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Tick-borne diseases of Canine and Feline in Pakistan

Areeba Yousaf[1]*, Abdul Rehman[1], Tasawar Abbas[2], Tehseen Abbas[3], Muhammad Ahmed Madni[4], Ghulam Hussain Dilbar[4]*

[1]*Department of Biochemistry and Molecular Biology. Institute of Biochemistry, Biotechnology and Bioinformatics, The Islamia University of Bahawalpur, Pakistan
[2]Institute: Center for Applied Molecular Biology, Punjab University, Lahore
[3]Department of Zoology, The Islamia University of Bahawalpur, Pakistan
[4]*Faculty of Veterinary and Animal Sciences, The Islamia University of Bahawalpur, Pakistan

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Abstract

Tick-borne diseases (TBDs) represent a serious threat to the well-being of pets and can also impact human health due to their zoonotic nature. Over recent years, awareness of TBDs has steadily increased. However, there remains a lack of information regarding their occurrence in many parts of the world, particularly those regions that are heavily affected. In Pakistan's rich of biodiversity, the scarcity of current information on TBDs poses a critical challenge for pet owners, veterinarians, and healthcare professionals alike. In this review, we provide a comprehensive overview of TBDs in companion animals, specifically focusing on dogs and cats. We evaluate the prevalence of the following tick borne diseases: babesiosis, hepatozoonosis, anaplasmosis, ehrlichiosis, mycoplasmosis, rickettsiosis and lyme borreliosis.

Introduction

Tick-borne diseases that affect pets have a significant impact on their well-being and also present a continuous threat to humans as they can be enacted from animals to humans. This emphasizes the importance of pets acting as reservoirs for these diseases. In Pakistan, various factors like changes in agricultural practices, alterations in the landscape, lack of protection for the ecosystem, and economic instability contribute to creating environments that encourages the persistence and spread of parasites and their vectors. This is especially concerning for tick-borne diseases that affect dogs and cats, who are considered companion animals. A significant percentage of these pets, ranging from 52% to 75%, are allowed to roam freely even though they have owners who care for them. Furthermore, the population of stray dogs and cats is increasing, which worsens the problem (Jackman and Rowan, 2007). The lack of awareness and care for animal welfare, along with limited access to veterinary services and irresponsible pet ownership, has led to the spread of diseases that impact humans, animals, and wildlife (Fung et al., 2014, Trotman and Brown, 2007).

Moreover, it is important to take into account various societal, economic, population-related, and environmental

*areebayousaf98@gmail.com

influences such as globalization, traveling, climate change, and how it affects the spread of disease vectors across different regions over time (Weston et al., 2014). In Pakistan, there are different types of tests available for tick-borne diseases (TBDs), such as microscopic, serological, and molecular methods. However, only a few of these tests are commonly used in clinical practices due to variations in their sensitivity and specificity for acute and chronic cases. This article summarizes the detection and prevalence of the most important TBDs that affect pets in Pakistan.

Babesiosis

Babesia species, which are protozoa found inside red blood cells, are spread by hard ticks from the Ixodid family. This causes babesiosis, a serious and widespread disease in dogs (Li et al., 2020). Babesiosis is a rapidly spreading disease that affects both animals and humans, with significant global economic and medical impacts (Gray et al., 2010, Schnittger et al., 2012). Babesia is divided into large (2.5-5.0 µm) and small (1.0-2.5 µm) piroplasms based on genetics, vector specificity, and geographic distribution. Among the large piroplasms are three distinct species: *B. canis*, *B. vogeli*, and *B. rossi* (Schaarschmidt et al., 2013, Solano-Gallego and Baneth, 2011). The small piroplasm encompasses three unique genetic forms: *B. gibsoni*, *B. conradae*, and *B. vulpes* (Kjemtrup et al., 2006, Zahler et al., 2000a). Recent genetic analyses have identified three visually similar but genotypically distinct small piroplasms in canines: the "California" genotype, *B. gibsoni* Asia type, and *Theileria annae* (Birkenheuer et al., 2004, Zahler et al., 2000b). Natural infections are primarily caused by two species: *B. canis* and *B. gibsoni* (Augustine et al., 2017). Remarkably, *B. gibsoni* is the most common cause of canine babesiosis in both domestic and wild canids (Hartelt et al., 2007, Cao et al., 2015).

