Feline Infectious Peritonitis
“the scourge of cats”

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Feline Infectious Peritonitis - FIP

- A sporadic fatal immune-mediated “infectious” disease of cats
- A major factor in kitten mortality*
- Most commonly affects kittens up to 1 year of age
- More common in kittens that are or have been housed with multiple cats

*Cave et al., Vet Rec 2002; 151:497-501
The cause?

• The underlying culprit is a coronavirus but beyond that….

• There are still a lot of questions and unknown aspects of this disease!
Coronavirus – what is it?

- **FCoV** is very common in cats but only rarely causes FIP.
The feline coronavirus (FCoV) infects wild and domestic felines. Most feline coronaviruses (FCoV) cause harmless often inapparent GI infections. Rarely, FCoV causes FIP in a cat ("FIP-causing-FCoV").
Some basics about FCoV

- It is an RNA virus
- They mutate frequently often while multiplying within the infected cat
- Most mutations are probably meaningless as far as the cat is concerned but some result in the ability to cause FIP in that cat
An important point to remember

• The majority of cats infected with FCoV show no clinical disease, or only transient mild gastrointestinal or respiratory signs; And they do NOT develop FIP.
How common are FCoV infections?

- FCoV is extremely common wherever cats are housed in groups as it is readily transmitted between cats.
- Prevalence of antibodies to FCoV range from 10-90% depending on the study population.
- One study showed that 33% of cats and kittens entering a CA shelter were infected at time of intake which increased to more than 60% after only one week. Kittens and juvenile cats had more than 90% infection rates.

FCoV Transmission

- Transmission is typically by fecal-oral contact with contaminated feces.
- Either directly or via fomites
- FCoV is VERY easy to transmit and therefore difficult to control.
- Keeping cats in separate cages or even separate rooms rarely prevents transmission.
Transmission and reinfection

- Once a cat is infected with FCoV virus can be shed in the cat’s stool for weeks to months. Many cats will eventually eliminate the infection.
- However, the cat is NOT immune to reinfection via direct contact or fomites.
Infection-reinfection cycle

- Re-infection with either the same, or a different, strain is common in multicat housing situations.
- Whether a cat becomes persistently or transiently infected is usually independent of the virus strain*. 

Addie DD et al., J Gen Virol 2003;84:2735-44
Which cat is shedding?

- With each new infection, the cat can shed infective virus again for weeks to months.
- Approximately 1 in 3 FCoV infected cats sheds virus in its feces. Without costly testing (fecal PCR analysis), it is impossible to determine which cat is actively shedding since most have no signs.
FCoV Shedding FAQ’s

- Some healthy carrier cats can shed virus up to 10 months*
- Most shed virus intermittently, some shed chronically – these can be a continual source for infection of other cats
- Truly antibody negative cats probably don’t shed
- Cats with high FCoV antibody titers seem to shed virus more consistently and higher amounts*
More shedding FAQ’s

• Height of the FCoV antibody titer is directly correlated with amount of virus in the cat.

• **Cats with FIP appear to shed less FCoV**

• **Cats with FIP appear NOT to shed the mutated form**
Prevalence of FIP – what is “normal” and what is an “outbreak”?

- FIP has become more prevalent since its first description in 1963.
- It now results in more deaths than FeLV related disease.
- The reason may be due to the changes in management i.e. cats are housed in more crowded conditions for longer periods of time.*
Prevalence of FIP – what is “normal” and what is an “outbreak”?

- Study numbers range from 1-12% of FCoV antibody seropositive cats in a given facility.
- 5-10% prevalence rates and “outbreaks” of >10% can be typical in multiple cat environments.
- However, the rate of FIP in more traditional rapid turnover shelters is < 0.6%
- Therefore: rates higher than 1% in a shelter may be cause for concern?
How many of you have had FIP in your facility in the past year?

YES | NO
Which cats get FIP?

Feline Infectious Peritonitis is caused by a FCoV when it mutates in a susceptible probably stressed cat/kitten.

Susceptible cat =
- Under 3 years of age (>50% are under 1 year)
- genetic predisposition

Stress =
- crowding
- other diseases
- surgery
- movement (cage to cage or house to house)
- Etc.
In other words……

Dose of FCoV
Viral mutation(s) in the cat
Cat’s immune system
Genetic factors
Stress

= FIP
Dose

• More FCoV in the environment and in cats may result in a higher likelihood of the “right” mutation

• More virus replicating at higher rates means more rolls of the dice hence more chances that an adverse mutation will occur
Dose and virulence of FCoV

- A “virulent” FCoV is one more likely to cause FIP by:
  1) replicating and therefore shedding at a higher rates
  2) having an increased tendency to mutate to an FIP causing form (loaded dice).
  3) Or both!
Mutation(s)

- It is not just one mutation
- Several different simple changes in certain specific viral genes result in mutations that can induce FIP
- Hence there is no one “FIP VIRUS” rather it is a FCoV that has mutated in one of several ways that may cause FIP in a susceptible cat
The cat’s immune system

- FIP is essentially caused by an interplay of antibody, virus and the epithelia of various organs.
- However, antibodies to FCoV can also be protective.
- A compromised immune system for any reason can make FIP more likely to occur.
Genetic factors

• In one study of purebred cats, those that were closely related to an FIP cat have a higher risk (25%) of developing the disease
How many of you have seen more FIP in littermates?

