Tuberculous Lesions in Free-Ranging White-Tailed Deer in Michigan

Authors: Daniel J. O'Brien, Scott D. Fitzgerald, Timothy J. Lyon, Kelly L. Butler, Jean S. Fierke, et. al.

Source: Journal of Wildlife Diseases, 37(3) : 608-613

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-37.3.608

SHORT COMMUNICATIONS

Journal of Wildlife Diseases, 37(3), 2001, pp. 608–613

Tuberculous Lesions in Free-Ranging White-Tailed Deer in Michigan

Daniel J. O'Brien,[1,4] Scott D. Fitzgerald,[2] Timothy J. Lyon,[1] Kelly L. Butler,[2] Jean S. Fierke,[1] Kathy R. Clarke,[2] Stephen M. Schmitt,[1] Thomas M. Cooley,[1] and Dale E. Berry[3] [1] Rose Lake Wildlife Disease Laboratory, Michigan Department of Natural Resources, 8562 E. Stoll Rd., East Lansing, Michigan 48823, USA; [2] Animal Health Diagnostic Laboratory and Department of Pathology, College of Veterinary Medicine, Michigan State University, East Lansing, Michigan 48824, USA; [3] Community Health Laboratory, Michigan Department of Community Health, 3350 N. Martin Luther King, Jr., Blvd., Lansing, Michigan 48909; [4] Corresponding author (e-mail: obriend@state.mi.us).

ABSTRACT: Descriptions of the anatomical distribution of *Mycobacterium bovis* gross lesions in large samples of white-tailed deer (*Odocoileus virginianus*) are lacking in the scientific literature. This report describes the distribution of gross lesions in the 58 white-tailed deer that cultured positive for *M. bovis* among the 19,500 submitted for tuberculosis testing in Michigan (USA) in 1999. For the vast majority (19,348) of those tested, only the head was submitted; for others, only extracranial tissues (33) or both the head and extracranial tissues (119) were available. Among those deer that cultured positive, cranial gross lesions were noted most frequently in the medial retropharyngeal lymph nodes, although solitary, unilateral parotid lymph node lesions also were found. Extracranial lesions occurred most commonly in the thorax. The distribution of lesions largely agreed with the few existing case reports of the *M. bovis* in white-tailed deer, although gross lesions were also found in sites apparently not previously reported in this species (liver, spleen, rumen, mammary gland). Some practical issues that may assist future surveillance and public education efforts are also discussed.

Key words: Bovine tuberculosis, *Mycobacterium bovis,* white-tailed deer, *Odocoileus virginianus,* disease surveillance.

In 1994, a disseminated case of bovine tuberculosis (*Mycobacterium bovis*) was discovered in a hunter harvested white-tailed deer (*Odocoileus virginianus*) in northeastern lower Michigan (USA; Schmitt et al., 1997). The disease focus subsequently defined around that index case is thought to constitute the first self-sustaining *M. bovis* outbreak in free-ranging North American cervids. Recognizing the potential economic risks to livestock producers from spillover infections (Robinson et al., 1989; Lugton et al., 1998) and public health risks from zoonotic transmission (Fanning and Edwards, 1991), disease control officials from the Michigan Departments of Natural Resources (MDNR), Agriculture (MDA) and Community Health (MDCH), Michigan State University's (MSU) Animal Health Diagnostic Laboratory (AHDL) and the United States Department of Agriculture (USDA) initiated an extensive cooperative surveillance and eradication program encompassing domestic stock, wild cervids, and mammalian scavengers (Bruning-Fann et al., 1998).

Studies of the anatomical distribution of gross lesions of *M. bovis* have been published for sufficiently large samples of red deer (*Cervus elaphus*; Stuart, 1988), elk (*Cervus canadensis*; Rohonczy et al., 1996), and fallow deer (*Dama dama*; Towar et al., 1965). In contrast, such descriptions for white-tailed deer have been more anecdotal, reporting observations made on only one (LeDune, 1937; Friend et al., 1963) or two (Levine, 1934) animals, on deer for which viscera were unavailable for examination (Belli, 1962), or for animals from which *M. bovis* was never isolated (Ferris et al., 1961). Other than a previous communication from this laboratory (Schmitt et al., 1997), no accounts apparently exist which describe the anatomical distribution of culture-positive *M. bovis* lesions for a large sample of white-tailed deer necropsies. We report here an update based on a larger sample, with the objective of making comparisons with previous

case reports in this species, between white-tailed deer and other cervids, and of making practical observations which might improve the effectiveness of disease monitoring.

