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GIS Analysis of Tularemia Outbreaks in Armenia, 1996-2013

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Objective

We have applied GIS methodologies to create a retrospective analysis of tularemia outbreaks in the Republic of Armenia.

Introduction

The Armenian landscape is composed of a complex mountainous relief (400-4095 m above sea level) with several landscape-ecological zones. Fauna diversity is conditioned by ecological factors, 13 families of rodents, and 12 types of vectors. Because of these complex ecological features, many diseases remain endemic in the country. For example, approximately 95% of Armenia is a natural focus for tularemia. Rodents (voles/*Microtus socialis*) play the most important role in the epizotoology of tularemia. Voles inhabit all the landscape-ecological zones 1400-3300 m above sea level. In addition, 80 types of parasite ticks and fleas are found in all ecological zones of Armenia.

Methods

For GIS analysis, we used the archives of medical institutions at SHAEI centers across Armenia. We utilized annual registration forms and reports, and the SHAEI annual analysis of epidemiological situation reports. A tool for registering epidemiological data was developed. Addresses of patients were registered, GPS coordinates were determined by placing the addresses into Google Earth, and GPS mapping was done. Data analysis was conducted with ArcGIS, in particular, by ArcGIS Spatial Analyst and ArcGIS Geostatistical Analyst modules.

Results

From 1996-2012, a total of 266 cases of tularemia were registered in Armenia, 99 (37.2%) of which were women, and 167 (62.7%) men. GIS mapping showed that by ecological zones, 199 of these tularemia cases were registered in the steppe vegetation zone; by climatic zones, 224 cases were registered in a zone with moderate, relatively dry warm summers and cold winters (1400-2300m); and by elevation zones, 206 cases were registered in a middle mountain steppe zone. In 1996-2012, two outbreaks of tularemia were registered in Armenia. Epidemiological investigations indicated that the cases were linked by water source; the first was in March-May, 2003 in the Fountain village, Kotayk marz, and the second, in 2007 in the Tsovagyugh village, Gegharkunik marz. It is remarkable that the location of both outbreaks coincides with the three zones described above. During the first outbreak in Kotayk marz, 158 cases were registered. 99% (156) of cases used drinking water, which did not meet the requirements for drinking water, and 2 cases (1%) used that water for domestic (non-drinking) purposes. During this outbreak, the community was supplied with water mainly from one source. This source contained ground waters, coming from field territories of 20,000 square meters and was supplied to the community through a pipeline. Tularemia epizooties among rodents were registered at the same period. Numerous rodent communities were found in the area close to the water source. Laboratory examination of 211 voles was completed, and 95% of were positive for tularemia. The rodents were freely able to penetrate into the water basin. No water disinfection was done, and the water was contaminated with the bacteria, *E. coli*, which was found in the water at >1x103 CFU/mL.

Conclusions

The analysis of Fountain village outbreak data values with the use of GIS methodology show that the study results were significant (z-score: -7.795563, p-value: 0.0000001), and case study by clusters had to be performed. However, since the cause of the outbreak was clarified, there was no need for cluster analysis. The use of water was a significant cause of the outbreak, with R value of 27.19. The use of GIS during outbreaks allows for the detection of environmental factors contributing to the spread of diseases, the relationship between geographical distribution of cases, storages and vectors. This technology may be used for planning future surveillance and prevention strategies, as well as for developing models to determine future cases and/or outbreaks.

Keywords

CBEP; tularemia; Armenia

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