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SPECIAL ARTICLE

SOMETHING OLD, SOMETHING NEW
Update of the 2009 and 2013 ABCD guidelines on prevention and management of feline infectious diseases

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Overview: The ABCD has published 34 guidelines in two Special Issues of the *Journal of Feline Medicine and Surgery* (*JFMS*): the first in July 2009 (Volume 11, Issue 7, pages 527–620) and the second in July 2013 (Volume 15, Issue 7, pages 528–652). The present article contains updates and new information on 18 of these (17 disease guidelines and one special article 'Prevention of infectious diseases in cat shelters'). For detailed information, readers are referred to the guidelines published in the above-mentioned *JFMS* Special Issues.

European Advisory Board on Cat Diseases
The European Advisory Board on Cat Diseases (ABCD) is a body of experts in immunology, vaccinology and clinical feline medicine that issues guidelines on prevention and management of feline infectious diseases in Europe, for the benefit of the health and welfare of cats. The guidelines are based on current scientific knowledge of the diseases and available vaccines concerned.

The latest full versions of the disease guidelines updated in this article are available at www.abcdcatsvets.org and www.abcd-vets.org

Feline panleukopenia

Canine parvovirus type 2 (CPV-2), which is closely related to feline panleukopenia virus (FPV), was described in 1978 as a new parvovirus (cited in Carmichael[1]). It evolved from FPV with the acquisition of five or six amino acid changes in the capsid protein[2] and does not infect cats. However, during further adaptation to the dog, which most likely occurred in the raccoon, the virus underwent amino acid changes that made the mutated virus bind more efficiently to the canine cellular receptor, while retaining the ability to infect cats.[3,4] This led to the emergence of the new type, CPV-2a, which contains a series of further mutations including those at amino acid 426 of the VP2 that determine the antigenic types 2a, 2b and 2c. The parvoviruses currently circulating in dog populations worldwide (genetically and antigenically defined as types CPV-2a, -2b and -2c) can infect cats and may even cause disease.[5–7] However, CPV infections of cats are rare in Europe and the USA, and the virus has only sporadically been found in diagnostic material.[6] CPV was isolated from feline peripheral blood lymphocytes after numerous blind passages, and viral DNA was demonstrated subsequently by PCR.[8] Recently, however, a case of CPV-2c infection in a cat with severe clinical disease was described in Portugal.[9]

Feline panleukopenia: ABCD guidelines on prevention and management
The feline panleukopenia guidelines that the present article is updating were published in *J Feline Med Surg* in 2009 (11: 538–546) and updated in 2013 (15: 530–531). This further update has been compiled by Uwe Truyen.

During the evolution of FPV to CPV-2 with its various antigenic types, neutralising epitopes have become modified such that cross-neutralisation by FPV antisera is markedly lower against the newer viruses.[10]

Persistent infections with viral shedding are rare; using PCR, healthy cats have been found positive for FPV in faeces over weeks,[11] and CPV-2 viruses could be isolated from the faeces of healthy cats in the UK in two shelters.[12] It is unknown whether these findings are of epidemiological significance.

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The parvovirus sequences encountered in wild carnivores (pumas, coyotes, raccoons, and others) revealed a wide genotypic variation. This finding suggests infection of predators by their parvovirus-infected prey, and hence a new route of infection.[13]

Following intrauterine infection, FPV antigen persists in the cerebellum of kittens for weeks.[14]

Detailed information on the prevention and management of parvovirus infection in cats is provided in the ABCD guidelines[15] and a previous update.[16]

Feline herpesvirus infection

Feline herpesvirus (FHV), together with feline calicivirus, is involved in the feline upper respiratory tract syndrome. In addition, FHV has been recognised as the most important cause of corneal ulceration, both superficial and deep, and in particular of dendritic ulcers. The infection becomes latent, allowing lifelong persistence of the virus, which is sporadically interrupted by episodes of viral reactivation and re-excretion. Thiry et al[17] and Horzinek et al[16] presented a table summarising recommendations for treatment of acute FHV ocular disease. The amino acid L-lysine has been proposed for systemic treatment, to be administered as a bolus, separate from food. No reports of side effects have been published, but findings on efficacy are conflicting.[18–25] Cave et al[26] investigated the effects of physiological concentrations of L-lysine on the in vitro replication of FHV at L-arginine levels sufficient to maintain cell growth. FHV was not inhibited at any L-lysine concentration studied. The in vivo efficacy of L-lysine treatment on primary and recurrent FHV infection is unknown.

Feline herpesvirus infection: ABCD guidelines on prevention and management

The feline herpesvirus infection guidelines that the present article is updating were published in *J Feline Med Surg* in 2009 (11: 547–555) and updated in 2013 (15: 531–533). This further update has been compiled by Etienne Thiry.

