Leptospirosis: a guide for those working in the countryside

By Mark D. Walker

Leptospirosis is considered an occupational disease because it is mainly seen in those working in the countryside such as farmers, countryside rangers and foresters. Leptospirosis is a bacterial infection contracted through activity in areas contaminated by rats and other rodents. Although in most cases it is not serious, in a minority of sufferers symptoms can be severe and even lead to death. Here the condition is summarised and prevention methods outlined.

Introduction

Andy Holmes was a British Olympic Rowing champion. He won Gold in the Coxed fours in the Los Angeles Olympic Games in 1984, then Gold and Bronze in the coxless and coxed pairs in Seoul four years later. His rowing brought him into daily contact with freshwater. In October 2010 he contracted the bacterial infection leptospirosis, a condition more popularly known as 'Weil's disease', and died shortly afterwards (The Telegraph, 2010). His tragic death highlighted the potential risk of this infection to those active outdoors. Leptospirosis is a major disease in the developing world where it causes a large number of deaths annually (Pappas et al. 2008). However, it also remains a persistent, although less significant, problem in temperate areas. This short review describes what the main symptoms are and how those active in the countryside can reduce the risks of succumbing to infection.

What is Leptospirosis?

Leptospirosis is a bacterial infection caused by bacteria from the *Leptospira* genus. It is a zoonotic disease, meaning it is transmitted to humans from animals. A wide number of mammals act in its transmission, but rodents, and especially rats, are the most important (Faine, 1982). Livestock are also able to harbour the infection. When bacteria gain entry into the human body they rapidly multiply, then spread, causing many of the symptoms of the illness we know as leptospirosis. The severity and range of symptoms vary greatly between sufferers depending on age, general health and the type of leptospirosis causing infection. Some sufferers experience merely a flu-like illness, but in a small proportion of cases the disease progresses to become much more serious (Bharti et al. 2003). If left unchecked it can affect the liver and kidneys and ultimately the lungs. When the disease progresses into this more severe stage then death occurs in a significant number of cases.

Classification of bacteria: Bacteria are classified according to their shape, and leptospirosis bacteria belong to the Spirochaete order of bacteria because they have a tightly coiled corkscrew-like appearance (Levett, 2001). They are placed within the genus Leptospira with originally two species being recognised, the pathogenic disease causing L. interrogans, and a saprohytic species L. biflexa (Levett, 2001). The bacteria could be further classified into different groups known as 'serovars' depending on the composition of their surface proteins. Over 300 different serovars are known, classed into approximately 25 groups (Kmety and Dikken, 1993; ECDC, 2017). However with genetic analysis it was realised that this did not correspond to the

reality; now a large number of species are recognised (Yasuda et al. 1987). However, the idea of serovars has remained as it is of practical use. Different strains cause different symptoms.
Biology of Leptospira: As mentioned Leptospires are tightly coiled. Their appearance under the microscope is distinctive; they are often being said to have a 'question mark' shape with a distinctive hooked end (Levett, 2001). In size they are 0.1 to 20 micrometres long. Leptospires are highly mobile and move rapidly. Importantly Leptospires have a double membrane which means they are particularly tough and able to survive in the environment for a considerable length of time away from hosts (Haake, 2000). Another property is their ability to form a protective biofilm that also considerably aids survival in the environment (Ristow et al. 2008).
History: The disease was first identified by the German biologist Adolf Weil in 1886 and it is after him that the more severe form of the illness is named. The bacterial Leptospires were identified soon after (Inada et al. 1916). By 1917 it was realised that rats are the main distributor of the Leptospira pathogens (Ido, 1917). That livestock can carry the disease was discovered in the 1950s (Alston and Broom, 1958).
A worldwide problem: Leptospirosis is probably the most widespread bacterial infection in the world (WHO 2017). In particular it is a considerable problem in the developing world where underlying prevalence levels are stubbornly high (Pappas et al. 2008). This is mainly due to a lack of sanitation which aids its spread and persistence. Many thousands of people succumb to leptospirosis each year. An additional problem is leptospirosis outbreaks in which large numbers of clustered cases occur in localised locations and can affect large numbers of people (Faine, 1982). Examples include an outbreak in Brazil in 2000 which led to the death of 2000 people (Riley, 1999). Such outbreaks are often the result of localised flooding leading to large numbers of people becoming exposed to the pathogen (Pellizer et al. 2006; Lau et al. 2010).

