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Research paper

Feline leishmaniosis: Is the cat a small dog?

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ABSTRACT

Leishmania infantum is a vector-borne zoonotic disease transmitted by phlebotomine sand flies and dogs are considered the main reservoir of the parasite. Feline leishmaniosis (FeL) caused by *L. infantum* is an emergent feline disease more and more frequently reported in endemic areas. This review summarizes current knowledge focusing similarities and differences with canine leishmaniosis (CanL). Cats are infected by the same *Leishmania* species than dogs but prevalence of the infection is lower and cases of disease are less frequently reported. Scarce information is available on adaptive immune response of cats naturally exposed to *L. infantum* infection and mechanisms responsible for susceptibility or resistance of feline hosts. However, about half of clinical cases of FeL are reported in cats with possible impaired immunocompetence. Coinfections or comorbidities are frequently detected in sick cats and they can contribute to a misrepresentation of clinical FeL albeit lesions associated with the presence of the parasite have been detected in skin, lymph nodes, spleen, bone marrow, liver, oral mucosa, stomach, large bowel, kidney, nasal exudate, lung, eye. As for dogs, skin or mucocutaneous lesions are the most common reason for veterinary consultation and finding on physical examination in cats with leishmaniosis.

Molecular investigations of *Leishmania* DNA and anti- *Leishmania* antibody detection are largely used with the same methodologies for both CanL and FeL, however few information is available about their diagnostic performance in feline hosts. Treatment of cats with clinical FeL is still empirically based and off label by using the most common drugs prescribed to dogs. Life expectancy of cats with clinical FeL is usually good unless concurrent conditions or complications occur and prognosis does not seem significantly influenced by therapy or retroviral coinfection.

According to current knowledge, cats can play a role as additional reservoir host of *L. infantum* and, in a « One Health » perspective, preventative measures should be taken.

In conclusion, albeit feline infection and the associated cat disease caused by *L. infantum* is increasingly reported in endemic areas and have many similarities with CanL, consolidated evidence-based knowledge is not available and we cannot exclude that important differences between dogs and cats exist about transmission, immunopathogenesis and best practice for management and prevention.

1. Introduction

Leishmania infantum (Li),[1] is a vector-borne zoonotic disease transmitted by phlebotomine sand flies and dogs are considered the main reservoir host of the parasite (Solano-Gallego et al., 2009). In fact, the majority of infected dogs do not show clinical signs or develop a mild disease and sustain the survival of the parasite during cold seasons when vectors are not active (Bates, 2007; Pennisi, 2015). A huge amount of investigations have been − and still are − performed to better understand pathomechanisms of canine leishmaniosis (CanL)[2] make early and accurate diagnosis, manage the disease and prevent spreading of the infection.

Feline leishmaniosis (FeL)[3] caused by *Li* appears as an emerging feline disease, in fact in the past two decades it was more and more frequently reported in endemic areas and sporadically seen also in non-endemic areas in rehomed cats (Rüfenacht et al., 2005; Richter et al., 2014; Pennisi et al., 2015a; Maia et al., 2015; Basso et al., 2016; Pimenta et al., 2015). However, the increased level of medical care

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[1] *Li: Leishmania infantum.*
[2] CanL: Canine Leishmaniosis.
[3] FeL: Feline Leishmaniosis.

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given to cats contributed to the «emergence» of FeL as well as availability of more sensitive diagnostic tools and progress in understanding parasite-host-vector interactions (Cantacessi et al., 2015).

In recent years, more detailed information on FeL has been published and it increased evidence that there are more similarities with CanL than it was speculated in the past and the aim of this review is to summarize current knowledge about FeL focusing on similarities and differences with CanL.

