Research

EDITORIAL

Simulating the impact of badger culling on bovine tuberculosis in cattle

Rowland Kao

IT is now 15 years since the Krebs report on bovine tuberculosis (TB) in cattle and badgers highlighted the need for a rigorous scientific trial to quantify the role of badgers in causing cattle herd breakdowns (Krebs and others 1997). The report resulted in the implementation of the randomised badger culling trial (RBCT), with the Independent Scientific Group on Cattle TB (ISG) being responsible for the analysis of the RBCT data. While the ISG's analyses and final report in 2007 (Bourne and others 2007) offered considerable insight into bovine TB epidemiology, it did not provide the definitive answers that had initially been hoped for. One of the most contentious outcomes of the RBCT was the identification of an increase in breakdown incidence due to the 'badger perturbation effect', most obviously seen in the 'reactive' cull of badgers in response to a local herd breakdown, but also observed under more widespread 'proactive' culling (Donnelly and others 2003, Vial and Donnelly 2011). Culling only became beneficial when culling areas were projected on to unfeasibly large areas, and this meant that the ISG recommended against the use of badger culling as an effective means to control bovine TB in British cattle (Bourne and others 2007). However, this conclusion has been challenged on various grounds, and an independent scientific review postulated that under some circumstances badger culling could be effective (King and others 2007). Adding to the controversy, the Irish Four Areas Project also concluded that badger culling could be effective (Griffin and others 2005), although substantial differences in the underlying epidemiology and the conduct of the two trials might account for much of the difference between the British and Irish experiences (O'Connor and others 2011).

Further problems in the interpretation of the RBCT outcomes lie in the changing picture of the epidemic itself: while the trial areas were extensive and it could be argued

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that they were representative of areas with a high breakdown risk in 1997, current high-risk areas are much greater in extent and therefore important differences may exist in the underlying demography of both cattle and badgers over this greater area. In combination with the use of natural barriers, such as rivers or coastlines, as suggested by the King report (2007), this greater extent implies that careful consideration should be given as to how local conditions might alter the requirements of control.

An underlying problem in this debate is the contrast between the burdens of proof demanded by the scientific and policy constituencies. The burden of scientific proof requires near certainty in outcome; the classic limit for scientific confidence is that 19 times out of 20, a repeated experiment will produce a stated result (ie, the result is within the 95 per cent confidence interval). Policy, however, must balance the efficacy of a potential measure with social, economic and political requirements, and in the event that a decision is to be made, it is made only when the balance of probabilities is in its favour. Thus, there is an inherent paradox in the need to take statistically rigorous, scientifically sophisticated recommendations and view them through the relatively fuzzy lens of sociopolitical realities. In the case of bovine TB, the debate is made particularly difficult by the stark contrast between the demands of the livestock industry to control bovine TB, and the national affection of the general public for badgers, an affection reflected in and reinforced by the popular literature (such as The Wind in the Willows by Kenneth Grahame), and embedded in legislation under the Protection of Badgers Act of 1992.

Under these circumstances, it is not surprising that all options for bovine TB control currently remain on the table, including vaccination of both badgers and cattle, and badger culling, which is being considered in Northern Ireland, England and Wales. An ongoing investigation of some of these options is the Welsh 'Intensive Action Area' (IAA) programme (http://wales.gov.uk/topics/environmentcountryside/ahw/disease/bovinetuberculosis/intensiveactionpilotarea/?lang=en), a five-year programme in a geographically isolated region of north Pembrokeshire under which multiple, stringent measures to control bovine TB are being applied. These measures include stricter cattle controls, improved biosecurity measures, tackling disease in non-bovids, and a government-led badger cull. While it cannot be considered a scientifically rigorous trial, should the IAA programme be effective in reducing bovine TB breakdown rates compared to neighbouring areas, it will have established a proof of the principle that current measures can be effective, although without establishing the relative efficacy of the different measures.

Can simulation modelling predict the effect that culling badgers may make on bovine TB incidence in cattle?

'There is an inherent paradox in the need to take statistically rigorous, scientifically sophisticated recommendations and view them through the relatively fuzzy lens of sociopolitical realities'

In a paper summarised on p 177 of this week's *Veterinary Record*, Fenwick (2011) uses a simulation modelling approach to predict the impact of badger culling in the IAA. Using a combination of publicly available data on herd densities, the exact geographical shape of the IAA and the outcomes of the RBCT analyses, Fenwick has constructed a series of 'what-if' scenarios, considering the impact of various assumptions regarding the permeability of boundaries to badger movement, and measured the impact of culling over different time frames and distances from the IAA. These simulations show that, if we assume that the IAA has effectively the same characteristics as the RBCT areas except that some of the IAA boundaries present a natural barrier to badger migration, then culling could have a net positive benefit.

