Epidemiology of leptospirosis: an Indian perspective

Dhanze Himani*, M. Kumar Suman2 and B. G. Mane3

1Ph.D. Scholar, Division of Veterinary Public Health, Indian Veterinary Research Institute, Izatnagar-243 122 (UP), India.
2Assistant Professor, Dept. of Veterinary Public Health, College of Veterinary Science and Animal Husbandry, Junagadh Agriculture University, Junagadh (GI), India.
3Assistant Professor, Dept. of Livestock Products Technology, DGCN-COVAS, CSK-Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176062 (HP), India.

*Corresponding Author:
Ph.D. Scholar, Division of Veterinary Public Health, Indian Veterinary Research Institute, Izatnagar-243 122 (UP), India.
Email: hdhanze@yahoo.co.in

Received: 25/04/2013
Revised: 25/07/2013
Accepted: 27/07/2013

Abstract
Leptospirosis is one of the most recognized zoonotic diseases around the world and has been reported from every continent inhabited by man. In recent years the disease has assumed considerable significance being increasingly involved in cases of abortions, repeat breeding and other reproductive problems in livestock resulting in huge economic losses. Leptospirosis is known to be endemic in India since the early 20th century with most outbreaks reported from the coastal regions of the Indian peninsula and the Andaman Islands. The transmission cycle of leptospirosis involves the maintenance hosts, the carrier hosts, the environment and human beings. The carrier animals in India include rats, pigs, cattle, bandicoots and dogs. With almost every known species of rodent, marsupial and mammal a potential carrier and/or excretor of leptospires, proper understanding of the epidemiological features of these organisms is a critical step in designing interventions for diminishing the risk of the disease transmission. Intervention strategies include vaccination, rodent control, and improved environmental hygiene to eliminate possibility of water, soil and food contamination. Mass awareness or public education is of utmost importance.

Keywords: Leptospirosis, endemic, emerging zoonoses, epidemiology, environmental hygiene

Introduction
Leptospirosis is one of the most recognized zoonotic diseases around the world. It has been recorded in nearly all the mammalian species. The disease has been reported from every continent inhabited by man. It manifests as an acute or chronic disease or as a clinically inapparent contagious disease of domesticated and wild animals as well as man. It is a direct zoonotic disease caused by spirochetes belonging to genus Leptospira. Large number of animals acts as carriers or vectors. Human infections result from accidental contact with carrier animals or environment contaminated with leptospires and are primarily associated as an occupational disease. Leptospirosis has been recognized as an important emerging zoonotic disease because of its epidemic presence and increasing incidence in both developing and developed countries (Meites et al., 2004). In recent years leptospirosis has assumed considerable significance being increasingly involved in cases of abortions, repeat breeding and other reproductive problems in livestock resulting in huge economic losses. In man, the disease is associated with a mild fever to severe jaundice and death as a result of multiorgan failure (Srivastava and Kumar, 2003).

Leptospirosis is known to be endemic in India since the early 20th century (Chowdry, 1903; Woolley, 1911, 1913; De Castro, 1922;
Most outbreaks of leptospirosis in India are reported from the coastal regions of the states of Gujarat, Maharashtra, West Bengal, Orissa, Kerala, Tamil Nadu, Karnataka and the Andaman Islands. Highest rates occur during October to November which coincides with the monsoon season in these parts. A number of leptospirosis outbreaks have occurred in the past few years in different parts of India. Significant outbreaks have been observed in Orissa (Faine, 1994; Sehgal et al., 2001), Mumbai (Karande et al., 2002) and the Andaman archipelago (Sehgal et al., 1995; Singh et al., 1999). Recent reports include the 2007 outbreak in Karnataka in which 1,516 cases were reported (http://www.gideonline.com). Reports from the Southern part of Gujarat revealed 130 deaths within a span of two months due to leptospirosis in 2011 (Promed, 2011). More recently 209 cases with 12 deaths were reported from Kochi, Kerala. In October 2012, 16 deaths were reported from Surat and Valsad districts of Gujarat (http://www.healthmap.org). These alarming reports underline the continued risk this disease poses at this hour.