Feline leukaemia virus infection

Feline leukaemia virus (FeLV) is a gamma retrovirus affecting domestic cats worldwide. It also infects small wild cats including *Felis silvestris*, European and Iberian lynxes, Florida panthers and the Chilean wildcat (*Leopardus guigna*).[27–30] The prevalence of FeLV infection in Europe and North America has greatly diminished. In individually kept cats it is low; often, but not everywhere, less than 1%.[31–35]

After infection of bone marrow cells, viraemia develops within a few weeks. Mainly lymphocytes and monocytes are infected, whereas later infection involves mostly neutrophils.[36] Viraemia may be overcome by the immune system (transient viraemia) in some cats,[37] whereas others develop a persistent viraemia. A smaller proportion (~5%) exhibits an atypical course of infection, displaying antigenaemia, but no or only low-level viraemia.[38,39] A cat that has overcome viraemia remains latently infected. Reactivation may occur; it is not clear how often this happens under field conditions, but it is believed to be rare. Generally, up to 10% of all feline blood samples submitted to a laboratory prove to be provirus-positive and p27-negative; since FeLV may be reactivated in some of these cats, they should be considered latently infected.[35,40,41] Probably no cat can clear an FeLV infection from all cells.

Experimentally, susceptible kittens can be protected from FeLV infection after passive immunisation with high-titred specific antisera.[38] This observation suggests that antibodies have a role in protection; however, once persistent viraemia has become established, treatment with neutralising monoclonal antibodies to FeLV has proven ineffective.[42]

In an experimental study, seroconversion was observed in cats as the sole evidence of FeLV infection.[43] These cats had been exposed once intranasally to low doses of FeLV (10,000 FFU). Since some of them seroconverted, it was concluded that the virus had replicated somewhere to sufficient levels to trigger antibody synthesis. PCR analysis of several organs was negative, indicating that further replication must have been controlled by the immune system.

In most situations, individual cats are tested for FeLV infection. However, when the cost of testing is a limitation, pooled saliva samples can be used to detect FeLV RNA; the RNA PCR is sufficiently sensitive to detect a single infected cat in a pool of up to 30 samples. This approach may be chosen when screening multi-cat households.[44] While all viraemic cats are positive for FeLV RNA in saliva, a few may shed FeLV RNA in saliva, but are not (yet) viraemic or antigenaemic.[45]

The observation that antibodies can develop as the sole parameter of exposure to FeLV[43] led to the examination of various FeLV antigens to assess their diagnostic potential to detect antibodies. In contrast to published results,[46] a recombinant preparation of FeLV p15(E) proved highly effective for the detection of antibodies induced by FeLV infection and thus for the diagnosis of a previous infection.[47]

The HIV integrase inhibitor raltegravir was found to inhibit FeLV replication in vitro.[48] The drug is tolerated well by cats, and within 1 week leads to a marked reduction in viral loads. However, this is not sufficient for the immune system to control the viraemia, and treatment must be continued over long periods in order to maintain low viral loads and prevent disease [EBM grade III].[49]

Feline leukaemia virus infection: ABCD guidelines on prevention and management

The feline leukaemia virus infection guidelines that the present article is updating were published in *J Feline Med Surg* in 2009 (11: 565–574) and updated in 2013 (15: 534–535). This further update has been compiled by Hans Lutz.

In many experiments it was shown that no FeLV vaccine provides complete protection or prevents infection. Cats that overcome p27 antigenaemia without exception test provirus-positive in blood, and also test positive for viral RNA in plasma, although at much lower levels than persistently viraemic cats [EBM grade III].[50] These experiments confirm that FeLV vaccination does not induce sterilising immunity and does not protect cats from infection. However, cats vaccinated with conventional, adjuvanted, whole inactivated virus vaccines did not show p27, viral RNA or DNA after a low-dose challenge with the subgroup A virus FeLV A/61E.[51] Various factors may have played a role: the challenge virus was used at a very low dose (10,000 $TCID_{50}$ injected once, intraperitoneally), the assays used were less sensitive than those used by Hofmann-Lehmann et al,[50] and the cats had a different genetic background. Testing for FeLV in internal organs would have resulted in observations as reported by Major et al.[43] Thus, the proposition remains valid that vaccination against FeLV protects cats from disease but not from infection.

Until recently, no data had been published to demonstrate that immunity lasts longer than 1 year after primary vaccination; most vaccine manufacturers therefore recommend annual boosters. However, the demonstration that one FeLV vaccine provided immunity for at least 2 years[52] [EBM grade II] suggests that this may also apply to other vaccines. Combined with the lower susceptibility of adult cats to FeLV infection, the ABCD recommends that, in cats older than 3 years, a booster immunisation every 2–3 years is sufficient.