2. Etiology, diffusion and transmission

Cats were found infected by the same *Leishmania* spp. detected in dogs and *L. infantum* is the species most frequently reported in both dogs and cats in the Old World and in Central and South America. *Leishmania infantum* has been detected in cats in Mediterranean countries (Italy, Spain, Portugal, France, Greece, Turkey, Cyprus), Iran and Brazil (Pennisi et al., 2015a; Can et al., 2016; Attipa et al., 2017; Metzdorf et al., 2017). Zymodeme MON1 is the most frequently characterized zymodeme in dogs, cats and humans in the Mediterranean area (Maia et al., 2015; Pennisi et al., 2015a; Pratlong et al., 2013). However, *L. infantum* antibody and molecular prevalence is usually considered lower in cats compared to dogs as well as cases of FeL are more rare (Otranto et al., 2017; Pennisi et al., 2015a). Sporadic or rare occurrence of both CanL and FeL in non-endemic areas can be the consequence of rehoming or travelling of companion animals (Solano-Gallego et al., 2009; Pennisi, 2015; Cleare et al., 2014; Svobodova et al., 2017; Richter et al., 2014; Rüfenacht et al., 2005; Best et al., 2014). Other *Leishmania* species are found in both dogs and cats in the New World (*Leishmania amazonensis, Leishmania braziliensis, Leishmania mexicana, Leishmania venezuelensis*) (Solano-Gallego et al., 2009; Pennisi et al., 2015a). *Leishmania tropica* and *Leishmania major* were rarely reported in dogs and found mainly associated with skin or mucocutaneous lesions (Baneth et al., 2017). Recently, these latter species were confirmed in cats in Turkey (Can et al., 2016; Paşa et al., 2015).

Sand fly-transmission is considered the most important way of transmission of *Leishmania* to humans and animals and, according to several studies about the feeding habit of sand flies, this is likely also in feline infection but it has never been investigated (González et al., 2017; Pennisi et al., 2015a).

Non-vectorial transmission ways of CanL are now well known and responsible for autochtonous cases in non-endemic areas (Solano-Gallego et al., 2009; Karkamo et al., 2014; Naucke et al., 2016; Svobodova et al., 2017) but similar information about FeL is lacking. However, blood transfusion could be a source of infection in cats as it is proven in dogs and humans. In endemic areas healthy cats − similarly to healthy dogs and humans − can be found positive at blood PCR (Pennisi et al., 2015b; Can et al., 2016; Persichetti et al., 2016; Attipa et al., 2017; Akhtardanesh et al., 2017; Brianti et al., 2017; Diakou et al., 2017; Metzdorf et al., 2017; Otranto et al., 2017).

3. Pathogenesis and clinical features

It is currently known that susceptibility to progressive infection and development of lesions and clinical signs in dogs is mostly linked to adaptive immune response evolving to immune exhaustion and associated with a predominant T helper 2 (Th2) and an impaired T helper 1 (Th1) response (Solano-Gallego et al., 2009; Esch et al., 2013). A similar pattern of humoral and cell mediated adaptive immune response is elicited by *L. infantum* in cats from endemic areas (Priolo et al., 2017). In fact, it was recently observed in a study involving cats from Italy and Spain that about one fourth of them produce *L. infantum* specific IFNγ by *ex vivo* stimulated blood and they have a significantly lower antibody level compared to non-producer cats (Priolo et al., 2017). Sick dogs with severe clinical disease, high blood parasitemia and antibody level, lack in specific IFN-γ production by *ex vivo* stimulated whole blood (Solano-Gallego et al., 2016b). Cats with *L. infantum*-associated clinical disease have high blood parasitemia and low to very high antibody levels but relationship between antibody titer and severity of disease and also their specific IFN-γ production were not investigated (Bardagi et al., 2016; Basso et al., 2016, p. 20; Brianti et al., 2015; Dedola et al., 2015; Maia et al., 2015; Pennisi et al., 2015a, 2016; Pimenta et al., 2015). However, longitudinal studies confirmed that progression to disease is associated in cats with increasing antibody titers as it occurs in CanL (Foglia Manzillo et al., 2013; Maroli et al., 2007). Moreover, in followed up cases of FeL clinical improvement obtained by anti- *L. infantum* therapy is associated with significant reduction of antibody level as it is reported in canine mild or moderate disease cases (Pennisi et al., 2004; Solano-Gallego et al., 2016a).

Duration of incubation is extremely variable in CanL but diagnoses obtained in animals imported to non-endemic areas years before demonstrate that it can be very long lasting in both dogs and cats (Richter et al., 2014; Rüfenacht et al., 2005; Solano-Gallego et al., 2011).

