4th Fel. Nutr. Sem.
8/92

MANAGEMENT OF CORONAVIRUS INFECTIONS IN CATTERIES

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Coronavirus infections in cats may cause no disease, very mild disease, or Feline Infectious Peritonitis [FIP]. Because the diagnosis of the disease can be very difficult and the identification of asymptomatic carriers impossible, FIP control can be an exercise in frustration. In our discussion of the nature of coronaviruses, the diseases they cause, and the limitations of current diagnostic tests, we will consider techniques designed to minimize the problems that make FIP the most feared disease that can affect a cattery.

Points to consider:

- there is no effective treatment for FIP -- virtually 100% of cats with the disease will die. Many different treatment methods are currently being investigated but none at this time show great promise.
- there is currently no diagnostic test that will, in all cases, accurately diagnose the disease.
- there is no way to positively identify asymptomatic carrier cats -- currently the site of virus shedding, the duration and frequency of shedding, and the eventual outcome of shedding cats is unknown. Coronavirus-antibody tests that are now available cannot predict what will happen to an antibody-positive cat and what risk he or she may present to other cats.
- the incubation time [ie., the time from infection until the appearance of disease] for FIP in a cattery situation is unknown. It may be weeks, months, or years. Development of FIP in a kitten long after being sold as a healthy animal is a far too common scenario.
- there is no proven effective way to control FIP in an enzootic cattery.

Coronavirus -- an enveloped, single-stranded RNA virus.

Feline coronaviruses are related to Canine Coronavirus [CCV] and Transmissible Gastroenteritis virus [TGE] of swine. Cats can actually become infected with these viruses and develop antibodies that are indistinguishable from any other coronavirus antibody.

Feline Enteric Coronavirus [FECV] causes asymptomatic to mild intestinal infections in cats, primarily kittens. Typically will only grow in cells lining the intestinal tract.

Feline Infectious Peritonitis Virus [FIPV] is capable of causing FIP, enteritis, or both. It may be distinguished from FECV by its ability to infect macrophages and circulating monocytes and thus be disseminated to the rest of the body.

There are many strains of FECV and FIPV -- actually a continuum with varying disease-causing capabilities. Some strains of the viruses will never cause FIP, some strains will cause FIP only in some individuals, and some strains will cause FIP in virtually all cats infected.

Incidence:

- greatest in cats between 6 months and 2 years of age although rates of infection are high up to 5 years of age.
- males and females equally affected.
- catteries, colonies, and multi-cat households most commonly affected.
- purebred cats at greater risk -- probably due to raising in confinement but may also be a genetic predisposition in certain lines.
- prevalence of positive coronavirus antibody titers is high in purebred and other cattery-raised cats. One study showed positive titers in 94% of cats from catteries that had FIP problems and in 83% of cats from catteries that had not experienced FIP losses. The presence of coronavirus antibody in a cattery does not correlate with its FIP history. Other researchers have shown that in catteries or multi-cat households, titers are either completely absent or are present in 80-90% of the cats.

Transmission of the virus to other cats:

- the means of spread is not known with certainty but is believed to be by ingestion or inhalation of the virus.
- typically thought that transmission most effective when cats have close contact with infected cats or their excreta.
- site of viral shed from an infected cat is not known, but is probably via the saliva, urine, and/or feces.
- possibility of spread by contact with viruses on clothing, bedding, utensils, or other items in the environment. The virus may persist in the environment for several weeks but can be deactivated by many disinfectants.
- infection may be passed from an infected pregnant queen to her developing kittens. How often this occurs is not known.

Pathogenesis -- the origination and development of FIP:

- incubation in nature not known -- 2-3 weeks in experimental setting.
- initial infection takes place in the lining cells of the pharynx, the lung, and perhaps the intestine as well. Minimal signs of disease at this stage.
- antibodies to FIPV develop by 7-10 days after infection. Unfortunately, they do not protect against disease but rather enhance the virus's ability to infect macrophages and circulating blood monocytes. This process is called "antibody-dependent enhancement" or "ADE". These cells then carry the virus throughout the body. The virus-infected macrophages may then attach to and migrate through the walls of small blood vessels and there induce damage. The interaction between the virus and the body's immune response is responsible for the damage caused by the disease.
- it is proposed that the cat's ability to mount a strong cell-mediated immunity [CMI] determines the outcome of infection. Strong CMI eliminates the disease, partial CMI allows the development of noneffusive [dry] FIP, whereas weak CMI allows the development of effusive [wet] FIP. [See diagram]

Effusive FIP:

- abdomen and/or chest distends with viscous, pale yellow to golden, clear or slightly cloudy fluid. The fluid may clot upon exposure to air and may contain flakes of fibrin. Determination of protein content and the number and types of cells present is usually diagnostic although in equivocal cases, protein electrophoresis of the fluid may be necessary to confirm the diagnosis.
- the lining of the affected body cavity is covered by multiple white, fibrin-containing plaques -- often most evident on the liver and spleen.
- the mesenteric lymph nodes may be enlarged and the mesentery may be thickened and gelatinous.
- in general, the course of the disease in the effusive form is likely to be more rapid than the course of the noneffusive form.

