Floods Associated with Environmental Factors and Leptospirosis: our Experience at Tuzla Canton, Bosnia and Herzegovina

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ABSTRACT

Background: Leptospirosis is the most common zoonotic disease in Tuzla Canton. Objective: Determine the influence of environmental and precipitation factors on the incidence of leptospirosis. Methods: A retrospective study included 80 patients with leptospirosis. Data on precipitation were obtained from the online database of Federal Hydrometeorological Institute of BiH. OpenStreetMap (OSM) was used for spatial analysis; patients were geolocated and put on a map. Statistical data processing included basic tests of descriptive statistics. Results: In the period between 01.01.2014 and 31.12.2014, 80 patients with leptospirosis confirmed by clinical and serological testing were hospitalized in the Clinic for Infectious Diseases of the University Clinical Center Tuzla. Gender wise, out of 80 patients, 54 were male (67.5% of the total), and 26 were female (32.5%). More patients lived in the countryside: 64/80 (or 89%). The largest number of patients was engaged in agriculture and animal husbandry: 48/80 (or 60%), mostly cows 32/80 (40%), chickens 12/80 (15%), sheep 4/80 (5%) and pigs 3/80 (3.8%). Of the total number of patients, 50 (or 62.5%) had contact with domestic animals: dogs 10/80 (or 12.5%) and cats 5/80 (6.3%). Half of 53/80 (66.3%) patients had contact with flooded areas in the study period. The increase in leptospirosis diagnosed patients in the City of Srebrenik was statistically significant for 2014 (p<0.01). Conclusion: Leptospirosis in one of the neglected infectious diseases in our area, but the proven increase in the number of infected people after heavy rainfall obliges us to control the risks associated with this disease.

Keywords: Leptospirosis, water-borne infections, zoonoses.
rodents, dogs, cats, cows, and pigs also play important roles in the pathogenesis of the disease (6). Risk factors for infection include occupational exposure: farmers, veterinarians, butchers, recreational activities, swimming, fishing, long trips, hunters, socio-economic circumstances: poverty, undeveloped sewerage network, inadequate water supply.

In middle of May 2014 the area of Tuzla Canton was hit by unprecedented floods after heavy rainfall that exceeded the record of the last 120 years, since the measurements were made. The extratropical cyclone „Tamara” shed the amount of rain that is normal for more than three months in just three days. Tuzla Canton is located in the Northeastern part of Bosnia and Herzegovina, and it is the most populous canton in our country.

2. OBJECTIVE
To investigated connection between heavy rainfall and floodings with the appearance of leptospirosis in our area.

3. PATIENTS AND METHODS
This cross-sectional retrospective study included 80 patients with leptospirosis from Tuzla Canton who were treated at the Clinic for Infectious Diseases of the University Clinical Center Tuzla in the period from January 1, 2014 to December 31, 2014. In all patients leptospirosis was confirmed by serological testing from blood using the factory Leptospira IgM and IgG test (Virion/Serion GmbH, Würzburg, Germany). Epidemiological and demographic data on patients were obtained by reviewing their medical records. Meteorological data (temperatures, humidity, precipitation) were obtained from the online database of the Federal Hydrometeorological Institute of Bosnia and Herzegovina (7). For spatial analysis we used OpenStreetMap (OSM) a geographic database from around the world. Using the addresses contained in the OSM, we geolocated patients and mapped them. Thematic maps were created by classifying the input data by the method of optimizing natural distribution (natural breaks–Jenks) with 5 classes. Visualization of these clusters was performed with colors from the natural spectrum (spectral series). Statistical progressing of the data included basic tests of descriptive statistics and was performed using IBM SPSS 23.0 (SPSS Inc., Chicago, IL, USA). A p<0.05 was considered statistically significant.

The study was approved by the Ethics Committee of the Public Health Institution University Clinical Center Tuzla number 02-09/2-46-19.

4. RESULTS
In the period from January 1, 2014 to December 31, 2014, 80 patients were hospitalized with a diagnosis of leptospirosis at the Clinic for Infectious Diseases of the University Clinical Center Tuzla. This number is a record since the monitoring, but also in relation to previous and subsequent years (Table 1).

Figure 1 clearly shows the relationship between precipitation and the increase in the number of patients with leptospirosis. There is a noticeable periodic increase in the so-called. "Two-toothed" increase in patients in the study period.

