Molecular Survey of *Bartonella* Species in Shelter Cats in Rio De Janeiro: Clinical, Hematological, and Risk Factors

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Abstract. The present study aimed to detect *Bartonella* DNA in cats belonging to shelters, and to evaluate risk factors, clinical signs, and hematological abnormalities associated with infection. Complete blood counts and screening for the presence of *Bartonella* DNA were performed on cats' ethylenediamine tetraacetic acid anticoagulant–blood samples. Eighty-three cats (39.9%) were positive for *Bartonella* species. *Bartonella* DNA was also detected in fleas and in the blood of cats infested by positive flea. Cats that had not been sterilized, had outdoor access, had histories of fights, and had concurrent flea infestation were more likely to be infected by *Bartonella* species ($P < 0.05$). Age and sex were not associated with infection. Fifty-one (38.6%) symptomatic cats were positive to *Bartonella* species ($P > 0.05$). Clinical conditions most commonly observed were signs of respiratory abnormality and *Sporothrix* species coinfection ($P > 0.05$). Regarding hematological changes, eosinophilia was associated with infection ($P < 0.05$). A high frequency of *Bartonella* species infection was found in shelter cats and highlights the importance of adequate flea-control programs to prevent infection in cats and consequently in adopters and other animals.

INTRODUCTION

Bartonella species are Gram-negative facultative intracellular and arthropod-transmitted bacteria that infect numerous host species, including humans, rodents, rabbits, felids, canids, and ruminants.¹ Cats are likely the main mammalian reservoir hosts for the zoonotic species *Bartonella henselae*, *Bartonella clarridgeiae*, and *Bartonella koehlerae*, agents commonly associated with human disease and transmitted between cats by means of cat bites and scratches with teeth and nail contaminated with flea feces. In humans, these bacteria are responsible for many clinical syndromes, including cat scratch disease, endocarditis, bacillary angiomatosis, bacillary peliosis, meningitis, and glomerulonephritis.^{2,3} Some of these can be fatal, especially for immunocompromised patients.^{2,3}

Although *Bartonella* infection in cats is common, details of the relationship of these bacteria with the cat, including the possible role of *Bartonella* species in the pathogenesis of feline diseases, are far from clear.¹ Most infected cats remain asymptomatic carriers for years. However, studies have suggested a potential association between *Bartonella* DNA detection and clinical signs in cats, such as endocarditis,^{4,5} stomatitis,⁶ pyogranulomatous myocarditis and diaphragmatic myositis,⁷ fever of unknown cause,^{8,9} and central nervous system diseases.¹⁰ Regarding hematological findings, limited data are available in cats that were naturally or experimentally infected. Nevertheless, some cats have shown transient anemia, persistent eosinophilia, and mature neutrophilia.^{11,12}

Bartonellosis in cats occurs worldwide. However, in Brazil, there are very few studies, especially focusing on detection

and molecular characterization of *Bartonella* species.^{13–16} Considering that bartonellosis can lead to nonspecific signs, studies involving these agents are important, particularly to assess their actual occurrence in veterinary clinical practice.

The aims of this study were to detect *Bartonella* DNA in blood of potentially naturally infected cats by means of polymerase chain reaction (PCR) diagnosis and to evaluate associated risk factors, clinical signs, and hematological abnormalities in cats from shelters located in Metropolitan Region of Rio de Janeiro, Brazil.

METHODS

Cat samples. The procedures followed in this study were previously approved by the Ethics Committee for the use of animals at the Universidade Federal Rural do Rio de Janeiro (protocol number 027/2014).

The survey was carried out in shelters that are autonomous and independent organizations that aim to rescue, sterilize, and promote adoption of abandoned cats located in the Metropolitan Region of Rio de Janeiro, Brazil. Most of the cats probably still live in the shelter and stay available for adoption in events often promoted in fairs in public spaces, playgrounds, and agricultural stores.

