**Feline Infectious Peritonitis (FIP)**

**Extended Version**

**Classic case:** Ascites, YOUNG, MALE cat no obvious source; malaise, wt. loss; no response to ABX

Fatal, progressive, viral, immune-complex disease of cats; Definitive Dx difficult antemortem

May involve mutation of feline coronavirus (FCoV) to virulent FIP virus

**Presentation:**

- **Young** cats, post-weaning - 6 mos - 2 yrs age
- **MALES >> Females**
- **Multi-cat** environments - CATTERIES, shelters
- Asian breeds, e.g. Himalayan, Birman
- Also seen in exotic felines (zoo cats)

- **Nonspecific** signs:
  - Inappetence, weight loss, wasting
  - Fever, lethargy, unkempt appearance
  - Occasional diarrhea

- **More specific** signs-:
  - Not really two different kinds
  - More of a spectrum of disease

<table>
<thead>
<tr>
<th>Effusive</th>
<th>Non-effusive, pyogranulomatous dz</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute</strong>, common</td>
<td><strong>Chronic</strong></td>
</tr>
<tr>
<td><strong>Peritonitis</strong></td>
<td><strong>Abdominal (palpable masses) 50%</strong></td>
</tr>
<tr>
<td>Abdominal effusion</td>
<td>• Icterus, hepatomegaly</td>
</tr>
<tr>
<td>Pot-bellied</td>
<td>• PU/PD</td>
</tr>
<tr>
<td>Palpable fluid wave</td>
<td>• Mesenteric lymphadenopathy</td>
</tr>
<tr>
<td>Adhesions</td>
<td>• Splenomegaly</td>
</tr>
<tr>
<td>Abdominal masses</td>
<td>• Intestinal thickening &amp; obstruction</td>
</tr>
<tr>
<td>Vomiting, diarrhea</td>
<td>• Pleural 10-15% cases</td>
</tr>
<tr>
<td>4/- Pleuritis</td>
<td>• Dyspnea</td>
</tr>
<tr>
<td><strong>Pleural effusion</strong></td>
<td>• CANS - focal or diffuse - 60%</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>• Personality changes, seizures</td>
</tr>
<tr>
<td>Recumbent a lot</td>
<td>• Ataxia, paralysis</td>
</tr>
<tr>
<td>Tire easily</td>
<td>• Nystagmus, CNS signs</td>
</tr>
<tr>
<td>Muffled heart &amp; lung sounds</td>
<td>• Hypermetria, intention tremors</td>
</tr>
</tbody>
</table>

**Other signs:**

- Dermatologic
  - Intradermal pustules
- Not pruritic
- Reproductive
  - Infertility, stillbirth, abortion
  - Congenital malformation
  - **Fading kittens**
- Sequela:
  - DIC*
  - *disseminated intravascular coagulation

- **CNS** - focal or diffuse - 60%
  - Personality changes, seizures
  - Ataxia, paralysis
  - Nystagmus, CNS signs
  - Hypermetria, intention tremors

- **Ocular** 60%
  - Anterior uveitis
    - Iris color change
    - Corneal edema
    - Aqueous flare
    - Hypopyon, hyphema
  - Posterior chamber, fundic lesions
  - Blindness

*Image courtesy, Uwe Gille*
Feline Infectious Peritonitis (FIP)

Extended Version

**DDX:** (nothing good)

- FIV
- FeLV
- Congestive heart failure
- Neoplasia (lymphoma)
- Pyothorax
- Chylothorax
- Lymphocytic plasmacytic cholangitis

**Ocular signs:**

- Toxoplasmosis,
- FIV
- FeLV
- Systemic mycosis

**Hyperglobulinemia:**

- Lymphoma
- Multiple myeloma
- Chronic infection

**Test(s) of choice:**

**Supportive diagnostics:**

- CBC – nonregenerative anemia
- Chemistry:
  - **Hyperglobulinemia w/ low albumin/globulin ratio – a hallmark of FIP**
    - Electrophoresis - polyclonal gammopathy - $\uparrow \alpha_2$ & $\gamma$ globulins most common
  - Azotemia
  - $\uparrow$ Liver enzymes
  - $\uparrow$ Bilirubin
  - UA - Bilirubinuria

- Analysis of effusion(s)
  
  - **Nonseptic exudate – high protein, low cells**
    - Clear, straw-colored, viscous, fibrin strands
    - **Protein > 3.5mg/dL**
    - **Low total cell count (< 2000/mcL)**
    - **Globulin conc > 32% strongly suggests FIP**
    - **0.9 albumin/globulin ratio (74% sensitivity, 86% specificity for FIP)**

  - **Rivalta screening test for FIP**
    - Mix 1 drop conc. acetic acid (vinegar) in 10 ml distilled H2O
    - Add 1 drop effusion to above mixture
    - Neg - drop of effusion disappears into solution
    - **Pos - drop of effusion maintains shape and sinks slowly**
    - Positive predictive value (86%), neg. predictive value (96%) for FIP

- Imaging studies:
  - Radiographs/ultrasound
    - Identify effusion(s), organomegaly, lymphadenopathy
  - Computed tomography - hydrocephalus in >75% FIP cases

- FCoV serology:
  - Positive titer **exposure to FCoV; most + cats DO NOT develop FIP**
  - Titers > 1:16,000 - suggestive of FIP **if C/S present**
  - Terminal stage of FIP - titer may be negative (rare)
Test(s) of choice: (continued)
- CSF analysis:
  - High protein > 20 mg/dL
  - Cell count >5 cells/μL - mononuclear pleocytosis w/ neutrophils
- α1 Acid glycoprotein (AGP): Acute phase protein; ↑s w/infectious dz in cats
  - Plasma or effusion > 1500 ug/dL suggests FIP

