Importance of leptospirosis for human and animal health, present condition, problems and solution proposals in Turkey and the World

Bilgili Ali 1,* and Hanedan Başak 2

1 University of Ankara, Faculty of Veterinary Medicine, Department of Pharmacology and Toxicology, Ankara, Turkey.
2 University of Ataturk, Faculty of Veterinary Medicine, Department of Internal Medicine, Erzurum, Turkey.

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Abstract

Considering the fact that a major part of emerging diseases in humans are caused by animals and that animal health directly affects human health and animal products are undisputedly necessary in human nutrition, it is concluded that human health depends on animal health. Leptospirosis, commonly present in many domestic and wild animals in the world, caused by more than 250 pathogenic serotypes, is an important zoonotic bacterial disease that causes economic losses of breeders, negatively affects sustainable livestock production, and threatens public health. Human leptospirosis is acquired by contact with environmental sources such as water or soil, directly or indirectly contact with infected animals such as wild, livestock or pet animals, or occupational exposure. For this reason, prevention of infection in humans and its control depends on breaking of this contact chain and control of infection in animal reservoirs and its elimination. In this presentation context, with the specified reasons, concise knowledge was given on problems, actions to be taken, and solution proposals for prevention of leptospirosis, by tabularizing leptospirosis data in humans and animals in the recent years related to our country and border countries, including European countries, and the world countries.

Keywords: Leptospirosis; Human and animal health; Problems; Solution proposals

1. Introduction

Leptospirosis is a common zoonotic disease in many domestic and wild animals in the world [1]. Leptospirosis is caused by infection due to spirochete bacterium of the genus of *Leptospira* with over 250 pathogenic serovars [2]. Leptospirosis commonly occurs in tropical and subtropical areas [3]. Pathogenic leptospires remain alive in the environmental conditions but not propagate [3], not live in frozen environments, and die over 50 ºC [4]. The *Leptospira* bacteria are transmitted to humans with contact to infected environmental sources (e.g., water and soil), infected wild or domesticated animals or occupational exposure [5].

2. Present condition

Leptospirosis is the most common occupational disease occurring due to fresh water or animal exposure in temperate regions. Butchers, hunters, sewage and farm workers, veterinary surgeons, laboratory staff are mostly exposed to leptospirosis [6, 7]. Leptospirosis is considered environmental disease due to spare time activities such as canoe, rafting, canyon, hiking and other outdoor sports [8, 9]. There are increased incidences for leptospirosis in humans who return travel [10]. Kutsuna et al. [11] have reported the leptospirosis occurrence in five cases who returned trip from Southeast Asia countries due to fresh water exposure.

* Corresponding author
E-mail address: abilgili61@gmail.com

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Leptospirosis epidemics generally occur due to water flooding in the events of heavy precipitation or hurricane, typhoon or earthquakes [12, 13]. Leptospirosis cases have been reported in the result of water flooding after excessive rainfall in Nicaragua [14] and Philippines [15]. Seasonal peaks with high incidence of leptospirosis occur in Thailand [16] and tropical islands [17].

Important environmental factors associated with leptospirosis such as still waters, floods, poor canalization systems, and poor house cleaning have been reported in scientific articles published in Indonesia [18]. Other risk factors for leptospirosis are dirty surface, closeness to sewage systems, inattention to hygiene, walking barefoot, open wound, and gathering firewood [19].

Rodents, marsupials and mammals may be carrier and contaminate environment [20]. Important risk factors in dogs in North California are exposure to wild animals, living in farming areas, water exposure such as pond, stream, and pool [21].

Leptospires shed in urine of animals may live for months in warm and humid environment. Animals are mostly infected by environmental exposure. In some mammal species venereal transmission may occur. Transmission from person to person is rare [22]. Placental transmission may occur [4].

Humans generally are incidental host and infection occurs by exposure to urine of infected animals or exposure to contaminated water and soil [3, 23]. Milking, abort materials, consumption of raw milk, slaughtering, and carrying animal carcass are also contamination sources. Laboratory animals are natural carriers. Thus, laboratory animals may be a contamination source for staff responsible from laboratory animals [24]. Hosts may spread bacteria via urine for months or lifelong [25]. Transmission may be via mouth, mucous membranes, and impaired skin integrity [26].

2.1. Epidemiology

The prevalence of leptospirosis in humans and animals in Turkey and in the world is presented in tables below.

