Wildlife Health Australia

Leptospira infection in Australian mammals

Fact sheet

Introductory statement

Leptospirosis is a worldwide bacterial disease that affects a wide range of mammalian species, has significant agricultural impacts and is a frequent a zoonotic disease in humans (Ellis 2015). Almost all mammal species can excrete or be carriers of the organism (Adler and de la Peña Moctezuma 2010). The most commonly identified carriers of the infectious organism in Australia are rodents and small marsupials, with domestic animals such as cattle, pigs, sheep, goats and dogs also recognised as sources of disease (Adler and de la Peña Moctezuma 2010). Evidence of infection with *Leptospira* spp. has been found in a wide range of Australian mammals (Ladds 2009).

Aetiology

Leptospira spp. are motile spirochaete bacteria from the family Leptospiraceae in the order Spirochaetales. There are now over 20 recognised species consisting of over 300 antigenically distinct serovars worldwide, however further changes in taxonomy are expected. Closely related serovars are occasionally grouped into serogroups, which have proven useful for epidemiology. Accepted nomenclature dictates that genus and species are italicised, followed by the non-italicised, capitalised serovar (e.g. *Leptospira interrogans* serovar Icterohaemorrhagiae) (Levett 2015).

Natural hosts

Rodents are the maintenance hosts for most *Leptospira* serovars but many serovars are adapted to other wild or domestic mammal species. While each has a host preference, serovars are often capable of infecting other mammalian species, with variable resultant disease (Heath and Johnson 1994; Ellis 2015).

World distribution

Leptospira spp. are widespread globally (other than Antarctica). Theoretically, any serovar can occur in any area, but generally a limited number of serovars are endemic in any one region. Rates of incidental disease in

animals are higher in tropical areas, particularly if ecological factors result in increased overlap between susceptible and reservoir species (Ellis 2015).

Occurrences in Australian wildlife

Evidence of infection with *Leptospira* bacteria has been reported in a wide range of Australian native mammals and feral species. **Table 1** (Appendix A) summarises **the known identifications from animals in Australia** to Feb 2018 and indicates whether there has been serological evidence of exposure and/or confirmed presence of organisms in the kidney or urine, the latter indicating potential to shed the organism.

Australian wildlife and feral species that have been implicated as **potential reservoirs** for leptospiral infection include:

- Northern brown bandicoot (*Isoodon macrourus*) (Emanuel et al. 1964)
- Common brushtail possum (*Trichosurus vulpecula*) (in Australia and also in New Zealand) (Brockie 1975; Durfee and Presidente 1979b, 1979c)
- Flying-foxes (*Pteropus* spp.) (Smythe et al. 2002)
- Native and introduced rodent species (Emanuel et al. 1964)

Australian wildlife or feral species in which **clinical signs or pathology** associated with leptospiral infection have been reported include:

- Common wombat (*Vombatus ursinus*) (Munday and Corbould 1973)
- Common brushtail possum (Durfee and Presidente 1979b, 1979c)
- Platypus (*Ornithorhynchus anatinus*) (McColl and Whittington 1985)
- Common water rat (*Hydromys chrysogaster*) (Durfee and Presidente 1979a; Ladds 2009)
- Feral rodent species (Ladds 2009)
- Tasmanian devil (*Sarcophilus harrisii*) (Wynwood et al. 2016)

Leptospira have not been isolated in southern hemisphere pinnipeds but antibodies to several *Leptospira* serovars, *L. borgpetersenii* Hardjo*, L. interrogans* Canicola and *L. interrogans* Pomona, have been found in New Zealand fur seal (*Arctocephalus forsteri*) pups in New Zealand, without evidence of disease (Mackereth et al. 2005).

Epidemiology

Leptospirosis epidemiology in terrestrial mammals has been reviewed by Heath and Johnson (1994). Briefly, infection of a mammalian species with a *Leptospira* serovar for which it is the preferred host usually produces subclinical disease with prolonged bacterial shedding. Antibody prevalence in the host population will therefore be high. In contrast, disease in non-preferred hosts is usually of the form of sporadic infections or outbreaks; infection is not maintained and seroprevalence in the population will be low.