Wherever possible, cats entering a shelter should be kept in quarantine for at least 3 weeks, if not (re)homed sooner. All incoming cats (at least in shelters that allow contact between cats after the quarantine period) should be screened for FeLV antigen and feline immunodeficiency virus (FIV) antibody, and ideally also for FeLV antibody.[47] Antigen-negative but antibody-positive results suggest that the cat is not viraemic/antigenaemic, but may be latently infected. Therefore, PCR for FeLV DNA should additionally be performed. If the PCR shows a high FeLV DNA load, this cat should prudently be considered latently infected; the cat should best be placed in a home without other cats for several months. If only an FeLV antigen test is performed, cats testing negative should ideally be retested 6 weeks later (and kept in quarantine for this time period), as it may take 4–6 weeks after infection for the test to return positive results. To prevent (re)activation of other infections caused by the stress of entering the shelter, newcomer cats should be kept isolated and observed for clinical signs. After quarantine, they can be introduced into small groups of healthy cats. FeLV antigen- and/or FIV antibody-positive cats should be kept separate, but may be housed together with other retrovirus-positive cats, and adopted out to suitable homes as soon as possible.

The ABCD does not recommend euthanasia of healthy FeLV-positive cats. However, if no adequate home can be found, if separation from the rest of the population is impossible, or if the cat is sick, euthanasia should be considered. Detailed recommendations are provided in the ABCD guidelines 'Prevention of infectious diseases in cat shelters'.[53]

Detailed information on the prevention and management of feline leukaemia virus infection is provided in the ABCD guidelines[54] and a previous update.[16]

Feline immunodeficiency virus infection

It is generally accepted that feline immunodeficiency virus (FIV) infection can induce clinical signs of immunodeficiency, leading to opportunistic infections or lymphomas, and clinical signs consistent with immunodeficiency in natural infection have been documented.[55] However, in some cats the clinical signs are mild, which likely reflects both heterogeneity among circulating field isolates as well as host factors, and it has been reported that many FIV-infected cats have a normal life expectancy.[56–58] Therefore, surrogate markers are required to provide an objective assessment of FIV progression in individual cats. Recently it was shown that viruses dominating in early infection display a distinct receptor usage phenotype and that the emergence of viruses with an altered receptor usage phenotype coincides with the onset of immunodeficiency.[59] Accordingly, viral phenotyping might assist in the clinical staging of individual cats diagnosed with FIV infection.

FIV infection was found to be prevalent in a survey of four large-scale hoarding situations;[60] this high prevalence was probably related to the fact that the cats were living in close confinement under stressful conditions, and exhibiting aggressive behaviour. Therefore, it is recommended that cats should be tested for FIV infection at the time of seizure during hoarding investigations, as the results will influence housing decisions, medical care and adoption options.

FIV infection is also common in rescue shelters and it is recommended that all cats in rescue centres should be neutered and kept

Feline immunodeficiency virus infection: ABCD guidelines on prevention and management

The feline immunodeficiency virus infection guidelines that the present article is updating were published in *J Feline Med Surg* in 2009 (11: 575–584) and updated in 2013 (15: 535). This further update has been compiled by Margaret J Hosie.

indoors, in order to reduce the risk of territorial aggression, which can result in penetrating bite wounds and consequently FIV transmission. This recommendation is supported by studies linking cat bite wounds and abscesses with FIV infection.[61,62] A recent survey of cats in a rescue shelter, in which FIV-infected cats were housed together with uninfected cats, found no evidence of FIV transmission, in spite of the cats having unrestricted access, and sharing food and water bowls, litter trays and bedding for several years.[63] However, it is possibly significant that the cats had been neutered before entering this shelter and the median age of the uninfected cats was 4 months; kittens are a low risk group for FIV infection[64] because territorial aggression has not yet developed. Similarly, neutered cats are less likely to display territorial aggression than intact cats and, therefore, FIV transmission might be more likely to occur in rescue centres housing older cats, especially if those cats exhibit aggressive behaviour.

Detailed information on the prevention and management of feline immunodeficiency virus infection is provided in the ABCD guidelines[65] and a previous update.[16]

Rabies

Rabies is caused by a *Lyssavirus*, a member of the *Rhabdoviridae* family. The genus *Lyssavirus* contains 12 species: rabies virus, Mokola virus, Lagos bat virus and Duvenhage virus from Africa, European bat lyssaviruses (EBLV) 1 and 2, Australian bat lyssavirus, and five recently recognised species (International Committee on Taxonomy of Viruses, 2012). Each of these viruses is considered capable of causing a rabies-like disease in animals and humans.

Feline rabies: ABCD guidelines on prevention and management

The feline rabies guidelines that the present article is updating were published in *J Feline Med Surg* in 2009 (11: 585–593) and updated in 2013 (15: 535–536). This further update has been compiled by Tadeusz Frymus.

Various control measures (eg, vaccination of wildlife, immunisation of dogs and cats, diagnostic measures, control of pet movements) eliminated rabies from large regions of Europe, especially its western and northern parts. In rabies-free countries, however, though sporadic, the illegal importation of pets from regions where this disease is endemic poses an increasing risk.[66] Rabies was recently recognised in a kitten imported into France from Morocco,[67] and a few cases in dogs were documented in Europe recently.

