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THE EPIDEMIOLOGY OF MYCOBACTERIUM BOVIS IN CANADIAN CATTLE BETWEEN 1985-1994

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L'objectif de ce projet était d'étudier l'épidémiologie de la tuberculose dans le cheptel bovin et cervin canadien dans la période 1985-1994. Les données individuelles et de troupeaux ont été collectées à partir des 9 élevages ayant été affectés par la tuberculose pendant cette période, et ont été analysées. Les troupeaux et animaux positifs ont donné une culture positive vis-à-vis de M. bovis. Les troupeaux réactifs ont été définis comme ayant eu un ou plusieurs animaux positifs ou suspects à un examen cervical, mi-cervical, pathologique ou histopathologique vis-à-vis de la tuberculose. Les animaux réactifs ont été positifs ou suspects à un de ces tests. Les facteurs de risque de la propagation de Mycobacterium bovis entre troupeaux ont été identifiés en utilisant un modèle de régression logistique. La taille du troupeau, ainsi que la raison pour laquelle les tests initiaux ont été réalisés étaient des facteurs de risque significatifs. Les troupeaux, qui ont recu des animaux en provenance de troupeaux positifs ou réactifs, ont été testés car les propriétaires pensaient que les animaux avaient été en contact avec des animaux infectés, avaient paturé ou avaient été séparés seulement d'une clôture avec des animaux positifs ou suspects, ou étaient les troupeaux d'origine des cas positifs ou réactifs. Ces élevages avaient significativement plus de chance d'être des troupeaux positifs ou réactifs que ceux testés parce qu'ils étaient dans le périmètre d'un élevage infecté. L'odds ratio pour ces élevages, comparés aux élevages dans le périmètre, était respectivement de 57,8, 46,1, 31,8 et 14,9. Une analyse de régression binomiale négative a été utilisée pour identifier les facteurs de risque pour un animal d'être positif ou réactif au sein d'un élevage positif ou réactif. Les animaux entre 12 et 24 mois d'âge et ceux de plus de 24 mois d'âge avaient un risque plus élevé d'être des animaux positifs ou réactifs que ceux ayant moins de 12 mois d'âge. Les ratios des taux d'incidence pour les groupes d'animaux âgés sur celui des plus jeunes étaient respectivement de 7,6 et 10,4.

INTRODUCTION

Microorganisms of the genus *Mycobacterium* cause tuberculosis in many animal species including humans. Generally, *Mycobacterium bovis* (*M.bovis*) infects cattle and cervidae, but it has the potential to infect virtually all species of mammals including humans, domestic animals and wildlife species (1,2). Currently in many developed countries, like Canada, its major impact is as a barrier to both domestic and international trade.

In 1923 the Canadian tuberculosis control and eradication program was established. By 1961, through tuberculin testing and slaughter, a prevalence of 0.11% was reached. In 1978 the main program thrust changed from testing and slaughter to slaughter surveillance with depopulation of infected herds (3). A program for the eradication of bovine tuberculosis in captive ungulates was implemented in 1989 (3).

MATERIALS AND METHODS

The herd and individual animal data for the study were collected from tuberculosis outbreak files and records which were located at the Regional or District offices of Agriculture and Agrifood Canada. In all but one of the nine tuberculosis outbreaks, the index animals were identified either at routine slaughter surveillance or at post mortem examination. One herd was identified through routine skin testing at the owner's request. All of the following herd categories were identified and tested for tuberculosis as part of an investigation of a positive/reactor herd: source herds (tracebacks); herds which received animals from a positive/reactor herd (traceouts); herds which had common pasture or fenceline contact with an infected herd (contact); and herds within a certain radius of the positive/reactor herd or were tested as part of an area test (perimeter).

Herd data were extracted from every farm that was identified in the outbreak and for which there were test results available. Individual animal data were collected only from farms which were classified as positive or "reactor" farms. A positive farm or animal was one where *M.bovis* had been cultured. A reactor animal was one which had a positive or suspicious reaction to any test other than the caudal fold test (ie. mid-cervical tuberculin test, a comparative cervical test, or gross or histopathologic examination). A reactor farm was one which had one or more reactor animals.

The data were extracted from the files, entered on data entry forms and then transferred to a database program (Microsoft Access). Data were analysed and tabulated using a computer statistical program (Stata). Table I lists the variables from the herd data which had an unconditional association with the outcome variable, herd classification (positive/reactor or negative). Multiple logistic regression was used to investigate the relationship between these herd factors and the risk of being classified positive/reactor. The variables OUTBREAK and BREED were considered confounders and were thus forced into all models.

The variables from the individual animal data which had an unconditional association with the outcome variable, reactor status of the animal (positive/reactor or negative) were age of the animal, breed, and outbreak. The relationship between these factors and the risk of being classified as positive/reactor were evaluated using negative binomial regression.