The organisms colonise the renal tubules of carrier animals and are shed in the urine. An individual may be a carrier for a short duration but in many species this status continues for the lifetime of the animal. Excretion of the organism may be intermittent and can be affected by factors such as the species, age and diet of the animal (Adler and de la Peña Moctezuma 2010).

The organism does not survive dry or acid conditions (Adler and de la Peña Moctezuma 2010). Transmission of the organism can occur by indirect or direct routes. Urine can contaminate water, soil and vegetation providing an avenue for indirect exposure and allowing the organism to enter through cuts, abrasions and

mucous membranes. Direct exposure can occur through contact with infected body fluids (including urine) and tissues.

Clinical signs

Infection can cause acute systemic febrile or haemorrhagic disease however, many infections are inapparent. Pregnant animals may undergo abortion or give birth to stillborn or diseased neonates (Ellis 2015). Clinical signs are variable in domestic animals and commonly include fever, malaise and signs of pulmonary, renal, liver and reproductive disease (Adler and de la Peña Moctezuma 2010). In Australian native species (common wombats and common brushtail possums)[1], overt clinical disease has only been seen under experimental conditions; signs included depression, anorexia, lethargy and increased drinking (Munday and Corbould 1973; Day et al. 1997; Ladds 2009). A single report of clinical signs consistent with leptospirosis in a Tasmanian devil does not provide specifics of the signs (Wynwood et al. 2016). In seals of the northern hemisphere, signs of anorexia, extreme lethargy, thirst and abdominal pain are reported (Zuerner et al. 2009). Infected seals are often emaciated and infection has been associated with abortion and neonatal mortality (Smith et al. 1977).

Diagnosis

Diagnosis of leptospirosis is made by demonstrating serological evidence of exposure or detection of the organism (via isolation or nucleic acid methods) in urine or tissues. The former is generally used to demonstrate historical exposure or acute infection if paired tests show a rising titre. The latter is used in the more acute stages to show definitive infection (Ellis 2015). Serological testing alone cannot always confirm the presence of particular serovar as serological cross-reactions can occur. Only direct detection of the agent confirms the presence of a particular serovar (DAWR pers comm Aug 2018).

Dark field microscopy, culture, polymerase chain reaction (PCR) and histopathological examination of tissues can be used (see “Laboratory diagnostic specimens and procedures”).

Pathology

The main mechanism of pathology is considered common across all species and involves damage to the endothelial cells of small vessels. If death occurs acutely, little will be seen grossly (Ellis 2015). In Australian native species, including common brushtail possums, acute changes in the kidneys include gross swelling and foci of suppurative nephritis with tubular necrosis on microscopic examination. Chronically, the kidneys can appear pitted with capsular adhesions and non suppurative interstitial nephritis is detected histologically (De Lisle et al. 1975; Durfee and Presidente 1979b, 1979c; Cooke 1998; Ladds 2009). Northern hemisphere seals affected by leptospirosis demonstrate similar acute and chronic changes in the kidneys in addition to occasional multifocal hepatitis (Dierauf et al. 1985). Similar chronic histopathological changes have been detected in platypus, feral rodents and common water rats, but definitive attribution of these lesions to leptospirosis has not always been shown (Durfee and Presidente 1979a; McColl and Whittington 1985; Ladds 2009). Potentially fatal nephritis due to leptospirosis has been reported in a Tasmanian devil, but no details as to the nature of the inflammation were provided (Wynwood et al. 2016).

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[1] Other host species [as listed under “Occurrences in Australian wildlife: clinical signs and pathology”] are from reports where only post mortem pathological changes were described.

Laboratory diagnostic specimens and procedures

It is advisable that submitters contact their local state/territory laboratory to confirm the preferred samples for testing. Note that leptospirosis is a notifiable disease in some jurisdictions.

The gold standard serological test is the microscopic agglutination test (MAT), which incorporates live cultures as the antigen. The MAT panel is assembled to have an antigenic panel representing all the serovars in a region. The MAT detects all classes of antibody. Enzyme linked immunosorbent assays (ELISA) are rapid screening tests that can be directed against a range of antibodies and species of animal.

