ADVISORY COMMITTEE ON THE MICROBIOLOGICAL SAFETY OF FOOD

INFORMATION PAPER

SAMPLING METHODS USED FOR THE UK-WIDE SURVEY OF THE PREVALENCE OF JOHNE'S DISEASE IN UK DAIRY HERDS

In December 2009 the Committee received a presentation on the survey of *Mycobacterium avium* subspecies *paratuberculosis* (MAP), the cause of Johne's disease in the UK dairy herd. Following the discussion, Members requested a summary paper that outlined the sampling methods and computer model used for the survey[1].

Please find attached, for your information, a summary paper from Defra that describes the Bayesian methods that were used in the survey.

Secretariat
September 2010

[1] http://acmsf.food.gov.uk/acmsfmeets/acmsf2009/acmsf031209/acmsfmin031209

UK-WIDE SURVEY OF THE PREVALENCE OF JOHNE'S DISEASE IN UK DAIRY HERDS

SUMMARY OF BAYESIAN METHODS

Motivation

In order to estimate the prevalence of Johne's disease in the national herd it was necessary to take into account the sensitivity and specificity of the diagnostic tests used in the survey, namely serology (individual animal level), liquid culture of faeces (pooled for 5 animals), and bulk milk PCR (herd level). Since these diagnostic test characteristics were unknown for each of the tests employed we had to employ statistical methods that were able to simultaneously estimate the test characteristics and the prevalence of infection.

Priors

In order to do this, we used Bayesian methods. The basic idea behind the Bayesian approach is that prior knowledge relating to the unknown parameters (here the test characteristics and prevalence of Johne's disease) can be included in the statistical analysis and will influence the final estimates. This prior knowledge or "priors" could be expert opinion or findings based on results from previous experiments. Since the final Bayesian model estimates will be based on both the priors and the new data, the inclusion of the priors should result in more robust final estimates, since they are based on more information than the new data alone. If one has no prior knowledge of a parameter, then one can input what is known as an "uninformed prior", which will result in the final estimates being driven solely by the available data. As part of the analysis of the Johne's survey data in GB, a comparison of the prevalence estimates using both uninformative and informative priors showed that the choice of priors actually made only a minimal difference; this is because the size of the data set was sufficiently large so that the choice of priors only had limited influence.

References for use in sensitivity and specificity estimation

Several studies propose Bayesian approaches for estimating prevalence and test sensitivity/specificity in the absence of a gold standard (see for example Branscum *et al*., 2004; 2005; also the University of Davis website http://www.epi.ucdavis.edu/diagnostictests/software.html#DiagnosticTestSeSp has many examples), and their use for estimating test sensitivities and specificities has become relatively widespread. The reason for this growth in their use is the increased power of modern computers, allowing the complex methods that are needed to drive the approach able to be implemented in desktop computers.

Other advantages: estimation of uncertainty

A further advantage is that Bayesian methods are very good at estimating the uncertainty relating to each of the estimated parameters, which is very useful in the context of interpreting the results of the Johne's survey, where the degree of confidence in the results is very important.

Validation of models

The Bayesian approach also provides a method of comparing models with different assumptions. This way we were able to determine which was the best model to use for the data out of several compared. We were also able to provide a comparison of the observed data versus the model predictions to check that the model outputs were sensible.

References

Branscum AJ, Gardner IA, Johnson WO (2004). Bayesian modelling of animal- and herd-level prevalences. Prev Vet Med. ;66:101-12.

Branscum, A.J., Gardner, I.A., Johnson, W.O. (2005) Estimation of diagnostic-test sensitivity and specificity through Bayesian modelling. Prev Vet Med 68 145-163.