The cycle of infection

Leptospires cycle between various mammal hosts and the environment (Figure 1).
Reservoir mammals: Leptospires survive in the renal tubules of infected carrier animals (ECDC, 2016). Although these may cause the host no detrimental effect, infected animals continue to excrete leptospires in their urine. They can do so for weeks or months (ECDC, 2016). A wide range of mammalian species can act as carriers, including livestock and rats. A high proportion of rats have been shown to harbour the infection (Vinetz et al. 2001). In a study, around 14 per cent of rats in the United Kingdom were found to harbour the infection (Webster et al. 2009). Leptospires are emitted during urination and contaminate water and soil where the carrier has been active.
Leptospires in the environment: Leptospires can survive significant lengths of time in the environment (Waitkins, 1984). They are surprisingly long lasting and resistant, but persist longest when conditions are warm and moist (ECDC, 2017). Leptospirosis is commonest in tropical areas as here the bacteria can survive longest. Areas around water are particularly favourable to the survival of Leptospires as they do not tolerate desiccation well.
Transmission to man: Humans become infected through contact with infected urine or through contact with soil and water that has been contaminated (ECDC, 2017). Humans usually become infected by leptospires entering the body through cuts and abrasions or through the conjunctiva

after eye rubbing (Levett 2001). It is also possible to ingest leptospires in water. Contamination of water supplies can lead to outbreaks where many people become infected. There is some debate as to whether leptospires can infect humans through unbroken skin in submerged water. Obviously, for humans to become infected they must be active in areas contaminated by Leptospires.

Symptoms

Leptospirosis is notorious for the wide range of symptoms sufferers experience (Plank and Dean 2000; Levett 2001) (Table 1). This makes making a correct diagnosis difficult. Leptospirosis is often confused with other illnesses such as influenza viral illnesses, pyrexia and meningitis (Bharti et al. 2003). Once infected there is an incubation period of between 2 and 30 days before symptoms develop (ECDC, 2017). Leptospirosis is often said to be 'biphasic'; with symptoms occurring in two discrete stages (Levett, 2001). Sufferers may simply suffer the mild form of the disease, however if unlucky the more severe potentially serious form may develop.

Mild infection: The mild form of the illness is known as *anicteric leptospirosis* (Levett, 2001). Initially the sufferer undergoes an acute illness. Typically within a few days of infection a sufferer suddenly develops flu-like symptoms including a fever, headaches and muscle pain. Conjunctivitis is often cited as a characteristic feature of leptospirosis, but this is only seen in about a third of cases, thus its absence does not imply one is not suffering this condition (Bharti et al. 2003). In this stage the bacteria has entered the body and is multiplying rapidly.

After a few days these symptoms may clear up. This is now the immune stage of the disease when the body begins to fight an immune response to the infection. However leptospires are now produced in the urine. The sufferer may become a carrier for some weeks or months; continuing to pass the infection on in their urine.

Severe infection: If unlucky the sufferer may experience the more severe 'Icteric' form of leptospirosis (Levett, 2001). The sufferer experiences the same initial symptoms similar to flu and then appear to recover. However, then they enter a following stage known as the 'leptopisaec' phase. The sufferer again becomes ill and gets progressively worse. This stage is classically characterised by symptoms such as jaundice, meningitis, and liver failure (Bharti et al. 2003). Other symptoms such as fever, headaches and muscle pain also return.