Noneffusive FIP:

- effusion is minimal or absent.
- one or more organs develop characteristic "pyogranulomatous inflammation". These inflammatory lesions are multiple and of variable size within and on the surface of the affected organ. Biopsy of one of the lesions and identification of the typical cells and their orientation to the blood vessels is the only definitive way to diagnose this form of the disease.
- may affect almost any abdominal organ [kidneys, liver, mesenteric lymph nodes, and spleen are most common]. Thus the organ[s] affected and their degree of involvement determine the signs and laboratory test changes seen.
- may cause disease in the eyes [ocular FIP].
- may cause disease of the central nervous system [CNS], ie., the brain or spinal cord. Again, the signs seen are determined by the locations of the lesions.
- may cause pyogranulomas in the lungs but disease here usually doesn't cause breathing difficulty. Changes on x-rays may be seen.

In sum, the diagnosis of FIP is usually difficult and may be impossible without biopsy of appropriate lesions. Diagnosis after death is the most common. Please perform a post-mortem examination with submission of appropriate samples for histopathologic examination of all animals that die. Don't assume that death was caused by FIP just because the cat may have had a positive coronavirus antibody titer prior to its demise.

Treatment -- virtually 100% unsuccessful. Some temporary remission has been reported to occur in a few cases treated with immunosuppressive chemotherapy. Unfortunately, even in those cats that were carefully selected for optimum response and treated aggressively, any benefit from therapy was seen in less than 10% of cases treated.

Control in the Cattery:

- A way to completely control FIP in enzootic catteries is not known.
  - inability to identify asymptomatic carriers hinders ability to remove them as a source of infection to the other cats.
  - inability of current tests to identify antibody specific for FIP makes it impossible to determine the risk that an antibody-positive cat poses to other cats.
  - in cats that die of FIP, the most significant shedding of viruses occurs prior to the development of any illness.
  - eliminating any cats in the cattery that test antibody-positive is not realistic. Most cats in the cattery will more than likely be positive if any are, and clearly, not all antibody-positive cats are shedding or will ever shed FIPV.
  - interpretation of antibody titers is difficult. There is no standardization among laboratories that perform the test, so reported titer levels from one lab can't be compared with those from another lab. Regrettably, anyone can set up a lab and run tests -- there is no regulatory body that oversees them. Also, inoculation with any vaccine has the potential to cause false positive antibody titers when checked with IFA [the most commonly run test] or standard ELISA tests. The KELA test run at the diagnostic laboratory here at Cornell can detect these "background" levels caused by vaccination, but even this test can't as yet distinguish between titers caused by FIPV or a less pathogenic coronavirus. In short, be cautious in placing too much credence in an FIP test result!

- As a rule, catteries that have the best husbandry practices have the least amount of difficulty with FIP. Recall the techniques discussed previously regarding reducing overcrowding, segregation of cats into specific groups, reducing incidence of other disease, etc.

- Even with all the potential problems encountered with titer interpretation, it is probably wise to not bring antibody positive cats into the cattery. An antibody positive cat has the potential to develop FIP or shed FIPV. Ideally the cat should test negative, be quarantined, and retest negative 6-8 weeks later before incorporating into the cattery.

- A recent study by Addie and Jarrett of Scotland outlines principles that may prove effective in assuring that kittens sold don't subsequently develop FIP.
  - a total of 400 kittens from 41 households with various FIP histories were divided into three different types of groups. Group "N" included kittens that were allowed to mix with the rest of the household, group "M" included kittens that were isolated with their mother, and group "I" included kittens that were isolated from all cats, including the mother, beginning at 2-6 weeks of age. None of the kittens from group "I" developed FIP or even developed coronavirus antibodies. Thus, by segregating the queen prior to

parturition and after the birth of her kittens, and by early-weaning the kittens and keeping in isolation from the other cats, we may be able to prevent transmission of the virus from carrier cats to susceptible kittens. Kittens should test antibody negative at least twice -- once when at least 10 weeks of age and again 4 weeks later prior to selling.