As a result of the mass vaccination of dogs in many areas affected by wildlife rabies, cats have become the companion animal species most commonly reported as rabid, as is the case in many states of the USA.[68] In a recent report from Pennsylvania, among 2755 rabid animals with reported human exposure, as many as 799 (29.0%) were free-ranging cats, whereas only 57 (2.1%) were dogs.[69]

Because of the public health risk associated with susceptible domestic cats becoming infected following exposure to rabid wild or domestic animals, all cats with outdoor access in endemic areas should be vaccinated. The vaccine should be administered in accordance with local or state regulations. In countries where rabies is absent, rabies vaccination is indicated when a cat moves or travels to an area where rabies is endemic.

EU Regulation 576/2013 established new rules for the non-commercial movement of pet animals (dogs, cats and ferrets) between EU countries as of 29 December 2014. According to these rules, all such cats should be identified by microchip (or tattoo, if applied before 4 July 2011) and vaccinated against rabies; a 21-day waiting period following primary vaccination is required. This means that for the purpose of travel, cats generally must be at least 15 weeks old, as 12 weeks is the minimum age for rabies vaccination. Some countries accept younger animals without rabies vaccination under certain conditions, but most do not (for details see http://ec.europa.eu/food/animal/liveanimals/pets/nat_rules_dogscatferret_en.htm). According to the recent pet movement regulation, serological testing for rabies neutralising antibodies is no longer required before entry into any EU member state.

Detailed information on the prevention and management of rabies in cats is provided in the ABCD guidelines[70] and a previous update.[16]

Feline infectious peritonitis

Given the number of major recent developments in the field of feline coronavirus (FCoV) and feline infectious peritonitis (FIP), fully updated ABCD guidelines on FIP will be published in the near future. For the purpose of this interim update, some key developments in FIP diagnosis and treatment are outlined below.

Feline infectious peritonitis: ABCD guidelines on prevention and management

The feline infectious peritonitis guidelines that the present article is updating were published in *J Feline Med Surg* in 2009 (11: 594–604) and updated in 2013 (15: 536). This further update has been compiled by Diane Addie.

Among the most interesting of the developments relating to FIP diagnosis is the advent of a commercially available reverse transcription PCR (RT-PCR) test which distinguishes mutations on the spike of type I FCoVs that are associated with the development of systemic spread of the virus.[71] There is a question of this test not being as sensitive as conventional FCoV RT-PCR, not only because it does not detect type II FCoVs, but also because the spike protein is the protein most subject to evolutionary immune pressure, and so the spike gene

is the most variable of the coronavirus genes, and thus primers may not bind, giving a false negative result.

It is the view of the ABCD that RT-PCR is a preferred method of FIP confirmation for effusions, over immunofluorescence of macrophages, which is less widely available and more prone to human error.

In a comparison of commercially available FCoV antibody tests, 16 applications of FCoV antibody tests were considered: sensitivity was deemed extremely important because many uses of FCoV antibody tests involve ruling out a diagnosis of FIP or FCoV infection.[72] An in-house ELISA fared best, both in terms of sensitivity/specificity and quantity of sample required (only 5 μl). The most sensitive rapid immunomigration (RIM) tests were identified. RIM tests fared best in terms of rapidity of result, which is useful when screening a healthy cat, but they may give false negative results if used to support FIP diagnosis on effusion samples, due to binding of virus to antibody, rendering the antibody unavailable for the test antigen.[73]

For treatment, Polyprenyl Immunostimulant (Sass & Sass) is only for use in non-effusive FIP, having no efficacy in effusive FIP. One study of three non-effusive FIP cases reported survival of 14 months for one cat and over 2 years for two cats [EBM grade IV].[74] However, a conference abstract report of 58 cats showed only 22% survival at 6 months, with just one cat surviving at a year [EBM grade III].[75] A placebo-controlled study is required.

Gil et al[76] showed that in cats with FeLV or FIV infection, feline interferon omega therapy resulted in a tendency towards reduced FCoV shedding [EBM grade III].

Chloroquine inhibits FCoV replication in vitro and has anti-inflammatory effects in vivo.[77] However, reported survival times were only around 30 days at best and the drug increased alanine aminotransferase levels. Thus, the ABCD does not recommend its use until further studies have demonstrated significant benefit.

A placebo-controlled double blind trial on propentofylline showed no efficacy [EBM grade I].[78]

Detailed information on the prevention and management of feline infectious peritonitis is provided in the ABCD guidelines[79] and a previous update.[16]

Influenza A virus infection in cats: ABCD guidelines on prevention and management

The influenza A virus infection in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2009 (11: 615–618) and updated in 2013 (15: 537). This further update has been compiled by Etienne Thiry.