A complex genetic background modulates susceptibility or resistance of dogs and it contributes to the wide and dynamic clinical spectrum of CanL including subclinical infection, self-limiting mild disease or severe progressive illness (de Vasconcelos et al., 2017; Solano-Gallego et al., 2009). In the Balearic Islands the immunological pattern of resistant dogs is more frequently found in the autochthonous Ibizan Hounds than in other breeds and these dogs rarely develop clinical leishmaniosis (Martínez-Orellana et al., 2017; Solano-Gallego et al., 2000). Sanchez-Robert et al. (2005) studied polymorphism and mutations of the solute carrier family 11, member 1 gene (Slc11a1), also known as natural resistance-associated macrophage protein 1 gene (Nramp1), and they found a breed-specific haplotype distribution (six haplotypes exclusively found in Ibizan Hounds) and one haplotype significantly associated with the disease (Sanchez-Robert et al., 2008, 2005). Moreover, in Boxer dogs from endemic area specific alleles were respectively associated with susceptibility to severe disease or were found in healthy old individuals supposed to be resistant to clinical leishmaniosis, and analysis of single nucleotide polymorphisms confirmed as well the genetic component of the disease in this breed (Quilez et al., 2012; Sanchez-Robert et al., 2005). Genetic susceptibility may explain a peak of higher disease prevalence reported in dogs younger than three years (Abranches et al., 1991). Conversely, immunosenescence and the progressive chronic course of disease may explain another peak of disease seen in dogs older that eight years (Abranches et al., 1991; Day, 2010). Age range of cats reported with FeL is wide (2–21 years), however they are mostly mature cats (7–10 years old) at diagnosis and very few have 2–3 years of age (Bardagi et al., 2016; Basso et al., 2016; Britti et al., 2005; Hervás et al., 1999; Navarro et al., 2010; Pennisi et al., 2015a, 2016). Moreover, FeL was never reported in pedegree cats so that at present there are no data supporting a genetic susceptibility to the disease in some cats. However, studies comparing the genetic background of infected cats according to their clinical status can elucidate mechanisms of susceptibility of feline hosts going beyond the somatic phenotype of domestic shorthair cats (*Felis silvestris domesticus*) that have undergone thousands of years of natural selection in endemic areas. As concerning the age of cats affected by FeL, this is a further datum to support a chronic course of the disease as in dogs.

Other vector-borne co-infections (e.g. *Dirofilaria immitis*, *Ehrlichia canis*, *Hepatozoon canis*) can influence parasite burden and progression of CanL (De Tommasi et al., 2013; Morgado et al., 2016; Tabar et al., 2013). In cats the association between retroviral, coronavirus, *Toxoplasma* or some vector-borne co-infections in cats antibody and/or PCR positive to *L. infantum* has been explored (Attipa et al., 2017; Ayllón et al., 2012; Pennisi et al., 2012, 2000, 1998; Persichetti et al., 2016; Sherry et al., 2011; Sobrinho et al., 2012; Solano-Gallego et al., 2007; Spada et al., 2016, 2013; Vita et al., 2005). A significant association between Feline Immunodeficiency Virus (FIV) and *L. infantum* positivity was found only in few cases (Pennisi et al., 1998; Sobrinho et al., 2012; Spada et al., 2013). However, the review of 89 reported cases of FeL

where cats were serologically tested for FIV and Feline Leukemia Virus (FeLV) provides a 30.3% prevalence of FIV coinfection in cats with FeL and only four cats with FeLV co-infection (three of them also FIV positive) were detected (Bardagi et al., 2016; Basso et al., 2016; Brianti et al., 2015; Britti et al., 2005; Caracappa et al., 2008; Coelho et al., 2010; Dalmau et al., 2008; Dedola et al., 2015; Fileccia, 2012; Grevot et al., 2005; Hervás et al., 1999; Ibba, 2009; Laruelle-Magalon and Toga, 1996; Leiva et al., 2005; Marcos et al., 2009; Migliazzo et al., 2015; Ozon et al., 1998; Pennisi et al., 2013; Pimenta et al., 2015; Pocholle et al., 2012; Poli et al., 2002; Richter et al., 2014; Rüfenacht et al., 2005; Sanches et al., 2011; Verneuil, 2013; Vides et al., 2011). Other FeL cases reported in FIV negative cats were diagnosed in animals affected by immune-mediated diseases (and treated with immunosuppressive drugs), neoplasia, or diabetes mellitus (Bardagi et al., 2016; Basso et al., 2016; Caracappa et al., 2008; Laruelle-Magalon and Toga, 1996; Leiva et al., 2005; Maia et al., 2015; Marcos et al., 2009; Maroli et al., 2007; Migliazzo et al., 2015; Rüfenacht et al., 2005) and impaired immuno-competence is overall suspected in about half clinical cases of FeL. In the face of a great number of both experimentally and field controlled prospective studies on CanL, no prospective controlled study is available on immune mechanisms involved in the pathogenesis of FeL. A time-limited (post infection follow up duration of 8–24 weeks) experimental study with strains of *L. infantum* was performed in few cats back in 1984 (Kirkpatrick et al., 1984). Methodologies used in that study let us conclude only that infection was established and cats produced specific antibodies (Kirkpatrick et al., 1984). A more recent experimental study was performed by intradermal inoculation of stray cats (some found co-infected by FeLV) with *Leishmania braziliensis* (Simões-Mattos et al., 2005). In this latter study, dissemination of the parasite from the primary site of infection and development of multifocal skin nodules were described. Interestingly, ulceration of nodules followed by spontaneous healing recurred several times and seroconversion was detected when the size of skin lesions decreased. Self-cure of skin lesions was documented as well as the persistence of antibodies in both clinically cured cats and in the only one with a subsequent recurrence (Simões-Mattos et al., 2005).

