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Feline infectious peritonitis: answers to frequently asked questions concerning FIP and coronavirus

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ABSTRACT: Feline infectious peritonitis (FIP) is caused by infection with feline coronavirus (FCoV), a highly infectious virus transmitted mostly indirectly, by sharing litter trays with a FCoV excretor, or by fomites. The majority of FCoV-infected cats remain healthy, with up to 12% developing FIP. While any age or breed of cat can develop FIP, FIP disproportionately affects pedigree kittens: most studies found that around 70% of FIP cases occurred in pure-bred cats under 2 years of age. In this paper, some questions about FCoV and FIP that are likely to be asked of, and by, a veterinary nurse will be addressed.

Keywords: feline infectious peritonitis; FIP; feline coronavirus

Should we hospitalise a cat with FIP?

There is no reason for most cats with FIP to be hospitalised unless it is made necessary by a treatment, such as thoracentesis on a cat with a pleural effusion, or for observation during first administration of a novel treatment (for example, an infusion of anti-TNF-alpha antibody (Doki, Takano, Kawagoe, Kito, & Hohdatsu, 2016) such as infliximab, or a novel anti-viral such as GS-441524 (Murphy et al., 2018; Pedersen et al., 2019). The novel anti-viral drug GS-441524 injection stings and some cat guardians struggle to give it. In that case, if a veterinary nurse can do a daily home visit to give the treatment that would be preferable to a clinic visit.

Stress is increasingly being recognised as being important in the cat, and cats which develop FIP frequently have a history of stress shortly preceding the onset of FIP clinical signs (Rohrer, Suter, & Lutz, 1993; Riemer, Kuehner, Ritz, Sauter-Louis, & Hartmann, 2016). For the patient who already has FIP, it is unknown how much further stress would affect prognosis, but it would be prudent to minimise stress as

much as possible; so for that reason, it would be best for the cat to be at home as much as possible, rather than being hospitalised.

FCoV shedding increased significantly in FCoV-infected cats entering a rescue shelter due to the stress of the situation (Pedersen, Sato, Foley, & Poland, 2004). Therefore, it is possible that being admitted to a veterinary hospital would increase the cat's shedding of FCoV – another reason for FIP patients to be treated at home. Where hospitalisation is unavoidable, something as simple as supplying a cardboard box for the cat to hide in, in his or her cage, can reduce stress for the cat (Rochlitz, 1999), and the box can be disposed of in clinical waste for incineration when the cat leaves to destroy any infection within.

If we allow the FIP patient home, will he put the other cats at risk?

Based on our knowledge of coronavirus shedding, it is probable that in-contact cats of an FIP patient will already be infected with FCoV, because they will probably have been sharing litter trays: see [Figure 1](#)