Table 1 The human and animal cases due to leptospirosis identified by Etlik Veterinary Control Central Research Institution in 2017 (Ministry of Agriculture and Forestry, 2018) [27].

| Province   | Sample Number | Human Total | Human Positive | Human Negative | Sheep Total | Sheep Positive | Sheep Negative |
|------------|---------------|-------------|----------------|----------------|-------------|----------------|----------------|
Table 2 The sheep and goat cases due to leptospirosis identified by Etilk Veterinary Control Central Research Institution in 2016 (Ministry of Agriculture and Forestry, 2018) [27].

|                | Total | Sheep | Goat |
|----------------|-------|-------|------|
| Sample Number  | 662   | 652   | 10   |
| Positive       | 71    | 71    |      |
| Negative       | 591   | 581   | 10   |

Leptospirosis was determined in 4 humans in the city of Ankara and Zonguldak, and in 2 sheep in the city of Ankara by Etilk Veterinary Control Central Research Institution in 2017.

Table 3 The leptospirosis in sheep according to importing country and province that animals are transported in 2016 (Ministry of Agriculture and Forestry, 2018) [27].

| Province       | Sheep | Importing Country |
|----------------|-------|-------------------|
| Ankara         | 23    | Ukraine           |
| Balikesir      | 48    | Bulgaria          |
| Total          | 71    |                   |

Leptospirosis was determined in sheep imported from Ukraine and Bulgaria to Turkey in 2016.

Table 4 Leptospirosis prevalence of animals in Turkey.

| Province             | Animal          | Sample Number | Prevalence (%) | Scientific Source                  |
|----------------------|-----------------|---------------|----------------|------------------------------------|
| Kırşehir             | *Microtus hartingi* | 43            | 46.5           | Azkur et al., 2013 [28]            |
| Ankara               | Stray dogs      | 51            | 43.96          | Aslantaş et al., 2005 [29]         |
| Various cities       | Cattle          | 15.596        | 8.04           | Özdemir and Erol, 2002 [30]        |
| Kayseri              | Cattle          | 2395          | 25.42          | Gumussoy et al., 2006 [31]         |
| Southern Marmara     | Cattle          | 922           | 3.4            | Kocabıyık and Çetin, 2004 [32]     |
| Diyarbakır           | Cattle          | 96            | 9              | Yesilmen et al., 2012 [33]         |
| Hatay                | Cattle          | 512           | 8.8            | Aslantaş and Özdemir, 2005 [34]    |
| Afyon                | Water Buffalo   | 93            | 32.26          | Kenar and Özdemir, 2013 [35]       |
| Kars                 | Cattle          | 163           | 40.5           | Genç et al., 2005 [36]             |
| Erzurum and Van      | Sheep           | 108           | 17             | Sağlam et al., 2008 [37]           |
Table 5 Leptospirosis prevalence of animals in the world.

| Country | Animal         | Sample Number | Prevalence (%) | Scientific Source            |
|---------|----------------|---------------|----------------|------------------------------|
| Egypt   | Rat            | 270           | 75.9           | Samir et al., 2015 [38]     |
| Brazil  | Rat            | 47            | 36.2           | Lilenbaum et al., 1993 [39] |
| Europe  | Rat            | 420           | 14.3           | Heuser et al., 2017 [40]    |
| Brazil  | Capybara       | 41            | 43.9           | de Alquerque et al., 2017 [41] |
| France  | Goypus         | 133           | 76             | Vein et al. 2014 [42]       |
| Tanzania| Bat            | 36            | 19.4           | Mgode et al., 2014 [43]     |
| Mexico  | Crocodile      | 48            | 100            | Perez-Flores et al., 2017 [44] |
| Slovenia| Reptile        | 297           | 25.0           | Lindtner-Knific et al., 2013 [45] |
| Iran    | Dog            | 150           | 22             | Zakeri et al., 2010 [46]    |
| Spain   | Dog            | 338           | 25.8           | Lopez et al., 2019 [47]     |
| Brazil  | Dog            | 192           | 9.90           | Abreu et al., 2019 [48]     |
|         | Rodent         | 132           | 1.51           |                             |
| Egypt   | Dog            | 168           | 58.3           | Samir et al., 2015 [38]     |
| Brazil  | Feral cat      | 57            | 2              | Ullmann et al., 2012 [49]   |
| Egypt   | Cattle         | 625           | 37.6           | Samir et al., 2015 [38]     |
| India   | Cattle         | 320           | 67.18          | Alamuri et al., 2019 [50]   |
|         | Buffalo        | 106           | 70.08          |                             |
| India   | Cattle         | 267           | 75.66          | Govindan et al., 2015 [51]  |
| Sri Lanka| Cattle        | 164           | 12.2           | Gamage et al., 2014 [52]    |
| Iran    | Sheep          | 75            | 17.33          | Zakeri et al., 2010 [46]    |
| Egypt   | Sheep          | 99            | 45.5           | Samir et al., 2015 [38]     |
| Brazil  | Sheep          | 308           | 47.4           | Martins et al., 2012 [53]   |
| New Zealand| Sheep    | 399           | 57             | Fang et al., 2015 [54]      |
| Chile   | Work Horse     | 160           | 30.63          | Tadich et al., 2016 [55]    |
|         | Military Horse | 266           | 23.31          |                             |
| Pakistan| Horse          | 384           | 33.85          | Sohail et al., 2016 [1]     |

