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<td><strong>Authors(s)</strong></td>
<td>Collins, John D.</td>
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<td><strong>Publication date</strong></td>
<td>2000-10</td>
</tr>
<tr>
<td><strong>Series</strong></td>
<td>Selected Papers, 1999</td>
</tr>
<tr>
<td><strong>Publisher</strong></td>
<td>University College Dublin. Centre for Veterinary Epidemiology and Risk Analysis</td>
</tr>
<tr>
<td><strong>Item record/more information</strong></td>
<td><a href="http://hdl.handle.net/10197/8841">http://hdl.handle.net/10197/8841</a></td>
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Tuberculosis in Cattle: A Re-appraisal
J.D. Collins

Introduction
The problems posed by tuberculosis in cattle to-day are different from those faced by M’Fadyean and co-workers 100 years ago and differ from those addressed in the early days of eradication in Ireland and Britain. At that time the impetus for public action came from the realisation that the disease was zoonotic in nature and was a threat both to the farming family and the wider consumer. To-day, while the same hazard still remains, the risk to human health is at a low level in most developed countries. This has shifted the emphasis to the trading implications of the disease for both the beef and dairy industries, with a resulting change in attitude towards the commercial, and away from the health and social, relevance of the disease in cattle. In turn this change in emphasis has adversely affected the perception of the hazard posed by tuberculosis in cattle held by the farming community generally and has led to an deterioration in the appreciation of risk in the minds of all but those farming households who are directly affected by the occurrence of tuberculosis in their own herd.

Impediments to Eradication
National bovine tuberculosis eradication programmes in countries in which the test and slaughter policy had been adopted proved highly effective provided the policy was sustained at an effective level for a relatively lengthy period after the clinical disease had all but disappeared (O’Reilly and Daborn, 1995). Such successes were achieved at a time when herds were smaller, and the intensity and demands of production were lower. Also, in a pre-EEC era the effects of mandatory consequential tuberculin testing was less pronounced. Tuberculosis in cattle was effectively controlled on the basis of clinical examination, judicious risk assessment, the removal of tuberculin reactor cattle followed by disinfection of premises and the implementation of sound hygienic practices followed by a periodic review of herd disease status by means of strategic tuberculin testing and meat plant surveillance. That is, before the involvement of a wildlife reservoir of *Mycobacterium bovis* appeared. The three countries currently experiencing a resurgence of tuberculosis in their national cattle herds, viz. Ireland, Southwest Britain and New Zealand, each have in common an infected wildlife population of considerable dimensions. The persistence of an infected wildlife population in close contact with the target species of the disease eradication programme, namely cattle, and the failure fully to implement available means for the separation of these two species represents a serious barrier to the ultimate eradication of bovine tuberculosis and compromises the likelihood of success unless this reservoir is removed or the problem is solved by means of a vaccine for use in wildlife, or by some other means (Report, 1995).

The consequences of removal of an infected wildlife reservoir, as assessed by changes in the rate of tuberculin reactor disclosure rates, as a proxy for tuberculosis, in the exposed cattle population, has been the subject of investigation for a considerable time in New Zealand (Tweedle and Livingstone, 1994), Ireland (Dolan, 1993), and in Great Britain (Nolan and Wilesmith, 1994). The Irish experience to-date has resulted in a significant decline both in tuberculin reactor rates and herd restrictions due to tuberculosis in herds in areas where badger removals has been conducted under strict licensing conditions after a period of at least three years (O’Mairtin et al., 1998). Such findings are fully
compatible with a basic requirement of disease eradication, namely, that the eradication of a pathogen requires that there is a single host species with no external reservoir species. To ignore this impediment is tantamount to dismissing one of the basic tenets of eradication.

There are other impediments to eradication in these countries and elsewhere, not least of which are the limitations of the tuberculin test in identifying cattle infected with *M. bovis* (Monaghan et al., 1994), and the failure to deal effectively with the environmental sources of *M. bovis*, such as contaminated slurries on infected holdings.