Confirmatory testing:
- PCR w/ reverse transcription:
  - Blood sample: cannot distinguish between FCoV and FIP
  - Effusion sample: sensitive & specific
- FIP mRNA PCR multiTest
  - Detects mRNA of M gene expressed during replication in mononuclear cells
  - Test on whole blood – detects replicating virus particles (U of Auburn Molecular Dx Lab)
  - Enteric virus replicates only in intestine, so will not cross react in this test
- DEFINITIVE DIAGNOSIS: Biopsy w/ immunohistochemistry
  - Histopathology
    - Pyogranulomatous inflammation w/ vasculitis, viral particles in macrophages
  - + Immunohistochemistry

Dx most often based on clin sx, characteristics of effusion, & lack of other dz, esp. in a young cat

Rx of choice:

<table>
<thead>
<tr>
<th>Supportive/palliative care based on clinical signs</th>
<th>Acute Therapy</th>
<th>Chronic Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize stress</td>
<td>Flows</td>
<td>Typically unrewarding, MAY improve signs, $$$</td>
</tr>
<tr>
<td>- Comfortable, quiet environment</td>
<td></td>
<td>- Immunomodulating drugs to reduce viral load</td>
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<tr>
<td>- Reduce intercat conflict</td>
<td></td>
<td>- Human α-interferon</td>
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<tr>
<td>Nutritional support for anorectic cats</td>
<td></td>
<td>- Recombinant feline interferon</td>
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<tr>
<td>- Hand-feed</td>
<td></td>
<td>- w/ corticosteroids for better efficacy</td>
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<tr>
<td>- Warm food</td>
<td></td>
<td>- Acemannan – immunomodulator from Aloe</td>
</tr>
<tr>
<td>- Offer multiple types</td>
<td></td>
<td>- Immune suppression</td>
</tr>
<tr>
<td>Vitamin supplementation</td>
<td></td>
<td>- Control of immune-mediated vasculitis</td>
</tr>
<tr>
<td>- A, B complex, B1, C, E</td>
<td></td>
<td>- Prednisolone +/- cyclophosphamide</td>
</tr>
<tr>
<td>IV or SQ fluids</td>
<td></td>
<td>- Low dose aspirin</td>
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<tr>
<td>Rx 2° bacterial infections</td>
<td></td>
<td>- Anti-inflammatory, anti-thrombogenic</td>
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<tr>
<td>- Broad spectrum antibiotics</td>
<td></td>
<td>- Thalidomide - immunomodulator</td>
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<tr>
<td></td>
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<td>- Teratogenic (owner approval)</td>
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</table>

If quality of life is poor – Consider euthanasia
Feline Infectious Peritonitis (FIP)

**Prognosis:** Grave
- **INCURABLE, fatal** disease regardless of form or Rx
  - **Dry form:** 1 yr survival
  - **Wet form:** survive days to 2 mos post Dx

**Prevention:**

<table>
<thead>
<tr>
<th>Husbandry practices (CATTERY)</th>
<th>Intranasal FIP Vaccine</th>
</tr>
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<tbody>
<tr>
<td>• Separate seronegative from seropositive</td>
<td>• NOT recommended for low risk cats</td>
</tr>
<tr>
<td>• Breed only seronegative cats</td>
<td>• Protects 50-75% cats</td>
</tr>
<tr>
<td>• Remove kittens from queen at 5-6 weeks</td>
<td></td>
</tr>
<tr>
<td>• Add only seronegative cats to population</td>
<td></td>
</tr>
</tbody>
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<tr>
<th>Environment / hygiene / management</th>
<th>Client education</th>
</tr>
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<tr>
<td>• Remove feces DAILY</td>
<td>• Select cats only from reputable breeder</td>
</tr>
<tr>
<td>• Increase number of litter boxes</td>
<td>• FIP + cats - keep separate ALWAYS</td>
</tr>
<tr>
<td>• Disinfect - viricidal product (Bleach works)</td>
<td>(or euthanize)</td>
</tr>
<tr>
<td>• Reduce crowding stress</td>
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</tbody>
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**Pearls:** Dx most often based on C/S, characteristics of effusion, lack of other dz, esp. in a young cat

Pathophysiology of FIP is theorized to go like this:
- Begins with coronavirus (FCoV) infection of GI tract (many cats)
  - FCoV mutates into virulent strain (a few young cats)
  - multi-organ systemic disease and FIP

**Feline enteric coronavirus (FCoV)**
- Greatest risk of developing FIP is in first 6–18 mo after infection w/ FCoV.
- The risk decreases to about 4% at 36 mo post infection

- FCoV, relatively benign RNA virus, large genome, is vulnerable to mutation
  - FCoV causes a mild self-limiting diarrhea
  - Ubiquitous in multi-cat environments
  - Carrier cats have no clinical signs
  - Many cats infected, FEW develop FIP

- RFcoV replicates w/in enterocytes
  - +/- replication in oropharynx 1st few days
  - Shed in feces 2 days post-infection
  - Hours to days in saliva

- Transmission: Feco-oral, saliva (mutual grooming), transplacental

Image courtesy Kalumet
Pearls: (continued – pathogenesis of FIP)

- **FCoV spontaneously mutates into FIP virus**
  - Each FIP virus unique to cat
  - FCoV is transmissible, FIP virus is **NOT** transmissible

- FIP virus replicates w/in macrophages & regional lymph nodes, **UNlike** FCoV
  - Virus travels systemically with macrophages

- **Outcome of infection varies** with pathogenicity of mutant virus & immune response
  1. Elimination of virus
  2. Develop effusive FIP: Complement-mediated response
  3. Develop non-effusive FIP: Partial cell-mediated response
  4. Formation of antibody-antigen complexes - deposited in vascular endothelium