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Table I
The names , descriptions, and categories of variables used in the evaluation of risk factors affecting between herd transmission of tuberculosis in Canadian cattle and cervid tuberculosis outbreaks between 1985 and 1994

VARIABLE	DESCRIPTION	CLASS.	NEGATIVE HERDS NUMBER (%)	POSITIVE HERDS NUMBER (%) (a)
HERD CLASSIFICATION	Herd Status	0 = Neg	876	
		1 = Pos/Reac		119
OUTBREAK	Outbreak Number	PEI Cattle	162 (99.4%)	1 (0.6%)
		Que Cattle	194 (90.2%)	21 (9.8%)
		Ont Cervid	62 (88.6%)	8 (11.4%)
		Man Cattle	154 (87.5%)	22 (12.5%)
		Alb/Sask Cer	109 (66.1%)	56 (33.9%)
		Alb Cattle	89 (93.7%)	6 (6.3%)
		Que Cervid	28 (84.5%)	5 (15.5%)
			p <0.001	
BREED	Breed/Species that is the predominant animal involved in the outbreak	Dairy	151 (95.6%)	7 (4.4%)
		Beef	477 (93.3%)	34 (6.7%)
		Cervid	110 (66.7%)	55 (33.3%)
		Bison	3 (42.9%)	4 (57.1%)
		Other	18 (69.2%)	8 (30.8%)
			p < 0.001	
HERDSIZE	Total animals on the farm	1=0-15	167 (95.4%)	8 (4.6%)
		2=16-35	142 (87.7%)	20 (12.3%)
		3=36-80	216 (84%)	41 (16%)
		4= >80	209 (83.3%)	42 (16.7%)
			p = 0.001	
INVESTIGATION CODE	Reason for the initiation of the investigation	Perimeter	430 (99.5%)	2 (0.5%)
		Traceback	63 (88.7%)	8 (11.3%)
		Traceout	201 (72%)	78 (28%)
		Contact	111 (86.7%)	17 (13.3%)
		Other	11 (91.7%)	1 (8.3%)
			p < 0.001	

a. The index herds have been eliminated from the data for this analysis.

RESULTS

A description of the statistically significant risk factors in the logistic regression for analysis of between herd spread of *M.bovis* are in Table II. Breed was not a statistically significant variable and was so highly correlated with outbreak that it was impossible to separate the influence of the outbreak variable from the breed variable. Increasing herd size and all investigation codes compared to perimeter testing were factors which contributed to a herd having an increased risk of being a tuberculosis positive/reactor herd.

Table II
Results of the logistic regression analysis of herd classification for tuberculosis in Canadian cattle and cervid tuberculosis outbreaks between 1985-1994

Variable	Odds Ratio	SE(OR)	p-value	95% CI(OR)
Investigation Code				
Perimeter	1	-	0.000	-
Traceback	14.94	13.42		2.57 - 86.87
Traceout	57.84	48.76		11.08 - 301.87
Contact	31.80	27.71		5.76 - 175.47
Other	46.12	66.16		2.77 - 767.15
Herdsize				
0 - 15	1	-	0.000	-
16 - 35	2.94	1.68		0.96 - 9.03
36 - 80	5.76	3.20		1.94 - 17.09
> 80	9.32	5.16		3.15 - 27.58

The results of the negative binomial regression indicate that increasing age of the animal was a significant risk factor for having a positive/reactor status. The incidence rate ratio for animals 12-24 months old and greater than 24 months old compared to animals less than 12 month old was 7.65 and 10.42 respectively (p<0.01).

DISCUSSION

Tuberculosis is a disease which is spread primarily through aerosol transmission of droplet nuclei (1,4,5). Ingestion is a possible route of infection which is more important in deer than in cattle but the infective dose has been shown to be considerably larger than for the aerosol route (1,5). This study showed that traceout, traceback and contact herds were at much greater risk of being positive/reactor herds, compared to perimeter tested herds. It is interesting to note that a farm that was tested because it received animals from a positive/reactor farm or co-pastured or had fence line contact with one, had a greater risk of containing positive/reactor animals than a farm that was tested because a reactor/positive animal may have originated there. This makes intuitive sense as traceback investigations look at every farm that provided animals to a positive/reactor farm. Considering the low prevalence of tuberculosis it is unlikely that more than one farm was the source or positive/reactor animals. The greatest proportion of herds tested in outbreak situations in Canada were perimeter herds (.31). Thus a large proportion of the outbreak investigation resources were used on the lowest risk group. There were 123 *M.bovis* infected herds found in the United States during the period 1982-1993 (6) . Five (4%) of these were detected through skin testing. The remainder, 118 (96%) were detected at slaughter and through follow-up epidemiological procedures. A case control study in Ireland showed that herds which purchased animals in a six month period after being derestricted following an outbreak, were twice as likely to fail the six month check test than herds which did not purchase animals (the status of the source herd was not stated) (7). There are numerous reports in the literature concerning transmission of tuberculosis to previously free herds and countries via purchase of infected animals (8).

Herd size was a significant risk factor in the study for between herd spread of tuberculosis. In a study in the Republic of Ireland, increasing herd size was also found to be a risk factor for being a positive tuberculosis herd (9). Larger herds may be associated with management practices that increase the risk of transmission of the organism such as greater movement of animals. The density of animals may be higher in larger herds and thus the probability of transmission may be greater because of more opportunities for interactions between infected and susceptible animals. The more animals (in absolute numbers) that are tested the more likely it is to find one that is at a stage of the disease that is detectable by a diagnostic test.

Older animals were more likely to be identified as reactor positive animals than younger animals. Older animals have had a longer period to become infected with the organism and to mount an immune response. It should be noted however that young cervids may be heavily infected yet remain negative to a tuberculin test (10).

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