

Vector-Borne Diseases: Impact of Climate Change on Vectors and Rodent Reservoirs
Berlin, 27 & 28 September 2007

Emergence of Hantavirus in Germany: Rodents, climate and human infections

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Puumala Hantavirus (PUUV) is the prevalent serotype in central and northern Europe with bank vole (*Myodes glareolus*) as main reservoir. PUUV is transmitted to humans by infected rodents through urine, droppings, or saliva. While 80 % of infected humans reportedly are asymptomatic or develop mild symptoms, PUUV can cause Nephropathia epidemica, a renal disease of sudden onset with fever, headache, backpain and gastrointestinal symptoms, in rare events leading to internal haemorrhaging and death.

Between 2001 and 2006 the incidence of PUUV infections in Germany ranged from 0.1 - 0.5 per 100.000 inhabitants and year. Approximately 75 % of infections were reported from the State of Baden-Württemberg, with between 24 and 169 infections annually. In 2007, a PUUV epidemic with early seasonal onset was observed in Baden-Württemberg: Based on 925 laboratory-confirmed infections, the 8month incidence of 8.4/100.000 represents an eight-fold increase over the statewide median incidence of the same period in the years 2001 to 2006 (1.04/100.000). Patients were predominantly male (71.3 %) and aged 20 - 60 years (81.5 %). 48.6 % required hospital treatment. Most cases were reported from districts with large areas of beech forest, which is the main habitat of bank vole.

To further investigate potential routes of infection and risk factors as well as possible causes of the early seasonal onset and high number of cases several studies were initiated by the state health department: A case control study, enlargement of laboratory analysis, investigation of bank vole population (in cooperation with Friedrich-Löffler-Institute and others), and an analysis of the association of PUUV incidence with habitat factors, climate and other potential risk factors.

The case control study comprised cases with clinical onset between 1 April and 30 June 2007 and randomly recruited controls, matched for sex, age group (± 10 years) and place of residence. Interviews covered socio-demographic factors and exposure in the four weeks before clinical onset. 191 matched pairs were included in the analysis. Multivariate analysis confirmed the known risk factors noticing small rodents and cleaning of utility rooms. Primarily visiting forest shelters was detected as new source of human PUUV infection.

Spatial and temporal incidence of PUUV infections between 2001 and 2006 was analysed with regard to bank vole habitat, climatic factors and human population density by using Poisson-regression. A regression model which included data on beech forest, seed plants, beech-nut crop, human population density, winter and spring temperature above long-term average and year of investigation showed a fit of $R^2 = 35\%$. The model indicated a positive association with the year of investigation, suggesting that the disease might spread out. Furthermore, increasing winter and spring temperature were significantly associated with an increase in PUUV incidence. This result highlights the possible impact of climate change.

The results so far gave hints to some aspects of the present epidemic. Causal aspects of rodent population dynamics and spread of PUUV infection remain however poorly understood and need to be further investigated.