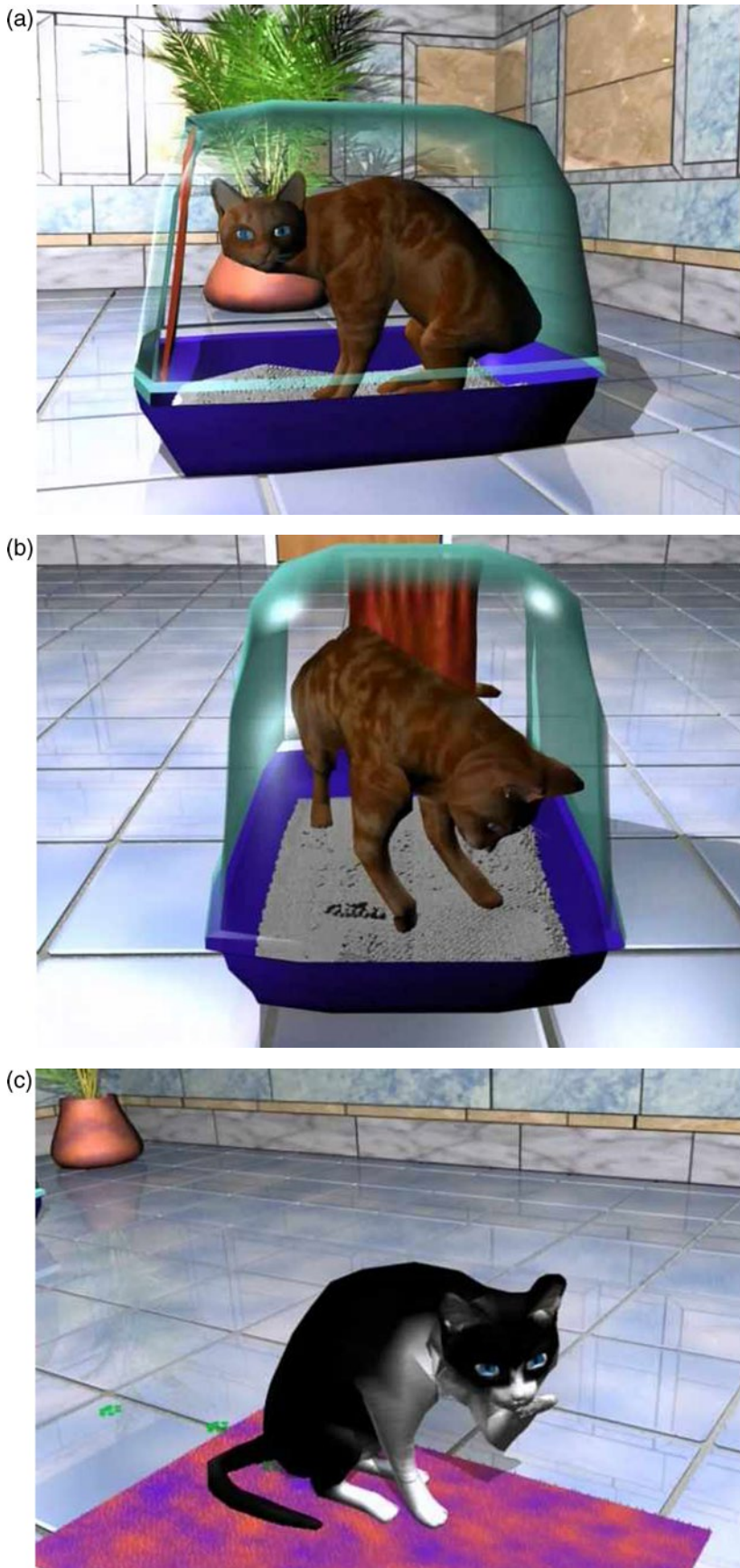


Figure 1. Indirect transmission of FCoV through sharing a litter tray. (a) A feline coronavirus-infected cat passes virus containing faeces in a litter tray. (b) The cat covers the contaminated faeces with cat litter: dust from the litter can now transport the virus to uninfected cats sharing the same house or cattery. (c) A housemate of the FCoV-infected cat has used the same litter tray and has tracked invisible virus (illustrated in green) on his paws and in process of grooming, swallows contaminated particles and becomes infected. These are stills taken from a YouTube film on FCoV transmission which can be seen in full at: www.youtube.com/watch?v=rkqUjeQNEQs

(<https://www.youtube.com/watch?v=rkqUjeQNEQs>). Therefore, cats from the same household will either already have some immunity to FCoV, or will be in early stages of developing FIP, and further exposure will make no difference. For this reason it should be safe to allow a cat with FIP to be nursed at home, rather than in the veterinary surgery.

It is important to help your clients to understand that they should not bring in a new cat while they have a cat with FIP because that will put the new cat at risk: about 75% of cats with FIP shed FCoV in their faeces (Addie, Toth, Herrewegh, & Jarrett, 1996).

Do we need to isolate a cat with FIP?

If the cat did require to be hospitalised, extreme care should be taken to avoid fomite transmission of the virus, although the cat with FIP is probably no more infectious than a healthy FCoV-infected kitten (kittens shed more FCoV than do adult cats). To the best of a practice's ability to do so, barrier nursing standards should be applied to all cats in a veterinary hospital, regardless of their health status, because you never know when a cat may be a carrier of FCoV, or of an even more contagious pathogen.