The symptoms of the disease can vary from no symptoms at all to more severe clinical signs, such as fever, anemia, pallor, jaundice, hemoglobinuria, splenomegaly, weakness, and, in the worst cases, death. (Solano-Gallego and Baneth, 2011, Bajer et al., 2013). Microscopy is typically the easiest and most accessible way to diagnose the disease, while PCR is commonly used to detect the Babesia protozoans. (Skotarczak, 2008). Molecular techniques may have varying levels of sensitivity throughout the course of the illness. Treatment doesn't completely get rid of the parasite, but it can help reduce the amount of parasites in the blood and improve the patient's symptoms. (Irwin, 2009). The epidemiological prevalence of babesiosis in dogs and cats in Pakistan is summarized in Table 1.

Hepatozoonosis

The disease in dogs is caused by a protozoan called *Hepatozoon canis*, which is transmitted via the ingestion of ticks that carry mature *H. canis* oocysts. Symptoms can be diverse, showing signs like fever, lethargy, muscle weakness, weight loss, and joint pain. In more serious cases, neurological issues such as seizures and paralysis may occur (Sherding, 2006). The sickness is serious and can be fatal if not treated. The infection is commonly detected by looking for intracellular gamonts in blood samples under a microscope. Antibody and molecular tests using PCR can also be done (Baneth, 2011). Eradicating the parasite completely is often not possible (Sasanelli et al., 2010). The outlook for treated dogs is influenced by the extent of parasitic infection. Using ecto-parasiticide treatment to prevent exposure to disease-carrying vectors can help safeguard against infection. Cases of hepatozoonosis are rare in Pakistan, however previous studies using molecular analysis had indicated the prevalence of hepatozoonosis in Pakistan falls between 11.9% and 45.5%. Details of the prevalence rates among canines in Pakistan can be found in Table 2.

Anaplasmosis

This can affect both dogs and cats and is caused by two main pathogens: *Anaplasma phagocytophilum*, which causes canine granulocytic anaplasmosis (CGA) in temperate zones, whereas *Anaplasma platys*, which triggers canine cyclic thrombocytopenia, is more prevalent in tropical and subtropical locations (Chomel, 2011). While many dogs infected with *A. phagocytophilum* may not show any symptoms, some may exhibit clinical signs and changes in their blood (Kohn et al., 2008). *A. platys* infection in dogs can be subclinical, but it may show clinical and hematological abnormalities (Bouzouraa et al., 2016). Diagnosing both types of Anaplasmosis in dogs can be challenging, requiring a mix of clinical observation, hematological assessment, and lab tests. Identification of morulae (intracytoplasmic inclusions) in neutrophils (*A. phagocytophilum*) or platelets (*A. platys*) in stained blood smears is indicative of infection (Sainz et al., 2015). It is suggested to confirm the diagnosis through additional tests like serology and PCR (Carrade et al., 2009). Using Doxycycline has been shown to be successful in treating both infections (Sainz et al., 2015). Proper tick control is essential to prevent Anaplasmosis in dogs, as different types of ticks such as Rhipicephalus, Dermacentor, and Ixodes have been known to carry the pathogens globally (Parola et al., 2003, Sanogo et al., 2003). Previous studies using molecular analysis had reported the prevalence of *Anaplasma sp.*, between 11.34% (Ghauri et al., 2021) and 26.5% in dogs in Pakistan (Iatta et al., 2021). The microscopic and molecular prevalence of canine and feline *Anaplasmosis* is given in Table 3.

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Ehrlichiosis

The primary agents responsible for this infection include *Ehrlichia canis* (which causes CME), Ehrlichia chaffeensis, and *Ehrlichia ewingii* that affects dogs and cats worldwide. Ticks play a crucial role in the transmission of these harmful pathogens (Wright et al., 2014, Gaines et al., 2014). The symptoms of CME in dogs closely resemble those of granulocytic Anaplasmosis and can also partially manifest in cats. While *E. ewingii* infection in dogs leads to observable symptoms, there have been no reports of these symptoms in cats. On the other hand, *E. chaffeensis* infection in dogs typically presents mild symptoms or may not show any at all, especially without co-infections, and there have been no reported signs of infection in cats (Allison and Little, 2013). In the clinical scenarios (Mylonakis et al., 2003), discovering Ehrlichia canis morulae (aggregates of Ehrlichia canis organisms) in a blood smear, preferably a buffy coat smear, is a rare but important finding. Other diagnostic methods for example serological tests or molecular tests involving polymerase chain reaction (PCR) are necessary in confirming the diagnosis. The preferred treatment for rickettsial infections, including ehrlichiosis, is Doxycycline; (Nicholson et al., 2010, Neer et al., 2002). It is important to avoid tick exposure and prevent transmission by using ecto-parasiticide compounds. The epidemiological studies on canine and feline ehrlichiosis is given in Table 4.