Fenwick's model is abstract – for example, it does not consider the role of cattle movements in the transmission of bovine TB (Gilbert and others 2005, Green and others 2008), the importance of individual herd size (Brooks-Pollock and Keeling 2009), or what was perhaps the most surprising outcome of the RBCT analyses: that cattle-to-badger transmission is an important component of bovine TB epidemiology in Great Britain (Woodroffe and others 2006). Neither is the simulation used to statistically fit model parameters to the observed breakdown patterns in the IAA. However, its value does not lie in its specific predictions but in demonstrating that simply increasing the restrictiveness of the geographical boundaries of a culling area without any change in the epidemiology could change the benefit of culling from negative to positive. As such, it provides optimism that the IAA programme, properly applied, could provide a real benefit to farmers. Of course, the real answer must await the outcome of the IAA programme itself.

References

BOURNE, F. J., DONNELLY, C. A., COX, D. R., GETTINBY, G., MCINERNEY, J. P., MORRISON, W. I. & WOODROFFE, R. (2007) Bovine TB: the scientific evidence. Final Report of the Independent Scientific Group on Cattle TB

BROOKS-POLLOCK, E. & KEELING, M. (2009) Herd size and bovine tuberculosis persistence in cattle farms in Great Britain. *Preventive Veterinary Medicine* **92**, 360-365

DONNELLY, C. A., WOODROFFE, R., COX, D. R., BOURNE, J., GETTINBY, G., LE FEVRE, A. M., MCINERNEY, J. P. & MORRISON, W. I. (2003) Impact of localized badger culling on tuberculosis incidence in British cattle. *Nature* **426**, 834-837

FENWICK, N. I. D. (2011) Modelled impacts of badger culling on cattle TB in a real area with geographic boundaries. *Veterinary Record* doi: 10.1136/vr.100051

GILBERT, M., MITCHELL, A., BOURN, D., MAWDSLEY, J., CLIFTON-HADLEY, R. & WINT, W. (2005) Cattle movements and bovine tuberculosis in Great Britain. *Nature* **435**, 491-496

GREEN, D. M., KISS, I. Z., MITCHELL, A. P. & KAO, R. R. (2008) Estimates for local and movement-based transmission of bovine tuberculosis in British cattle. *Proceedings of the Royal Society B: Biological Sciences* **275**, 1001-1005

GRIFFIN, J. M., WILLIAMS, D. H., KELLY, G. E., CLEGG, T. A., O'BOYLE, I., COLLINS, J. D. & MORE, S. J. (2005) The impact of badger removal on the control of tuberculosis in cattle herds in Ireland. *Preventive Veterinary Medicine* **67**, 237-266

KING, D., ROPER, T. J., YOUNG, D., WOOLHOUSE, M. E. J., COLLINS, D. A. & WOOD, P. (2007) Bovine tuberculosis in cattle and badgers: a report by the Chief Scientific Adviser, Sir David King. Defra. http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/atoz/tb/documents/badgersreport-king.pdf. Accessed February 8, 2012

KREBS, J. R., ANDERSON, R., CLUTTON-BROCK, T., MORRISON, W. I., YOUNG, D. B., DONNELLY, C. A., FROST, S. & WOODROFFE, R. (1997) Bovine Tuberculosis in Cattle and Badgers – An Independent Scientific Review. Ministry of Agriculture, Fisheries and Food

O'CONNOR, C. M., HAYDON, D. T. & KAO, R. R. (2011) An ecological and comparative perspective on the control of bovine tuberculosis in Great Britain and the Republic of Ireland. *Preventive Veterinary Medicine* doi:10.1016/j.prevetmed.2011.11.010

VIAL, F. & DONNELLY, C. A. (2011) Localized reactive badger culling increases risk of bovine tuberculosis in nearby cattle herds. *Biology Letters* doi: 10.1098/rsbl.2011.0554

WOODROFFE, R., DONNELLY, C. A., JENKINS, H. E., JOHNSTON, W. T., COX, D. R., BOURNE, F. J. & OTHERS (2006) Culling and cattle controls influence tuberculosis risk for badgers. *Proceedings of the National Academy of Sciences of the United States of America* **103**, 14713-14717

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