Causal organism

Leptospira (Greek ‘leptos’=fine and Latin ‘spira’=coil) are ubiquitous spirochetes. They are spiral shaped bacteria and possess a Gram negative like cell envelope consisting of cytoplasmic and outer membranes. One or both ends of the spirochete are usually hooked. The live organisms are best observed by dark field microscopy. The genus has been classified into two species; the free living (L. biflexa) and parasitic leptospires (L. interrogans), which are morphologically indistinguishable (Faine, 1982). In 2007 meeting of the Subcommittee on the Taxonomy of Leptospiraceae held in Ecuador, some of the previously described genomospecies were given the status of species resulting in a family comprising 13 pathogenic Leptospira species with more than 260 serovars and 6 saprophytic species comprising more than 60 serovars. It is expected that additional new species exist and will add to this ever expanding taxa (Adler and Moctezuma, 2010). Survival of the leptospirae depends on variation in soil and water conditions in the contaminated area. They are susceptible to drying, pH lower than 6 or greater than 8, ambient temperatures lower than 7ºC or higher than 34ºC. They can survive for as long as 183 days in water saturated soil but survives for less than 30 minutes when soil is air dried. It can survive for very long periods in free surface water (WHO, 2006).

Animal reservoirs and carriers

Carrier animals, domestic or wild, maintain and propagate leptospires within the population. The organisms may then be transmitted to humans directly by contact with infected urine or indirectly via contaminated soil or water, especially in times of flood. Human leptospirosis constitutes a dead-end infection; human to human transmission is virtually unknown (Victoriano et al., 2009). Animal hosts of leptospires are broadly categorized as carrier hosts, in whom the carrier state is temporary and ranges from a few months to years, and reservoir hosts in whom the carrier state is lifelong.

Rodents and domestic mammals, such as cattle, pigs and dogs, serve as major reservoir hosts but leptospires have been isolated from virtually all mammalian species. Infected animals may excrete leptospires intermittently or regularly for months or years, or even for their lifetime. Vaccinated animals may still shed infectious organisms in the urine. In India carrier animals include rats, pigs, cattle, bandicoots and dogs. The predominant serovars in India are Copenhageni, Autumnalis, Pyrogenes, Grippotyphosa, Canicola, Australis, Javanica, Sejroe, Louisiana, and Pomona (Victoriano et al., 2009).

Mode of Transmission

Leptospires are ubiquitous. The primary source of leptospires is the excretor animal, from whose renal tubules leptospires are excreted through the urine to the environment. Transmission can be direct or indirect. Direct transmission occurs when leptospires from tissues, body fluids or urine of acutely infected or asymptomatic carrier animals enter the body of the new host and initiate infection. Direct transmission among animals can be
transplacental, haematogenous, by sexual contact or by suckling milk from infected mother. Presence of leptospires in genital tracts as well as transplacental transmission has been demonstrated in animals (Ellis et al., 1985, 1986). It is considered that the most common portal of entry of leptospires into the host body is through intact skin (Faine, 1994). Direct transmission from animals to human beings is common amongst the occupational groups who handle animals and animal tissue, such as butchers, veterinarians, cattle and pig farmers, rodent control workers, etc. Accidental infection to veterinarians has also been recorded (Bolin and Koellner, 1988). When the immediate source of infection is environment contaminated with the urine of carrier animals, the transmission is termed as indirect.

Three basic factors i.e. the animal carriers, environment suitable for the survival of leptospires and exposure of people to contaminated environment and carrier animals, are always involved in the transmission of leptospiral infection (Fig. 1).

**Core determinants and risk factors**

The specific risk factors of infection vary from one epidemiological setting to another. The source of infection in an area is determined by factors such as rodent density, population size of the farm and other domestic animals, sanitation of animal habitats, availability of veterinary services for prompt detection and treatment of animal leptospirosis and control programs. The important behavioural, socio-cultural and occupational factors that influence the transmission in humans include the levels of personal hygiene, personal practices such as bathing in unprotected water bodies; water associated recreational activities, use of protective gear, agricultural and other occupational practices, animal rearing practices,

---

**Fig 1: Transmission of leptospirosis in animals and humans**

Journal of Foodborne and Zoonotic Diseases | July-September, 2013 | Vol 1 | Issue 1 | Pages 6-13
©2013 Jakraya Publications (P) Ltd
level of hygiene in milking and slaughtering places, etc.

Various physico-chemical characteristics of the environment and climatic factors also influence the survival of organism in environment and thus its subsequent transmission. These factors include rainfall, humidity, ambient temperature, water retaining capacity of the soil, pH and salinity of the soil and surface waters and forest cover (Sehgal, 2006). Contamination of environment and capacity of organism to survive for longer period under dampness may result in high incidence of disease on heavily irrigated pastures and in areas with high rainfall.

Occurrence of leptospirosis shows seasonal fluctuation in most of the epidemiological settings. In India, particularly in Andaman and Nicobar Islands the peak occurrence always follows the peak rainfall (WHO, 2007). The risk factors associated with its epidemiology in Andaman are agricultural work, exposure to wet fields, participating in rice harvesting, working in the jungles, other outdoor activity, fishing in freshwater, crossing water bodies on the way and use of stream water for bathing.

