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Frequency of *Leptospira spp* serovars reported in horses: a literature review

Frecuencia de leptospirosis en equinos: revisión de literatura

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Abstract

Equine leptospirosis has been associated with abortions, renal failure and uveitis, which constitutes a health and economic problem. However, it is generally asymptomatic, which makes this disease of little interest in equines in comparison with other domestic and wild species. At present, the real epidemiological situation of leptospirosis in equines is unknown; just as the disease develops in these animals. A search of scientific literature was carried out; with the objective of knowing which are the serovars of genus leptospira reported in equines from 2010 to 2020. In the literature review, 21 articles were selected, in which it was identified that *Leptospira bratislava,* is the most frequently reported (11.43%, IC 95%: 6-19.1%) is in contact with equines, followed by *Leptospira icterohaemorrhagiae* (9.52%, IC 95%: 4.6-16.8%).
Keywords: host, Infection, uveitis, zoonosis.

Resumen

La leptospirosis equina ha sido asociada con abortos, insuficiencia renal y uveítis, lo cual constituye un problema de salud y económico, sin embargo, de manera general es asintomática, lo cual provoca que dicha enfermedad sea de poco interés en equinos en comparación con otras especies domésticas y silvestres. En la actualidad la situación epidemiológica real de leptospirosis en equinos se desconoce; al igual que la enfermedad se desarrolla en estos animales. Se realizó una búsqueda de literatura científica; con el objetivo de conocer cuáles son las serovariedades del género leptospira reportadas en equinos desde 2010 a 2020. En la revisión de literatura se seleccionaron 21 artículos, en los cuales se identificó que *Leptospira bratislava*, es la que se reportó con mayor frecuencia (11.43%, IC 95%: 6-19.1%), seguida por *Leptospira icterohaemorrhagiae* (9.52%, IC 95%: 4.6-16.8%).
Palabras clave: hospedero, infección, uveítis, zoonosis.

INTRODUCTION

Leptospirosis described in 1886 by the German physician Adolph Weil, is currently one of the most widely distributed infectious diseases worldwide, bacteria of the genus *Leptospira spp* (Adler and de la Peña, 2010).

The frequency of leptospirosis is usually associated with bad hygiene, so its presence is more frequent in regions where activities such as agriculture, the manufacture of products of animal origin, forestry, livestock, mining, etc (Torres *et al*., 2016).

This disease has relevance for public and animal health, due to the participation of natural and accidental hosts, which are important for maintenance. Rodents are considered the main hosts, in addition to bovines, horses, pigs, sheep, goats, dogs and cats; as well as wild mammals (Andersen *et al*., 2016). Some of these meet the function of carriers, which may be able to eliminate bacteria by urine as sick individuals do, without presenting detectable clinical signs (Wood *et al*., 2018; Ellis, 2014; Moral *et al*., 2014).

In equines, leptospirosis is commonly associated with genitourinary and ophthalmic diseases in which damage to placenta and fetus, kidneys and eyes can be appreciated. In general, the clinical picture is mild or subclinical; however, in the acute way, depression, jaundice, pyrexia, while in severe infections are observed abortions, neonatal diseases or the birth of a healthy pony with antibodies against this bacterium. In some cases, perinatal mortality is presented, as well as respiratory disorders and recurrent uveitis (ERU) or iridocyclitis (Divers, *et al*., 2019; Arent and Kedzierska-Mięszkowska, 2013; Verma *et al.*, 2010).

Equines are infected when consuming water contaminated with leptospira; as well as any other species when in contact with urine or other fluids of infected animals. These bacteria have the ability to enter the body through mucous membranes, skin abrasions and transplacental route, so that later they can lodge mainly in the renal tubules of animals, where they are colonizing the kidney (Khalili *et al*., 2019).

In later, bacteria are eliminated by urine, polluting rivers, lakes and other water sources that are used for activities aimed at trade, agriculture, livestock, included for the consumption of the human being, in this way the infection is facilitated in humans and animals (Pulido *et al*., 2014). In certain occasions some products, fabrics and fluids of these animals can act as a source of infection.

Hamond *et al*. (2013), it proposes another non-conventional path of disease transmission, through sexual contagion, because it found the presence of DNA, from *Leptospira spp* in equine semen, in 50% of evaluated samples and frequency of 60% for *Leptospira bratislava* and *Leptospira Copenhageni*. It is worth mentioning that, although exposure to leptospira is common, the development of equine disease occurs at rare occasions (Malalana, 2019).

