Update on feline panleukopenia

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What is feline panleukopenia?
- Feline panleukopenia, also known as feline infectious enteritis is a highly contagious and often fatal disease of cats caused by feline panleukopenia virus (FPV) or canine parvovirus (CPV), two closely related strains of Carnivore protoparvovirus 1. These are non-enveloped single-stranded DNA viruses in the genus Protoparvovirus, family Paroviridae with a 5 kb genome.
- Over 95% of cases of feline panleukopenia are caused by feline panleukopenia virus (FPV).
- CPVs have been identified in cats in South East Asia and in individual cases of feline panleukopenia in Europe

How is feline panleukopenia transmitted?
- Transmission of paroviruses is usually faecal-oral and indirect by ingestion of virus particles in fomites (e.g. infected body fluids, faeces).
- FPV and CPV are resistant to many disinfectants and have the ability to survive harsh environments for 12 months or more.
- Reservoirs of FPV in the environment are likely maintained by cats that are subclinically infected (asymptomatic) and by recovered infected cats that shed virus in their faeces for around six weeks after recovery.

How quickly does disease develop after exposure?
- Clinical signs of disease occur after a 2 to 10 day incubation period.
- FPV and CPV need to use the host’s cellular enzymes to replicate successfully (cellular DNA polymerases in rapidly multiplying cells).
- Viral replication first occurs in the lymphoid tissues of the oropharynx 18 to 24 hours post-infection. This is followed by a viraemia 2 to 7 days later with widespread dissemination of the virus in lymphoid tissue, bone marrow and intestinal crypt epithelium.
- Clinical disease comprises severe enteritis and profound immunosuppression as a result of leukopenia and lymphoid depletion, with severe secondary sepsis.

What are the risk factors for developing disease?
- Kittens are at high risk, especially from the age of 6 to 12 weeks when maternal antibodies wane.
- Unvaccinated cats are also at high risk of developing disease.

What are the clinical signs of disease?
- In kittens < 6 weeks old, sudden death due to severe dehydration and sepsis is a common presentation (per-acute disease).
- In older kittens and cats clinical signs are acute and progressive. Lethargy and anorexia usually occur first and are followed later by vomiting and/or small bowel diarrhoea.
- In contrast to dogs with paroviral enteritis, diarrhoea in cats is often not haemorrhagic.
The onset of gastrointestinal signs usually coincides with leukopenia, which is often severe, characterised by neutropenia and lymphopenia (leukocyte counts of 50-3000 cells/µL in severe cases and 3000-7000 cells/µL in less severe disease).

Infected queens can abort (in early pregnancy) or give birth to kittens with neurological defects that affect co-ordination and vision (late pregnancy), most notably cerebellar hypoplasia. This also occurs in pregnant queens vaccinated with modified live virus (MLV) vaccines.

How common is feline panleukopenia in Australia?
- Effective vaccinations against FPV have been available since the 1960s.
- FPV vaccines afford protection against canine parvoviruses.
- Clinical disease was rare in Australian cats from the mid-1970s until 2014, when an outbreak of 63 cases in Melbourne was logged by veterinarians on Disease Watchdog, a national online disease surveillance reporting tool.
- Three outbreaks causing over 350 fatalities were identified in; (A) 2014, Melbourne; (B) 2015, Melbourne and Mildura, a city 540 km from Melbourne; (C) 2016, Melbourne and Sydney. Outbreaks in Mildura and Melbourne were caused by identical, or closely related, FPV genotype(s), while the Sydney outbreak was caused by a different FPV genotype. Most cases occurred in cats from council pounds or charitable or private shelters.
- The median age of cats at diagnosis was 8 weeks. All outbreaks occurred from summer to autumn, coinciding with peak shelter intakes of kittens.
- Since then, recurrent outbreaks have occurred over summer and spring months in Melbourne and Sydney, coinciding with peak kitten season.

What are the risk factors for feline panleukopenia in Australia?
- Two important factors were identified as contributing to the recent feline panleukopenia outbreaks in Sydney and Melbourne; absent or incomplete vaccination and suboptimal biosecurity. Movement of unvaccinated kittens or cats from council pounds or private shelters to networks of private foster carers was identified in all outbreaks.
- Shelters with the highest number of fatalities did not perform routine vaccination. In shelters that did administer vaccines, disease occurred in incompletely-vaccinated cats < 16 weeks old (e.g. kittens that had received only one or two vaccine) or cats that had not been vaccinated because of respiratory disease or other illnesses.