Currently, in areas endemic for *L. infantum,* FeL is less frequently reported than CanL. Case reports published in recent years provided information on the most common clinical signs and clinico-pathological abnormalities associated with FeL (Bardagi et al., 2016; Basso et al., 2016; Brianti et al., 2014; Dedola et al., 2015; Maia et al., 2015; Pennisi et al., 2015a, 2016; Pimenta et al., 2015). However, coinfections or comorbidities are frequently detected in these cats and they can contribute to a misrepresentation of clinical FeL albeit lesions associated with the presence of the parasite have been detected in skin, lymph nodes, spleen, bone marrow, liver, oral mucosa, stomach, large bowel, kidney, nasal exudate, lung, eye (Pennisi, 2015). Less frequent and less severe clinical presentations could currently be unreported and we are presumably underestimating the clinical relevance of FeL. As it is reported in CanL, skin or mucocutaneous lesions are the most common reason for veterinary consultation and finding on physical examination in cats with leishmaniosis (Bardagi et al., 2016; Basso et al., 2016; Brianti et al., 2015; Dedola et al., 2015; Maia et al., 2015; Pennisi et al., 2015a, 2016; Saridomichelakis and Koutinas, 2014). Moreover, diverse macroscopic skin lesions can occur in the same dogs or cats. Similarly, ocular manifestations are frequently found in dogs and cats affected by leishmaniosis and can be the reason for consultations (Bardagi et al., 2016; Di Pietro et al., 2016; Pennisi, 2015; Pennisi et al., 2016; Pimenta et al., 2015). Clinical findings detected in CanL and FeL and their frequency are compared in Table 1.

Table 1
Frequency of clinical signs, lesions and clinicopathological abnormalities detected in dogs and cats with leishmaniosis (Di Pietro et al., 2016; Pennisi et al., 2015a; Saridomichelakis and Koutinas, 2014; Solano-Gallego et al., 2009).

Comparison of clinical and clinicopathological abnormalities reported in CanL and FeL		
Clinical signs and lesions	DOGS	CATS
GENERAL	+++	+++
Lymphadenomegaly	+++	+++
Weight loss	++	++
Anorexia	+	++
Polyphagia	+	NR
Lethargy	+	+
Pale mucous membranes	++	+
Fever	+	+
Polyuria and polydypsia	+	+
CUTANEOUS	+++	+++
Exfoliative dermatitis (alopecia +/−)	++/+++	+
Ulcerative dermatitis	+/++	++
Nodular dermatitis	+	+
Papular dermatitis	+	NR
Sterile pustular dermatitis	+	NR
Onychogriphosis	+/+++	NR
Nasal/footpad hyperkeratosis	++	NR
Hemorrhagic blister/bulla	NR	+
OCULAR	+/+++	++
Blepharitis	+	+
Conjunctivitis	+	+
Keratoconjunctivitis	++	+
Uveitis	++	+
OTHER	++	++
Mucocutaneous/mucosal lesions	+	+
Vomiting/diarrhoea	+	+
Stomatitis	+	++
Splenomegaly	+	+
Vascular disorders	+	NR
Epistaxis	+	NR
Chronic nasal discharge	NR	+
Lameness	+	NR
Atrophic masticatory myositis	+	NR
Neurologic disease	+	NR
Abortion	NR	+
Laboratory abnormalities	NR/+++	+++
Hyperglobulinemia	++/+++	+++
Hypoalbuminemia	+	+
Mild to moderate non regenerative anemia	++	++
Leukocytosis/Leukopenia	+	+
Thrombocytopenia	+	+
Pancytopenia	NR	+
Impaired secondary hemostasis and fibrinolysis	+	NR
Proteinuria	+	+
Renal azotemia	+	+
Elevated liver ezyme activities	+	NR

+++: present in ≥50% cases ++: present in < 50% cases +: present in < 25% cases NR: not reported.

