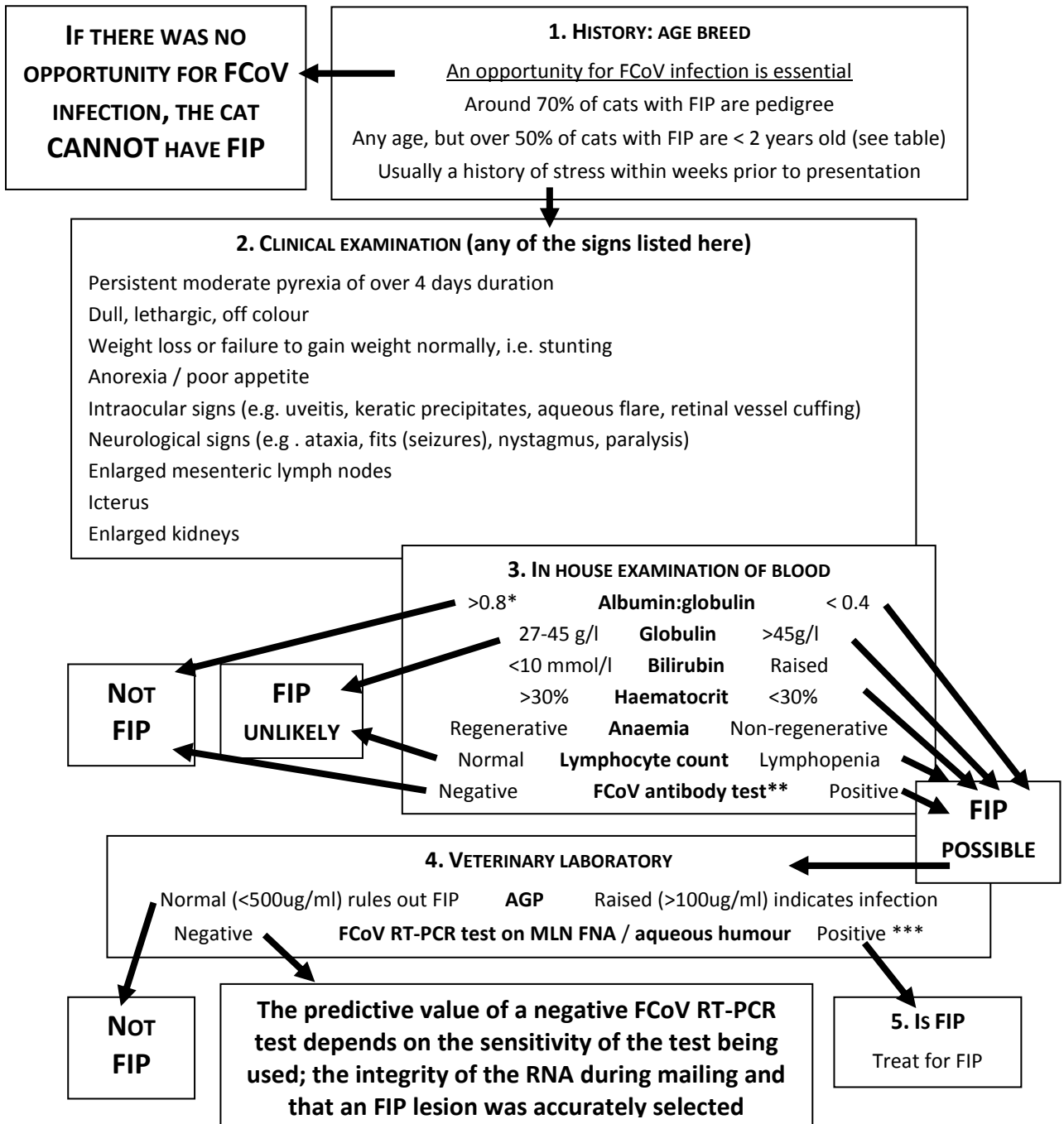
- Longstaff L, Porter E, Crossley VJ, Hayhow SE, Helps CR, Tasker S. J. 2017. [Feline coronavirus quantitative reverse transcriptase polymerase chain reaction on effusion samples in cats with and without feline infectious peritonitis](#). *Feline Med Surg*. 19(2):240-245. doi: 10.1177/1098612X15606957.
- Meli ML, Burr P, Decaro N, Graham E, Jarrett O, Lutz H, McDonald M, Addie DD. 2013 Samples with high virus loads cause a trend toward lower signal in feline coronavirus antibody tests. *J Feline Med Surg* 15 4 295 – 299
- Menachery VD, Yount BL Jr, Debbink K, Agnihothram S, Gralinski LE, Plante JA, Graham RL, Scobey T, Ge XY, Donaldson EF, Randell SH, Lanzavecchia A, Marasco WA, Shi ZL, Baric RS. 2015. A SARS-like cluster of circulating bat coronaviruses shows potential for human emergence. *Nat Med*. 21(12):1508-13. doi: 10.1038/nm.3985. Epub 2015 Nov 9. Erratum in: *Nat Med*. 2016 Apr;22(4):446.
- Million M, Lagier JC, Gautret P, Colson P, Fournier PE, Amrane S, Hocquart M, Mailhe M, Esteves-Vieira V, Doudier B, Aubry C, Correard F, Giraud-Gatineau A, Roussel Y, Berenger C, Cassir N, Seng P, Zandotti C, Dhiver C, Ravaux I, Tomei C, Eldin C, Tissot-Dupont H, Honoré S, Stein A, Jacquier A, Deharo JC, Chabrière E, Levasseur A, Fenollar F, Rolain JM, Obadia Y, Brouqui P, Drancourt M, La Scola B, Parola P, Raoult D. Early treatment of COVID-19 patients with hydroxychloroquine and azithromycin: A retrospective analysis of 1061 cases in Marseille, France. *Travel Med Infect Dis*. 2020 May 5:101738. doi: 10.1016/j.tmaid.2020.101738.
- Pedersen NC, Kim Y, Liu H, Galasiti Kankanamalage AC, Eckstrand C, Groutas WC, Bannasch M, Meadows JM, Chang KO. 2018. Efficacy of a 3C-like protease inhibitor in treating various forms of acquired feline infectious peritonitis. *J. Feline Med. Surg*. 20 (4): 378-392.
- Pedersen NC, Perron M, Bannasch M, Montgomery E, Murakami E, Liepnieks M, Liu H. 2019. Efficacy and safety of the nucleoside analog GS-441524 for treatment of cats with naturally occurring feline infectious peritonitis. *J Feline Med Surg*. 21(4):271-281.
- Porter E, Tasker S, Day MJ, Harley R, Kipar A, Siddell SG, Helps CR. 2014 Amino acid changes in the spike protein of feline coronavirus correlate with systemic spread of virus from the intestine and not with feline infectious peritonitis. *Vet Res*. 45:49.