Key message: The single most effective way to prevent FIP is to prevent the kitten/cat ever becoming infected with feline coronavirus (FCoV).

How does FCoV spread within the veterinary hospital?

Virus transmission is mainly indirect, on fomites; therefore, in the veterinary practice one needs to be vigilant about possible virus transmission on:

- brushes (see Figure 2)
- poop scoops
- feet and hands
- cat litter dust: use non-tracking cat litters, or simply newspaper or paper towel in the litter tray

Which cat litter is best to minimise FCoV transmission?

Changing the cat litter alone cannot abrogate FCoV transmission (Addie, Houe, Maitland, Passantino, & Decaro,



Figure 2. In this FCoV-aware veterinary cat ward, each pen had its own brush and shovel so that no pathogen fomites would be spread from pen to pen on brush bristles. Brushes and shovels were disinfected between pen occupants.

2019). However, different cat litters have been shown to have different abilities to inhibit FCoV *in vitro*, and Fuller's Earth-based cat litters were able to prevent infection of cell culture, while sawdust-based cat litters had little inhibitory effect on the virus. In two households, there appeared to be less virus shedding on a Fuller's Earth non-clumping cat litter (Dr Elsey Cat Attract) (Addie et al., 2019).

What temperature should I set the washing machine or dishwasher to kill FCoV and other pathogens?

Washing machines to launder bedding and dishwashers should be set at 60°C, which will kill FCoV and most pathogens (but not protozoal oocysts, which require steam cleaning) (Addie, Boucraut-Baralon, et al., 2015).

Did my cat catch FCoV/FIP in your practice?

The development of FIP often occurs shortly after a visit to the veterinary surgeon, often for routine vaccination or neutering (Riemer et al., 2016); therefore, it would be a reasonable question for a cat's guardian to pose: did the cat become infected during their visit to the veterinary surgery?

One quick way to establish whether that was possible is to look at the incubation period: from first becoming infected with FCoV to the development of FIP takes at least 3 weeks, so if a cat has been spayed, then is noticed to have an effusion a week later when the stitches are being removed, she must have been already infected prior to the operation.

Of course, the question then arises why your practice didn't offer a FCoV antibody test along with the routine pre-anaesthetic blood tests, to establish whether there was

any risk in performing the surgery? In this author's opinion, guardians of all pedigree cats should routinely be offered a FCoV antibody or faecal reverse-transcriptase polymerase chain reaction (RT-PCR) test pre-neutering: pedigree cats under two years old make up the majority of cats with FIP (Pesteanu-Somogyi, Radzai, & Pressler, 2006; Norris et al., 2005; Riemer et al., 2016; Soma, Wada, Taharaguchi, & Tajima, 2013; Tsai, Chueh, Lin, & Su, 2011; Worthing et al., 2012). Be sure to use a test with very good sensitivity to avoid a false negative result (Addie, Le Poder, et al., 2015). Because many pedigree kittens will have antibodies to FCoV, it may be preferable to offer a pre-operation RT-PCR test to establish if a cat is actually shedding FCoV. FCoV RT-PCR tests are more expensive than antibody tests and need to be performed more than a week before the planned date of surgery (as the sample will need to be mailed to a reference laboratory), but as these would have to be done anyway if the antibody test were positive, it is perhaps a better

option because it could save the cat a wasted trip to the surgery, as the guardian could bring in the faecal sample.

The other at-risk groups which should be offered these kinds of pre-operation test are cats who have recently been obtained from rescue shelters, or rescued from hoarding situations.

Key message: Use a veterinary laboratory that reports the quantity of virus in the sample, so that cats who have a positive result can be re-tested a month later, and if still positive, you will be able to assess whether the amount of virus has increased, decreased, or remained the same (a list of laboratories is available at www.catvirus.com).