The MAT generally allows an exact serovar to be identified although cross-reactivity can occur. ELISAs can have variable specificity as to which serovars they detect. Both tests utilise serum. Histopathology and immunohistochemistry can be performed on formalin fixed sections of kidney.

In dark field microscopy, samples of urine or blood are examined directly with a microscope to see the bacteria. Organisms can be difficult to see, other materials in the fluid can be mistaken for the bacteria, and the serovar cannot be determined, rendering this technique less than ideal other than for screening of species with large numbers of urinary organisms.

Culture can be undertaken on fresh/frozen renal tissue or urine. Culture of renal tissue or urine is difficult and can often result in false negative results, but when successful the exact serovar can be determined. *Leptospira* spp. require culture and maintenance in specific media and are generally grown at 28 – 30 ^{o} C in the laboratory (Ellis 2015).

PCR can be carried out on fresh tissue or fluid samples and detects the organism or its targeted DNA and can provide rapid detection in a range of body fluids and tissues. It is generally highly specific and can detect an infection before serology or culture, but does not identify to the type of serovar (Xu et al. 2014; Ellis 2015).

Organisms and/or associated inflammation can be identified on histopathological examination of kidneys, allowing for definitive or more often presumptive diagnosis of infection (C. Sangster pers. comm. Aug 2018). Immunohistochemical staining of tissue sections can also be used to detect antigen (Wild et al. 2002).

Treatment

Leptospires are sensitive to most antibiotics (Adler and de la Peña Moctezuma 2010). Intensive supportive therapy may be required in severe cases of acute disease (Ellis 2015). Treatment is not considered necessary in wild animals that do not display clinical signs.

Prevention and control

Control of the disease in domestic animals is based on prevention, vaccination (where applicable) and treatment (Adler and de la Peña Moctezuma 2010). Control is not feasible or practical in wild animals, in most cases. For captive animal situations an effort should be taken to keep rodent populations under control to reduce the risk of indirect or direct exposure to the organism (Adler and de la Peña Moctezuma 2010).

Leptospires are susceptible to extremes of pH, surviving for long periods in alkaline soils, but cannot survive drying. They are sensitive to acid at pH 6.8 or lower but can survive alkaline conditions up to pH7.8-7.9. A wide range of chemical compounds are toxic to leptospires (Adler and de la Peña Moctezuma 2010).

Surveillance and management

Wildlife disease surveillance in Australia is coordinated by the Wildlife Health Australia. The National Wildlife Health Information System (eWHIS) captures information from a variety of sources including Australian government agencies, zoo and wildlife parks, wildlife carers, universities and members of the public. Coordinators in each of Australia's States and Territories report monthly on significant wildlife cases identified in their jurisdictions.

Statistics

There are a small number of cases of positive serological results to *Leptospira* antibodies in Australian wildlife species, listed on the National Wildlife Health Surveillance Database www.wildlifehealthaustralia.com.au. NOTE: access to information contained within the National Wildlife Health Information System dataset is by application. Please contact admin@wildlifehealthaustralia.com.au.

Research

Key research questions revolve around understanding potential wildlife reservoirs in Australia and the impact of these on other animals and humans. In addition, the role of leptospirosis as a threat to endangered species has been highlighted and requires further investigation.

There is research in progress to better understand the relationships between wildlife and human leptospirosis, especially where new serovars are emerging. The impact certain wildlife species may have on transmission to other wildlife needs to be considered in this context also. Current research is helping to improve understanding of infection and the management and prevention of disease (Smythe et al. 2002; Wynwood et al. 2016).

Little is known about the impact feral animals are having on the movement of leptospiral serovars in Australia. The introduction of exotic serovars into our wildlife and domestic animal populations needs to be reviewed and studies undertaken to better determine the risk of entry. The establishment of exotic serovars in a country cannot be reversed and this may have an impact over time on domestic animals and wildlife (L Smythe pers. comm. 2005).