The sufferer is said to be experiencing Weil's disease when the liver is damaged leading to jaundice. Renal failure may also occur in a significant number of cases. The most severe form of leptospirosis is when severe pulmonary haemorrhage syndrome develops; here the lungs are affected and begin to haemorrhage. The patient experiences chest pain and difficulty breathing.

The severity of illness experience depends on the serovar of leptospirosis someone is infected with, the fitness of the sufferer, their age and other unknown factors. Many people become infected but fail to develop any symptoms at all. Some experience the first phase of illness with it failing to develop into the more severe forms. Typically only 5 to 10 per cent develop Weil's

disease (Abdulkader et al. 1997), of these 70 per cent develop jaundice and 40 per cent renal failure. Once more severe forms of leptospirosis develop mortality rates can be as high as 40 per cent. This illustrates the need for prompt treatment.

Treatment and diagnosis

Diagnosis is usually performed using a laboratory test known as Microscopic Agglutination Test (MAT test) which identifies the molecular surface proteins on the leptospires, or through an ELISA test searching for the antibodies to the infection. However, such tests require laboratory expertise and thus take time. More recently genetic diagnosis using PCR techniques have been developed; these are much quicker and may allow much swifter confirmation of infection (Levett et al. 2005, Ahmed et al. 2009). Leptospirosis being a bacterial infection can be treated using a range of antibiotics. The most common antibiotic used being Doxycycline which can be taken orally twice daily for a week (Bharti et al. 2003).

Leptospirosis is relatively simple to treat once diagnosed, but identifying infection is problematic. The earlier antibiotic treatment is begun the more effective it is (Levett, 2001). However, the condition is easy to misdiagnose due to the varied range of symptoms sufferers experience. It is often confused with influenza or meningitis. This emphasises the importance of awareness of the condition. Leptospirosis should be considered in anyone experiencing compatible symptoms following activity in high risk environments.

Who gets Leptospirosis?

Numbers: Public Health England records the number of laboratory confirmed cases of leptospirosis in England and Wales. In 2016 a total of 72 people tested positive for leptospirosis (PHE, 2017), in 2015 there were 63 confirmed cases (Figure 2). Generally the annual number of cases has remained relatively steady over the years. In the 1940s there were roughly a hundred cases annually (Broom 1951). Although the number of cases of leptospirosis has remained steady, the profile of those contracting the illness has changed.

Traditional risk factors: Traditionally leptospirosis was associated with those engaged in hard outdoors based occupations such as coal miners, sewer workers, navvies and farmers (Waitkins, 1986). As might be expected the disease was most commonly seen in men of working age. Industrial changes mean that few coal miners or navvies continue to be infected. However, farmers remain an important group still at risk. Although increased mechanisation has reduced risks in the agricultural sector, reducing manual labour to some degree, this remains still a very hands on profession. Sewer workers still also become infected. Increased awareness and enhanced protective measures in these professions have helped reduce the risks to those in these occupations (HSE, 2016).

New risk groups: A notable feature is the increase in the number of people contracting leptospirosis through recreational activities (Figure 3). In 2016 a total of 26 people fell ill with leptospirosis following exposure to natural freshwater. Many of these would have been engaged in recreational pursuits such as angling. Over the past few decades outdoor and extreme sports have increased in popularity (Mumford, 1989). These often involve contact with fresh water. Leptospirosis has been seen in canoeists (Shaw, 1992), triathletes (CDC, 1998), and white

water rafters (Wilkins et al. 1988). These activities continue to increase in popularity. This is likely to lead to even more cases occurring. Another increasing trend is the number of people contracting the illness while abroad with the numbers increasing on a yearly basis. In 2016 a total of 42 people contracted leptospirosis after foreign holidays.
Seasonality: The condition is mainly caught in the summer months; this is probably because these are the warmest months which favours the survival of leptospires in the environment, but also because people are most active outside during this season (PHE, 2017). Men are more likely to become infected than women; in 2016 a total of 57 men compared to 15 women were affected. This possibly reflects the strong male dominance in those occupational groups most at risk such as farming and countryside management. It is also likely that recreational activities where infection is likely such as fishing and triathlons are more popular for men than women.