At present it is not accurately known whether the conditions in the horse kidney alter the physiological functions of the bacteria and, therefore, affect their survival, generate reduction of their pathogenesis, or if there are differences in infection between males and females (Hamond *et al*., 2012a). However, through histopathological studies in young horses' kidneys, the formation of petechiae and lymphocytic infiltration in the proximal tubules and glomeruli has been observed. It has also been reported that *Pomona* serovar, in these organs causes fever and acute renal failure (Verma *et al*., 2010).

The objective of this literature review was to know the frequency of leptospirosis in equines reported in the literature of the last 10 years.

METHODOLOGY

A review was carried out in web search browsers as PubMed, Science Direct, SciELO, from the scientific literature peer-reviewed and published in the last 10 years (2010-2020), the keywords used were frequency, equines, *Leptospira spp*, leptospirosis, infection, diagnosis, uveitis and combination of these.

Reports of serovariety, country and continent were obtained from the articles consulted; based on this, the overall frequency of positive animals and the frequency of serovars were calculated.

Then the EpiInfo 7® program was used to analyze the data, know the frequencies and 95% of confidence intervals (95% CI) of the information obtained from the scientific peer-reviewed articles (CDC, 2016).

RESULTS

In a representative sample of 21 papers, where any serovar of leptospira was detected at 7218 horses (Table 1). In these, 40 serovarieties were found (Table 2), being *Leptospira bratislava* the most frequently reported with 11.43% (IC 95%: 6-19.1%), followed by *Leptospira icterohaemorrhagiae* with 9.52%, (IC 95%: 4.6-16.8% ; which suggests that these serovarieties reported are the ones that are in contact with equines.

From 21 articles analyzed, it was reported that Brazil is the country where more studies have been carried out on equine leptospirosis during the last decade, with 47.62% (IC 95 %: 25.71-70.22%) as shown in Table 3.

In Table 4, the serovar reported in the literature consulted in equines are shown during the last ten years.

Table 1. Horse frequencies reported with leptospirosis

Author	Animals used in the study (N)
Ali, 2012	409
Alves, 2016	100
Arent and Kedzierska-Mięszkowska, 2013	620
Bedoya *et al*., 2013	293
De Oliveira *et al*., 2014	257
Hamond *et al*., 2012[b]	119
Hamond *et al*., 2013	10
Hamond *et al*., 2015	206
Malalana *et al*., 2019	Not available
Martins *et al*., 2017	54
Méndez *et al*., 2013	24
Peixoto Ribeiro *et al*., 2018	1640
Pinna *et al*., 2014	608
Pikalo *et al*., 2016	314
Rey Riaño *et al*., 2015	94
Siqueira *et al*., 2019	1200
Simbizi *et al*., 2016	663
Troncoso *et al*., 2013	55
Tsegay *et al*., 2016	418
Vera *et al*., 219	134
Total	**7218**

Table 2. Frequency of different species of leptospira reported in equines in 2010 to 2020

Leptospira	Frequency	%	% Accumulated	95% confidence interval	
arborea	1	0.95	0.95	0.02	5.19
australis	4	3.81	4.76	1.05	9.47
autumnalis	5	4.76	9.52	1.56	10.76
ballum	2	1.90	11.43	0.23	6.71
bataviae	1	0.95	12.38	0.02	5.19
bataviae (sv. swart)	1	0.95	13.33	0.02	5.19
bratislava	12	11.43	24.76	6.05	19.11
bratislava jez-bratislava	1	0.95	25.71	0.02	5.19
butembo	1	0.95	26.67	0.02	5.19
canicola	6	5.71	32.38	2.13	12.02
celledoni	1	0.95	33.33	0.02	5.19
copenhageni	6	5.71	39.05	2.13	12.02
copenhageni y australis	1	0.95	40.00	0.02	5.19
cynopteri	1	0.95	40.95	0.02	5.19