Influenza A virus infection in cats

Recommendations for the prevention of influenza A H5N1 and H1N1 infections in cats were published in the ABCD guidelines[80] and subsequently updated.[16]

Cats were recently found to be susceptible to the H3N2 and H5N2 influenza viruses, the agents of canine influenza in Asia, leading to morbidity and mortality in cats for H3N2, but only to mild clinical signs for H5N2.[81,82] Experimental infection of cats with the recent H5N8 influenza A virus was successful, but remained subclinical.[83]

Feline viral papillomatosis

Papillomaviruses cause cutaneous lesions in man and several animal species, including cats. The ABCD has published guidelines on the prevention and management of feline viral papillomatosis.[84]

In each host, including cats,[85] different papillomavirus (PV) types exist. To date, four feline PVs from domestic cats have been fully sequenced and classified.[85] These viruses were designated as *Felis domesticus* PVs (FdPVs), but recently changed to *Felis catus* PVs (FcaPVs).[86]

Feline viral papillomatosis: ABCD guidelines on prevention and management

The feline viral papillomatosis guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 560–562). This update has been compiled by Herman Egberink.

A clear association between papillomavirus DNA (the *Felis domesticus* papillomavirus 2 – FdPV-2) and squamous cell carcinomas (SCCs)

EBM ranking used in this article

Evidence-based medicine (EBM) is a process of clinical decision-making that allows clinicians to find, appraise and integrate the current best evidence with individual clinical expertise, client wishes and patient needs.

This article uses EBM ranking to grade the level of evidence of various statements and recommendations on a scale of I to IV as follows:

- **EBM grade I** This is the best evidence, comprising data obtained from properly designed, randomised controlled clinical trials in the target species (in this context cats);
- **EBM grade II** Data obtained from properly designed, randomised controlled studies in the target species with spontaneous disease in an experimental setting;
- **EBM grade III** Data based on non-randomised clinical trials, multiple case series, other experimental studies, and dramatic results from uncontrolled studies;
- **EBM grade IV** Expert opinion, case reports, studies in other species, pathophysiological justification.

Further reading

Lloret A. **The process of evidence-based medicine.** *J Feline Med Surg* 2009; 11: 529.
Roudebush P, Allen TA, Dodd CE, et al. **Application of evidence-based medicine to veterinary clinical nutrition.** *J Am Vet Med Assoc* 2004; 224: 1765–1771.

was reported; DNA was detected in all 20 Bowenoid in situ carcinomas (BISCs) examined, and in 17 of 20 cases of invasive SCC.[87] However, FdPV-2 DNA was also present in 52% of normal skin swabs.[88] Although FdPV-2 has been detected most frequently in BISCs and SCCs, other PV types have also been identified. Recently, a novel PV type, designated FcaPV-3, was detected in a feline BISC.[86] In one study, 50% of the sequenced PV DNA was most closely related to human PV DNA.[89] In another study, PV DNA could not be detected in any of 30 oral SCC samples screened,[90] which is at variance with earlier observations.

Bartonella species infection in cats

Bartonella species infection in cats: ABCD guidelines on prevention and management
The *Bartonella* species infection in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 563–569). This update has been compiled by Fulvio Marsilio.

The ABCD guidelines on *Bartonella* species infection in cats[91] list various species and subspecies of *Bartonella* that are confirmed or potential human pathogens: *B bacilliformis*, *B quintana*, *B elizabethae*, *B grahamii*, *B henselae*, *B clarridgeiae*, *B koehlerae*, *B vinsonii* subspecies *berkhoffii*, *B vinsonii* subspecies *arupensis*, *B washoensis* and *B asiatica*. Additionally *B rochalimae* should now be included, for which reservoir hosts may be raccoons, coyotes, red foxes and cats. The vectors are fleas, and humans may be accidental hosts.

The important role of fleas in the transmission of *B henselae* and *B clarridgeiae* among cats has been demonstrated. Using a quantitative molecular approach, *B henselae* DNA was detected in both fleas and their faeces for the entire life span of the arthropod (ie, 12 days) starting from 24 h after the blood meal.[92]

Recently, the possible role of several bat fly species (*Nycteribiidae*) as *Bartonella* vectors has been studied. It remains a subject of debate, but a reservoir function should be considered in addition to pathogenic, parasitic or mutualistic interactions.[93]

The role of *Bartonella* as a pathogen after natural transmission is still unclear; however, *B henselae* was found in association with pyogranulomatous myocarditis and diaphragmatic myositis in two cats.[94]

For laboratory diagnosis, a real-time PCR and pyrosequencing-based algorithm was described that allowed rapid differentiation of at least 11 medically relevant *Bartonella* species within 5 h from receipt of the specimens.[95]

Coxiellosis/Q fever in cats

Q fever is a zoonotic disease caused by *Coxiella burnetii*. ABCD guidelines on prevention and management of coxiellosis/Q fever in cats have been published.[96]

Coxiellosis/Q fever in cats: ABCD guidelines on prevention and management
The coxiellosis/Q fever in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 573–575). This update has been compiled by Herman Egberink.