Prevention
A number of simple precautionary measures can reduce the risk of becoming infected with leptospirosis. The Health and Safety Executive provides information for those engaged in certain occupations who may be exposed to leptospirosis through their daily work (HSE, 2016). The National Health Service also provides advice on preventing infection (NHS Choices, 2014).

Avoid possibly contaminated sites: A simple precaution is to avoid those areas where rodents and thus the leptospira bacteria are likely to be present. Rats are likely to be attracted to open sewers, drains, rubbish tips, and disused canals.
Reduce vermin populations: The Health and Safety Executive recommends taking action to control the population of vermin such as rats (HSE 2016). Agricultural practices often lead to an increase in rodent populations (Faine 1982). Foodstuffs intended for livestock may be stored poorly thus encouraging vermin. Farming activities often generate large quantities of rubbish, which if not disposed of properly may also allow rodents to increase in abundance (Faine 1982). Similarly the increasing use of the countryside for recreational activities; for example through picnicking, may increase amounts of litter. Rodent populations can be kept in check through general tidiness, proper secure storage of foodstuffs, prompt removal of litter and through active control of rodent populations (Faine 1982).
Treatment of cuts and grazes: The NHS advises that cuts and grazes should be thoroughly cleaned and then covered with waterproof dressings, especially if you intend to be active in the countryside or around water. If you have obvious cuts or areas of open skin, be aware that these may act as entry points for infection.
Hygiene: If you have worked outside, and especially in areas where rodents might be active, then ensure you wash your hands. Despite this being common sense, it is surprising how often it is omitted. Avoid putting dirty hands into your mouth. Additionally if you have been active around open water the NHS advises that you wash thoroughly, even showering if needed (NHS Choices, 2014).
Protective clothing: If you are aware that you are working in an area where rodents may be active then wear appropriate protective clothing. Gloves should be worn when handling potentially soiled objects. Other protective clothing should be worn as required.
Awareness: An important part of avoiding leptospirosis is simple awareness that it may be a

potential danger. If you become ill after working in locations where it is present, then be aware that leptospirosis may be the cause. Treatment is more effective the earlier it is started, thus spotting the signs and seeking appropriate medical advice in a timely manner is important in preventing complications.

Summary

Although relatively uncommon leptospirosis is a condition that those active in the countryside should be aware of. Places harbouring rat populations may be contaminated with leptospires. If activity in possibly contaminated areas is unavoidable then measures to prevent infection should be taken. These include appropriate protective clothing, correct dressing of wounds, and general good standards of hygiene. If symptoms consistent with infection occur following activity in possible risk areas then leptospirosis should be considered and appropriate medical advice sought immediately.

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TABLES AND FIGURES

Table and figures

Table 1: *Typical symptoms of Leptospirosis adapted from Daher et al. (1999). Symptoms in 88 survivors of Leptospirosis infection.*

Symptom	Percent of patients
Fever	97
Headache	74
Muscle pain	95
Jaundice	98
Heart irregularities	13
Lung complications	12