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<th>NO</th>
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The impact of stress

- Immune system health is impacted by many factors including crowding (stress), concurrent illnesses etc.
Clinical signs

• The most common clinical sign(s) in young cats is:

A cyclic antibiotic un-responsive fever, lethargy, unexplained weight loss and failure to grow
Other clinical signs include...

- Accumulation of high protein fluid in the chest and/or abdominal cavity ("wet FIP")
Other clinical signs....

- Ocular changes!
- These include changes to the iris, uveitis and lesions on the retina.
Clinical signs

- Signs of organ failure especially kidney and liver
- Neurological changes (can include ataxia, changes in personality etc.)
The challenge of diagnosis -
the available tests include:

- Complete blood count
- Serum chemistry
- Tests on effusion (fluid)
- Titers in blood, titers in effusion
- PCR in blood, effusion or feces
- Immunohistochemistry (IFA) on effusion, or tissue
- Histology/necropsy
CBC and serum chemistry

- **CBC**
  blood counts are often changed in cats with FIP but none are diagnostic

- **Serum chemistry**
  Albumin/globulin ratio
  
  - < 0.8 probability of FIP is high
  - > 0.8 cat likely does NOT have FIP
  
  - α-acid glycoprotein
    - >1500µg/mL
  
  - Elevated kidney or liver values may provide clues
Tests on effusion

- Classified as a modified transudate
- High protein content (globulins)
- Low cell content
- “Positive Rivalta test”

(similar fluid found with lymphoma, heart failure, peritonitis and liver disease)
The Rivalta test

- Fill a clear test tube ¾ full with distilled water, add one drop 98% acetic acid and mix (or vinegar).
- Carefully place one drop of the cat’s effusion on the surface of the acid.
- If drop disappears Test = negative
- If drop retains shape Test = positive

Courtesy of Dr. Katrin Hartmann, Univ of Munich, Germany
Titers

• There is NO “FIP specific” antibody titer test!
• A large percentage of the feline population is FCoV antibody-positive
• Even high, rising and/or fluctuating titers can be found in healthy cats that never develop FIP
• No cat should be euthanized simply because of a positive titer test
FCoV titers – usefulness?

- As part of several tests to help narrow the possibility of FIP
- To determine whether a cat has been exposed to FCoV
- To maintain a FCoV negative household
- Negative or very high titers may be more useful
- Titers on effusion may be more useful
PCR

• RT-PCR on blood has the same limitations as titer tests
• Both healthy and cats with FIP can have positive blood tests
• RT-PCR on feces is useful to document which cat is shedding FCoV
• New test (Auburn U) – mRNA in macrophages.
Immunohistochemistry

- IFA staining detects FCoV antigen in cells (either tissue or cells in effusion).
- Finding FCoV in macrophages has a positive predictive value of 100%!
Histology

- Use for biopsy or necropsy samples.
- Results are often not 100% diagnostic ("suggestive of FIP")
- If FIP is suspected it is best to ask for FCoV staining – to see if found in macrophages
Tests for diagnosis vs. management of FIP

**Tests for diagnosis**

- **Clinical signs, age and history**
  - Serum albumin/globulin
  - Serum chemistry (to look at organ function)
  - Serum titer (if truly negative, likely not FIP)
  - Rivalta test on fluid
  - IFA on fluid, tissue (biopsy or necropsy)
  - Histochemistry (with IFA)

**Tests for management of FIP**

- Titers on serum
  - to look for potential high shedders
  - to determine level of FCoV infection in a population
- PCR on serum
- PCR on feces
  - to determine fecal FCoV shedding

- PCR on feces

Management of FIP

• It’s all about decreasing the amount of FCoV

1) Lower the number of cats
2) Lower stress
3) Lower concurrent other diseases
4) Focus on litterbox hygiene?
In a shelter

• Focus on population management
• Decrease amount of handling – (in-cage-cat-cleaning?)
• Consider making a break between the “dirty population” and “clean” incoming cats (or adults and kittens).
In a foster home

- Do not add cats to the home until all current kittens are gone and home is thoroughly cleaned
- Adopt out non-siblings
- Littermates?
Lower the dose in both

• Remember the source of an outbreak is probably **NOT** the kitten with FIP!
• Decrease population numbers (Identify high shedders?)
• Litterbox hygiene?
Lower the number of susceptible cats

- Kittens and young cats often shed more FCoV
- Too many litters in a shelter or foster home can easily “breed” FIP
Cleaning and disinfection

- Source of FCoV is the litterbox and the “spreader” is us! (Kennel staff should change clothes after cleaning a room)
- Frequent scooping and/or complete litter changes may help (watch that dust!)
- FCoV can survive up to 4 weeks in the environment (but is killed by most disinfectants)
Controlling FIP in a nutshell

• Focus on decreasing FCoV in the environment

POPULATION MANAGEMENT
GOOD HUSBANDRY/HYGIENE

• FIP appears in multiple cat populations
• Risk of outbreaks occur in shelters/foster homes that are crowded
• Risk increases the more time a cat spends in a shelter
THE END

Finally! I’m exhausted