4. Diagnosis

Leishmania amastigotes are found in infected feline macrophages in lymph nodes, bone marrow, skin, mucosal or eye lesions and rarely in circulating neutrophils as it occurs in dogs (Bardagi et al., 2016; Basso et al., 2016, p. 20; Brianti et al., 2015; Fileccia, 2012; Maia et al., 2015; Pennisi et al., 2015a, 2016; Pimenta et al., 2015). Cytological investigations from the above tissues provide useful information about the pathogenesis of suspected lesions, can confirm diagnosis and require minimally invasive procedures in both dogs and cats. As in dogs, lymphoid hyperplasia is the most common lymph node cytological pattern seen in *L. infantum* PCR positive feline lymph nodes, and it was found irrespective to the clinical status of cats, their antibody titer or FIV co-infection (Perillo et al., 2013; Solano-Gallego and Miró, 2013).

Histological evaluation of dog and cat lesions is also used and granulomatous inflammation is usually found associated with FeL as described in dogs (Dedola et al., 2015; Fileccia, 2012; Maia et al., 2015; Migliazzo et al., 2015; Navarro et al., 2010). It was particularly useful to detect associated feline skin diseases such as squamous cell carcinoma, pemphigus foliaceus, and eosinophilic granuloma found in some cats with FeL (Grevot et al., 2005; Laruelle-Magalon and Toga, 1996; Maia et al., 2015; Monteverde et al., 2006; Pocholle et al., 2012;

Rüfenacht et al., 2005). Immunohistochemistry evidences the parasites in feline tissues and heterologous (canine or rabbit) hyperimmune serum or monoclonal antibody were used as primary antibody (Migliazzo et al., 2015; Navarro et al., 2010).

Molecular investigations of *Leishmania* DNA are largely used with the same methodologies for both CanL and FeL diagnosis (Pennisi et al., 2015a; Solano-Gallego et al., 2009). In feline epidemiological investigations most studies were performed on EDTA-blood and usually a lower positivity rate was found in cats compared to dogs from the same area (Otranto et al., 2017; Pennisi et al., 2015a). Limited data are available about other tissues (lymph node, bone marrow, skin) or non-invasive sampling (conjunctival or oral swabs) (Benassi et al., 2017; Brianti et al., 2017; Otranto et al., 2017; Pennisi et al., 2015a). Biopsied skin or mucosal lesions and bone marrow or lymph node samplings obtained from sick cats have usually high parasite loads measured by quantitative real time PCR (Migliazzo et al., 2015) as seen in dogs.

Culture of infected tissues was rarely performed because it is restricted to research laboratories and time consuming but it provided feline strains that in most cases showed the same zymodemes and genotypes detected in dogs or humans (Maia et al., 2015; Pennisi et al., 2015a; Pratlong et al., 2013).

Anti- *Leishmania* antibody detection has been extensively used in cats for research and clinical aims by means of IFAT, ELISA, DAT and Western blot (WB) techniques (Pennisi et al., 2015a). Cut off setting for IFAT was established at 1:80 dilution that is similar to that used in dogs and almost all cats affected by clinical FeL have low to very high antibody level (Bardagi et al., 2016; Basso et al., 2016; Brianti et al., 2015; Dedola et al., 2015; Maia et al., 2015; Pennisi et al., 2016, 2015a, 2012; Pimenta et al., 2015). However, FeL cannot be excluded only on the basis of a negative serological test because, as in dogs, discrepancies are known between IFAT, ELISA, DAT and WB (Foglia Manzillo et al., 2013; Persichetti et al., 2017; Solano-Gallego et al., 2009). Recently diagnostic performance of ELISA, IFAT and WB were compared in cats and WB offered best sensitivity and specificity (Persichetti et al., 2017).

