Institution: University of Glasgow

Unit of Assessment: Unit 6; Agriculture, Veterinary and Food Science

Title of case study: Risk-based surveillance and testing defines government policy on bovine tuberculosis

1. Summary of the impact

A University of Glasgow bovine tuberculosis (bTB) surveillance model was fundamental to new Scottish Government policy on bTB testing. Implemented on 1st January 2012, the policy change used the Glasgow model to indicate which cattle herds can be exempt from routine testing while still maintaining Scotland's Officially bTB Free status. In 2012 this translated to exemption of more than 30% of Scottish herds from routine testing, with an associated government saving of £150,000. The revised policy also provided savings to the Scottish farming industry in the region of £100,000 (2012) and limited the risks of bTB testing to farmers, veterinarians and cattle. The rapid success of the ground-breaking Scottish research-led bTB policy development has been highlighted by the Civil Service as best practice and has been presented to numerous policy audiences including the European Commission, providing the opportunity to transform industry practices and livestock surveillance policy across the UK and beyond.

2. Underpinning research

Bovine TB surveillance

Veterinary surveillance involves the screening, collection of samples and analysis of infections in animals, with the aim of rapidly identifying and controlling threats to animal and human health. bTB is a disease notifiable to the Animal Health Veterinary Laboratories Agency (AHVLA) resulting from infection with the bacterium *Mycobacterium bovis.* Conventional surveillance for bTB involves government sponsored testing of all herds at regular intervals (ranging from annually in high risk areas to a minimum of every 4 years in areas with the lowest risk), with additional detection measures also in place in slaughterhouses. Individual cattle within herds are tested for infection using the standard skin test (the Single Intradermal Comparative Tuberculin Test), with bTB-positive cattle termed 'reactors'. Herd Official Tuberculosis Free (OTF) status is lost when one or more reactors within a herd have been identified. National OTF status is granted by the European Commission when at least 99.9% of herds remain bTB free for 6 consecutive years.

Defining the spread of bTB: transmission routes and associated risk factors

The epidemiology group within the University of Glasgow Boyd Orr Centre for Population and Ecosystem Health has an established track record in the use of livestock movement data to inform risk-based modelling of disease transmission. In order to develop the risk-based surveillance model, Professor Rowland Kao and others quantified risk factors for bTB across Scotland using comprehensive official government-held databases containing recorded information from all GB herd testing for bTB and cattle movements over the period 2003–2008. The results, published in 2012, showed risk in Scotland was most reliably associated with the importation of cattle from annual testing areas of England and Wales and from Ireland. These import risks proved to be of particular relevance to 'fattening' herds in which cattle are reared for slaughter.[1]

Development of a risk-based bTB surveillance model

In 2009, Scotland was granted OTF status, at which point the majority of cattle herds in Scotland were tested on a standard 4-year cycle. Following this, the Scottish Government called for an analysis of risk-based veterinary surveillance of bTB to identify possible efficiency savings to current monitoring systems. Owing to their unique combination of expertise in bTB, the cattle industry and disease modelling, University of Glasgow researchers led jointly by Professor Kao, Professor Dominic Mellor and Professor David Logue were appointed by the Scottish Government in March 2010 to develop a risk-based, bTB surveillance model specifically designed for Scotland. Based on the risk factors identified for Scotland, the resultant predictive statistical model used detailed information on the past patterns of herd outbreaks to calculate the probability that any given herd would be free from infection with *M. bovis.* This was used to assess the relative contribution of the following infection risk factors: (i) herd size, (ii) the proportion of the herd sent for slaughter, (iii) the type of herd (beef, fattening, dairy, etc.), and (iv) the receipt of new cattle from

high incidence bTB areas. Variables were modelled along with the testing interval period and the probability of slaughterhouse detection of bTB to compare a set of risk-based surveillance scenarios. Each scenario was compared with the conventional surveillance strategy to determine which strategies produced better, similar and lower levels of detection.

These analyses, published in 2013, revealed that by giving consideration to these risk factors, only 65% of Scottish herds would require regular 4-yearly testing to replicate the detection rates achieved with the conventional system.[2] Using this approach, only herds in which less than 25% of the stock was slaughtered annually or herds for which more than 40% of the stock were imported on a regular basis needed to be tested every 4 years. Herds in which more than 40% of the stock was slaughtered each year could be wholly exempted from testing. Historically, most false-positives occurred in the now-exempt herds; thus the risk-based approach further reduces the burden associated with unnecessary testing.

Key University of Glasgow researchers: Rowland Kao (Professor of Mathematical Population Biology, 2009-present), Dominic Mellor (Professor of Epidemiology and Public Health, 2008-present), David Logue (Professor of Food Animal Disease, 2005-2011; Honorary Senior Research Fellow, 2011-present), Dr Paul Bessell (Research Associate, 2010-2011; now Roslin Institute, May 2011), Dr Richard Orton (Scientific Programmer, 2009-2012, Research Associate, 2012-present).
Key collaborators: Badger density data were provided by Dr Michael Hutchings (SRUC, Scotland's Rural College) and Dr Piran White (University of York).

