Lyme Disease and Climate Change

Lyme disease is the most common tick borne disease in Europe and results from an infection with the bacteria *Borrelia burgdorferi*. The disease occurs in humans following a bite from a tick *Ixodes ricinus* which has been infected with this organism. Although the deer is the principal carrier of the tick in most European countries, woodland birds are the main reservoir hosts in Ireland, and unlike Central Europe, rodents are hardly ever involved. Ticks spend the greater part of their life cycle free within their habitat where they are vulnerable to environmental factors including temperature and rainfall. Changed climatic conditions may therefore impact on the incidence of vector borne disease, not only because the ticks live outside their host in the environment for a part of their lives, but, in addition, alterations in habitats and species behaviour of the host may also result from climate change in Ireland [1]. Significant changes have occurred in the Irish climate in recent times, and are comparable to global changes [2]: an increase of 0.5 ^{0}C in mean temperatures has been observed in the 20th century, the rise being most marked in the last decade; A change in the incidence of Lyme disease from present levels may therefore be expected as temperatures increase as a result of climate change.

Lyme Disease

Lyme disease is the only vector borne disease of significance in Ireland. Following the bite, which may have gone unnoticed, the disease is characterized by general malaise, fever, headache, muscle and joint aches, and lymphadenopathy. A red circular lesion, erythema migrans, characteristic of the disease may also occur. Untreated, the infection can spread to produce varied symptoms including aseptic meningitis, meningo-encephalitis, polyarthritis and myocarditis. Case definitions of the principal manifestations of European Lyme borreliosis have been produced and include the dermatological, neurological, musculoskeletal and cardiac manifestations of this multi-system disease [3]. Treatment is with antibiotics, and while complete recovery is usual, some patients continue to suffer from ongoing symptoms such as persistent fatigue, muscle pain, cognitive defects and sleep disturbances.

Present incidence

The reported incidence of Lyme disease varies widely, from an average of 300 per 100,000 in Austria, to 43 cases per 100,000 per year in the Netherlands and to 0.3 and 0.6 per 100,000 in the U.K. and Ireland respectively [4]. Lyme disease is not a notifiable disease in Ireland and consequently the actual incidence is not known. However, no clear trend is apparent in the incidence in Ireland in recent years (Table 1).

Environmental requirements

The optimal habitat for the infected tick in Ireland has been described5; it is comprised of mature heterogeneous woodland that is inhabited with an abundant and diverse fauna, such as birds and small mammals for the earlier larvae and nymph stage, and larger mammals for the adult phase. This optimal habitat outlined is scarce in Ireland at the moment, in comparison with some continental European countries, and is one reason why the incidence of Lyme disease in Ireland is low [5]; in addition, many tick-infested cattle, sheep and enclosed red deer do not carry borrelia; in one particular study of Irish habitats that were suitable for reservoir hosts, approximately 15% of the tick population was infected [6]. Interestingly, evidence of past infection with borrelia in Irish blood donors correlates well with the perceived risk at the locations concerned [7]. Finally, the most predominant type of borrelia (B. valaisiana) in Ireland has not been associated to date with Lyme disease, and many strains of the second commonest variety (B. garinii) may be of low pathogenicity [5]. The environmental requirements of ticks have been described [8]; prolonged cold spells are detrimental to ticks, and warmer temperatures, particularly during the winter, accelerate their development; the tick also requires a microclimate with at least 80% humidity to avoid desiccation in the non-parasitic phase, and they are therefore restricted to areas with a good vegetation cover in summer time in order to preserve humidity.

Future incidence

With both increases in mean temperatures of between 1.5 and 2.5 ^{0}C and changes in rainfall expected over the coming decades in Ireland [1], it is possible that changes may be expected in the incidence of Lyme disease. Already changes in tick distribution linked to changed climatic conditions have been described, where the distribution has moved northwards in Sweden [9] and to higher altitudes in the Czech Republic [10]. The risk of Lyme disease in Ireland may also increase, as a result of climate change. Warmer winters will both increase the extent and the amount of tick activity in Ireland, with the risk of occurrence of the disease extending to later in the year and possibly also in to early spring [11]. Although the survival, activity and distribution of the tick may reduce if raised summer temperatures coincide with lowered summer precipitation, an analysis of Irish data has shown that the tick will continue to seek hosts if there is appropriate vegetation cover [9]. In addition, it is significant that forest cover is anticipated to double in Ireland in the next twenty five years [12], which could also be expected to increase the habitats for host animals.