Rodents were determined to be an important as leptospirosis resource in Turkey and the other countries (Tables 4 and 5).

Table 6 Leptospirosis prevalence of humans in Turkey.

| Province | Sample Number | Prevalence (Number) | Scientific Source |
|----------|---------------|---------------------|-------------------|
| Samsun   | 157           | 116                 | Yilmaz et al., 2015 [56] |
| İstanbul | 35            | 22                  | Turhan et al., 2006 [57] |
| Rize     | 561           | 14                  | Bilir, 2016 [58]    |
**Table 7** Leptospirosis prevalence of humans in the world.

| Country | Sample Number | Prevalence (%) | Scientific Source |
|---------|---------------|----------------|-------------------|
| Denmark |               | 0.34/per 100,000 population | van Alphen et al., 2015 [59] |
| Malaysia | 350 | 28.6 | Mohd Rizuan et al., 2016 [60] |
| India | 1209 | 17.6 | Padma Kumari et al., 2016 [61] |
| Kenya | 737 | 13.4 | Cook et al., 2017 [62] |
| Iran | 369 | 26.5 | Zakeri et al., 2010 [46] |
| Germany | 142 | 4.2 | Brockmann et al., 2016 [8] |
| Egypt | 175 | 49.7 | Samir et al., 2015 [38] |

**Table 8** Confirmed leptospirosis cases: number and rate/per 100,000 population in 2010-2014 in EU/EEA (ECDC, 2016) [63].