Human health implications

Outbreaks of leptospirosis in numerous tropical locations have led to its identification as a globally emerging infectious disease (Levett 2001). The clinical manifestations are variable, ranging from subclinical infection to hepatic and renal failure, severe pulmonary haemorrhage and death (Adler and de la Peña Moctezuma 2010). Humans are incidental hosts of leptospirosis with infection caused by direct and indirect exposure through work, recreational activities and most commonly as a result of habitation in areas of substandard hygiene and increased flood risk (Haake and Levett 2015). A review estimates 1.03 million human cases of leptospirosis with 58, 900 deaths per year worldwide (Costa et al. 2015).

In Australia, the incidence in humans is minimal, close to 1.0 per 100,000 (Smythe et al. 2000). The highest number of notified cases is from Queensland with an average incidence over the years 2009 to 2013 of 2.3 per 100,000 (Queensland Government 2017). There is a broad range of occupations associated with the disease but the most common are the animal associated industries such as meatworkers and dairy farmers and agriculture such as the banana industry workers (Queensland Government 2017). Appropriate workplace

health and safety practices contribute to reducing the risk of contracting the disease. Nearly all serovars identified in Australian native wildlife have also been found in humans and therefore it is prudent to regard all serovars as potentially zoonotic.

Good hygiene should be exercised by people handling animals likely to carry the disease. This includes washing hands and ensuring cuts and abrasions are well covered by bandages before handling the animals. Where appropriate, other personal protective equipment should also be used to protect against exposure.

Conclusions

Leptospira spp. are distributed worldwide and have been identified in a wide range of Australian wildlife. Little obvious clinical disease has been recognised in Australian wildlife species, but it is likely both feral and native species serve a role as reservoir species. Potential also exists for this pathogen to have detrimental effects on Australian native mammals, including endangered species.

Appendix A.

Table 1. Summary of serological and shedding evidence of leptospirosis in native and feral Australian mammalian species [Note: There is cross reactivity between sv Canicola, Broomi and Bindjei and serological testing alone cannot confirm the presence of sv Canicola. Only isolation of the agent confirms the presence of a particular serovar. In Australia, Leptospira interrogans sv Canicola has not been isolated in dogs (the only species recognised as the maintenance host for L. interrogans sv Canicola)].

Scientific name	Common name	Serovar	Serology	Evidence of shedding	Source
Native species					
Arctocephalus forsteri	New Zealand fur seal	Canicola[a,]	+		Mackereth et al. (2005)
		Hardjo[a]	+		Mackereth et al. (2005)
		Pomona[a]	+		Mackereth et al. (2005)
Hydromys chrysogaster	Common water rat	Australis	+[b]		Emanuel et al. (1964)
		Celledoni	+		Battey et al. (1964)
		Pyrogenes	+[b]		Battey et al. (1964); Emanuel et al. (1964)
		Tarrasovi[d]	+	+	Battey et al. (1964); Emanuel et al. (1964)
Isoodon macrourus	Northern brown bandicoot	Australis	+[b]	+	Battey et al. (1964); Emanuel et al. (1964)
		Bindjei	+		Battey et al. (1964)
		Broomi		+	Emanuel et al. (1964)
		Canicola	+[b]		Battey et al. (1964); Emanuel et al. (1964)
		Celledoni	+	+	Battey et al. (1964); Emanuel et al. (1964)
		Grippotyphosa	+	+	Battey et al. (1964)
		Hebdomadis	+[b]		Battey et al. (1964); Emanuel et al. (1964)
		Kremastos		+	Emanuel et al. (1964)
		Medanensis	+	+	Battey et al. (1964)
		Mini		+	Emanuel et al. (1964)
		Pomona	+	+	Battey et al. (1964); Emanuel et al. (1964)
		Pyrogenes	+[b]		Battey et al. (1964); Emanuel et al. (1964)
		Tarrasovi	+		Battey et al. (1964)
		Zanoni	+	+	Battey et al. (1964); Emanuel et al. (1964)
Macropus eugenii	Tammar wallaby	Hardjo	+		Milner et al. (1981)