Table 1. Distribution of Leptospirosis cases by demographic characteristics in 2014.

| Characteristic                     | N* (%) |
|-----------------------------------|--------|
| Gender                            |        |
| Male                              | 54 (67,5%) |
| Female                            | 26 (32,5%) |
| Place of residence                |        |
| Village                           | 64 (80%) |
| City                              | 16 (20%) |
| Occupation                        |        |
| Farmer with livestock              | 10 (12,5%) |
| Farmer without livestock           | 5 (6,3%) |
| Miner                             | 6 (7,5%) |
| Waste management                  | 6 (7,5%) |
| Construction worker               | 5 (6,3%) |
| Other                             |        |
| Residential                       | 50 (62,5%) |
| Keeping animals and pets           | 42 (52,2%) |
| Rats/mice around home              | 53 (66,5%) |
| Exposure to flooding weather       |        |

More patients were males 54/80 (67.5%) than females 26/80 (32.5%). The patients ranged from 15 to 75 years of age, and the mean age was 48.5 years. The highest prevalence of patients with leptospirosis was in the age group of 51–60 years with 24 cases (30%). The lowest prevalence was in the group of 15–20 years (2.5%). The majority of patients live in the countryside, 64/80 (or 80%), and environmental risk factors dominate occupational exposure as a risk factor. From the anamnestic data, we found that 50/80 (or 62.5%) patients had contact with domestic animals: dogs 10/80 (or 12.5%) and cats 5/80 (or 6.5%). Of the other animals they raised: cows 32/80 (40%), chickens 12/80 (15%), sheep 4/80 (5%) and pigs 3/80 (3.8%). Half of the 42/80 (52.5%) reported seeing rats or mice in their living environment.
More than half of the 53/80 patients (66.3%) had contact with flooded areas during the study period. The largest number of patients was engaged in agriculture and animal husbandry: 48/80 (or 60%), followed by farming without animals 10 (or 12.5%). Additionally, there were 5 miners (or 6.3%), 6 garbage collectors (or 7.5%), and 6 construction workers (or 7.5%) (Figure 2).

The increase in Leptospirosis patients in the City of Srebrenik compared to other cities and municipalities, as well as the total number of cases in the entire canton is statistically significant for 2014 (p<0.01) (Figure 3).

5. DISCUSSION

Our study shows a strong association between the rainy weather period and the incidence of leptospirosis. We analyzed, used a geographic information system (GIS) and Open Source Software (OSS) the area with the most disease, with an emphasis on flooded areas and epidemiological data. The use of GIS in determining the distribution of infectious diseases is increasingly used because of it is “strength” in visualization analysis of epidemiological data but also in the control of infectious diseases. The most affected was the area of the City of Srebrenik where we had the largest number of patients, which was statistically proven. The reason for this, discovered by mapping using GIS, is the proximity of the house of the sick and the riverbed of the river Tinja which overflowed due to the cyclone “Tamara”.

According to the results of climatologic analyses May and August were the rainiest months in 2014 with deviations of 261.8% for May and 218.2% for August from usual precipitation for the same period and the same year was the warmest year on record (7). This resulted in (Figure 2) the so-called “two toothed” increase in the number of patients in that year. Namely the precipitation in the month of May, and then the extremely warm months of June and July favored the retention of bacteria in the soil that had previously been flooded. Temperature has been shown to be a key factor for the duration of infection in an area as well as for indirect Leptospirota exchange among hosts (4).

Immediately after the water receded the farmers went out to cultivate the land and spent several hours on wet and muddy soil working near potential reservoirs of infection such as rodents, cattle and domestic pets. In our area Leptospirosis has been proven to be a disease that is more common in people living in rural areas due to depopulation of rural parts of the country, where mostly middle-aged or elderly people remain living. This is supported by our results that the most affected age group is 51-60 years and the most respondents are engaged in agriculture or animal husbandry. A study in northern Poland identified 15.8% of seropositive rural residents who were exposed to direct contact with animals and 1.5% among those who did not have such contact (8).

A serological survey described by Spanish investigators on 197 people employed in agriculture showed positive results in 21% (9). Shortly afterwards new rainfall in August resulted in an increase in the number of patients in October. This periodic occurrence of patients in our study coincides with the incubation period for the development of infection with bacteria of the genus Leptospirota of 7-45 days (4), but also with epidemiological and demographic analyses. Research in Malaysia has shown similar results that an increase in the number of patients occurs 3-4 weeks after heavy rainfall (10). In Brazil, it was estimated that for each millimeter increase in maximum daily precipitation during the month above the average for the study period there was an increase in the number of leptospirosis cases by 0.55% compared to the average for that period (11). Although studies report 1.000.000 cases per year with about 50.000 deaths (4), leptospirosis is considered a neglected zoonosis in temperate climates. Extreme weather events such as floods which have become more frequent and intense in recent years and can potentially result in an increase in the incidence of the disease. In the capital of India after heavy rain in just one day in 2005 the incidence of Leptospirosis increased eightfold (12).

6. CONCLUSION

Leptospirosis is one of neglected infectious diseases in our area but the proven increase in the number of infected people after heavy rainfall obliges us to control the risk associated with this disease. According to the climate scenario of global warming floods will become more frequent. If we are able to predict the occurrence of cases early enough it will be of great benefit to public health but also to local communities to take appropriate preventive measures and preserve the health of the population. Leptospirosis can be prevented in time by the use of appropriate protective equipment such as: rubber boots, gloves and goggles.

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