| Country | 2010 Case | 2010 Rate | 2011 Case | 2011 Rate | 2012 Case | 2012 Rate | 2013 Case | 2013 Rate | 2014 Reported Cases | 2014 Confirmed Cases | 2014 Rate |
|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------------|----------------------|-----------|
| Austria | 9 | 0.1 | 3 | 0.0 | 16 | 0.2 | 15 | 0.2 | 9 | 9 | 0.1 |
| Belgium | 7 | 0.1 | 15 | 0.1 | 16 | 0.1 | 15 | 0.1 | 34 | 34 | 0.3 |
| Bulgaria | 11 | 0.1 | 12 | 0.2 | 4 | 0.1 | 3 | 0.0 | 43 | 31 | 0.4 |
| Croatia | . | . | . | . | . | . | . | . | 0.0 | 105 | 105 |
| Cyprus | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0.0 |
| Czech Republic | 40 | 0.4 | 31 | 0.3 | 22 | 0.2 | 6 | 0.1 | 37 | 35 | 0.3 |
| Denmark | 6 | 0.1 | 9 | 0.2 | 7 | 0.1 | 3 | 0.1 | 7 | 7 | 0.1 |
| Estonia | 1 | 0.1 | 2 | 0.2 | 5 | 0.4 | 2 | 0.2 | 2 | 2 | 0.2 |
| Finland | 0 | 0.0 | 8 | 0.1 | 2 | 0.0 | 1 | 0.0 | 2 | 2 | 0.0 |
| France | 39 | 0.1 | 71 | 0.1 | 25 | 0.0 | 36 | 0.1 | 628 | 96 | 0.1 |
| Germany | 70 | 0.1 | 50 | 0.1 | 85 | 0.1 | 80 | 0.1 | 160 | 123 | 0.2 |
| Greece | 24 | 0.2 | 20 | 0.2 | 14 | 0.1 | 24 | 0.2 | 36 | 36 | 0.3 |
| Hungary | 9 | 0.1 | 16 | 0.2 | 9 | 0.1 | 7 | 0.1 | 62 | 31 | 0.3 |
| Iceland | . | . | . | . | . | . | . | . | 0.0 | . | . |
| Ireland | 17 | 0.4 | 16 | 0.4 | 15 | 0.3 | 13 | 0.3 | 23 | 22 | 0.5 |
| Italy | 33 | 0.1 | 43 | 0.1 | 7 | 0.0 | . | . | . | . | . |
| Latvia | 2 | 0.1 | 6 | 0.3 | 1 | 0.0 | 1 | 0.0 | 7 | 7 | 0.3 |
| Liechtenstein | . | . | . | . | . | . | . | . | . | . | . |
| Lithuania | 5 | 0.2 | 3 | 0.1 | 20 | 0.7 | 10 | 0.3 | 3 | 3 | 0.1 |
| Luxemburg | 0 | 0.0 | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 | 0 | 0 | 0.0 |
| Malta | 1 | 0.2 | 1 | 0.2 | 3 | 0.7 | 3 | 0.7 | 0 | 0 | 0.0 |
| Netherlands | 30 | 0.2 | 29 | 0.2 | 48 | 0.3 | 26 | 0.2 | 100 | 100 | 0.6 |
| Norway | . | . | . | . | . | . | . | . | . | . | . |
| Poland | 4 | 0.0 | 3 | 0.0 | 2 | 0.0 | 0 | 0.0 | 43 | 10 | 0.0 |
| Portugal | 29 | 0.3 | 33 | 0.3 | 21 | 0.2 | 37 | 0.4 | 69 | 65 | 0.6 |
| Romania | 181 | 0.9 | 98 | 0.5 | 74 | 0.4 | 65 | 0.3 | 96 | 92 | 0.5 |
| Slovakia | 27 | 0.5 | 7 | 0.1 | 8 | 0.1 | 5 | 0.1 | 12 | 12 | 0.2 |
| Slovenia | 9 | 0.4 | 9 | 0.4 | 4 | 0.2 | 0 | 0.0 | 31 | 31 | 1.5 |
| Spain | 0 | . | 4 | . | 0 | . | . | 0 | 0 | 0 | . |
| Sweden | 4 | 0.0 | 4 | 0.0 | 4 | 0.0 | 5 | 0.1 | 6 | 6 | 0.1 |
| United Kingdom | 42 | 0.1 | 52 | 0.1 | 78 | 0.1 | 50 | 0.1 | 78 | 78 | 0.1 |
| EU/EEA | 600 | 0.1 | 545 | 0.1 | 491 | 0.1 | 407 | 0.1 | 1593 | 937 | 0.2 |

Source: Country reports; . = no data reported; - = no report.
European Centre for Disease Prevention and Control. Annual Epidemiological Report 2016 – Leptospirosis. [Internet]. Stockholm: EDC; 2016. Access Address: http://ecdc.europa.eu/en/healthtopics/leptospirosis/Pages/Annual-epidemiological-report-2016.aspx

Leptospirosis prevalence appeared to be high in humans in the cities Samsun, Rize, and Istanbul of Turkey and some other countries (Tables 6, 7). In EU countries, leptospirosis prevalence appeared to change according to the years and in Germany in 2014, confirmed cases were high than other EU countries.

Figure 1 The number of cases due to leptospirosis in humans in 2013-2017 in Turkey (Ministry of Health, 2018) [64].

In Turkey, increasing rate of human cases due to leptospirosis is appeared from 2013 to 2017 in Figure I.

2.2. Clinical signs of leptospirosis

Mild symptoms are fever, shivering, muscle pain, nausea, vomiting, cough, and inappetence. Severe symptoms are liver damage, kidney failure, bleeding, hearing loss, dyspnea, vomiting, mental confusion, somnolence, aggressive behavior, seizure, and azotemia [4].

2.3. Diagnosis of leptospirosis

Leptospirosis diagnosis is made by culture from blood and urine, and by serological tests ELISA and PCR [4].

2.4. Treatment of leptospirosis

In treatment of leptospirosis penicillin G, ampicillin, amoxicillin, doxycycline, and ceftriaxone are used [4]. The intervention method to prevent leptospirosis cases in the high risk groups is the use of chemoprophylaxis. Mostly used antibiotic is doxycycline for chemoprophylaxis of leptospirosis. The efficiency of chemoprophylaxis varies according to when and what amount to administer after exposure to Leptospira spp. [65]. Although antibiotic treatment is applied in six human cases, it is shown by PCR that Leptospira spp. are shed in urine [66]. Leptospira spp. are shown under dark field microscope in a dog 10 days after penicillin and doxycycline treatment [67].