Figure 1: *The transmission of leptospirosis from rat to man.*

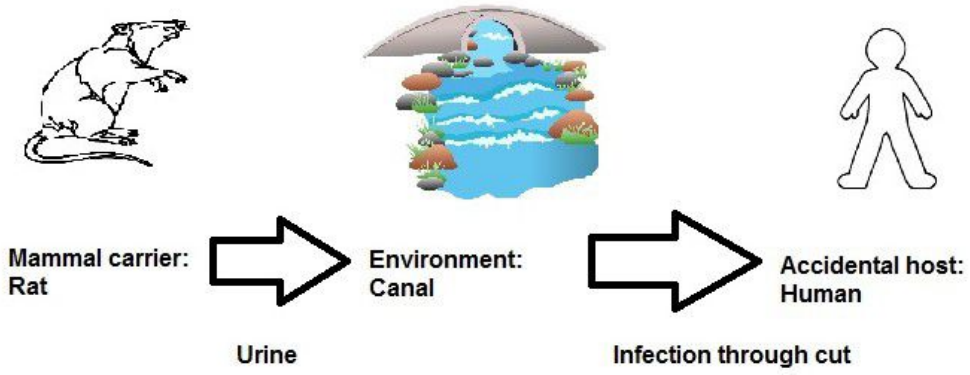

Figure 2: *The number of confirmed cases each year between 2014 and 2016. Figures from the Public Health England Quarterly Reports for Zoonotic infections (2016-2012).*

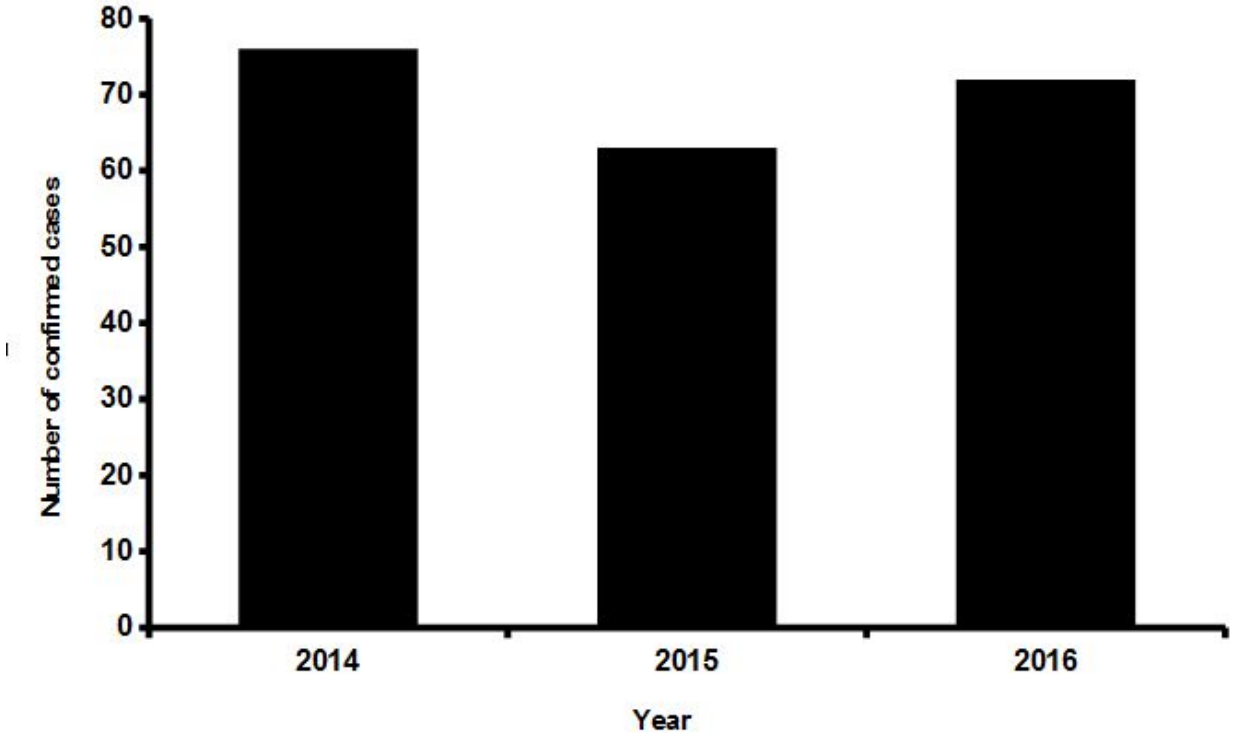

Figure 3: *Risk factors for leptospirosis: number of cases each year between 2014 and 2016. Figures from the Public Health England Quarterly Reports for Zoonotic infections (2016-2012).*