Scientific name	Common name	Serovar	Serology	Evidence of shedding	Source
Macropus giganteus	Eastern grey kangaroo	Topaz	+		Roberts et al. (2010)
Melomys burtoni[e]	Grassland mosaic-tailed rat	Australis	+[b]		Emanuel et al. (1964)
		Bindjei		+	Emanuel et al. (1964)
		Canicola	+[b]		Emanuel et al. (1964)
		Celledoni	+		Emanuel et al. (1964)
		Zanoni		+	Emanuel et al. (1964)
Melomys cervinipes	Fawn-footed mosaic-tailed rat	Bindjei		+	Battey et al. (1964)
		Canicola	+[b]		Battey et al. (1964)
		Celledoni	+	+	Emanuel et al. (1964)
		Pomona	+		Battey et al. (1964)
		Pyrogenes	+[b]		Battey et al. (1964)
		Zanoni		+	Battey et al. (1964)
Ornithorhynchus anatinus	Platypus	Autumnalis	+		McColl and Whittington (1985)
		Grippotyphosa	+		McColl and Whittington (1985)
		Hardjo	+		McColl and Whittington (1985); Loewenstein et al. (2008)
Perameles sp.	Bandicoot	Topaz		+	Smythe et al. (2007)
Perameles gunnii	Eastern barred bandicoot	Pomona	+		Munday (1972)
Perameles nasuta	Long-nosed bandicoot	Australis	+[b]	+	Emanuel et al. (1964)
		Canicola	+[b]		Battey et al. (1964); Emanuel et al. (1964)
		Celledoni	+		Battey et al. (1964); Emanuel et al. (1964)
		Grippotyphosa	+		Battey et al. (1964)
		Hebdomadis	+[b]		Battey et al. (1964); Emanuel et al. (1964)
		Kremastos		+	Emanuel et al. (1964)
		Medanensis		+	Battey et al. (1964)
		Pomona	+		Emanuel et al. (1964)
		Pyrogenes	+[b]		(Emanuel et al. 1964)
		Tarrasovi	+		Battey et al. (1964); Emanuel et al. (1964)

Scientific name	Common name	Serovar	Serology	Evidence of shedding	Source
Phascolarctos cinereus	Koala	Hardjo	+		Milner et al. (1981)
Potorous tridactylus	Long-nosed potoroo	Tarrasovi	+		Munday (1972)
Pteropus spp.	Flying foxes[c]	Australis	+		Smythe et al. (2002)
		Bulgarica	+		Smythe et al. (2002)
		Canicola	+		Smythe et al. (2002)
		Cynopteri	+		Smythe et al. (2002)
		Hardjo	+		Smythe et al. (2002)
		Pomona	+		Smythe et al. (2002)
		Tarassovi	+		Smythe et al. (2002)
Pteropus alecto	Black flying fox	*Leptospira* spp.		+	Cox et al. (2005)
		Australis	+		Cox et al. (2005)
		Cynopteri	+		Cox et al. (2005)
		Panama	+		Cox et al. (2005)
Pteropus conspiculattus	Spectacled flying fox	*Leptospira* spp.		+	Cox et al. (2005)
Pteropus poliocephalus	Grey-headed flying fox	*Leptospira* spp.		+	Cox et al. (2005)
Pteropus scapulatus	Little red flying fox	*Leptospira* spp.		+	Cox et al. (2005)
Rattus fuscipes[f]	Bush rat	Australis	+	+	Emanuel et al. (1964); Milner et al. (1981)
		Ballum	+		Milner et al. (1981)
		Celledoni	+	+	Emanuel et al. (1964)
		Pomona	+		Emanuel et al. (1964)
		Pyrogenes	+[b]		Emanuel et al. (1964)
		Tarrasovi	+	+	Emanuel et al. (1964)
		Zanoni		+	Emanuel et al. (1964)
Rattus sordidus	Dusky field rat	Australis	+[b]	+	Emanuel et al. (1964)
		Grippotyphosa	+	+	Battey et al. (1964)
		Pomona	+		Battey et al. (1964)
		Pyrogenes	+[b]		Battey et al. (1964); Emanuel et al. (1964)
		Zanoni		+	Emanuel et al. (1964)
Sarcophilus harrisii	Tasmanian devil	*Leptospira* spp.		+	Wynwood et al. (2016)
		Celledoni	+		Wynwood et al. (2016)
		Javanica	+		Wynwood et al. (2016)