Two-hundred eight cats were sampled and divided into groups: group 1, those in the Rio de Janeiro municipality (68 cats in four shelters), and group 2, those in the Belford Roxo, Duque de Caxias, Guapimirim, Itaguaí, Mesquita, Nova Iguaçu, São Gonçalo, and Seropédica municipalities (140 cats in 14 shelters).

Blood samples were aseptically obtained by cephalic phlebotomy, transferred into sterile tubes containing ethylenediamine tetraacetic acid anticoagulant, and maintained at 4°C until hematological analysis (up to 12 hours after blood collection).

Cats were physically examined for ectoparasites presence, which were also collected when possible. All ectoparasites were identified based on the morphological criteria observed

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with a stereoscopic microscope, according to standard taxonomic keys.¹⁷

Tutors or those responsible for the shelters have signed a consent form, allowing the study at the shelter and ensuring to provide accurate and honest answers to the semi-structured questionnaire applied. As so, the following data were recorded for each cat: age (kitten ≤ 1 year versus adult > 1 year), sex (male versus female), outdoor access, sterility status, evidence of fight history, ectoparasites status (previous and current infestation), ectoparasiticide use, vaccination status, worm therapy, and contact with other animal species. Following clinical evaluation, cats were classified as symptomatic or asymptomatic according to clinical manifestation previously reported on the literature^{6,18} and other clinical signs observed during feline physical examination.

Hematological analysis. Complete blood count was measured using the fully automated analyzer Poch-100 iV (Roche, Basel, Switzerland), in accordance with the manufacturer's recommendations. Differential leukocyte count, hematological abnormalities, and hemoparasites examination were performed manually on Diff Quick-stained thin blood smears, using an optical microscope, with immersion objective lens magnification of $\times 100$ and total plasma protein concentration determined by refractometry.¹⁹ After hematological tests were completed, blood samples were stored at -80°C until molecular analyses were undertaken.

Molecular assays. DNA extraction from 200 μL of whole blood was performed using a ReliaPrep™ Blood gDNA Miniprep System kit (Promega, Madison, WI), in accordance with the manufacturer's instructions. Flea DNA extraction was performed individually as previously described.²⁰ Concentration and purity were determined using a NanoDrop 2000 spectrophotometer (Thermo Scientific, Waltham, MA). For monitoring contaminant DNA during the process of DNA extraction, sterilized ultrapure water was used as a negative control and processed in parallel with the samples. DNA samples were screened for the presence of the 16S-23S rRNA intergenic spacer (ITS) region and the *gltA* gene using primers previously reported.^{21,22} Following amplification, PCR products were subjected to horizontal electrophoresis on 1% agarose gel and stained with GelRed (Biotium, Fremont, CA). The positive control consisted of *B. henselae* (Houston strain) cultured in HEp-2 cells. All PCR runs were performed with nuclease-free water (Invitrogen, Waltham, MA) as negative control.

Sequence analysis. A total of 51 positive cat samples were randomly selected, purified using an Illustra GFX PCR Purification Kit (GE Healthcare, Pittsburgh, PA), and submitted to sequencing using an automatic sequencer (ABI3730xl, Applied Biosystem, Waltham, MA). Sense and antisense sequences were analyzed using DNA Sequence Assembler v.4 software and compared with those deposited in the GenBank DNA database using the basic local alignment search tool (BLAST, National Center for Biotechnology Information, available at <https://blast.ncbi.nlm.nih.gov>).

Statistical analysis. Association between *Bartonella* species infection and risk factors, months of blood collection, clinical signs, and hematological abnormalities was evaluated by comparing frequencies with Chi-square and Fisher's exact test, with a significance level of 5%. Hematological analyses were evaluated with the Lilliefors normality test, followed by analysis of variance or the Mann-Whitney test at the 5%

significance level. In addition and in accordance to reference intervals,²³ frequencies of the hematological abnormalities eosinophilia (eosinophils count $> 0.8 \times 10^3$ cells/ μL), thrombocytopenia (platelets count $< 300 \times 10^3$ cells/ μL), lymphopenia (lymphocytes count $< 1.5 \times 10^3$ cells/ μL), and hyperproteinemia (total plasma protein concentration > 7.5 g/dL) were correlated with *Bartonella* positivity. All statistical tests were performed using Bioestat 5.0 statistical software (Instituto de Desenvolvimento Sustentável Mamirauá, Amazonas, Brazil).