When serological and molecular tests are used at the same time discrepancies can be seen in cats as it occurs in dogs (Foglia Manzillo et al., 2013; Pennisi et al., 2015a; Solano-Gallego et al., 2009). The lack of consistency among serology and molecular tests can depend on their different performances (sensitivity and specificity) obviously influenced by many different factors.

5. Treatment and prognosis

Treatment of cats with clinical FeL is still empirically based and off label by using the most common drugs prescribed to dogs and a clinical cure is usually obtained as in dogs (Bardagi et al., 2016; Basso et al., 2016; Brianti et al., 2015; Dedola et al., 2015; Maia et al., 2015; Pennisi et al., 2015a, 2016; Pimenta et al., 2015; Solano-Gallego et al., 2011). This means that efficacy and safety of used protocols have never been evaluated in controlled studies and cats should be monitored very carefully for adverse effects during treatment (particularly cats affected by renal disease) and for possible clinical recurrence after stopping therapy (Pennisi et al., 2015a, 2016). Long-term oral administration of allopurinol as monotherapy or maintenance treatment after a course of subcutaneous injections of meglumine antimoniate are the most frequently used regimens. However, two cats stopped allopurinol monotherapy because of acute kidney injury after few weeks of therapy (Pennisi et al., 2016). Domperidone was recently used in two cats in association with allopurinol and miltefosine was given in one other case (Bardagi et al., 2016; Dedola et al., 2015; Maia et al., 2015). It should however be considered that propylene glycol is among the excipients of the miltefosine oral formulation licensed for the treatment of CanL (Milteforan™) and that it causes Heinz body formation and decreased life span in feline red blood cells but this latter adverse effect was not evaluated in the reported case (Christopher et al., 1990; Maia et al., 2015).

Life expectancy of cats with clinical FeL is usually good (several years after diagnosis) unless concurrent conditions or complications occur (Pennisi et al., 2015a, 2016). However, according to a retrospective evaluation of 14 cases, prognosis is not significantly influenced by therapy or retroviral coinfection (Pennisi et al., 2016).

6. Prevention of *L. infantum* infection

It is suggested that individual cats should be protected from the risk of becoming infected by *L. infantum* and of developing a clinical disease (Pennisi et al., 2015a). Moreover, protection of feline populations is probably needed for a “One Health” strategy for the regional control of *L. infantum* infection. In fact, *Phlebotomus perniciosus* and *Lutzomyia longipalpis*, proven vectors of *L. infantum,* were found infected after feeding respectively on one single sick cat with FeL (da Silva et al., 2010; Maroli et al., 2007). This is an important information but infectivity to sand flies of infected healthy individuals, as demonstrated in dogs, could be epidemiologically more relevant as the percentage of antibody and/or PCR positive cats is often not negligible in endemic areas (Akhtardanesh et al., 2017; Can et al., 2016; Chatzis et al., 2014a, 2014b; Fatollahzadeh et al., 2016; Magalhães-Junior et al., 2016; Maia et al., 2010, 2008; Martín-Sánchez et al., 2007; Mendonça et al., 2017; Millán et al., 2011; Otranto et al., 2017; Pennisi et al., 2000, 1998; Sarkari et al., 2009; Spada et al., 2013; Vita et al., 2005). Prospective studies may confirm that cats play an epidemiological role as additional reservoir species of *L. infantum* as it was well established for dogs (Otranto and Dantas-Torres, 2013).

Pyrethroids are used in dogs for preventing the bites of sand flies but almost all are toxic to cats (Pennisi et al., 2015a; Solano-Gallego et al., 2011). However, the only pyrethroid formulation licensed for cats was able to reduce the incidence of *L. infantum* infection in kennelled dogs and in cats as well (Brianti et al., 2017, 2014).

According to current knowledge, testing of blood donors by antibody detection and blood PCR is the only advisable measure for preventing non-vectorial transmission to cats (Pennisi et al., 2015b)

7. Conclusion

Feline infection and the associated cat disease caused by *L. infantum* is increasingly reported in endemic areas and have many similarities with CanL. However, consolidated evidence-based knowledge about FeL is still not available and we cannot exclude that important differences between dogs and cats exist. In fact, we are still at an infancy stage of knowledge about transmission, immunopathogenesis, development, management and prevention of the feline disease and we make therapy empirically.

Published case reports of FeL are probably only the minimal part of all diagnosed cases and these latter can be only part of all occurring cases.

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