The future incidence of the disease in Ireland will also be determined by the exposure of the population to infected ticks, and it is importance to account for non-climatic factors in the distribution of tick borne disease. Alterations in land use patterns and residential developments in wooded areas have been linked to changes in the incidence of Lyme disease in the USA, for example [13]. Increased forest cover in Ireland in the coming decades, coupled with warmer weather will result in increased opportunities for exposure from both occupational and leisure activities. Farming practices may also change as a result of climatic influences, again altering habitats and exposure patterns, and geographic information systems could be used to identify communities at risk of developing Lyme disease. To reliably anticipate the future impacts of climate change on biodiversity, it will be necessary to expand baseline ecological monitoring, and to combine the results of such an approach, with meteorological data combined with accurate spatial and time series data on the incidence of Lyme disease. The importance of surveillance for Lyme disease has been stressed [4], however, there are no plans to make Lyme disease a notifiable disease in European Community disease surveillance systems [14], and it is not a notifiable disease in Ireland. There are also difficulties surrounding accurate serological diagnosis of Lyme disease and this is a task for specialist laboratories [3]. Many reactive samples from Ireland are sent to the Lyme Borreliosis Unit at Southampton General Hospital, UK, for confirmation.

The public health approach to this disease must include promotion of health education and emphasise the importance of reducing opportunities for exposure to this disease. Consideration might also be given to making this disease notifiable. This would be a major step forward in elucidating the complex relationship between our environment and the incidence of this disease.

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References

1. Sweeney J, Albanito F, Brereton A et al. Climate change â Redefining the Impacts for Ireland STRIVE Report. Environmental Protection Agency; 2008.
2. Sweeney J, Donnelly A, Mc Elwain L, Jones M. Climate Change: Indicators for Ireland. Environmental ProtectionAgency; 2002.
3. Stanek G, Oâ Connell S, Commino M et al. European Union concerted action on risk assessment in Lyme borreliosis: clinical case definitions for Lyme borreliosis. Wien Klin Wochenschr 1996; 108:741-7
4. Lindgren E, Jaenson T, editors. Lyme borreliosis in Europe: Influences of climate change: epidemiology, ecology and adaptation measures. Copenhagen: World Health Organization Regional Office for Europe; 2006
5. Gray JS, Kirstein F, Kahl O, Robertson JN. Lyme disease in Ireland (online) (1999) Environmental Resource Management Department of Biology and Environmental Science University College Dublin. Available from www.ucd.ie/agri/html/homepage/research_96_99/research_1998_99/erm/erm05.html accessed 09-09-2009
6. Kirstein F, Rijpkema S, Molkenboer M, Gray JS. The distribution and prevalence of B. burgdorferi genomospecies in Ixodes ricinus ticks in Ireland. European Journal of Epidemiology. 1997; 13: 67-72
7. Robertson JN, Gray JS, MacDonald S, Johnson H. The seroprevalence of Borrelia burgdorferi sensu lato infection in blood donors and park rangers in relation to local habitat. Zentralblatt f˜…r Bakteriologie. 1998; 288: 293-301
8. Gray JS, Dautel H, Estrada-Peˆ–a A, Kahl O, Lindgren E. Effects of Climate Change on Ticks and Tick-Borne Diseases in Europe. Interdisciplinary Perspectives on Infectious Diseases 2009; 593232. Published online 2009 January 4.
9. Lindgren L, T?lleklint L, Polfeldt T. Impact of climatic change on the northern latitude limit and population density of the disease-transmitting European tick Ixodes ricinus. Environmental Health Perspectives 2000; 108:119â 123.
9. Climate change-Vector borne diseases European Centre for Disease Prevention and Control http://www.ecdc.europa.eu/en/healthtopics/Pages/Climate_Change_Vector_Borne_Diseases.aspx Accessed 09-09-2009
10. Climate change-Vector borne diseases European Centre for Disease Prevention and Control http://www.ecdc.europa.eu/en/healthtopics/Pages/Climate_Change_Vector_Borne_Diseases.aspx Accessed 09-09-2009
11. Gray JS. Ixodes ricinus seasonal activity: Implications of global warming indicated by revisiting tick and weather data. International Journal of Medical Microbiology 2008; 298: 19-24
12. Sweeney J, Brereton T, Byrne C et al. Climate change Scenarios and Impacts for Ireland. Environmental Protection Agency; 2003.
13. Gubler DJ, Reiter P, Ebi KL, Yap W, Patz JA. Climate variability and change in the United states: Potential impacts on vector and rodent borne diseases. Environmental Health Perspectives. 2001; 109: 223-233
14. Smith R, Takkinen J. Lyme borreliosis: Europe-wide coordinated surveillance and action needed? Eurosurveillance. 2006;11: Article 1