3. References to the research

1. Bessell PR, Orton R, White PCL, Hutchings MR, Kao RR. Risk factors for bovine tuberculosis at the national level in Great Britain. *BMC Vet Res.* 2012; **8**, 51; doi: 10.1186/1746-6148-8-51.
2. Bessell PR, Orton R, O'Hare A, Mellor D, Logue D, Kao RR. Developing a framework for risk based surveillance of tuberculosis in cattle: a case study of its application in Scotland. *Epidemiol. Infect.* 2013; 141, 314-323; doi: 10.1017/S0950268812000635.

Grants: Kao RR. Risk Based Surveillance for Tuberculosis in Cattle (bTB), Scottish Government, £96,710, 2010-2011 (competitive, peer reviewed tender).

4. Details of the impact

Bovine TB: the problem

bTB is caused by the pathogen *M. bovis*, which infects livestock and wildlife, with severe socio-economic consequences and an impact on animal health. bTB is largely eliminated in many countries, but the control of *M. bovis* has proven problematic in both Great Britain and Ireland. In the absence of improved control, the projected economic burden to Great Britain over the next decade is predicted to be £1 billion. Though persistence of *M. bovis* in the environment and poor test sensitivity may play a role, efforts to understand and control bTB centre around the role of the Eurasian badger (*Meles meles*) as a potential reservoir. Despite the importance of badgers as a wildlife reservoir, this risk is concentrated in the South-West of England, and in the rest of Great Britain at least half of cases have previously been attributed to recorded movements of cattle from high risk areas that are under annual testing. Once detected, OTF status is withdrawn (OTFW) or suspended (OTFS) depending on whether infection is subsequently confirmed; all reactor cattle are slaughtered and movements of cattle from the herd suspended until OTF status is recovered, which requires that the herd be clear of reactors for two consecutive tests over six months.

University of Glasgow risk-based bTB surveillance model becomes Scottish Government policy

The Animal Health and Welfare Veterinary Laboratory Agency (AHVLA) is the UK statutory agency responsible for disease control, including implementation of bTB testing and advising policy-makers in government. Members from the AHVLA as well as the Chief Veterinary Officer for Scotland and Scottish Government Scientific advisor joined the Glasgow researchers on the project steering group tasked with working up the research findings into a framework that was practical for implementation. In April 2011, the University of Glasgow research team presented

their risk-based bTB model and a range of surveillance options to the steering group, and worked with them to identify the most appropriate surveillance model to implement through existing AHVLA channels in Scotland. The final form of the model was presented to the Scottish Government (including a group of government cattle stakeholders) in May 2011 and accepted in June, just 15 months after the initial research was commissioned.[a] Details of the revised bTB policy and its implementation date (1st January 2012) were announced via letters sent out by the AHVLA to the livestock industry and veterinarians through a Scottish Government press release in October 2011[b] which sparked widespread media coverage.[c]

The model can be easily adapted at any time to account for changes in individual risk factors, thereby ensuring that bTB surveillance and resource allocation remain optimal in Scotland. To ensure the model remains evidence-based, the University of Glasgow has been commissioned to undertake further monitoring of the surveillance system and consider options for improvement under the Scottish Government Centre of Expertise in Animal Disease Outbreaks, of which Profs. Kao and Mellor are Principal Investigators on the Centre Directorate. This is the first time that risk-based surveillance for bTB has been used in the European Union, and therefore the first time that a scientific underpinning has been used to inform bTB surveillance. Speaking of the University of Glasgow-informed Scottish bTB surveillance system, the Chief Veterinary Officer for Scotland commented…

'In other OTF countries a wide range of surveillance protocols are in operation but none have been fully successful. The Scottish risk based system of exemptions is therefore truly unique.' [d]

Revised Scottish Government policy saves money

Prior to the introduction of the new risk-based model developed by the University of Glasgow, all eligible cattle herds in Scotland were tested on a 4 year cycle and annual costs for bTB control in Scotland averaged £2 million per year. A major aim of the University of Glasgow-led policy revision was to provide a surveillance system that would save money and more effectively target surveillance resources. Under the revised policy, simple strategies are used to identify premises at low risk of infection to exempt them from testing. Additionally, the procedures for herd 'breakdown' follow-up testing have been changed by reducing two testing cycles to just one. Unconfirmed herd 'breakdown' testing at 6 and 12 months after restoration of OTF herd status is no longer required under the revised policy. The predictive ability of the model provides the opportunity for livestock owners to implement pre-emptive control measures via preferential purchase of cattle from areas where bTB is a low risk. As of June 2011 there were 12,580 Scottish agricultural holdings registered, with typically one herd per holding. Previously, one in four of these would have been subject to routine herd testing in each year (i.e. 3,145 of them). Of these in 2012, 1,018 herds (more than 30%) were exempt from routine testing, resulting in savings to the Scottish Government in the region of £150,000.[a,e,f] Consequently, the government funds saved from the revised policy have enabled investment in parallel animal health priorities (such as bovine viral diarrhoea eradication and reduction of sheep scab) to further enhance the health and welfare status and reputation of Scotland's livestock industry.[d]