Farm animals and pets are the main reservoir hosts of the bacterium, and exposure of cats is relatively common. In the UK, a seroprevalence as high as 61.5% was recently demonstrated.[97]

A Q fever outbreak among veterinary hospital personnel was linked to a caesarean section on a parturient queen. The breeding queen was *C burnetii* seropositive, and antibodies were demonstrated in 26% of the cats living in the same cattery.[98]

Francisella tularensis infection in cats

Francisella tularensis infection in cats: ABCD guidelines on prevention and management
The *Francisella tularensis* infection in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 585–587). This update has been compiled by Maria Grazia Pennisi.

Tularaemia is a potentially fatal zoonosis. Various clinical syndromes occur, but most patients either present with a localised infection of the skin and draining lymph nodes (ulceroglandular form) or with a systemic infection (typhoidal tularaemia). Oropharyngeal and pneumonic forms are rare.

The risk of acquiring the infection from cats is low, but exists for owners of cats with outdoor access, as well as for veterinarians and technicians.[99] Regular parasiticidal treatment to prevent tick infestations is recommended for outdoor cats. When handling animals with suppurative or draining skin or lymph node lesions in endemic areas, gloves and goggles should be worn. Gloves should be also be worn when examining the oral mucosa. Handling of diagnostic samples by laboratory staff requires adherence to appropriate biosafety procedures.[100]

Detailed information on the prevention and management of tularaemia in cats is provided in the ABCD guidelines.[101]

Mycobacterioses in cats

In recent years, awareness of the importance of mycobacterial infections in humans and animals has been increasing. ABCD guidelines on the prevention and management of mycobacteriosis in cats were published in 2013.[102]

An unusual cluster of *Mycobacterium bovis* infection in cats was recently reported from the UK. Cat-to-cat transmission was suspected, and two humans became infected.[103] Also nosocomial infection was reported in a cluster of cases that had attended a veterinary practice in Ireland.[104]

For diagnostic purposes, PCR is recommended; it should ideally be performed on fresh tissue samples, but fixed stained smears and formalin-fixed paraffin-embedded tissues can be used with good sensitivity.[105]

The zoonotic risk has to be considered when planning therapeutic measures.[102] It is complicated by the fact that confirmation of the mycobacterial species takes time, and antibiotic therapy requires several months. Therefore, euthanasia rather than treatment should be considered as a sensible course of action, in view of the public health implications and the prognostic uncertainties of treatment.

For the tuberculosis complex and non-tuberculous mycobacteria (NTM) groups, double or triple therapy is currently recommended: rifampicin (10–15 mg/kg q24h), plus a quinolone (marbofloxacin [2 mg/kg q24h] or pradofloxacin [3–5 mg/kg q24h]), plus a macrolide (clarithromycin [125 mg/cat q24h or 7–15 mg/kg q24h] or azythromycin [5–15 mg/kg q24h]) for 6–9 months. Ideally, the three drugs should be administered during an initial phase of 2 months, followed by two of the drugs for 4–7 months [EBM grade III].[106,107]

The newer fluoroquinolones (moxifloxacin and pradofloxacin) might be more effective than the older ones.[108,109] Unpublished clinical experience suggests that pradofloxacin is a good choice; in localised disease, pradofloxacin would be a good initial treatment pending species confirmation [EBM grade IV].[110]

Treatment of NTM infections is ideally based on culture and susceptibility tests for each case, as different mycobacterial species or strains may have different antibiotic sensitivity. However, this is not always possible, as specific culture systems are unavailable or results take too long.

Disseminated *M avium-intracellulare* complex (MAC) infections usually respond poorly to treatment, and older generation quinolones are not very effective.[111–113] The recommended first choice treatment is clarithromycin with clofazimine (4–8 mg/kg q24h) or rifampicin or doxycycline (5–10 mg/kg q12h) based on the few cases reported with good outcomes [EBM grade IV].[114–116] Limited clinical experience with pradofloxacin suggests that it is more effective than the older fluoroquinolones.[110]

Most cats with feline leprosy can be cured by surgery (small lesions), and treatment with combinations of rifampicin, clofazimine, clarithromycin and pradofloxacin for several months [EBM grade IV].[117,118] Spontaneous remission has been documented in one cat.[119]

Keeping the cat indoors and avoiding contact with wild rodents are the only measures for preventing mycobacterial infection.

Mycobacterioses in cats: ABCD guidelines on prevention and management

The mycobacterioses in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 591–597). This update has been compiled by Albert Lloret.