RESULTS

Of the 208 shelter cats sampled, 83 (39.9%) were positive for *Bartonella* species based on ITS (16S-23S) and *gltA* gene results. The frequencies in groups 1 and 2 were 22.1% and 48.6%, respectively ($P < 0.01$) (Table 1). *Bartonella* DNA was also detected in fleas from cats infected by the bacteria. Cats were more frequently infected by *Bartonella* species during the period of March to June (52.2%) than during December to March (27.7%) ($P < 0.05$) (Figure 1, Table 2). Among the 51 positive samples selected, sequencing confirmed *B. henselae* (68.6%, 35/51), *B. clarridgeiae* (23.5%, 12/51), and *B. koehlerae* (17.6%, 9/51) infections in cats. Cases in which ITS and *gltA* sequences from a single same cat corresponded to different feline *Bartonella* species were considered coinfections. In this way, three (5.9%) and two (3.9%) cats were concurrently infected with *B. henselae* plus *B. clarridgeiae* and *B. clarridgeiae* plus *B. koehlerae*, respectively. Cat fleas were found to harbor *B. henselae* and *B. clarridgeiae* DNA. No *B. koehlerae* specie was detected in fleas.

In addition, cats that were not sterilized, had outdoor access, showed evidence of fight histories, were infested with fleas at the time of collection, and did not receive ectoparasiticide prophylactic management or vaccination protocols were more likely to be infected by *Bartonella* species ($P < 0.05$). Young and adult cats of both sexes had a similar chance of becoming infected ($P > 0.05$).

Cats with past or present ectoparasite infestation or prior flea infestation had greater chances of bacterial infection, although these findings were not statistically significant ($P > 0.05$). By contrast, tick or lice infestation was not linked to infection ($P > 0.05$). Cats in contact with other species, especially opossums as reported by the owners, were more likely to be infected, although the correlation was not significant ($P > 0.05$) (Table 2).

TABLE 1

Distribution of *Bartonella* species bacteremia in shelters cats located in municipalities at the Metropolitan Region of Rio de Janeiro, Brazil

<i>Bartonella</i> species infection						
Group	Municipality	No. of cats	Positive	Negative	%	P-value
1	Rio de Janeiro	68	15	53	22.1	0.0004
2	Others	140	68	72	48.6	
	Duque de Caxias	7	4	3	57.1	
	Itaguaí	16	9	7	56.3	
	Mesquita	20	9	11	45.0	
	Nova Iguaçu	20	11	9	55.0	
	Seropédica	46	24	22	52.2	
	Belford Roxo	7	4	3	57.1	
	São Gonçalo	15	6	9	40.0	
	Guapimirim	9	1	8	11.1

FIGURE 1. Distribution of *Bartonella* species in shelter cats by period (months).

Symptomatic (38.6%) and asymptomatic (42.1%) cats had similar chances of becoming infected ($P > 0.05$). Bacterial infection was seen most commonly in cats presenting respiratory signs (42.6%) or *Sporothrix* species infection (39.3%). Less commonly, it was observed in cats with oral (28.6%) or ocular (20%) signs and chronic diarrhea (16.7%) ($P > 0.05$). Nonspecific clinical signs such as anorexia, lethargy, dehydration, fever, and lymphadenopathy were not associated with infection ($P > 0.05$) (Table 3). Hemoparasites were not detected at the microscopical evaluation of blood smears. Eosinophilia was associated with infection ($P < 0.05$), being observed in 64% of *Bartonella* species positive cats. No other hematological abnormality was associated with infection ($P > 0.05$) (Tables 4 and 5).