djasiman	3	2.86	43.81	0.59	8.12
grippothyphosa (sv. duyster)	1	0.95	44.76	0.02	5.19
grippotyphosa	7	6.67	51.43	2.72	13.25
grippotyphosa moska V	1	0.95	52.38	0.02	5.19
hardjo	4	3.81	56.19	1.05	9.47
hardjo bovis	1	0.95	57.14	0.02	5.19
hardjo prajitno	3	2.86	60.00	0.59	8.12
hardjobovis/wolffi	1	0.95	60.95	0.02	5.19
hardjoprajitno H89	1	0.95	61.90	0.02	5.19
hebdomadis	2	1.90	63.81	0.23	6.71
icterohaemorrhagiae	10	9.52	73.33	4.66	16.82
javanica	1	0.95	74.29	0.02	5.19
panama	2	1.90	76.19	0.23	6.71
patoc	1	0.95	77.14	0.02	5.19
poi	1	0.95	78.10	0.02	5.19
pomona	9	8.57	86.67	3.99	15.65
portland-vere sinaloa	1	0.95	87.62	0.02	5.19
pyrogenes	1	0.95	88.57	0.02	5.19
sentot	1	0.95	89.52	0.02	5.19
seramanga	1	0.95	90.48	0.02	5.19
serjoe	2	1.90	92.38	0.23	6.71
tarassovi	3	2.86	95.24	0.59	8.12
tarassovi perepelitsin	1	0.95	96.19	0.02	5.19
topaz	1	0.95	97.14	0.02%	5.19
wolffi	2	1.90	99.05	0.23%	6.71
zanoni	1	0.95	100	0.02%	5.19

Table 3. Frequency of reports by country with equine leptospirosis during 2010 -2020

Country/continent	Frequency	%	% Accumulated	95% confidence interval	
Germany/Europe	1	4.76	4.76	0.12	23.82
Brazil/America	10	47.62	52.38	25.71	70.22
Chile/ America	1	4.76	57.14	0.12	23.82
Colombia/ America	2	9.52	66.67	1.17	30.38
Iran/Asia	1	4.76	71.43	0.12	23.82
Italy/Europe	1	4.76	76.19	0.12	23.82
Mexico/America	1	4.76	80.95	0.12	23.82
Northwest England and North of Wales /Europe	1	4.76	85.71	0.12	23.82
Poland /Europe	1	4.76	90.48	0.12	23.82
South Africa /Africa	1	4.76	95.24	0.12	23.82
Southern Ethiopia /Africa	1	4.76	100.00	0.12	23.82
Total	21	100	100		

Table 4. Frequency by country of leptospira infections in equines 2010 to 2020

Author	Country /continent	Serovariety found *Leptospira:*	Reported frequency (%)	% positive animals 95% confidence interval
Ali, 2012	Iran/Asia	*pomona*	38.9	39.18 35-43.6
		grippotyphosa	32.7	
		icterohaemorrhagiae	15.1	
		canicola	10.4	
		hardjo	1.7	
		ballum	1.04	
Alves *et al*., 2016	Brazil/America	*patoc*	35.7	28.0 20.1-37.5
		butembo	32.1	
		sentot	14.3	
Arent and Kedzierska-Mięszkowska, 2013	Poland/Europe	*grippotyphosa*	11.7	39.0 35.3-43.0
		serjoe	4.5	
		bratislava	4.0	
		poi	3.7	
		pomona	3.6	
		icterohaemorrhagiae	2.9	
		celledoni	0.9	
		cynopteri	0.9	
		ballum	0.6	
		hebdomadis	0.6	
		bataviae	0.5	
		hardjo	0.4	
		zanoni	0.4	
		autumnalis	0.4	
		canicola	0.3	
		australis	0.3	
Bedoya *et al*., 2013	Colombia/America	*bratislava*	53.3	66.70 51.5-79.0
		hardjo bovis	28.5	
		icterohaemorrhagiae	26.3	
		hardjo prajitno	5.1	
		grippotyphosa	2.8	
		pomona	2.6	
Hamond *et al*., 2012b	Brazil/America	*copenhageni*	43.7	71.4

