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A Statistical Evaluation of the Tuberculosis Eradication Programme in Co. Longford

C. McClean¹, D. H. Williams¹, K.H. Christiansen and J.M. Griffin

Introduction

In 1986, a new intensive programme of bovine Tb eradication was put in place in Co. Longford. The programme consisted of: (a) more intensive testing; (b) severe interpretation of the comparative cervical test; (c) movement control; (d) wildlife control; and (e) supervision of tuberculin testing by private veterinary practitioners (PVPs).

Using the extensive database of test results this article provides an initial evaluation of the effect of the programme, and in particular seeks to establish the extent to which the programme has been effective in reducing Tb levels in the county.

In theory, a positive outcome of any bovine Tb-related intervention, that is, a reduction in the levels of Tb, could be the consequence of either (or both) of the following situations:

1. A reduced level of bovine Tb, reflecting improved control of the spread of the disease within herds. 

   As restriction and control measures are introduced to a single herd, the number of reactors within that herd decreases in the long term.

2. A reduced level of bovine Tb, reflecting improved control of the spread of the disease to herds. 

   As restriction and control measures are introduced across herds, the number of herds that break down decreases in the long term.

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A comprehensive system of bovine Tb eradication must consist of both forms of disease control.

Measuring Tb Levels

The number of reactors per thousand animal tests, APT, is commonly used as an measure of Tb levels. It is used to indicate both within-herd and to-herd spread of the disease. However, any measure of rate of positive tests to total number of tests has, by definition, a dynamic relationship with the level of testing intensity (i.e. the total number of tests carried out). A reduction in the intensity of testing may lead to a concentration of testing in high risk and restricted herds, and consequently yield a higher rate of reactors to total tests, although the number of new reactors or infected herds detected has actually decreased. Thus, for example, APT will increase, although there may have been no change in the true level of Tb. Conversely, if the intensity of testing increases, the APT is likely to decrease if the increase in testing includes a greater number of clear herds. This reduction in APT is an artefact of the testing regime and may bear a complex relationship to the true level of Tb.

This is of crucial importance when evaluating the effect of the Longford intervention, given that one of the components of the intervention was an increase in the level of testing. Since APT is sensitive both to real effect and artefact, it cannot be used as the sole measure of the level of Tb.
However, there are advantages to using a measure of the number of positive animal or herd tests to total number of tests. Both intensity of testing and numbers of reactors and infected herds are likely to vary with changes in the size of the population.

An increase in the population of cattle will lead to an increase in the numbers of infected animals or herds, but may not reflect any changes in actual Tb levels. Measures of the number of positive tests per total tests or numbers of positive tests per total population allow for changes in the intensity of testing and population size.

By careful selection of the measures used to estimate the level of Tb it is possible not only to evaluate whether or not a given intervention has been effective, but also what patterns of disease control have taken place.

**Materials and Methods**

Data for this study consist of testing records in Co. Longford from June 1981 to December 1991, involving a total of 3,702 herds. Measures of Tb were calculated on a monthly basis, and time series Intervention Analysis methods Box and Tiao, (1975) were used to identify the changing patterns in the disease, particularly with regard to the intervention of July, 1986.

**Results**

1. **APT**

Using time series analysis it has been established that there was a significant drop in APT (from an estimated level of 8.13 to 5.09, an estimated drop of 3.04 (s.e.=-0.908)), following the intervention (Fig. 1). Further, it can be shown that this drop is related to the increase in testing intensity. However, bearing in mind what has been said in regard to APT and changing levels of testing intensity, it is important to consider other measures to identify any changes in the to-herd and within-herd spread of bovine Tb.

2. **Proportion of Herds in Restriction**

One measure of the spread of the infection to herds is given by the number of herds in restriction as a proportion of the total number of active herds. On a monthly basis, this includes all new herd breakdowns, as well as herds previously restricted. Time series analysis shows that there has been a significant drop in the proportion of herds in restriction (allowing for a transition period immediately after the intervention, when the proportion of herds in restriction increased, as one would expect). The level prior to the intervention is estimated at 5.7%, which decreases linearly (following an initial increase) to an estimated level of 4.5% in 1991 (s.e.d. = 0.03%) (Fig 2). This gives strong indications that the level of herds detected as having Tb has been reduced.

3. **Proportion of New Herd Breakdowns to Total Clear Herd Tests**

Examination of the proportion of new herd breakdowns to total number of clear herd tests provides an alternative measure of the spread of Tb to herds. It will suffer the same distortion as APT, though possibly to a different extent.

Time series analysis shows that there has been a significant reduction in the proportion of new herd breakdowns, to total number of clear herd tests. The estimated level prior to the intervention is 7.9%, which reduces to an estimated 4.2% after the intervention (s.e.d. = 0.66%) (Fig. 3). This provides an indication that there has been a reduction in the spread Tb to clear herds.

4. **APT for restricted herds**

Applying APT to herds in restriction provides a measure of the within-herd spread of Tb for those herds. Like APT as
applied to all herd tests, it will be affected by changes in the level of testing.

Once again, times series analysis shows that there has been a significant drop in the APT for restricted herds, (from an estimated level of 14.04 to 9.51, an estimated drop of 4.53 (s.e. = 1.54)) (Fig. 4), indicating that there has been a reduction in the within-herd spread of the disease in restricted herds.

Conclusions

Time series analysis of APT provides an initial indication of a reduction in Tb levels following the July 1986 intervention. This is confirmed by the analysis of the proportion of herds in restriction, a measure which would be expected to increase following a stricter interpretation of the test and/or an increase in testing intensity. The analyses in 3. and 4. above show that the drop in Tb levels is associated with a reduction in both the to-herd and within-herd spread of the disease.

Reference

Fig 1. Plot of APT (monthly) vs Time

Fig 2. Plot of proportion of herds in restriction (monthly) vs Time
Fig 3. Plot of proportion of new herd breakdowns to clear herd tests (monthly) vs Time

![Graph showing the proportion of new herd breakdowns to clear herd tests over time.]

Fig 4. Plot of APT for restricted herds (monthly) vs Time

![Graph showing the APT for restricted herds over time.]

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