DISCUSSION

Zoonosis studies have become more important in recent years because the cat population has risen noticeably and adopting domestic animals has become more common. In Brazil, few previous studies have addressed *Bartonella* infection in cats, including risk factors, and hematological and clinical abnormalities. In the present study, 39.9% of cats tested positive for *Bartonella* DNA, which is higher than those found in previous reports, including those that address cats from shelters.^{13,15,24–26} Similar results were reported in California, United States.²⁶ Notably, it was found that 97.3% of cats harbored bacterial DNA in a shelter in Volta Redonda municipality, Rio de Janeiro, which is attributable to local conditions.²⁷

Bartonella infection was significantly higher in cats from group 2 when than in those from group 1 (Rio de Janeiro municipality), which may be explained by differences in hygiene conditions and preventive flea control applied in these shelters. Approximately 69% (97/140) of the cats from group 2 shelters were flea-infested, which represents four times the level observed in cats from group 1 (16.1%, 11/68). This finding supports us to establish a correlation between bacteremia and flea infestation. The presence of *Bartonella* DNA in *C. felis* fleas collected in bacteremic cats also suggests that

these ectoparasites play an important role in the transmission of *Bartonella* species to cats. *Ctenocephalides felis* was shown to be a potential vector for *Bartonella* species, including those for which cats serve as a natural reservoir, *B. henselae* and *B. clarridgeiae*.²⁸

Apparently, there is a seasonal trend of this bacterial infection. In the study, we observed that the number of cats infected by the bacteria (52.2%, 35/67) and infested by fleas (55.5%, 60/108) were both highest in the autumn months (March 20–June 19), a finding also observed in previous studies.^{26,29} A possible explanation is that owners, thinking that cat flea season is over, reduce measures to control flea infestation in their pets. Indeed, autumn months represent an active period for fleas, especially in Rio de Janeiro, where temperatures remain moderate year round and so fleas can proliferate. This pattern of seasonal incidence was also observed in humans infected with *Bartonella* in France. Authors have attributed such finding to cat flea activity and cat's behavior of spending more time inside the house during autumn months, and therefore, it increases the risk for transmission to humans.³⁰

Previous or current ectoparasite infestation showed a nonsignificant association with *Bartonella* species bacteremia in cats, with animals that had fleas at any time in their life being almost three times more likely to be bacteremic than those that had not. Cats harboring fleas at the time of blood collection had significantly increased risk of being infected by *Bartonella* species. A similar correlation to *B. henselae* bacteremia was found.³¹ In addition, vector-control programs were crucial to avoid *Bartonella* species infection, as cats that did not use ectoparasiticides were significantly more likely to be infected. These findings reinforce the association between *Bartonella* species bacteremia in cats and past or present flea contact, and highlights *C. felis* as a primary vector for these bacterial agents. It is noteworthy that prevention of *Bartonella* infection in cats is best accomplished by preventing exposure to ectoparasites, especially fleas.

Non-sterilized cats and those with outdoor access were significantly more likely to be bacteremic than other cats. Although it was not associated with infection, a study found that non-sterilized cats were twice as likely to be bacteremic than

TABLE 2

Statistical analysis of factors associated with *Bartonella* species bacteremia in cats from shelters located in the Metropolitan Region of Rio de Janeiro state, Brazil