Rickettsiosis

Rickettsiosis has long been linked exclusively to tick-borne Rickettsia species in the spotted fever group, including well-known agents like *Rickettsia rickettsii* and Brazilian spotted fever and Rickettsia conorii (the cause of Boutonneuse fever) (Raoult and Parola, 2007, Rovery and Raoult, 2007). However, other pathogens for humans and some related animals, with some not exclusively transmitted by ticks (e.g., *R. massiliae*, *R. parkeri*, *R. felis*). Tick species like Amblyomma, Dermacentor, and Rhipicephalus have been found to carry various Rickettsia species (Raoult and Parola, 2007). Infection with these species in dogs and cats is often mild, but can also be severe, especially with *R. rickettsii*, potentially leading to death (Greene and Breitschwerdt, 2006). Doxycycline is usually used as a treatment for rickettsial infections, which are commonly diagnosed via PCR or serological testing (Dantas-Torres, 2007). Prompt treatment is important to prevent fatality, as delays can be deadly (Allison and Little, 2013). The molecular prevalence of canine and feline Rickettsiosis is given in Table 5.

Hemotropic mycoplasmosis

Hemotropic mycoplasmosis, or hemobartonellosis deposition is uncommon in dogs in Pakistan. The infection results from predominantly *Mycoplasma haemocanis* and *Mycoplasma haematoparvum*. In felines, it may arise singly or concurrently with *M. haemofelis*, *M. haematominutum*, and *M. turicensis*. While blood transfusions have been linked to potential infections, blood-sucking arthropods may also play a role in transmission (Gary et al., 2006, Willi et al., 2006). Limited information is available about behavior and transmission of these bacteria's in the environment. Advanced PCR systems, both conventional and quantitative real-time, are now the preferred method for detecting these bacteria (Tasker et al., 2003, Barker et al., 2010). Treatment depends on the seriousness of the infection. Antibiotics like tetracycline are commonly used and are expected to work, though not all antibiotics have been successful in consistently clearing the infection (Messick, 2003, Willi et al., 2010). To prevent the spread of these bacteria, vector control measures are crucial. The prevalence rates among feline in Pakistan is given in Table 6.

Lyme borreliosis

Lyme disease, caused by a type of bacteria called Borrelia burgdorferi, is a disease that can be transmitted to humans, dogs, horses, and other mammals by Ixodes ticks (Barbieri et al., 2013). Diagnosing Lyme disease in dogs can be difficult because the symptoms are similar to other tick transmitted diseases. Traditional methods of testing, such as PCR and culture, are not always effective as the bacteria are hard to find in bodily fluids (Leschnik et al., 2010, Susta et al., 2012). Typically, a two-step process involving an ELISA test and immunoblotting is used for diagnosing Lyme disease. (Steere et al., 2008). Treatment for Lyme borreliosis should be started without delay. Whether to administer specific antibodies to dogs (or cats) without any symptoms is a subject of discussion (Littman et al., 2006, Greene and Breitschwerdt, 2006). It is advised to treat for 28 to 30 days, with doxycycline being the most frequently prescribed medication. Controlling ecto-parasites to prevent pathogen transmission is essential, especially considering the potential for zoonotic diseases. The only molecular study on the prevalence of lyme borreliosis had reported 4.3% and 8.9% infection rate in dogs in Pakistan (Usman et al., 2023).

Conclusions

There are many tick-borne diseases (TBDs) in companion animals all over Pakistan. However, there is a lack of data on the occurrence of these diseases. Some of the diseases and pathogens can be transmitted to humans, so it's important to prevent them in companion animals by using repellents, controlling the environment, vaccinating when possible, and taking preventative measures. A holistic approach involving both human and animal health is needed to tackle these diseases effectively.

Conflict of interest

The authors declare no conflict of interest with anyone.

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Table 1. Prevalence of canine and feline babesiosis in Pakistan.