Scientific name	Common name	Serovar	Serology	Evidence of shedding	Source
Trichosurus vulpecula	Common brushtail possum	Arborea	+		Eymann et al. (2007)
		Balcanica	+*	+	Hathaway et al. (1978); Durfee and Presidente (1979b)
		Hardjo	+	+	Brockie (1975); Hathaway et al. (1978); Milner et al. (1981); Eymann et al. (2007)
		Hebdomadis	+[b]		Emanuel et al. (1964)
Thylogale stigmatus	Red-legged pademelon	Grippotyphosa	+		Emanuel et al. (1964)
Uromys caudimaculatus	Giant white-tailed rat	Australis	+[b]	+	Battey et al. (1964); Emanuel et al. (1964)
		Canicola	+[b]		Battey et al. (1964)
		Grippotyphosa	+		Battey et al. (1964)
		Pomona	+		Battey et al. (1964)
		Pyrogenes	+[b]		Battey et al. (1964); Emanuel et al. (1964)
		Robinsoni		+	Emanuel et al. (1964)
		Tarrasovi	+	+	Battey et al. (1964); Emanuel et al. (1964)
		Zanoni		+	Battey et al. (1964)
Vombatus ursinus	Common wombat	Australis	+		Milner et al. (1981)
		Grippotyphosa	+		Milner et al. (1981)
		Hardjo	+		Durfee and Presidente (1979c)
		Pomona	+		Munday (1972); Durfee and Presidente (1979c); Milner et al. (1981)
		Pyrogenes[b]	+		Durfee and Presidente (1979c)
Wallabia bicolor	Swamp wallaby	Ballum	+		Milner et al. (1981)
Feral species					
Rodentia	Feral rodents	Arborea		+	Slack et al. (2006); Slack et al. (2010)
Cervus timorensis	Rusa deer	Hardjo	+		Durfee and Presidente (1979c); Milner et al. (1981)
Dama dama	Fallow deer	Grippotyphosa	+		Munday (1972)
Lepus europaeus	European hare	Tarrasovi	+		Munday (1972)
Mus musculus	House mouse	Arborea		+	Slack et al. (2010)

Scientific name	Common name	Serovar	Serology	Evidence of shedding	Source
		Australis	+[b]	+	Emanuel et al. (1964)
		Pyrogenes	+[b]		Emanuel et al. (1964)
		Zanoni		+	Emanuel et al. (1964)
Rattus norvegicus	Brown or Norway rat	Icterohaemorrhagiae	+		Munday (1972)
		Pyrogenes	+[b]		Emanuel et al. (1964)
		Zanoni		+	Emanuel et al. (1964)
Rattus rattus	Black rat	Australis	+[b]	+	Emanuel et al. (1964)
		Broomi		+	Emanuel et al. (1964)
		Canicola	+		Emanuel et al. (1964)
		Grippotyphosa	+		Emanuel et al. (1964)
		Pomona	+		Emanuel et al. (1964)
		Pyrogenes	+[b]		Emanuel et al. (1964)
		Zanoni		+	Emanuel et al. (1964)
Sus domesticus	Feral pig	Hardjo	+		Ridoutt et al. (2014)
		Pomona	+		Ridoutt et al. (2014)

[a] in New Zealand
[b] reported as serogroups, as study was unable to differentiate between serovars within the same serogroups
[c] all four species were serologically positive for leptospiral antibodies, but which serovar was found in which species not specified
[d] formerly known as Hyos
[e] also referred to as *M. lutillus*[f] also referred to as *R. assimilis*

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To provide feedback on this fact sheet

We are interested in hearing from anyone with information on this condition in Australia, including laboratory reports, historical datasets or survey results that could be added to the National Wildlife Health Information System. If you can help, please contact us at admin@wildlifehealthaustralia.com.au.

Wildlife Health Australia would be very grateful for any feedback on this fact sheet. Please provide detailed comments or suggestions to admin@wildlifehealthaustralia.com.au. We would also like to hear from you if you have a particular area of expertise and would like to produce a fact sheet (or sheets) for the network (or update current sheets). A small amount of funding is available to facilitate this.

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