Potential zoonotic risk

All members of the TB complex are potentially zoonotic, including *M microti*. However, the risk of transmission from cats (and dogs) to humans is low, as cats are spillover hosts.[107,120] In a recent cluster of feline cases of *M bovis* infection in the south west of England, two people became infected after having been in contact with the cats.[103] The Public Health Agency in England then changed the risk level of transmission from negligible to low (www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317140243205).

Euthanasia or treatment of cats with confirmed *M bovis* infection should be a consensus decision between the owner and the veterinarian, but due to the risk of cat-to-human transmission (see box above) and antimicrobial resistance, euthanasia has been suggested by some authorities and experts (www.bva.co.uk/News-campaigns-and-policy/Newsroom/News-releases/Updated-statement-on-TB-in-cats/). Similarly, euthanasia might be considered after infection with any of the other potentially zoonotic species (*M tuberculosis*, *M microti* and *M avium*).

Cryptococcosis in cats

Cryptococcosis in cats: ABCD guidelines on prevention and management

The cryptococcosis in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 611–618). This update has been compiled by Maria Grazia Pennisi.

Feline cryptococcosis occurs rarely or sporadically, but *Cryptococcus gattii* has a worldwide distribution with a high prevalence along the Pacific coast of North America. It has been reported also from Brazil,[121] and in Europe from Austria, Denmark, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.[122] *C neoformans* var *grubii* also has a worldwide distribution and is commonly isolated from affected individuals of various animal species. *C neoformans* is considered a cosmopolitan opportunistic pathogen in human urban populations, whereas *C gattii* is a true pathogen, more prevalent in rural areas.[123]

Feline cryptococcosis caused by *C neoformans* or *C gattii* is clinically indistinguishable.

This disease can manifest after a long incubation period[124] and presents in different clinical forms, including the nasal form, central nervous system (CNS) form (which can derive from the nasal form or occur independently), the cutaneous form and the systemic form.[125] CNS involvement most likely arises following local dissemination through the cribriform plate.[126] Recently, otitis interna following systemic spread of the fungus was reported.[127]

Detailed information on the prevention and management of cryptococcosis in cats is provided in the ABCD guidelines.[125]

Sporotrichosis in cats

Sporotrichosis in cats: ABCD guidelines on prevention and management
The sporotrichosis in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 619–623). This update has been compiled by Albert Lloret.

Sporotrichosis is a deep cutaneous mycosis caused by the dimorphic saprophytic fungus *Sporothrix schenckii*. *S schenckii* is not a unique species but a complex containing at least four distinct species. Most feline cases reported from Brazil are caused by *S brasiliensis*.[128]

The prevalence of the disease varies markedly between regions. In Central and South America, it represents the most common deep mycosis. In Brazil it is endemic, and an important epidemic affecting humans, cats and dogs was reported in Rio de Janeiro.[129–131] More than 2000 feline cases over 7 years have been seen by just one institution, showing the magnitude of the epidemics and the challenges of disease control.[132]

Using histopathology and staining procedures, the organisms are readily visualised. Cats with few and well organised granulomas tend to have low numbers of fungal organisms in the lesions. Cats in poor general condition and with large numbers of granulomas have the greatest numbers of fungal organisms.[133]

Detailed information on the prevention and management of sporotrichosis in cats is provided in the ABCD guidelines.[134]

Toxoplasma gondii infection in cats

Several antibody tests have been used to detect infection with *Toxoplasma gondii* and to diagnose toxoplasmosis in cats. The indirect immunofluorescence assay can be adapted to detect immunoglobulin M (IgM), IgG and IgA antibodies.

Antibody test results from healthy cats are useful to assess the health risk for humans. An antibody-negative cat could be shedding oocysts (early after infection, before antibodies have developed) or will shed oocysts if exposed; this cat poses the greatest public health risk.

An antibody-positive cat is unlikely to shed oocysts, because antibodies need 2–3 weeks to develop, by which time the infection has been controlled; also, shedding usually occurs only once in the cat's lifetime. Furthermore, a cat with antibodies is unlikely to shed oocysts if re-exposed or immunosuppressed.[135] In one study, cats inoculated with *T gondii* tissue cysts were orally re-challenged several years later, and a few of them did shed oocysts after this second challenge (although only low amounts and over a short time).[136] This, however, has never been shown to occur in naturally infected cats. Thus, the risk of shedding by an antibody-positive cat is very low.

Toxoplasma gondii infection in cats: ABCD guidelines on prevention and management
The *Toxoplasma gondii* infection in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 631–637). This update has been compiled by Katrin Hartmann.

Antibodies are common in both healthy and diseased cats and, therefore, do not prove clinical toxoplasmosis. Not only IgG antibodies, but also antibodies of the IgM class are commonly detected in healthy cats and stay high over long periods; thus their detection is also of no use for diagnosing toxoplasmosis. *T gondii*-specific IgM is detected in the serum of cats with latent or reactivated infection and titres, therefore, do not indicate recent exposure. If increasing IgM titres are detected, however, this can raise the suspicion of clinical toxoplasmosis.