Veterinary practices should strive to be as stress-free as possible for their feline patients

The website www.catfriendlyclinic.org has many suggestions for making the practice cat-friendly. While not all practices can afford a waiting room rebuild with cubicles for people and their cats, some measures can be fairly easily implemented to make your veterinary hospital as stress-free as possible. Some examples are:

- having a Feliway diffuser plugged in the waiting room at all times
- having cat-only consulting times blocked off, so that cats don't have the stress of sharing the waiting room with dogs
- supplying clean towels or blankets to cover the cat's cage in the waiting area: these also double as a sneeze barrier

When clients lose their cat to FIP, how long should they wait before obtaining a new cat or kitten? How long does the virus survive in the house?

FCoV is a moderately resistant virus, surviving up to seven weeks in dried-up cat litter particles (Scott, 1988); it is not as fragile as feline herpesvirus or leukaemia virus, which can survive only hours outside the body, but it's not as resistant as parvovirus, which can survive for a year or more in the environment (Addie, Boucraut-Baralon, et al., 2015).

FCoV can be killed by most household disinfectants, such as bleach (Addie et al., 2009). Therefore, after the death of a cat to FIP, the litter tray can be disinfected using bleach, and soft furnishings can be steam-cleaned. To be 100% sure that all coronavirus has gone, wait 2 months before obtaining another cat. If there are already cats in the household who were in contact with the FIP cat, those cats should be tested for FCoV antibodies. It is important to use a sensitive test (i.e. one which doesn't give false negative results; for example the FCoV Immunocomb, Biogal, Israel (Addie, Boucraut-Baralon, et al., 2015)) and the new cat or kitten should only be introduced after the existing cats have become seronegative, which can take some months to occur. The FCoV infection status of the new cat or kitten should also be established. An alternative option to FCoV antibody testing is to offer FCoV RT-PCR testing of faecal samples, which has become widely available. The advantages of FCoV RT-PCR tests are that they are able to differentiate cats who are actually shedding virus from those who were previously infected and have a residual antibody signal. One disadvantage is cost, which is higher than for antibody tests, plus there is a delay in getting results back from a reference laboratory. An advantage of FCoV antibody testing over RT-PCR is that a single negative FCoV antibody test rules out FCoV infection (provided the test is sufficiently sensitive and the cat is over 10 weeks old), whereas several monthly faecal RT-PCR tests must be performed to be confident of a negative result (Addie & Jarrett, 2001). Where cat guardians are unable to reliably obtain faecal samples uncontaminated by the faeces of other cats in the household, viral RNA can also be detected on plain cotton rectal swabs (not in transport medium) performed by the veterinary surgeon or nurse.

Key message: While doing such testing is potentially costly and a fair amount of work, it is less expensive in both financial and emotional terms than facing the diagnosis, treatment and usually death of a beloved pet due to FIP.

How can the client prevent their other cats developing FIP? Advice for people with FCoV antibody-positive healthy cats

The majority of FCoV-infected cats remain healthy, although up to 12% develop FIP (Addie, Toth, Murray, &

Jarrett, 1995). At time of writing, the best advice for people with cats in contact with a FIP case is to avoid stress as far as possible. Feline pheromone diffusers can be used in the home. Good nutrition is extremely important: cats are obligate carnivores; arginine is an essential amino acid for cats, which they can only obtain from real meat (Morris & Rogers, 1978). Arginine is essential for both the urea cycle and the proper functioning of the immune system.

It may be possible to avoid the stress of a booster vaccine by testing for antibodies against feline parvovirus: a high antibody titre indicates that the cat is protected. In the case of kittens, bear in mind that maternally derived antibodies to panleukopenia virus can persist until 20 weeks of age (Addie, Toth, Thompson, Greenwood, & Jarrett, 1998) and interfere with primary vaccination. The stress of a vaccine is not simply about the journey to the veterinary surgery and the procedure of giving an injection: the adjuvant contained within the vaccine is a major stressor to the immune system (Batista-Duarte, Portuondo, Pérez, & Carlos, 2014). If booster vaccination is essential, then use the least number of components possible, just core vaccines. For example, feline leukaemia (FeLV) vaccination is not core in countries such as the UK, where FeLV prevalence is under 1%, and in many cats' situations (e.g. indoor-only cats) (Lutz et al., 2009), but if it has to be given, then choose a non-adjuvanted vaccine, such as the recombinant canarypox FeLV vaccine (Purevax, Boehringer Ingelheim): such vaccines cause less inflammation and are likely safer in cats (Graf, Guscetti, Welle, Meier, & Pospischil, 2018).