Variable	Cats (n)	Positive (%)	P-value (χ^2)	Odds ratio	CI (95%)
Age					
Young (≤ 1 year)	68	28 (41.2)	–	1	–
Adult (> 1 year)	140	55 (39.3)	0.9122	1.08	0.60–1.95
Sex					
Female	110	41 (37.3)	–	1	–
Male	98	42 (42.9)	0.4971	1.26	0.72–2.20
Outdoor access					
No	135	46 (34.1)	–	1	–
Yes	73	37 (50.7)	0.0288	1.99	1.11–3.55
Sterilized					
No	101	49 (48.5)	–	2.02	–
Yes	107	34 (31.8)	0.0202	1	1.15–3.56
Historic of fights					
No	151	52 (34.4)	–	1	–
Yes	57	31 (54.4)	0.0138	2.27	1.22–4.22
Present ectoparasite infestation					
No	27	6 (22.2)	–	1	–
Yes	181	77 (42.5)	0.0718	2.59	1.00–6.73
Past ectoparasites infestation					
No	84	27 (32.1)	–	1	–
Yes	124	56 (45.2)	0.0824	1.74	0.97–3.10
Present tick infestation					
No	196	78 (39.8)	–	1	–
Yes	12	5 (41.7)	0.9998	1.08	0.33–3.53
Present lice infestation					
Yes	24	8 (33.3)	–	1	–
No	184	75 (40.8)	0.6332	1.38	0.56–3.38
Present flea infestation					
No	100	32 (32.0)	–	1	–
Yes	108	51 (47.2)	0.0359	1.9	1.08–3.35
Past flea infestation					
No	28	6 (21.4)	–	1	–
Yes	180	77 (42.8)	0.0525	2.74	1.06–7.09
Ectoparasiticide use					
Yes	135	46 (34.1)	–	1	–
No	73	37 (50.7)	0.0288	1.99	1.11–3.55
Vaccination					
Yes	89	28 (31.5)	–	1	–
No	119	55 (46.2)	0.0447	1.87	1.05–3.33
Worm therapy					
Yes	168	65 (38.7)	–	1	–
No	40	18 (45.0)	0.5805	1.3	0.64–2.60
Contact with other species					
No	78	24 (30.8)	–	1	–
Yes	130	59 (45.4)	0.0527	1.87	1.03–3.38
Contact with dogs					
No	23	9 (39.1)	–	1	–
Yes	185	73 (40.0)	0.8844	1.04	0.43–2.52
Contact with opossums					
No	196	75 (38.3)	–	1	–
Yes	12	8 (66.7)	0.0685	3.22	0.94–11.1
Contact with horse					
No	186	72 (38.7)	–	1	–
Yes	22	11 (50.0)	0.4281	1.58	0.65–3.84
Period (months)					
September 22–December 20	43	15 (34.9)	–	–	–
December 21–March 19	47	13 (27.7)	–	1	–
March 20–June 9	67	35 (52.2)	0.0154	2.86	1.29–6.36
June 20–September 21	51	20 (39.2)	–	–	–

sterilized ones.³² These findings reinforce the importance of fleas in cat infection as non-sterilized cats and those with outdoor access are greater exposed to arthropod vectors.

Interestingly, cats with histories of fight behavior had twice the chance of becoming infected. Experimental intradermal inoculation of *Bartonella* species has induced bacteremia in

cats.^{33,34} In addition, *Bartonella* species DNA has been successfully detected from saliva and nails of naturally infected cats.^{26,35,36} This evidence suggests the possibility that cats have other sources of infection besides direct horizontal transmission via fleas. Previous studies have demonstrated that *Bartonella* bacteremia is higher in younger animals,^{24,37}

TABLE 3

Association between *Bartonella* species bacteremia in asymptomatic and symptomatic cats, clinical signs, and diseases reported in 208 shelter cats from the Metropolitan Region of Rio de Janeiro state, Brazil