3. Problems

- The storage of waste matter and manure near farming.
- The lack of education for farmer.
- Uncontrolled and illegal animal transportation.
- Introducing unquarantined and uncontrolled animals to herd.
- The use of diseased or carrier bulls and stallions for breeding.
- Paying no attention for enough cleanliness and disinfection of barns.
• Not combating rodents [22].
• The contact of children and pregnant women during treatment of animals fed in house [68].
• Feeding raw offal to dogs [24].
• Not to vaccinate animals [69].
• That owners of animals do not apply to the Directorate of Agriculture and Forest for diagnosis of disease when disease occurs and the late removal of the diseased animals from flock.
• Personnel, vehicle and equipment inadequacies on performing planned mass vaccinations.
• The lack of the number of licensed animal market and uncontrolled buying and selling of animals.
• Increased animal movements due to the transportation and in the result of this, becoming difficult that animal movements are controlled.
• Distribution of them to particular area by collecting animals that are not tested with agricultural development cooperative projects.
• That owners of animals don't act conscious enough in the transaction processes; that payments are made from general budget since not having specific budget in combating disease and thus causing time losses.

4. Solution proposals

• Animals should be vaccinated with leptospirosis vaccine.
• Requiring laboratory test and certificated animal (animal free of leptospirosis or vaccinated animal against leptospirosis) during new animal selection for herd.
• Milk of the diseased animals should be properly disposed, not be consumed without boiling them or pasteurizing (for 10-15 min at 70°C).
• The diseased or carrier male animals should not be used for breeding; it should not be forgotten that bulls and stallions transmit the disease agent via mating; requiring laboratory test for bulls and stallions or artificial insemination should be preferred.
• Aborted fetus and placenta should not be handled with bare hands. They should be sent to the laboratory if possible or if not possible, they should be buried by digging a deep hole and liming or burned.
• The disease sources should be determined and eliminated.
• The number of diagnosis laboratory for leptospirosis should be increased.
• Education of researchers and researches on this subject should be promoted.
• Barns and shelters should be paid attention for cleanliness and disinfection.
• Raw offal should not be consumed to dogs [24].
• It should be combated with rodents such as mouse, rat, hamster and hedgehog and physical measures should be taken; riversides should be cleaned, and measures should be taken for the prevention of flooding of sewer systems [22].
• In the areas of disease risk, leptospirosis vaccination should be made regularly.
• It should be placed emphasis on the education of breeder.
• Animals should be kept out of contaminated pasture.
• Fly net should be mounted to the windows and doors of barns and pens.
• Vehicle, personnel and equipment deficits should be reinforced for succeeding at mass vaccination.
• Land vehicle including disinfection unit for combating diseases should be provided in Provincial and District of Directorate in order to be more effective for the determination of disease and intervention processes.
• Regular vaccinations against animal diseases should be maintained in a controlled manner for providing all kinds of hygienic conditions.
• Animal wastes should be stored away from shelter.
• Animals suspected with disease should be quarantined for combating disease and the diseased animals should be removed from herd after diagnosed with serological tests.
• Identifying animals and controlling animal movements should be implemented efficiently. Administrative fine should be performed when introducing animal with non-identity card herd.
• In the regions that disease occurs, support payments for livestock farming should be implemented on condition that animals have been vaccinated.
• Illegal animal transportations should be prevented.
• Use of polyvalent vaccines should be noticed and efficiencies of vaccines should be tested.
• In abortion cases, vaccine and antibiotic should be used together.
• Livestock markets should be certified and controlled for animal introduction.
• Children and pregnant women should not contact the diseased animals kept in house [68].
In endemic areas, risky occupational groups such as soldiers, sugar cane and rice workers should be offered with chemoprophylaxis.

Prophylaxis should be offered to persons going to places with 5% or higher incidence of leptospirosis.

Environmental conditions should be restored; contact with contaminated waters should be prevented. (People engaging in water sports should wear protective clothing).

When skin injury is suspected, treatment should be started.

Mechanized agriculture should be implemented for preventing disease contamination in agricultural area.

Proper herbicides should be applied.

5. Conclusion

Leptospirosis is a common zoonotic bacterial disease in animals and humans in the world. This disease can be substantially limited with knowing present problems and implementing the preventive measures.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no any conflict to declare by authors in this study.

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