		icterohaemorrhagiae	27.8	62.7-78.8
Hamond *et al*., 2013	Brazil/America	*bratislava*	30.0	60
		copenhageni	30.0	31.3-83.2
Hamond *et al*., 2014a	Brazil/America	*australis*	54.4	47.8
		icterohaemorrhagiae	43.6	39.5-56.1
Hamond *et al*., 2015	Brazil/America	*australis*	46.4	44.7
		pomona	70.5	38.0-51.5
Malalana *et al*., 2019	Northwest England and North of Wales /Europe	*bratislava*	19.4	51.4
		copenhageni y Australis	6.9	40.0-62.6
		autumnalis	8.3	
Martins *et al*., 2017	Brazil/America	*australis*	69.2	48.1
		icterohaemorrhagiae	30.8	35.4-61.1
Méndez *et al*., 2013	Mexico/America	*hardjoprajitno H89*	12.0	71
		wolffi	12.0	50.8-85.0
		tarassovi perepelitsin	41.0	
		grippotyphosa moska V	4.0	
		bratislava jez-bratislava	8.0	
		portland-vere sinaloa	8.0	
		hardjo prajitno	29.0	
		icterohaemorrhagiae	12.0	
		pomona	42.0	
Peixoto Ribeiro *et al*., 2018	Brazil/America	*serjoe*	5.9	32.7
		seramanga	5.3	30.5-35.0
		djasiman	3.9	
		grippotyphosa	3.9	
		icterohaemorrhagiae	3.6	
		autumnalis	2.6	
Pinna *et al*., 2014	Brazil/America	*bratislava*	62.3	44.9
		copenhageni	37.7	41.0-48.9
Pikalo *et al*., 2016	Germany /Europe	*icterohaemorrhagiae*	11.1	17.20
		bratislava	9.6	13.4-21.8
		grippotyphosa	1.9	
Rey *et al*., 2015	Colombia/America	*pomona*	41.5	76.6
		grippotyphosa	24.5	67.1-84.0
		canicola	16.0	
		javanica	23.4	
		hardjo prajitno	10.6	
		tarassovi	7.4	
		hebdomadis	7.4	

		wolffi	2.1	
		bratislava	1.1	
		icterohaemorrhagiae	40.4	
Troncoso *et al*., 2013	Chile/America	*autumnalis*	54.5	65.5 52.2-76.6
		bratislava	52.7	
		canicola	20.0	
		copenhageni	12.7	
		hardjo	7.3	
Siqueira *et al*., 2019	Brazil/America	*autumnalis*	2.3	8.0 6.6-9.7
		bratislava	54.5	
		canicola	4.5	
		grippothyphosa (sv. duyster)	2.27	
		hardjobovis/wolffi	22.7	
		copenhageni	2.3	
		panama	2.3	
		pomona	4.5	
		bataviae (sv. swart)	4.5	
Simbizi *et al*., 2016	South Africa/Africa	*bratislava*	32.9	85.0 82.1-87.6
		djasiman	25.8	
		arborea	11.0	
		tarassovi	7.7	
De Oliveira *et al*., 2014	Brazil/America	*panama*	6.2	7.40 4.8-11.3
		pyrogenes	3.5	
		grippotyphosa	3.5	
Tsegay *et al*., 2016	Southern Ethiopia /Africa	*bratislava*	34.3	44.0 39.3-48.8
		djasiman	9.8	
		topaz	6.0	
		pomona	5.3	
Vera *et al*., 219	Italy/Europe	*bratislava*	41.8	67.2 58.8-74.5
		canicola	63.6	
		tarassovi	28.4	
		copenhageni	17.9	
		pomona	10.4	
		hardjo	2.2	

DISCUSSION

Knowing the true value of the *Leptospira spp* frequency from the revised articles is very complicated, there was a confidence interval from there to be able to locate 95% with a range of values among which the real value of this agent frequency in the equine population (Molina, 2013). In this study, 40 serovars of *Leptospira spp* in horses were identified. Although *Leptospira bratislava* has been the most commonly reported in the equine literature in the last 10 years (Pinna *et al*., 2014), *Leptospira pomona* is the one considered to be the specific agent for equidae, since when the individual develops the disease, high titers of antibodies against the latter can be found (Divers *et al*., 2019).