Clinical signs or disease	Positive	Negative	Total	%	P-value
Asymptomatic	32	44	76	42.1	0.7301
Symptomatic	51	81	132	38.6	
Anorexia	0	11	11	0.0	0.0036
Lethargy	0	7	7	0.0	0.0434
Reproductive failure	0	1	1	0.0	1.0000
Diarrhea	2	10	12	16.7	0.1295
Skin lesions	5	17	22	22.7	0.1312
Ocular signs	1	4	5	20.0	0.6502
Oral signs	4	10	14	28.6	0.4142
Stomatitis	0	1	1	0.0	1.0000
Gingivitis	3	10	13	23.1	0.2515
Ulcers in the tongue	1	1	2	50.0	1.0000
Urinary tract disorders	1	3	4	25.0	0.6519
Fever (> 39.2°C)	12	25	37	32.4	0.3729
Dehydration	19	38	57	33.3	0.3029
Sporotrichosis	11	17	28	39.3	0.8921
Respiratory Signs	20	27	47	42.6	0.8008
Hyperthyroidism	1	1	2	50.0	1.0000

although our results demonstrate that young and adult cats of both sexes have similar chance of becoming infected. Such results are consistent with other studies.^{32,38}

Although the association was not significant, cats that lived in the presence of other animals generally showed almost two times more chance of becoming infected by *Bartonella* species. Interestingly, the presence of opossums in the neighborhood increased the risk of infection by three times.

Opossums (*Didelphis* species) are synanthropic animals and, therefore, adapted to peridomestic environments. *Ctenocephalides felis* flea, the main ectoparasite involved in transmission of *Bartonella* species among cats, has been shown to parasitize opossum species in Brazil, including Rio de Janeiro State.^{39,40} Along these lines, the presence of these ectoparasites in opossums indicates their proximity to human residences and to domestic animals. This interaction highlights the imminent risk of pathogen transmission between animal species through arthropod vectors and, consequently, to humans, thus posing a public health risk.³⁹ More studies are needed to understand the importance of opossums in epidemiological chain of this disease.

Endoparasites' presence or absence seems not to be related to *Bartonella* infection in cats. On the other hand, cats without adequate vaccinations were at significantly higher risk of infection. It is important to note that the shelter cats studied generally live under constantly stressful conditions, including poor nutrition, crowding, inadequate hygiene, and vaccination measures, which may interfere with the cats' immune status.⁴¹ In such scenarios, inadequate or absent vaccinal support predispose the animals to such immunosuppressive diseases as retroviruses, which appear to increase the pathogenicity of *B. henselae* infection in cats.⁴²

No clinical signs were associated with *Bartonella* species infection because symptomatic and asymptomatic cats have similar chances of becoming infected. This finding is consistent with those of other authors,¹⁸ according to whom most naturally infected cats do not show clinical signs and appear to tolerate chronic bacteremia without obvious clinical abnormalities. However, previous studies have suggested

TABLE 4
Hematological results from 208 shelter cats screened for *Bartonella* species infection

Parameter	Result	<i>Bartonella</i> species			P-value	Reference ²³
		Mean	DP	EP		
RBC (10 ⁶ /μL)	Positive	8.3	1.5	0.2	0.6645	5.0–10.0
	Negative	8.1	1.6	0.2		
Hematocrit (%)	Positive	37.7	6.5	0.7	0.3098	30–45
	Negative	36.1	7.0	0.6		
Hemoglobin (g/dL)	Positive	11.6	2.0	0.2	0.2335	9.8–15.4
	Negative	11.1	2.3	0.2		
MCV (fL)	Positive	45.5	4.8	0.5	0.4197	39–55
	Negative	44.7	4.1	0.4		
MCHC (%)	Positive	30.8	2.1	0.2	0.8655	30–36
	Negative	30.8	1.8	0.2		
Platelet (10 ³ /μL)	Positive	371	135	15.0	0.0494	300–800
	Negative	334	142	12.7		
TPPC (g/dL)	Positive	7.9	0.8	0.1	0.0109	6.0–7.5
	Negative	8.3	1.1	0.1		
WBC (10 ³ /μL)	Positive	17.14	7.55	0.83	0.4587	5.5–19.5
	Negative	16.70	8.13	0.73		
Band neutrophils (10 ³ /μL)	Positive	0.25	0.31	0.03	0.6806	0.0–0.3
	Negative	0.35	0.59	0.05		
Segmented neutrophils (10 ³ /μL)	Positive	10.21	6.77	0.74	0.9719	2.5–12.5
	Negative	10.23	6.83	0.61		
Lymphocytes (10 ³ /μL)	Positive	4.96	3.13	0.34	0.2116	1.5–7.0
	Negative	4.35	2.58	0.23		
Monocytes (10 ³ /μL)	Positive	0.45	0.38	0.04	0.2568	0.0–0.9
	Negative	0.53	0.47	0.04		
Eosinophils (10 ³ /μL)	Positive	1.27	0.88	0.10	0.0169	0.0–0.8
	Negative	1.14	1.14	0.10		
Basophils (10 ³ /μL)	Positive	0.01	0.07	0.01	0.9615	0.0–0.2
	Negative	0.01	0.06	0.01		

