The term leptospirosis represents a spectrum of human and veterinary diseases caused by pathogenic serovars of the spirochaete genus *Leptospira*. It is of global significance as a cause of human mortality and morbidity, and of disease in domestic and production animals and in wildlife. A One Health approach to leptospirosis control is essential because human infection almost invariably results either from direct animal exposure or from exposure to environments contaminated by infected animals. The relationships between human and veterinary leptospirosis are illustrated by Australian experience. A major factor limiting control of the disease is poor communication and cooperation between those working from medical and veterinary perspectives. *Leptospira* shows great antigenic and genetic diversity, and so international leptospirosis reference laboratories are a vital but fragile resource. There is a compelling need to maximise cooperation between all professions with an interest in leptospirosis, to create outcomes, to communicate with governments and to ensure essential resources.

*Leptospira* currently includes species recognised as pathogenic for animals, free-living saprophytic species, and species that are genetically intermediate between these two groups. The pathogenic species include the well recognised *L. borgpetersenii*, *L. kirschneri* and *L. interrogans*, and the genetically intermediate species such as *L. fainei* are also sometimes reported as pathogenic. Any mammal can potentially be infected, with effects from subclinical to fatal.

Leptospiral infection can be host-maintained, if transmitted readily within the host species, or incidental when such transmission does not occur. Infection of pigs with *L. interrogans* serovar Pomona is an example of the former. Human leptospirosis is always incidental, and almost always results from direct or indirect exposure to the urine of infected animals.

Incidental infections are usually more severe than infection in maintenance hosts. Annual global incidence of severe or fatal human leptospirosis has previously been estimated as 500,000, but is probably much higher. Flooding often leads to outbreaks with many fatalities. Survival of leptospires shed in animal urine is favoured by warm, wet conditions in tropical environments. In temperate countries, most human infection relates to occupational exposure, water sports, or overseas travel. In Australia, it is predominantly occupational; affected groups include dairy farmers, abattoir workers, meat inspectors and agricultural workers. However, surveillance between 1998 and 2004 showed a shift of 18% from occupational to recreational epidemiology.

Leptospirosis in Australia has been reported in many domestic animals such as pigs, cattle, sheep, horses and dogs, and in a number of wildlife species. Such animal infection is often asymptomatic, but can cause reproductive losses in cattle and pigs, and atypical mastitis in dairy cattle. Leptospirosis has been shown to reduce growth rate in farmed deer in New Zealand. No human vaccines are available in Australia, but animal vaccination...
helps prevent human infection as well as controlling veterinary
disease.

Australian experience exemplifies the relationships between
animal and human leptospirosis. Human incidence is highest
in Queensland, because of its tropical and subtropical climate.
The recently emerged *L. borgpetersenii* serovar Arborea now
causes the majority of human cases in Queensland (Figure 1),
often with occupational exposure to infected rodents. The major
Queensland floods of 2010–2011 led to an increase in human
infections, as wet conditions allowed leptospires to survive
longer in the environment.

**Resources, recognition, challenges, interdependence**

Although leptospirosis is of global significance, several factors
make control difficult. The human disease is under-diagnosed
and under-reported. Lack of recognition leads to inadequate
resources, which in turn leads to under-diagnosis: a vicious
circle. Government interest in leptospirosis is often lacking.
Because it is of greatest importance in resource-poor tropical
countries, human leptospirosis competes for resources with
greater problems such as malaria and HIV/AIDS. Resourcing
for veterinary leptospirosis is an even greater problem. Global
understanding of veterinary leptospirosis is very inadequate,
and in-depth veterinary expertise is poor and decreasing,
yet protecting people largely depends on control in animals.
Leptospirosis is expected to increase in the future as a result of
climate change12.

Leptospirosis is a complicated and moving target12, and it is
only through animal infection that we have some understanding
of this. *Leptospira* is a most unusual genus, as is becoming
understood through sequencing and genomic studies4,13. Patterns
of infection in different animal species change over time, as
illustrated by the emergence of serovar Arborea in Australia, and
serovars wax and wane in importance. A species may change
from an incidental to a maintenance host over time (McCaughan,
C.J., personal communication) and a serovar can show different
infection characteristics or different pathogenicity in different
parts of the world14. Detecting and understanding these changes
is beyond our present capacity. The situation is complicated by
the fact that serological diagnosis depends on previous isolation
of leptospires from human or animal sources. Our knowledge of
leptospiral diversity is certainly incomplete; new serovars, and
less frequently new species, are periodically discovered. Culture
media suitable for growing one serovar may be unsuitable for
growing another. We know most about the culture requirements
of serovars that we have already isolated.

The traditional professional separation of the medical and
veterinary perspectives is a major problem, and the medical

![Arborea total and percentage total](image_url)

Figure 1. Trend in confirmed cases of human leptospirosis in Queensland caused by *Leptospira borgpetersenii* serovar Arborea, 1999–2012. Figures were compiled by the WHO/FAO/OIE Collaborating Centre for Reference and Research on Leptospirosis in Brisbane.
profession must learn from the broader understanding of those working on the veterinary side. Furthermore, although human leptospirosis surveillance is important, surveillance in animals is vital – for human as much as for veterinary considerations. Yet veterinary leptospirosis surveillance is extremely limited.

An international resource for workers in the field is the International Leptospirosis Society (ILS) which was founded in 1994 and incorporated in Victoria in 2011. Its objectives are promoting awareness of leptospirosis, facilitating communication, and providing information and support. It provides low-cost proficiency testing to about 100 laboratories performing the leptospirosis microscopic agglutination test worldwide. Both medical and veterinary testing laboratories participate, and their results can be compared globally. In contrast, many other available proficiency testing schemes are restricted to either medical or veterinary testing.

Reference laboratories

Leptospirosis reference laboratories are a vital resource. Each has to try to maintain a full collection of the known leptospiral serovars, and to maintain and develop expertise in techniques for leptospirosis diagnosis and bacteriological and molecular characterisation. They provide both veterinary and medical testing laboratories with leptospiral cultures and with antisera for quality control. They also characterise new isolates, confirm new serovars, and assemble human and animal incidence data.

Several reference laboratories operate around the world. Cooperation between reference laboratories is essential, because of the diversity of leptospires, and the risk that a particular strain maintained in one laboratory may differ from the same strain in another laboratory. Exchange of cultures between reference laboratories is important, but is restricted by resources, and by the increasing cost and regulatory difficulty of shipping live cultures internationally. Much of the international burden is carried by two leptospirosis reference laboratories: the WHO/FAO/OIE Collaborating Centre for Reference and Research on Leptospirosis in Brisbane and the National Reference Laboratory for Leptospirosis at the Royal Tropical Institute, Amsterdam. An indication of the fragility of available resources is that both of these are in countries where human leptospirosis is fairly infrequent.

Future imperatives

Cooperation and cross-fertilisation between those with medical and veterinary perspectives on leptospirosis is needed to make effective use of scarce resources, to share knowledge, and to develop integrated control strategies. Cooperation with those involved in wildlife and natural resource management is similarly important. Key objectives must be improved veterinary surveillance, enhanced research at all levels, and support for the vital infrastructure of international leptospirosis reference laboratories.

References


Biographies

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