The FIP vaccine (Felocell FIP, Zoetis) can be used to protect FCoV antibody-negative cats, but if the cat already has a high FCoV antibody titre then it is likely he or she is either already immune, or in the early stages of developing FIP (Fehr et al., 1997).

How can we make our clientele more aware of FIP?

Buying a pedigree kitten is the biggest risk factor for a person having a cat with FIP. Pedigree kittens are most at risk because unfortunately the majority of cat breeders don't wean kittens at 5–7 weeks of age and isolate them from adult cats and other kittens (who may be shedding virus), which would prevent kittens from becoming infected (Addie & Jarrett,



Thinking of buying a purebred kitten?

Insist that the kitten tests negative for feline coronavirus antibodies to avoid him dying of feline infectious peritonitis (FIP).



Education and awareness are the best weapons we have in the battle against FIP.

Get informed about FIP:
Visit - www.catvirus.com



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Figure 3. A FCoV/FIP awareness poster for the veterinary practice waiting room, which can be downloaded from <http://www.catvirus.com/Choosekitten.htm#>.

1992). In addition, kittens get infected at an early age, before their immune systems are fully developed. Posters, such as the one shown in Figure 3, are available for educating the public about the dangers of buying a FCoV-infected pure-bred kitten. These posters can be downloaded, printed and put up in the practice waiting room (<http://www.catvirus.com/Choosekitten.htm#Poster>). If uninformed cat breeders were to experience consumer pressure to become FCoV-free, that would prevent a great deal of FIP from occurring.

Because a cure which could work in all FIP cases is not presently commercially

available, prevention is preferable to treatment. The single best way for your practice's clients who are going to purchase a pedigree kitten to avoid encountering FIP is to insist that the kitten has a negative result to a FCoV antibody test, performed at least 10 weeks old (because before 10 weeks of age, a kitten can be infected but not yet made antibodies (Addie & Jarrett, 1992)).

Should we use the FIP vaccine?

The FIP vaccine (Felocell FIP, Zoetis) (Gerber et al., 1990) has been shown to be

safe and effective (Fehr et al., 1995, 1997) and is highly recommended for kittens and cats over 16 weeks of age who will be put into a multicat situation where there is a high risk of FCoV infection: i.e. boarding and rescue catteries, and multicat pet households. This is an option for those people who cannot or will not undertake FCoV prevention by testing and hygiene. A preventable fraction of 75% was found when the vaccine was tested in a large cat shelter in the USA (Reeves, 1995), in other words, the vaccine saved 75% of cats who would otherwise have developed FIP.

Unfortunately the FIP vaccine is not available in many countries, and even if it were, it must be given at 16 weeks of age or older – too late for most pedigree kittens who become infected when maternally derived antibody wanes between five and seven weeks of age.

Conclusion

A Veterinary Nurse who is knowledgeable about FIP and FCoV will be an asset to a veterinary hospital, able to prevent nosocomial infection of FCoV within the hospital wards, and to respond to the most frequently asked questions, many of which will occur to a client only after they have left the consultation room.

Further information

FIP website: www.catvirus.com.

Free FIP awareness posters to download and print out for the practice waiting room: www.catvirus.com/Choosekitten.htm#Poster

Animation of FCoV transmission: <https://www.youtube.com/watch?v=rkqUjeQNEQs>

I encourage veterinary practices to download this film and play it on their practice waiting room monitors. Please subscribe to my YouTube channel and press the bell notification button to receive further updates on FCoV and FIP.

Making your clinic cat friendly: www.catfriendlyclinic.org

Book: Addie DD. *FIP and Coronavirus, Everything a Cat Lover Needs To Know*.

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