**Diagnosis**
The fact that some cattle infected with *M. bovis* contaminate their environment and may be a persistent source of the tubercle bacillus for other cattle for a considerable period without being detected is central to the problem of eradication. A feature of the natural history of tuberculosis in an exposed cattle population, as is the case in the human patient, is the sequential development of cell mediated immunity (CMI) and delayed-type hypersensitivity (DTH), as shown in Figure 1 and as originally described by Dannenberg and Rook (1994). This is reflected in the animal's response to diagnostic tests such as the tuberculin test and cytokine assays (Monaghan et al., 1997).

![Figure 1. Mycobacterium bovis. Sequence of natural infection in cattle.](image)

Cytokine assays for interferon-\(\gamma\) are now available commercially, while other procedures such as interleukin 2 (IL-2) assay, anamnestic ELISA and lymphocyte transformation analyses are now feasible. The usefulness of these procedures, as adjuncts to the tuberculin test, has already been demonstrated under both field and experimental conditions (Collins, 2000). Their strategic use, as supplementary tests to skin testing, may soon be employed in Member States of the European Community to enable the detection of the maximum number of infected and diseased animals in chronically infected herds, in which anergic but infected cattle are a persistent but unrecognised source of *M. bovis* for the herd (O’Keeffe and O’Driscoll, 1997).
Risk Assessment

When addressing eradication, it is important to appreciate that there are two distinct cattle populations to be considered, namely, those that are deemed to be free of *M. bovis* and those that are so infected. In the former case, provided contact with tuberculous wildlife is avoided, and the security of the herd in terms of its contiguity with nearby holdings and the disease-free status of animal purchases are reliably established, then the annual herd tuberculin test as applied under current EU rules is adequate for surveillance purposes and for eventual eradication, as has already been the experience in the past. In the case of the infected populations, under similar circumstances, the tuberculin test can again be relied upon to effectively identify infected herds as a unit, in the context of the annual herd tuberculin test. In both cases the procedures mentioned are supplemented by meat plant surveillance with the result that any further outbreaks can be expected to be effectively controlled by what can now be termed 'the traditional procedures', as described above. That is, provided all sources of infection have been removed and *M. bovis* does not persist on the farm. The latter may be the case if an anergic but infectious animal, or an infected but as yet tuberculin-unresponsive animal, recently purchased from a currently infected herd, is present in the herd. Alternatively, repeated exposure to infected cattle on contiguous holdings through direct or indirect contact may result in the re-introduction of infection (O’Keeffe and O’Driscoll, 1997). As already mentioned, infection may also be introduced into the herd as a result of contact with an infectious wildlife source such as the tuberculous badger or deer, in which case the security provided by the national bovine tuberculosis eradication programme is compromised, as the tuberculin test can only provide retrospective evidence of prior exposure to and infection with *M. bovis* from these, and other, extrinsic sources.

Conclusion

Risk management is now feasible on a scientific basis to a greater extent than ever before. This enables a rational approach to be made to risk communication, an aspect of disease control which, in the case of tuberculosis in cattle, has been sadly lacking. The judicious use of the new technologies of information and geographical technology, of cytokine and other *in-vitro* assays, in combination with the tried and tested *in vivo* assessment using the tuberculin test and clinical evaluation, and supported by the strategic and humane removal of infected wildlife reservoirs, offer the greatest prospect for success. Otherwise, failure to adopt this approach can only lead to a continuation of present dissatisfaction with the slow rate of progress and the continued persistence of this zoonotic disease in food animals, on the part of all concerned. Against the background of world trade and increasing concern on the part of consumers regarding the safety of the food supply, the eradication of tuberculosis from the Irish national cattle herd now requires to be more effectively addressed. This can be accomplished by the strategic application of modern science, combined with sound animal husbandry practices and the sustained co-operation of all parties.
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