How can I diagnose disease in-house?
- Signalment, vaccination history, clinical signs and haematology/biochemical findings are useful to increase or decrease index of suspicion for panleukopenia.
- Leukopenia, including neutropenia and lymphopenia occurs in about two-thirds of cases and its absence should not be used to rule out a diagnosis.
- Recovering cats will develop a rebound left-shift leucocytosis. Thrombocytopenia occurs in about half of cases and is caused by megakaryocyte destruction in the bone-marrow or DIC.
- Anaemia is usually mild unless GIT blood loss is severe
- The most common abnormalities on serum biochemistry panels are hypoalbuminaemia (45% cases), hypoproteinaemia (30%), liver enzyme elevations (AST, 30%) and electrolyte abnormalities, especially hypochloraemia (35%) and hyponatraemia (30%).
- Cage-side faecal antigen ELISA test kits designed to detect CPV in dogs can be used for diagnosis in cats, as they detect both CPV2a-c and FPV antigen in faeces. The sensitivity of these tests in one small study of 200 feline faecal samples, including 52 from cats with diarrhoea of which 10 were confirmed to have parvovirus infection on electron microscopy, ranged from 50 to 80% with 5 different
commercial kits. Test specificity was high (94-100%). Intermittent viral shedding or prevention of binding of monoclonal antibodies to viral epitopes by endogenous antibodies can negatively impact test sensitivity.

- Vaccination against FPV using modified live vaccines (MLV) can result in false-positive test results for 14 – 21d post-vaccination.
- Confirmation of infection is by PCR detection of FPV or CPV DNA in blood or faeces. In Australia some labs use a qPCR to detect FPV and CPV and it will not distinguish between the two.
- When testing by qPCR false positives can occur in recently vaccinated cats. Ask the laboratory to disclose the CT (cycle threshold) value. Assays with low CT values indicate high viral loads and are most consistent with active infections. Assays with high CT values indicate low viral loads and are more likely to be associated with vaccination. Studies in dogs show that viral loads shed post vaccination are generally four to five fold lower than natural infections.

**What is the treatment for feline panleukopenia?**

- Any cat treated as an in-patient should be quarantined in isolation, and barrier-nursed using strict hygiene to prevent fomite transmission.
- Dehydration is a major contributor to mortality. Fluid, blood glucose, acid-base and electrolyte imbalances should be monitored and restored. Parenteral glucose supplementation may be required in addition to intravenous crystalloid therapy in kittens.
- Hypoproteinaemia/anaemic cats may require plasma, typed whole-blood transfusion or synthetic colloids.
- Plasma and heparin therapy is appropriate for treatment of DIC.
- Antimicrobial therapy is essential since sepsis from translocation of enteric bacteria is a leading cause of death. Antibiotics effective against Gram-negative and anaerobic bacteria should be given intravenously where possible.
- The risk v benefits of antimicrobials should be assessed before use (e.g. aminoglycosides are contraindicated in acute kidney injury; risk of retinal toxicity from fluoroquinolones).
- Similar antimicrobials can be used for treatment of FPV as for CPV in dogs (e.g. ampicillin or ticarcillin-clavulanate alone or in combination with gentamycin or fluoroquinolones or third-generation cephalosporins).
- Anti-emetics, e.g. maropitant or maropitant plus ondansetron are indicated for control of vomiting and nausea. Gastroprotectants and H2 blockers may be indicated (e.g. sucralfate, famotidine).
- Early enteral nutrition with highly digestible diets is indicated as soon as emesis is controlled.

**Issues in vaccinology – The immunity gap**

- Ingestion of maternally-derived antibodies (MDA) in colostrum shortly after birth protects kittens against infections that the queen has been exposed to naturally or vaccinated against. MDA titres gradually decline over time and by 16 weeks of age, are no longer detectable in most kittens.
- As MDA levels fall, a point is reached where MDA no longer protect against infection BUT the antibodies interfere with vaccination, making it ineffective. This is known as the immunity gap.
- For example, MDA levels may wane to a level that fails to protect against FPV infection in 8 to 12 week-old kittens but is still of an adequate magnitude to interfere with vaccination, so vaccination of these kitten at this time point will fail to
confer vaccinal immunity (Figure 2). This window is known as the “immunity gap”.

