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Bovine tuberculosis in Northern Ireland: Risk factors associated with time from post-outbreak test to subsequent herd breakdown

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ABSTRACT

Compulsory bovine tuberculosis testing has been implemented since 1959 in Northern Ireland. Initial rapid progress in the eradication of the disease was followed by a situation where disease levels tended to fluctuate around a low level. This study explores recrudescence of bovine tuberculosis (bTB) in Northern Ireland herds by assessing risk factors associated with time from the six-month post-outbreak skin test until a further herd breakdown. Bovine herds ($n = 3377$) were recruited in 2002 and 2003 and their survival analysed using Kaplan–Meier survival estimates and a Cox proportional hazards model, with follow-up extending to August 2008. Exclusion criteria applied for study entry were bTB infection in a contiguous herd, changing of post restriction test to one of a higher risk status or chronic infection. Chronic infection was defined as any situation where disclosure preceded the post-outbreak test by two years or more. The application of these exclusion criteria meant that herds recruited to the study were largely cleared of infection and not directly contiguous to other infected herds. Of the 3377 herds, 1402 (41.5%) suffered a further herd breakdown before the end of follow-up. Median survival time was 582 days (interquartile range = 336–1002 days). Breakdown severity (defined as the number of Single Intradermal Comparative Tuberculin Test (SICTT) reactors at disclosure test), local bTB prevalence, herd size and type were identified as significant risk factors ($p < 0.05$), as was the purchase of higher numbers ($n > 27.38$ per year) of cattle. Consistent with other studies this work shows bTB confirmation to not be predictive of a future herd breakdown. This work shows bTB history as not being a risk factor for a future breakdown. This result could be reflective of the exclusion criteria used in the study, which may have selected for incidents where historical status was of less importance.

1. Introduction

Tuberculosis in cattle caused by *Mycobacterium bovis* has a worldwide distribution. Eradication has been largely successful in developed countries, particularly those with

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no significant wildlife reservoirs (Abernethy et al., 2006). An eradication scheme was introduced in Northern Ireland in 1959 but bovine tuberculosis remains endemic. Peak incidence (new cases) occurred during the spring of 2003 with a herd incidence of 10.20% and animal incidence of 0.99%. From 2003 to 2007 Northern Ireland bTB levels dropped yearly to reach a consistent level of herd and animal incidence below 6% and 0.60%, respectively. This steady state situation remained until autumn 2011 when an increase in both herd and animal incidence reached levels of 7.32% (herd incidence) and 0.66% (animal incidence) in 2012. Post the peak levels a consistent reduction in bTB levels have been documented during 2013 (www.dardni.gov.uk; accessed 16/12/2013). These figures are placed in context in Abernethy et al. (2012) where bTB trends are described for the UK and Republic of Ireland in the period 1995–2010. It describes a stable situation of very low bTB prevalence in Scotland and over most of the period a rising prevalence in England and Wales. The prevalence in the Republic of Ireland declined while Northern Ireland experienced both a rise and fall.

All cattle in Northern Ireland are individually identified and have both lifetime movement and tuberculosis test histories recorded. BTB surveillance of all herds is conducted annually using the Single Intradermal Comparative Tuberculin Test (SICTT) with test frequency increasing when bTB is suspected or proven, or where contiguous herds suffer a breakdown. Upon confirmation of bTB, a herd must enter a cycle of short-interval ('restricted') tests at sixty day intervals and movement restrictions are only lifted after the herd achieves two consecutive clear SICTT tests. When this herd restriction is removed, freedom to trade is restored but a post-outbreak test after six months is required. If the six month post-outbreak test is clear and subject to no other risk factors such as traced or contiguous infection it is placed back onto a yearly test cycle. Details of the Northern Ireland bTB control and eradication programme are given in Abernethy et al. (2006). The aim of this study was to investigate selected factors associated with time from the post-outbreak test to subsequent herd breakdown.

