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Future risk of bovine tuberculosis recurrence among higher risk herds in Ireland

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ABSTRACT

Within the Irish national bovine tuberculosis (bTB) eradication programme, controls are tighter on higher risk herds, known as H-herds. These H-herds are defined as herds that have previously had a bTB restriction (also known as a bTB episode), with at least 2 animals positive to the single intradermal comparative tuberculin test (SICTT) or with a bTB lesion detected at slaughter. Such herds are considered at higher risk of recurrence following the end of the bTB episode. In this study, we examined if, and when, the future bTB risk of H-herds returned to a similar level comparable to herds with no history of bTB. In addition, the proportion of bTB episodes in 2012 that could be attributed to the recent introduction of an infected animal was also estimated, providing an update of earlier work. The study population consisted of all Irish herds that were not bTB restricted at the start of 2012 and with at least one whole-herd SICTT in 2012, with the herd being the unit of interest. The outcome measure was a bTB restriction, defined as any herd where at least 1 standard SICTT reactor or an animal with a bTB lesion at slaughter in 2012 was identified. A logistic regression model was used to model the probability of a herd being restricted in 2012. Herds that were previously restricted had significantly higher odds of being restricted in 2012 compared to herds that had not. Similarly, the odds of being restricted in 2012 decreased as the time since the previous restriction increased, but increased as the severity of the previous restriction increased. Odds of being restricted also increased with an increase (although not linear) in herd size, the number of animals greater than 1 year of age purchased in 2011, the county incidence rate and the proportion of cows in the herd. The recent introduction of an infected animal accounted for 7.4% (6.7–8.2) of herd restrictions. This study confirms the key role of past bTB history in determining the future risk of Irish herds, with the odds related to both the severity of and time since the previous restriction. It also illustrates the difficulty in clearly defining H-herds, noting that risk persists for extended periods following a bTB restriction, regardless of breakdown severity. There is a need for robust controls on H-herds for an extended period post de-restriction.

1. Introduction

In Ireland, the national bovine tuberculosis (bTB) eradication programme includes both field surveillance, involving annual testing of every herd in Ireland using the single intradermal comparative tuberculin test (SICTT)

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and abattoir surveillance. The latter involves the inspection of bovine carcases at slaughter for tuberculous lesions. Herds with one or more positive animal(s) at the SICTT or slaughter have Officially TB Free (OTF) status suspended or withdrawn in accordance with Directive 64/432/EEC and movement restrictions imposed, known as either a herd 'restriction' or bTB episode. The restriction period lasts until two clear consecutive whole-herd SICTT tests at 60 day intervals are achieved post removal of infected animal(s), at which point the herd is de-restricted. Routinely available performance measures indicate a steadily improving situation (Sheridan, 2011; Department of Agriculture, Food and the Marine (DAFM), 2014a), both in terms of reactor numbers and herd incidence (15,612 and 3.88% in 2013, respectively).

Policy measures are under ongoing revision, guided by output from a national research programme. Recent enhancements to the programme relate to animals that disclose inconclusive results to the SICTT (Clegg et al., 2011a,b), the introduction of animals during a herd restriction for bTB (Clegg et al., 2013) and the testing of neighbouring herds (White et al., 2013). One key challenge relates to the recurrence of infection in herds that have previously had a bTB episode. Recurrence, as discussed in Good et al. (2011), may be the result of residually infected cattle, that is, animals not disclosed during a previous episode but remaining in the herd. The SICTT is an imperfect test, with a median estimate of sensitivity of 80% and specificity of 99.5% estimated from several studies (De la Rua-Domenech et al., 2006). The imperfect sensitivity may lead to infected animals being left behind in the herd at the end of a restriction period. Another source of recurrent infection is the re-introduction of infection either during or shortly following herd de-restriction, due to a local wildlife source, environmental contamination, or neighbouring cattle herds. Several studies in Ireland and the UK have highlighted the problem of recurrence, with Wolfe et al. (2009) noting that 10% of Irish herds are restricted again at the test conducted 6-months following de-restriction. This figure is somewhat higher in Great Britain, Abernethy et al. (2013) reported that 18% to 28% of herds between 2002 and 2009 were restricted at the 6-month test following de-restriction. In the corresponding period in Ireland, the comparable figure was stable with a mean of 12.2% of de-restricted herds. In Ireland, the future risk of a bTB outbreak is influenced by the severity of a previous outbreak (Olea-Popelka et al., 2004). Further, recent work has provided insights into the relative importance of 'neighbourhood', specifically farm-to-farm spread and spread from wildlife, in bTB persistence (White et al., 2013). There has been a significant decrease in recurrence in Irish herds during the 10 years to 2008 (with 2008-derestricted herds being 0.74 times (95% confidence interval: 0.68–0.81) as likely to be restricted during the subsequent study period compared with 1998-derestricted herds (Gallagher et al., 2013), however, recurrence rates remain high.

Within the Irish national programme, tighter controls are placed on higher-risk (or H-) herds, which are herds considered at higher risk of recurrence following de-restriction. These herds are defined as those experiencing a bTB episode with at least 2 standard reactors (animals with an increase in skin thickness at the bovine site more than 4 mm greater than the increase at the avian site) or at least 1 standard reactor and an animal with a TB lesion found at slaughter and where infection was acquired within the herd. In addition, if the outbreak in a H-herd is attributed to a badger source, the local badger population will be subject to population control measures (DAFM, 2014b). In general, lower risk (or L-) herds undergo a SICTT test 6-months after de-restriction and then, if clear, at annual intervals thereafter. In contrast, H-herds must pass three SICTT tests at 6 month intervals following de-restriction before returning to annual testing (Good et al., 2010). Questions remain as to the appropriateness both of the definition of H-herds as currently used and of the length of time during which tighter controls should last. There has been some previous research relevant to this question, but with inconclusive results. Wolfe et al. (2010) queried whether the identification of H-herds could be improved by developing a model including several known risk factors such as previous history, herd size, breakdown severity, but found that the predictive ability of the final model was poor. In this work, Wolfe et al. (2010) identified severity of a previous breakdown as a significant predictor of recurrence, in agreement with earlier studies (including Olea-Popelka et al., 2004), but did not consider the interval between de-restriction and subsequent recurrence.

Animal movement is a known risk factor for the spread of bTB between farms. Previous work has highlighted the substantial movement of animals in Ireland (Ashe et al., 2009), and animal-level bTB risk is known to increase with past evidence of bTB exposure (Olea-Popelka et al., 2008). Despite this, a previous study using national data from 2003 to 2004 found only a relatively small proportion, approximately 7%, of restrictions attributable to animal movements (Clegg et al., 2008). These authors recommended that a mandatory pre-movement test (which had been abolished in 1996) would only be cost-effective if focused on high-risk movements. Similar results were obtained, based on epidemiological investigations conducted in the mid-late 1990s (O'Keeffe and O'Driscoll, 1998; O'Keeffe and Higgins, 2003). Updated information is needed, given the changes both to national policy and progress that have occurred subsequently.

The primary aim of this study was to determine if the current criteria for designation of H-herds remain appropriate and to examine if, and when, the future bTB risk of H-herds returned to a similar level comparable to herds with no history of bTB. These are important gaps in knowledge relevant to national policy. Second, we estimated the proportion of herd outbreaks in 2012 that could be attributed to the recent introduction of an infected animal, providing an update of earlier figures from a study examining herds that were newly restricted due to bTB between 1 April 2003 and 31 March 2004 (Clegg et al., 2008) and a study of herds restocked following depopulation (Good et al., 2011).