In the serological studies in equines, there is identified that there is variation in the frequency of infection by *Leptospira* (Hamond *et al*., 2014b); which can be submitted on the four continents reported in the study sample. The most reported infections in the literature in equines of the last 10 years were caused by *Leptospira icterohaemorrahagiae*, *Leptospira pomona*, *Leptospira bratislava*, *Leptospira* copenhageni and *Leptospira grippotyphosa*. These data were obtained in accordance with the analyzed papers, derived from studies, both clinical, serological and ecology of the disease, which has allowed knowing the interface between animal-human environment and its importance for the concept of a one single health (Jaeger *et al*., 2019). On the other hand, Bertelloni *et al.* (2019) mention that environmental characteristics, such as wetlands, ponds and channels present at the center of Italy, associated with the presence of domestic and wild animals (the latter as reservoirs of leptospiras) enhance the dissemination of this disease, and they are reported frequencies in pigs of 19.74% and bovines of 13.03%. It is known that leptospira are transmitted efficiently through water, being able to survive for long periods in humid environments (Lourerio *et al*., 2013). For its part, Verma *et al*., 2019 showed the existence of the interaction between the pathogen and domestic and wild animals, through water settlements, as well as the bacterium presence in kidneys of wild animals. It has been suggested that the adaptation of serovar to the host, as well as, the nearby coexistence with cattle with horses can influence the frequency of exposure (Lowe, 2010). Pinna *et al*. (2014) demonstrate that *Leptospira bratislava* is adapted to equines, since this has been associated with reproductive problems in mares. However, *Leptospira bratislava* and *Leptospira muenchen*, have been associated with cases of infections in pigs, horses, bovines and dogs, and managed to identify similar strains in wild animals (Arent *et al*., 2016).

Witkswski *et al*. (2016) mention that *Leptospira grippotyphosa* and *Leptospira pomona* are associated with cases of recurrent uveitis in equines. Hashimoto *et al*. (2007) evaluated the prevalence of leptospirosis in equines without apparent clinical synology, and used weight loss and depression as inclusion criteria, with which they obtained 66.88% of overall frequency; of this value, antibodies represented 23.36% against

Leptospira icterohaemorrhagiae and 13.14% by *Leptospira grippotyphosa*. While Hamond *et al*. (2012b) found 89.5 seroprevalence in asymptomatic horses.

The disease severity varies with the serovar and the affected animal, when the disease is presented subclinically, animal deterioration is not apparent; however, when the presence of the disease is chronic, the physical and productive deterioration of animals are evident (Ellis, 2015).

Leptospira pomona kennewicki is considered as responsible for most clinical presentations in American horses, is associated with placenta diseases and fetus, kidneys and eyes ((Divers *et al*., 2019); however, clinical presentation can result in abortion or in a sick colt. This can be due to the gestational mare stage and at the time it was infected with the bacteria, as well as its immunological state (Bernard, 1993). From the clinical point of view, a study conducted in Sweden showed that there is no significant association between the presence of clinical signs of disease and positive titles to *Leptospira bratislava* or *Leptospira Icterohaemorrhagiae* with exception with the association between respiratory problems and fatigue with the *Leptospira Bratislava* (Båverud *et al*., 2009). . Such is the case of Rocha (2004) in which, by obtaining samples of horse kidneys, isolations and serological typing were achieved, where it determined the presence of *Leptospira australis* and *Leptospira pomona* strains, these two strains are the ones that have been most reported in Portuguese horses.

It has been associated with the frequency of infection with *Leptospira spp* to environmental conditions, including seasonal variations, as an example has to be *Leptospira icterohaemorrhagie* are presented more frequently between months of October and December, this attributed to the rodents usually invade the stables and houses at the end of summer and autumn. On the other hand, the increase in frequency *Leptospira bratislava* is presented between April and June and October to December (Båverud *et al*., 2009).

Leptospirosis is a neglected zoonosis with a worldwide distribution, affects many species of mammals, including livestock, causing clinical signs of acute character in animals of all ages and productive stages, which significantly affects animal production. The annual incidence of this zoonosis in humans is not well determined due to sub-notification; it is estimated as an example in Uruguay, which is 15 per 100,000 inhabitants. Human disease seems to be associated with infected animals, as well as with rains and floods in endemic regions (Zarantonelli *et al.,* 2018).

CONCLUSIONS

In general, the literature consulted allowed knowing the disease frequency and serovars found on horses. Exposure to different serovars may be related to the region in which equines are found, as well as the presence of one or more specific hosts for these serovars which act as a reservoir so that infection is presented. Horses are infected when they consume contaminated water with some leptospira species. While exposure to these agents is common in horses, systemic disease is rare, equines can be asymptomatic or present different clinical signs. Frequently reported leptospira species that can infect horses are, *Leptospira bratislava*, (11.43%, IC 95%: 6-19.1%) and with *Leptospira icterohaemorrhagiae* (9.52%, IC 95%: 4.6-16.8%). It is necessary to consider in future studies, the investigation of animal leptospirosis impact in public, animal and environmental health, in order to implement geographically specific prevention and control programs of this disease.

Declaration of interest conflicts

There is no kind of conflict of interest

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