- Takano T, Katoh Y, Doki T, Hohdatsu T. 2013. Effect of chloroquine on feline infectious peritonitis virus infection in vitro and in vivo. *Antiviral Res*. 99(2):100-7.
- Tasker S. 2018. Diagnosis of feline infectious peritonitis: Update on evidence supporting available tests. *J Feline Med Surg*. 20(3):228-243.
- Terada Y, Matsui N, Noguchi K, Kuwata R, Shimoda H, Soma T, Mochizuki M, Maeda K. 2014. Emergence of pathogenic coronaviruses in cats by homologous recombination between feline and canine coronaviruses. *PLoS One*. 9(9):e106534.
- Tsai HY, Chueh LL, Lin CN, Su BL. 2011 Clinicopathological findings and disease staging of feline infectious peritonitis: 51 cases from 2003 to 2009 in Taiwan. *J Feline Med Surg*. 13(2):74-80.
- Wichmann D, Sperhake JP, Lütgehetmann M, Steurer S, Edler C, Heinemann A, Heinrich F, Mushumba H, Kniep I, Schröder AS, Burdelski C, de Heer G, Nierhaus A, Frings D, Pfefferle S, Becker H, Bredereke-Wiedling H, de Weerth A, Paschen HR, Sheikhzadeh-Eggers S, Stang A, Schmiedel S, Bokemeyer C, Addo MM, Aepfelbacher M, Püschel K, Kluge S. Autopsy Findings and Venous Thromboembolism in Patients With COVID-19: A Prospective Cohort Study. *Ann Intern Med*. 2020 May 6. <https://www.acpjournals.org/doi/10.7326/M20-2003>
- Vennema H., de Groot R.J., Harbour D.A., Dalderup M., Gruffydd-Jones T., Horzinek M.C., Spaan W.J.M. 1990 Early death after feline infectious peritonitis virus challenge due to recombinant vaccinia virus immunization. *Journal of Virology*. 64: 3 1407-1409.
- Zheng S, Fan J, Yu F, et al. Viral load dynamics and disease severity in patients infected with SARS-CoV-2 in Zhejiang province, China, January-March 2020: retrospective cohort study. *BMJ*. 2020;369:m1443. Published 2020 Apr 21. doi:10.1136/bmj.m1443.

## EFFUSIVE FIP DIAGNOSTIC ALGORITHM



\* It is essential to use only the most sensitive FCoV antibody and RT-PCR tests.

## NON-EFFUSIVE FIP DIAGNOSTIC ALGORITHM



\* Note that 15% of cats with FIP have alb:glob of 0.8, therefore I have written over (>) 0.8 here

\*\* Use FCoV antibody test kits with best sensitivity available Addie et al, 2015

\*\*\* Positive FCoV RT-PCR on CSF does not equate with a diagnosis of FIP



## FCoV-ASSOCIATED DIARRHOEA DIAGNOSTIC ALGORITHM