DP = standard deviation; EP = standard error; SD = standard deviation; SE = standard error; RBC = red blood cell count; MCV = mean corpuscular volume; MCHC = mean corpuscular hemoglobin concentration; TPPC = total plasma protein concentration; WBC = white blood cell count.

TABLE 5

Hematological results for *Bartonella* infection in cats from shelters located in the Metropolitan Region of Rio de Janeiro state, Brazil

<i>Bartonella</i> species n (%)				
Hematological change		Positive (n = 83)	Negative (n = 125)	P-value
Eosinophilia	Yes	53 (63.9)	60 (48.0)	0.0352
	No	30 (36.1)	65 (52.0)	
Thrombocytopenia	Yes	20 (24.1)	50 (40.0)	0.0259
	No	63 (75.9)	75 (60.0)	
Lymphopenia	Yes	02 (2.4)	14 (11.2)	0.0305
	No	81 (97.6)	111 (88.8)	
Hyperproteinemia	Yes	52 (62.7)	92 (73.6)	0.1280
	No	31 (37.3)	33 (26.4)	

Bartonella species are causative agents of clinical condition such as endocarditis, stomatitis, pyogranulomatous myocarditis and diaphragmatic myositis, fever of unknown cause, and central nervous system diseases.^{4–10} It should be mentioned that it is difficult to establish causal associations between clinical conditions and such pathogens as *Bartonella* species, which have high prevalence in the reservoir host population. This high prevalence of asymptomatic bacteremia indicates that there is a long history of coevolution between *Bartonella* and their cat hosts.⁴³

Many of the symptoms exhibited by the cats of this study are nonspecific and common to other diseases affecting these animals routinely. Therefore, the likelihood that some clinical conditions have multiple causes must also be considered, particularly in cats exposed to arthropod vectors. Thus, a differential diagnosis with other diseases of common occurrence in the feline clinical routine is necessary.¹²

Regarding laboratory findings, eosinophilia was highly associated with *Bartonella* species infection in cats, being present in almost 64% of bacteremic cats. In accordance with our results, a study has observed persistent eosinophilia in cats experimentally infected with *Bartonella* species and related this hematological finding with infection chronicity.¹¹ On the other hand, researchers demonstrated that hematological findings in *Bartonella* spp.-infected cats may be uncommon.⁴⁴ It is important to note that other clinical conditions may also cause this hematological change, such as infection by intestinal parasites and skin or respiratory abnormalities found in cats from this study. Further studies are needed to establish the correlation between eosinophilia and *Bartonella* infection.

Concerning the zoonotic aspect of *Bartonella* infection, we highlight the importance of testing cats before adoption and a rigorous management of flea control in the ambient and cat adopted, especially because of the potential risk to immunocompromised patients. The high occurrence of *Bartonella* species in cats from shelters at Metropolitan Area of Rio de Janeiro emphasizes the need for local veterinary community, owners, and public health authorities to be alert to the risk of infection. Ectoparasites control measures, especially those designed to prevent flea infestation, should be implemented to minimize the risk of infection by cats, other vertebrate hosts, and humans.

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