Risk factors associated with bTB herd breakdowns have been extensively researched. These factors include presence of a wildlife source (Biek et al., 2012; Griffin et al., 1996; Ó Máirtin et al., 1998; Eves, 1999; Griffin et al., 2005; Reilly and Courtenay, 2007), presence of bTB in contiguous herds (Griffin et al., 1996; Denny and Wilesmith, 1999; White et al., 2013), environmental survival of *M. bovis* (Scanlon and Quinn, 2000; Ramírez-Villaescusa et al., 2010), previous bTB history (Olea-Popelka et al., 2004; Carrique-Mas et al., 2008; White et al., 2013), movement of animals (Carrique-Mas et al., 2008; Johnston et al., 2005; Ramírez-Villaescusa et al., 2010), severity of bTB breakdown (Olea-Popelka et al., 2004; Wolfe et al., 2010; Karolemeas et al., 2011; Gallagher et al., 2013), herd type (Griffin et al., 1993; Ramírez-Villaescusa et al., 2010; Alvarez et al., 2012), herd size (Griffin et al., 1996; Green and Cornell, 2005; Brooks-Pollock and Keeling, 2009, Mill et al., 2011; Gallagher et al., 2013) and bTB confirmation (Olea-Popelka et al., 2004; Abernethy et al., 2010; Wolfe et al., 2010; Karolemeas et al., 2011). Confirmation plays an important role in the Northern Ireland bTB testing programme. If bTB is confirmed in a herd the shortest possible restricted period is 120 days while with non-confirmation the shortest possible restricted period is 60 days.

2. Materials and methods

2.1. Study design and study population

A retrospective cohort study was undertaken. The study population comprised all herds with a negative post-outbreak test between January 1st 2002 and January 31st 2004. This period was chosen so as to avoid the disruption to normal bTB testing patterns associated with the 2001 foot and mouth epidemic. Herds were recruited to the study on the date they completed the clear post-outbreak test. On completion of a clear post-outbreak test these herds had carried out at least two negative herd tests and disclosed no bTB for a period of at least six months. Thus herds recruited to the study should fall into a subset where bTB internal to the herd is minimised. Exit from the study occurred when the herd suffered a subsequent bTB outbreak event, defined as the first positive SICTT following a negative post-outbreak test or the discovery of a confirmed TB lesion at routine slaughter (LRS). The disclosure date of the positive SICTT or LRS was considered to be the date of the bTB outbreak event, and all variables were related to this time-point. End of follow-up was 15th August 2008 and any herd that had not suffered a herd break down at this point exited the study.

Chronic breakdown herds (herds where bTB disclosure preceded the post-outbreak test by two years or more) or those located contiguous to another bTB infected herd were excluded from the study. Also excluded from the study were those herds with tests initially set as post-outbreak tests and later re-categorised to a higher risk status.

2.2. Data collection and variable definitions

The identification, movement and test history of all individual bovine animals was extracted from the Animal and Public Health Information System (APHIS) run by the Department of Agriculture and Rural Development for Northern Ireland. Variables included breakdown severity, local prevalence of bTB, herd size, herd type, purchase intensity, bTB confirmation, and bTB history of the herd. Breakdown severity was based on the number of standard reactors (0, 1, 2–3, 4–8, >8) as recommended by O'Keefe et al. (1998) with 0 reactors representing the situation where there is detection of a suspect lesion at slaughter and the first herd level test in a breakdown returns no skin reactors. Local prevalence for bTB was defined as the percentage herd prevalence in the local district council area at the date of the post-restriction herd test. Herd size was the number of cattle tested at the first herd level test in the breakdown. Herd type was either non-dairy or dairy with the latter herds being in possession of a milk licence. Purchase intensity was calculated as the number of cattle purchased into a herd after derestriction divided by the period the herd remained disease free or reached the end of follow up. BTB confirmation was based on finding