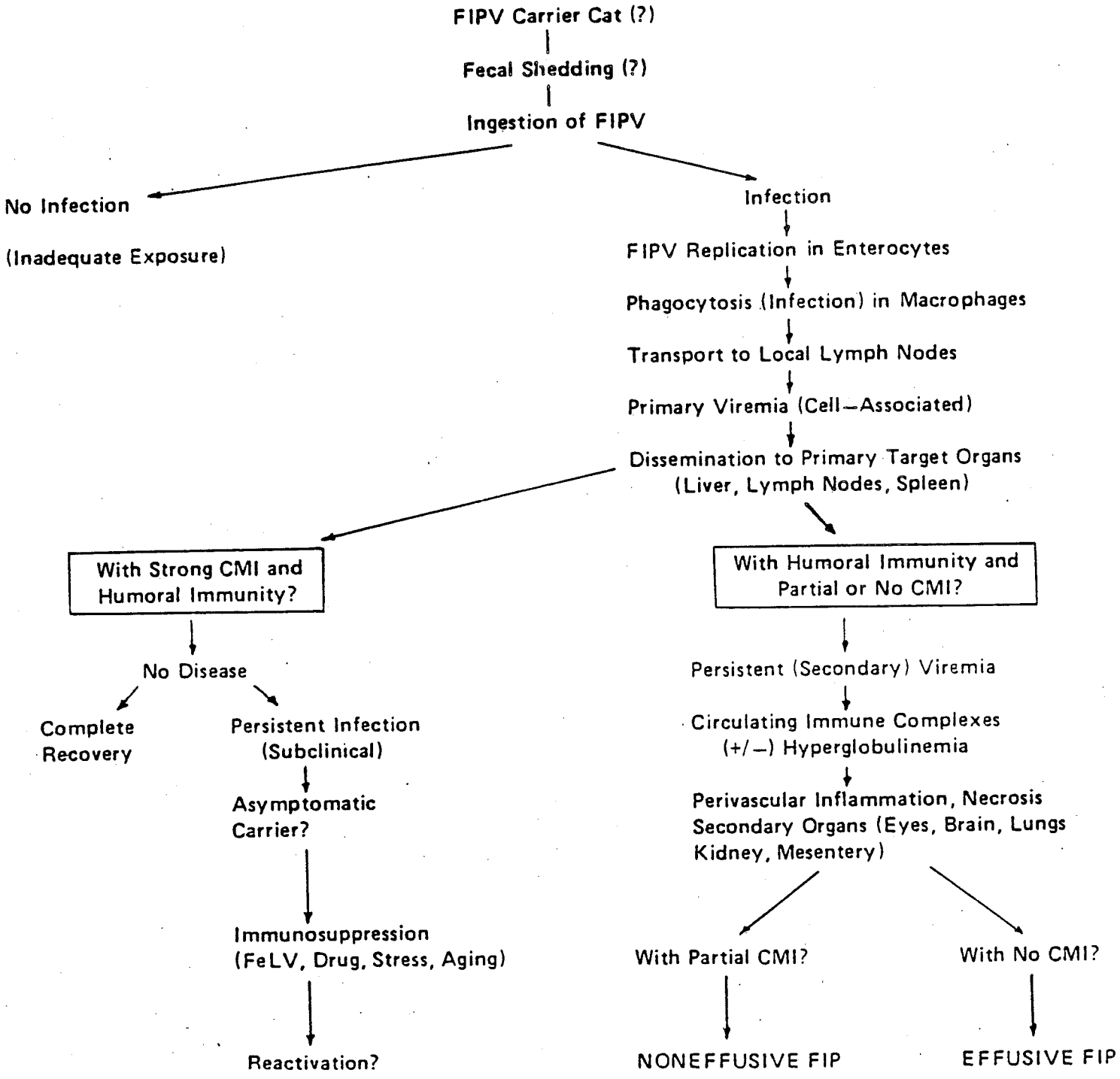
- Vaccination?
  - a vaccine designed to prevent the development of FIP was recently released.
  - studies show conflicting results regarding vaccine efficacy. Earlier studies by the manufacturer indicated a mean efficacy of 69%. Later independent studies have failed to show effectiveness although the challenge virus dose and virus strain were different in this recent test.
  - the vaccine is currently licensed for use at 16 weeks of age with boosters in 3-4 weeks, then annually. As revealed in the Addie and Jarrett study discussed above, exposure and infection of kittens may occur long before 16 weeks of age. Vaccination after exposure would not be helpful in preventing disease. The manufacturer is currently investigating vaccine efficacy when given earlier.

Suggested additional readings:

Addie D. D., Jarrett O. A STUDY OF NATURALLY OCCURRING FELINE CORONAVIRUS INFECTIONS IN KITTENS. Vet. Record, February 15, 1992.

Barlough Jeffrey E., Stoddart Cheryl A. Cornell Feline Health Center Information Bulletin 6, Sept. 1984

Olsen Christopher, Scott Fred W. FELINE INFECTIOUS PERITONITIS VACCINATION -- PAST AND PRESENT. Feline Health Topics for Veterinarians, 6(2), Spring 1991.



Proposed pathogenesis of FIP [Adapted from THE CAT: DISEASES AND CLINICAL MANAGEMENT, edited by Robert Sherding, Churchill Livingstone, 1989]