**Epidemiological settings**

The eco-epidemiological settings in which leptospiral transmission occurs can be broadly categorized as urban, rural, recreation associated and disaster sequel. In the urban setting, rats infesting sewage networks, overflowing sewage during rains, flooding of roads and exposure of people to flooded roads create an ideal environment for the transmission of leptospirosis. The best example is of the 2005 Mumbai outbreak where leptospirosis occurred following heavy rainfall and flooding.

In the rural setting it is often the agricultural exposure to wet fields possibly contaminated with the urine of rats or farm animals which is the cause of leptospiral infection. Farmers working in rice fields are at high risk of acquiring infection. The infection also occurs due to exposure to river or stream water as a result of recreational activities such as canoeing, rafting or swimming. Leptospirosis has now been recognized as a possible sequel of natural disasters such as cyclones and floods as during such times people and animals are exposed to wet environments for a prolonged period of time.

**Epidemiological characteristics of Leptospirosis in different animal species**

The leptospires dwell in the renal tubules of their animal host. Although they are susceptible to environmental factors, in particular drying, they can survive for long periods in water and wet soil. The transmission cycle of leptospirosis involves the maintenance hosts, the carrier hosts, the environment and human beings (Waitkins, 1987). Almost every known species of rodent, marsupial and mammal can be a carrier and/or excretor of leptospires (Faine, 1994).

Rodents were first to be recognized as carriers of leptospires. They are often incriminated as the source of infection to human beings. Although serovar Icterohaemorrhagiae has been often associated with rodents, other serovars have also been isolated (Matthias and Levett, 2002). Rats and bandicoots have shown evidence of anti-leptospiral antibodies following isolation of leptospires from suspected human patient from the suburbs of Chennai (Saravanan et al., 2000). Elsewhere in Tamil Nadu anti-leptospiral antibodies (52.1%) were evident from the field rodents (Natarajasenivasan et al., 2002). Relatively low sero-prevalence was observed among the rat population, yielding two isolates from the Andaman and Nicobar archipelago (Sharma et al., 2003). The rat population is roughly 3000 millions in India which cause an estimated 2000 crores of rupees loss annually.

Leptospirosis in cattle could be totally inapparent or may result in acute febrile illness or severe complications. The cattle may be infected with serovars Hardjo, Pomona, and Grippotyphosa. Infection with Icterohaemorrhagiae, Bratislava, Hebdomadis, Autumnalis, Australis, Sejroe, Canicola and Bataviae also occurs (Faine, 1982). Cattle are the maintenance host for Leptospira Hardjo and are the only reservoir of this serotype. Hardjo is
an important cause of bovine abortion and is
commonest leptospiral infection in man. A
serosurvey among animal populations of
Andaman and Nicobar Islands (Sharma et al.,
2003) showed that about 40% of the cows and
26% of the bulls were seropositive. Ratnam et al.
(1983) screened 40 cows in a village near
Chennai following an outbreak of leptospirosis
in cattle. Antibodies against leptospires were
found in 68% of the cows.

Pigs are commonly infected with
serovars Pomona, Tarassovi, Grippotyphosa,
Bratislava, Serjoe, Icterohaemorrhagiae and
Canicola (Faine, 1994). However, the most
common infection is of Pomona. Adult non-
pregnant infected pigs are usually symptom-free
and become chronic carriers. Leptospires have
also been isolated from the kidneys and genital
tracts of both sow and boar.

Pomona is the common infection and the
cause of most clinical leptospirosis cases in
sheep. Sheep are not natural maintenance host
for Pomona or Hardjo and are likely to have
infections of relatively short duration, producing
severe pathological effects.

Canicola and Icterohaemorrhagiae are
the commonest serovars that infect dogs (Faine,
1994). Acute leptospirosis in dogs is known as
Stuttgart disease, which is characterized by
vomiting, dehydration, bloodstained faeces,
mucosal sloughing and death. Some dogs
survive with chronic nephritis and continue to
excrete leptospires. Leptospirosis due to a
variety of serovars is reported rarely in cats and
it is not significantly different in course from the
disease in dogs. Venkataraman and Nedunchelliyan
(1992) reported an outbreak of leptospirosis in human beings and dogs in
Chennai city. Following the outbreak, a
serosurvey was conducted among humans and
dogs. Seroprevalence was 50.5% among humans
and 21.3% in dogs. Leptospira belonging to
serovar Icterohaemorrhagiae was isolated from a
human patient and Canicola from a dog.

In India leptospira seropositivity was
also found in wild animals like tiger, sambar
and elephant (Srivastava, 2003).