Region	Host	Sample	Diagnostic Method	Species	Prevalence	References
Hyderabad	Dog	Blood	Thin Smear	Species	5.0 %	(Gadahi et al., 2008)
Lahore	Dog	Blood	Thin Smear	B. canis	13.2%	(Ahmad et al., 2007)
	Dog	Blood	Thin Smear	B. canis	1.7%	(Ahmad et al., 2011)
	Dog	Blood	Thin Smear and PCR	B. canis, B. gibsoni	34.0%	(Tayyub et al., 2019)
	Cat	Blood	Thin smear and PCR	B. felis	3.1%	(Ahmad et al., 2011)
Multan	Dog	Blood	PCR	B. microti	1.3%	(Akram et al., 2019)
	Cat				13.2%	
Rawalpindi and Islamabad	Dog & Cat	Blood	Thin smear and PCR	B. microti	2.0%	
Rawalpindi	Dog	Blood	Thin Smear and PCR	B. gibsoni & B. vogeli	17.3%	(Ahmad et al., 2018a)
Kasur	Dog	Blood	Thin Smear and PCR	B. gibsoni & B. vogeli	23.3 %	(Ahmad et al., 2018a)
Muzaffargarh	Dog	Blood	Thin Smear and PCR	B. gibsoni & B. vogeli	13.8%	(Ahmad et al., 2018a)
Narowal	Dog	Blood	Thin Smear and PCR	B. canis & B. gibsoni	44.7%	(Tayyub et al., 2019)

*areebayousaf98@gmail.com

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Table 2. Prevalence of canine Hepatozoonosis in Pakistan

Region	Sample	Diagnostic Method	Species	Prevalence	References
Islamabad, Lahore, and Multan	Blood	PCR	H. canis	11.9%	(Qamar et al., 2017)
Kasur, Muzaffargarh and Rawalpindi	Blood	PCR	H. canis	45.5%	(Ahmad et al., 2018b)
Jhang	Blood	PCR	H. canis	15.66%	(Abbas et al., 2021)
Khyber Pakhtunkhwa	Ticks	PCR	H. canis	3.32 %	(Ali et al., 2023)

Table 3. Prevalence of canine and feline Anaplasmosis in Pakistan

Region	Host	Sample	Diagnostic Method	Species	Prevalence	References
Lahore	Cat	Blood	PCR	Anaplasma sp	13 %	(Ahmed et al., 2020)
Khyber Pakhtunkhwa	Dog	Ticks	PCR	Anaplasma sp	19.92 %	(Ali et al., 2023)
Lahore	Cat	Blood	Microscopy	A. phagocytophilum	3.39%	(Abbas et al., 2023)
			PCR		7.03%	
	Dog	Blood	PCR	A. platys	11.34%	(Ghauri et al., 2021)
Bahawalpur	Dog	Blood	PCR	A. platys	26.5%	(Iatta et al., 2021)

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Table 4. Prevalence of canine and feline Ehrlichisos in Pakistan

Region	Host	Sample	Diagnostic Method	Species	Prevalence	References
Islamabad/Rawapindi Lahore, & Multan	Dog	Blood	PCR	E. canis	24%	(Malik et al., 2018)
Bahawalpur	Dog	Blood	PCR	E. canis	24.5%	(Iatta et al., 2021)
Khyber Pakhtunkhwa	Dog	Ticks	PCR	E.canis Ehrlichia sp.	10.8% 3.3%	(Zeb et al., 2023)
	Dog	Ticks	PCR	Ehrlichia sp.	14.76 %	(Ali et al., 2023)
Punjab	Dog	Ticks	PCR	E.canis	12.8 %	(Cabezas-Cruz et al., 2019)
Lahore	Cat	Blood	Microscopy PCR	E.canis	1.3% 3.65%	(Abbas et al., 2023)
Sheikhupura	Dog	Blood	Microscopy PCR	Ehrlichia sp.	5.73% 9.63%	(Ahmad et al., 2022)

Table 5. Prevalence of canine and feline Rickettsiosis in Pakistan

Region	Host	Sample	Diagnostic Method	Species	Prevalence	References
All provinces	Cat	Ticks	PCR	*Rickettsia* sp.	33.3 %	Abdul Wahab 2024
	Dog	Ticks	PCR	*Rickettsia* sp.	12.17%	Abid Ali 2023
					7.03%	
Khyber Pakhtunkhwa	Dog	Ticks	PCR	*R. massiliae*	19.5%	Jhanzeb 2023
				Rickettsia sp.	7.5%	
				R. raoultii	6.7%	
Punjab	Dog	Ticks	PCR	*R. massiliae*	24.3%	Abdul Jabbar 2019
Bahawalpur	Dog	Blood	PCR	*Rickettsia* sp	2 %	Mazhar ayaz 2020

Table 6. Prevalence of feline Hemotropic mycoplasmosis in Pakistan

Region	Host	Sample	Diagnostic Method	Species	Prevalence	References
Lahore	Cat	Blood	PCR	M. haemofelis M. haemominutum	6.8% 18.2%	(Salim et al., 2020)
Faisalabad	Cat	Blood	Diff-Quik smear	Mycoplasmosis		(Saqib et al., 2016)

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