Reduction in bTB testing affords benefits to farmers and animal welfare

The reduction in bTB testing in Scotland has also impacted upon farmers, veterinarians and cattle. For testing to take place, cattle must be gathered and restrained in a 'crush' (a powerfully built cage that holds the animal upright and still) on two occasions, 3 days apart. This process represents a major challenge as cattle, particularly beef bulls, can exceed 1,000 kg in weight. A 2008 survey commissioned by the Health and Safety Executive (HSE) identified bTB testing as the most hazardous task undertaken by veterinarians, and indeed HSE statistics detail incidents where farmers have been killed whilst moving their cattle for the purposes of bTB testing.[h] The testing process is therefore time consuming, potentially dangerous to those carrying out the testing, stressful to the animal and very costly in terms of time and effort. Reducing the frequency of bTB testing and exempting some herds altogether will undoubtedly reduce the risks to people and stress on cattle resulting from the manual handling involved. The cost of the bTB testing process for farmers can peak at £50 in profit loss per animal due to reduced productivity (weight, milk yields). The reduction in bTB testing from the revised policy has translated to an estimated saving

of £100,000 per year to the Scottish farming industry.[f]

The success of the Scottish Government policy receives UK wide recognition

Whilst Scotland has been officially bTB free since 2009, incidence rates of bTB remain problematically high in the southwest of England and parts of Wales and Ireland, with an annual average of approximately 25% of herds in the South-West under movement restrictions due to bTB at some point in 2011. Given the wide sale and transfer of livestock between regions of the UK, these areas represent a challenge to surveillance measures across the whole of the UK and bTB control remains a high priority issue. In recognition of the Scottish policy on bTB testing, the Scottish Government bTB policy team was nominated and shortlisted for '*The Innovative Delivery Award*' at the 2012 UK Civil Service Annual Awards. These awards are designed to showcase best practice in implementing technology in government policy making. The policy development work has been further recognised by the Civil Service, which has translated the University of Glasgow research behind the Scottish Government policy into a case study on its 'Open policy making' website. The case studies aim to showcase proven best-practice examples of policy making, highlighting pointers for future approaches. In direct reference to the University of Glasgow research underpinning the Scottish Government bTB policy cost savings, the article states that '*The academic research is central to this achievement and re-affirms the Scottish Government's decision to engage academia after it recognised it did not have the resources or expertise to conduct the research in-house*.'[h] Furthermore the Boyd-Orr Centre for Population and Ecosystem Health was awarded the 2013 Queen's Anniversary Prize for Higher and Further Education.[j]

In response to such advocacy and demonstrable benefits gained from the incorporation of the University of Glasgow's research into bTB government policy in Scotland, the UK Department for Environment, Food and Rural Affairs (Defra) commissioned the University of Glasgow team in July 2012 (almost £300,000 in funding) to produce a model of risk-based bTB surveillance in England and Wales, which includes the aim of extending these efficiency measures to low risk areas of England and potentially Wales.[i] The AHVLA has supported this move by disseminating the 'Scottish experience' of successful research-led bTB policy development to the approximately 200 Official Veterinarians involved in bTB testing across England, Scotland and Wales in its distribution profile.[k] Furthermore, dissemination of the Scottish bTB policy to policy audiences as prominent as the European Commission has given the University of Glasgow and Scottish Government policy development work an international profile.[d]

5. Sources to corroborate the impact

a. Scottish Government final project report: Risk-based surveillance for tuberculosis in cattle. - published June 2011, ISBN: 978-1-78045-248-7, web only.
b. Scottish Government press release, 4 October 2011, announcing change in bovine TB testing policy, referencing University of Glasgow research.
c. Media coverage of revised policy implementation:
   (i) Farmers Guardian, 6 October 2011 'New TB testing regime for Scotland.'
   (ii) The Scottish Farmer, 6 October 2011 'Scottish TB testing in retreat.'
d. Statement from the Chief Veterinary Officer for Scotland (available on request)
e. AHVLA annual report and accounts 2012-2013, ISBN: 9780102984576; citing reduction in number of herds tested in 2012 with cost savings (p12).
f. Data on cost savings to government and farming industry were confirmed through personal correspondence with Scottish Government and can be made available on request.
g. Health and Safety Executive
   (i) 2008 report: Health and Safety issues in cattle handling on farms with particular reference to veterinary activities – copy available on request.
   (ii) Information on bTB testing related fatalities were obtained through personal correspondence with HSE and can be made available on request.
h. Civil Service case study, 'TB testing' in Scotland, Conor Quinn, 17th April 2013
i. Defra Science and Research projects: The Development of quantitative risk-based surveillance strategies for bTB in England and Wales – SE3285.
j. 2013 Queen's Anniversary Prize for Higher and Further Education
k. 'Official Veterinarian' newsletter, issue 7, Dec 2012