Occurrence and Prevalence of infection in
animals in India

Most leptospiral infections are
subclinical and infection is more common than
clinical disease. Preliminary reports on
occurrence of leptospirosis in cattle in India
were documented by Adinarayanan et al. (1960).
Subsequently, the prevalence of the disease in
animals from various parts of the country has
been reported by Rajasekhar and Nanjiah
(2001), Piramanayagan et al. (2002) and
Sivaseelan et al. (2003). Consequent to an
outbreak of bovine leptospirosis in Chennai,
serological evidence of leptospirosis was evident
among human subjects (Ratnam et al., 1983).
According to a NICD report (1997), prevalence
rate of Leptospirosis is high in Andaman,
Bengal, Gujrat, Karnataka, Andhra Pradesh,
Tamil Nadu and Kerala. The incidence rate of
leptospirosis in the Andaman Islands was
estimated to be between 50-65 cases/100,000 per
year, which is believed to be the highest in India
(Sehgal, 1998). Prevalence studies being carried
out by Indian Veterinary Research Institute
during the last 35 years have shown an overall
prevalence of 10.1% during 1975-90, with
highest in sheep (20.6%). The common serovars
identified in animals during the period were
Leptospira Pomona, Patoc, Australis,
Grippotyposa, Hardjo, Autumnalis, and RGA.
During 1991-2000 the overall sero-positivity
marginally increased to 13.4% which was due to
an increase in cases of leptospirosis in cattle
(15.8%) and dogs (19.1%) and the common
serovars were RGA, Patoc, Australis,
Autumnalis, Grippotyposa, Pyrogens, Ballum,
Hardjo, Pomona and Canicola. During the next 5
years (2000-2005) the disease status has
remained at an approximated 12%. Based on the
prevalence studies and distribution of Leptospira
in animals in different regions, the states have
been classified as high prevalence, moderate
prevalence and rarely reporting states (Table 1).

Prevention and Control

To understand the epidemiological fea-
tures of leptospirosis is a critical step in designing interventions for diminishing the risk of the disease transmission. Intervention strategies can target many points in the transmission cycle of leptospirosis. Although little can be done in wild animals, leptospirosis in domestic animals can be controlled through vaccination with inactivated whole cells or an outer membrane preparation (Palaniappan et al., 2002). Rodent control preferably through the use of slow acting rodenticides and improved environmental hygiene to eliminate possibility of water, soil and food contamination are some of the measures for diminishing the risk of leptospirosis transmission. Occupational hygiene (in sewers, farmers, and other high risk groups) that includes the use of water proof shoes and gloves is fundamental for preventing human leptospirosis (Koutis, 2007). The mass awareness or public education is of utmost importance.

Table 1: Distribution of Leptospira serovars in India

<table>
<thead>
<tr>
<th>State</th>
<th>Animal species</th>
<th>Serovars</th>
</tr>
</thead>
<tbody>
<tr>
<td>High prevalence</td>
<td>cattle, buffalo, pyrogenes, pomona,</td>
<td>Tamil Nadu, Kerala, Andaman</td>
</tr>
<tr>
<td></td>
<td>sheep, goats, australis, utumnalis,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pig hebdomadis, hardjo, Andaman</td>
<td></td>
</tr>
<tr>
<td></td>
<td>icterohaemorrhagiae</td>
<td></td>
</tr>
<tr>
<td>Moderate Prevalence</td>
<td>cattle, buffalo, pomona, hardjo,</td>
<td>Maharatra, U.P., M.P., U.P., M.P.,</td>
</tr>
<tr>
<td></td>
<td>sheep, canicola, javanica, Gujarat,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pigs, dogs, icterohaemorrhagiae,</td>
<td></td>
</tr>
<tr>
<td>Rarely Reported</td>
<td>horse pyrogenes,</td>
<td>Punjab, J&amp;K, Rajasthan,</td>
</tr>
<tr>
<td></td>
<td>icterohaemorrhagiae, pyrogenes, canicola</td>
<td>North-Eastern Hills, Himachal Pradesh</td>
</tr>
</tbody>
</table>

*Based on isolation and serology (Source - WHO, 2006)

Conclusion
Leptospirosis is a major endemic disease of zoonotic importance in India. Socioeconomic conditions, population density of animals, climatic conditions, environmental hygiene and occupational habits of humans are determinants of the incidence and prevalence of the disease in our country. Leptospirosis is preventable. Host/reservoir control measures, environmental control programs and animal vaccination, in conjunction with a strong surveillance system may significantly reduce, if not eliminate, the disease. The comprehensive and good understanding of the eco-epidemiological and cultural characteristics of a community that faces the problem of leptospirosis is an essential prerequisite for evolving an effective and acceptable control measure.

References
Dhanze …… Epidemiology of leptospirosis: an Indian perspective