![Figure 1](image1.png)

**Figure 1.** The immunity gap is the period when maternal immunity no longer protects the kitten from infection by feline panleukopenia virus, but still interferes with the development of vaccinal immunity. Figure adapted from ABCD guidelines on prevention and management of feline panleukopenia¹.

What are the WSAVA vaccine guideline recommendations for FPV?
- The World Small Animal Veterinary Association (WSAVA) recommends that kittens be vaccinated from 6 weeks of age every 3 to 4 weeks until they are 16 weeks of age or older.
- An adopted adult cat or kitten > 16 weeks of age requires only a single dose of MLV FPV vaccine to engender a protective response to that virus.
- A booster vaccine is recommended at the age of 6 months or 1 year with subsequent booster vaccinations every three years thereafter.
- Consideration for a booster vaccine at 6 months of age instead of 1 year is a more recent recommendation, and is aimed to catch animals that may not have responded to any of the vaccines given in the primary core vaccine course.
- Cats that have responded to vaccination with MLV core vaccines maintain a solid immunity for many years in the absence of any repeat vaccination. Therefore, after the first booster vaccination, re-vaccination is recommended every three years.

What are vaccine recommendations for shelters during FPV outbreaks?
- In situations where FPV has broken out in a shelter, kittens should be vaccinated from 4 weeks of age, using modified live virus (MLV) vaccines. Vaccination should be repeated every 2-3 weeks until 16 weeks of age.
- Cats of unknown vaccine status should not be housed together.
- MLV vaccines are recommended because they induce a more rapid onset of immunity than inactivated vaccines.
- In one study 64 eight-to-ten week old kittens were vaccinated with one dose of inactivated or MLV FPV vaccine. Protective antibody titres were present 14 days post-vaccination in 31% of kittens receiving inactivated FPV versus 85% of kittens receiving MLV, respectively.
Is measuring antibody titres before vaccination a useful practice?

- This was evaluated in a study that aimed to determine factors associated with a lack of adequate response to FPV vaccination in adult cats (> 1 year old) that had been vaccinated at least > 12 months previously.
- Healthy cats presenting for vaccination to a shelter or teaching hospital in Germany were vaccinated with a single dose of a MLV FPV vaccine. Blood was taken on days 0, 7 and 28 for detection of antibodies by haemagglutination inhibition (HI). A titre of ≥ 1:40 was considered protective against FPV. An adequate response to vaccination was a ≥ 4-fold increase in titre.
- 64% of cats had antibody titres of ≥ 1:40 at presentation and were likely already protected against FPV.
- 48% of cats had an adequate response to vaccination.
- 5% of cats were non-responders.
- Thus, almost a third of cats had no or low antibody titres. In contrast the prevalence of CPV Ab titres in dogs in the same area was 86%. Herd immunity in owned cats is likely to be lower than dogs because cats are more solitary, more likely to be kept indoors and less likely to have natural booster vaccination through more direct contact with cats or dogs.
- Factors associated with an adequate response to vaccination were lack of a non-protective pre-vaccination titre, having never been vaccinated before and DSH breed.
- This study showed that evaluation of FPV antibody titre in cats with previous FPV vaccination history can be useful to identify cats with high Ab titres, in which revaccination is unnecessary.
- Cats with high Ab titres likely neutralise the virus before it stimulates the immune system, as is the case with MDA.

What disinfectants are effective against FPV and CPV?

There are several disinfectants that are effective against paroviruses including:
1. F10™ – this is a combination of two classes of disinfectant, a biguanide and a quaternary ammonium compound (benzalkonium chloride), neither of which are effective against FPV or CPV by themselves. F10 disinfectant is effective against FPV and CPV at a concentration of 1:100 with a minimum contact time of 15 minutes.
2. Potassium peroxymonosulfate (Virkon™)
3. Sodium hypochlorite (household bleach) – is effective using a 1:32 dilution of a 5 to 6% solution of sodium hypochlorite. Bleach is corrosive and can cause damage to non-stainless steel cages.

References