A Comprehensive Approach to the Assessment of Surveillance Strategies: the Case of Scrapie in Great Britain

Victor del Río Vilas[12], Colin Birch[2], Alberto Vidal-Diez[2], Simon Gubbins[3], Marie McIntyre[3], Javier Guitian[4], Neil Nixon[4], Kim Stevens[4], Darren Green[5], Rowland Kao[5]

[1]*Department for Food, Environment and Rural Affairs (Defra), London, UK*
[2]*Veterinary Laboratories Agency, Weybridge, UK*
[3]*Institute for Animal Health, Pirbright, UK*
[4]*Epidemiology Division, Royal Veterinary College, London, UK*
[5]*Department of Zoology, University of Oxford, Oxford, UK*

BACKGROUND

Multiple surveillance activities have been conducted in Great Britain (GB) with the objective of estimating the occurrence of scrapie, a fatal neurological infectious disease of small ruminants: statutory reporting of clinical cases, annual surveys on sections of the population and occasional anonymous postal surveys. None of the surveillance sources is either unbiased or comprehensive and if the progress of control schemes is to be closely monitored, better estimates of disease occurrence are required. With this objective, the Department for Food, Environment and Rural Affairs (Defra) funded a project to: i) provide estimates of the frequency of scrapie that integrate currently available surveillance data; and ii) inform the most effective surveillance strategies that will result in sensitive systems for the detection of changes in disease prevalence in time. To make this review as comprehensive as possible it should also: i) consider clinical disease and infection at both individual animal and holding level; ii) subject to data availability, extend all analyses to the recently detected atypical form of scrapie and iii) in a context of scarce and competitive resources, approach the problem efficiently.

The approaches used within this project, outlined below, describe the efficient use and integration of all existing sources to evaluate the surveillance effort. Three surveillance attributes were of particular interest in the evaluation process: sensitivity, representativeness and cost.

METHODS

The project reviewed multiple sources of data: surveillance sources on the event of interest (either clinical disease or infection), new sources on unspecific events (deaths) and others that would allow the characterisation of the population, and subgroups within it, targeted by the surveillance system (e.g. demographic data from census, registries of movements of animals, geo-referenced datasets).

A wide range of techniques were used to achieve the goals of the project: i) multiple and one-list capture-recapture models to inform on the sensitivity of the surveillance system at the holding level; ii) empirical algorithms that allowed the manipulation of unrelated datasets and the assessment of their value to characterize the target populations (informing on the representativeness of our surveillance efforts); iii) back-calculation methods integrating all surveillance sources and genetic profile data to estimate the frequency of infection and the sensitivity of the surveillance at the individual level; iv) simulation approaches to evaluate the impact of modifications in the key parameters of the disease (e.g. holding prevalence, within holding prevalence) and its surveillance (e.g. number of samples, distribution of the surveillance effort across the multiple sources); v) spatial analysis to map the risk of scrapie and environmental disease determinants; and vi) analyses to study, for the first time, the occurrence of atypical scrapie in GB.

RESULTS

As important as the individual results from the discrete pieces of work, was the connection between outputs that allowed the progression of the project. Thus, the spatial characterization of the surveillance source populations allowed models to adjust for sampling biases. Similarly, frequency estimates from capture-recapture and back-calculation methods informed the parameters of simulation models that assessed the efficiency of different surveillance strategies. Cost-effective surveillance strategies were recommended that combined existing sources with new ones.

CONCLUSIONS

The availability of multiple surveillance sources, although themselves biased, was demonstrated to be paramount in the evaluation of the surveillance system, especially in the face of an apparent rapid decline of the occurrence of the disease and a heterogeneous distribution across the population. The need for further targeted surveillance, adapted to either type of scrapie, was obvious, as was the surveillance value of multiple datasets not directly related to the outcome of interest. Some of the approaches may be of use in many other contexts and diseases.