Clinical toxoplasmosis is ideally diagnosed by detection of the organism in muscle biopsies or bronchoalveolar lavage fluid, or by PCR performed on cerebrospinal fluid (CSF) or aqueous humour. During acute illness, tachyzoites can be detected in tissues and body fluids by cytology. They are rarely found in blood, but occasionally in CSF, fine-needle aspirates of organs (eg, lymph nodes), and transtracheal or bronchoalveolar washings, and are common in the peritoneal and thoracic fluid of animals developing thoracic effusions or ascites. Detection of tachyzoites confirms the diagnosis.

A tentative diagnosis can be based on increasing IgM titres, exclusion of other causes of the clinical signs, and a positive clinical response to an anti-*Toxoplasma* drug.[135,137]

Detailed information on the prevention and management of *T gondii* infection in cats is provided in the ABCD guidelines.[138]

Leishmaniosis in cats

Leishmania infection is less well known in cats than in dogs, but it may be underestimated in endemic areas and is of zoonotic concern. Detailed information on the prevention and management of leishmaniosis in cats was published in the ABCD guidelines.[139]

Leishmaniosis in cats: ABCD guidelines on prevention and management
The leishmaniosis infection in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 638–642). This update has been compiled by Maria Grazia Pennisi.

The information available for treatment is based only on case reports. Despite clinical improvements following long term oral administration of allopurinol (10–20 mg/kg q12h or q24h), the infection is not cleared, and recurrence of clinical signs may occur after cessation of therapy, as in dogs [EBM grade IV].[140,141] Meglumine antimoniate (5–50 mg/kg or 375 mg/cat q24h SC/IM under different proto-

cols) was used for therapy in four cases and led to good clinical responses, but long term follow-up is lacking [EBM grade IV].[140]

Giardiasis in cats

Giardia is a protozoan parasite of the small intestine. Seven genotypes have been identified and designated A to G. Types F and G are the subgroups commonly seen in cats, whereas A and B occur mainly in man and are considered as potentially zoonotic.[142] Giardiasis in cats is not considered a zoonotic risk.[143,144] However, recent European studies demonstrated the presence of subgroup A in cats,[145–147] either alone or as a dual infection (A and F).[146] Genotype B has also been identified in cats, but A is most prevalent, according to a Canadian study.[148] A correlation between body condition score, presence of diarrhoea and infection with *G intestinalis* has been observed;[149] but, in other studies, agent presence has not been notably different in cats with diarrhoea as compared with healthy cats. Co-infections with other enteropathogens have been demonstrated to be frequent in the UK.[150]

Giardiasis in cats: ABCD guidelines on prevention and management

The giardiasis in cats guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 650–652). This update has been compiled by Corine Boucraut-Baralon.

Detailed information on the prevention and management of giardiasis in cats is provided in the ABCD guidelines.[151]

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Prevention of infectious diseases in cat shelters

In shelter situations, infectious diseases are difficult to prevent and they spread quickly.[53] In addition, shelters are unstable biological environments; not only are disease outbreaks frequent, but also new pathogens may emerge or virulent variants of endemic pathogens may arise as a result of rapid transmission cycles and forced agent evolution. The virulent systemic feline calicivirus infection is a point in case.[152]

The ABCD guidelines describe the most important factors in minimising the spread of infectious agents in the shelter environment.[53] These include: housing in individual sections (quarantine pens for incoming cats, isolation facilities for sick or potentially infectious cats, separate accommodation for clinically healthy, FIV- and FeLV-negative cats, and for pregnant and lactating queens and their kittens); testing for infectious agents; hygiene measures; and stress reduction. Stress is reduced above all by allowing for low animal densities, and by providing adequate bedding and environmental enrichment such as scratching posts, toys and hiding areas. Newly sheltered cats provided with a hiding box during quarantine had significantly lower stress levels compared with cats without this enrichment.[153] Animal handling (eg, stroking anxious cats) may have positive effects, as suggested by an increase in secretory IgA and reduced incidence of upper respiratory tract disease.[154]

Prevention of infectious diseases in cat shelters: ABCD guidelines

The prevention of infectious diseases in cat shelters guidelines that the present article is updating were published in *J Feline Med Surg* in 2013 (15: 546–554). This update has been compiled by Karin Möstl.

Synthetic pheromones have been used in shelters with the objective of reducing stress. They are expected to alter the emotional state of the cat via the limbic system and the hypothalamus, and have been recommended for the management of anxiety-related behaviours, such as house soiling.[155] Horwitz and Pike[156] have published anecdotal observations that synthetic pheromones are useful when introducing new cats into a household. These data have not been corroborated by impartial, controlled studies. However, based on reports about use of synthetic pheromones in the treatment of undesirable, stress-related behaviour, they may be considered in addition to other stress-reducing measures.

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