As part of ongoing surveillance, licensed hunters were asked to voluntarily contribute the heads of deer harvested in 1999 for tuberculosis testing. In addition, carcasses bearing lesions considered suspicious by either hunters or MDNR deer check station personnel were collected. A smaller number of deer found dead in 1999 were also obtained by MDNR and MSU personnel. The diagnostic procedures used have been described in detail elsewhere (Schmitt et al., 1997), with the only procedural variation being that in 1999, animals not having visibly detected gross lesions were not subjected to diagnostic tests beyond necropsy. Initial examination of submitted samples occurred at MDNR's Rose Lake Wildlife Disease Laboratory (RLWDL; East Lansing, Michigan, USA), with necropsies carried out subsequently at MSU-AHDL by MSU, MDNR, and USDA personnel. The distribution of lesions was extracted from RLWDL examination records, and pathology reports generated by MSU-AHDL. Samples of tissues with gross lesions were subjected to histopathological exam by AHDL, and shipped to the USDA's National Veterinary Services Laboratories (NVSL) and the MDCH mycobacteriology lab for culture and isolation.

Two overlapping, but distinct, groups of tissue samples are enumerated and described here, in succession. The first is comprised of the various sets of tissues from individual deer submitted to RLWDL for bovine tuberculosis testing. The second is a subset of the first, comprised only of tissues from those deer that cultured positive for *M. bovis.* It should be noted that in this latter group, one or more than one distinct anatomical site may have borne gross tuberculous lesions in each animal. Thus, though 58 animals cultured *M. bovis* positive in all, more than 58 individual tissues are reported as having displayed *M. bovis* positive lesions. Some animals bore lesions only in a single lymph node in the head. Others cultured positive from multiple extracranial tissues only. Still others carried both cranial and extracranial lesions of bovine tuberculosis.

An anatomical breakdown of all white-tailed deer tissues submitted to RLWDL for tuberculosis testing from across Michigan in 1999 is presented in Table 1. The heads of 19,467 deer were submitted. One hundred nineteen of those were submitted with tissues in addition to the head. Tissues from a further 33 animals were submitted without the head. Lesions from 58 deer cultured positive for *M. bovis.* One of these animals was road killed, while another, found dead, had been radiocollared previously by researchers at MSU. The remaining 56 tuberculous deer were taken by hunters. Thirty-two (55%) of the deer culturing positive had only cranial lesions, though the proportion positive among deer for which only the head was submitted was small (0.2%). Of the 33 deer for which only extracranial tissues were submitted, five (15%) cultured positive, comprising 9% of all deer culturing positive. For deer from which both the head and extracranial tissues were submitted, 21 of 119 (18%) cultured positive, which was 36% of the total culture positives.

With respect to the anatomical distribution of gross lesions in the subset of 58 *M. bovis* positive deer, 43 of 58 (74%) bore lesions in at least one of the three pairs of cranial lymph nodes examined. Forty-one of the 43 deer with cranial lymph node lesions had them in the medial retropharyngeal lymph nodes. Forty-four percent (18/41) of the medial retropharyngeal lesions were bilateral, 37% (15/41) were left only, and 19% (8/41) were right only. Notably, two positive deer had unilateral lesions (one left-sided, the other right-sided) in the parotid lymph nodes, unaccompanied by gross lesions at any other anatomical site.

Twenty-six of 58 positive animals (45%)

TABLE 1. Frequency of tissue submissions from individual white-tailed deer to Rose Lake Wildlife Disease Laboratory (Michigan, USA) for *Mycobacterium bovis* testing, in 1999.

Tissues submitted	*M. bovis* culture status		Total
	Negative (%)	Positive (%)	
Carcass (entire)	33 (92)	3 (8)	36
Carcass (eviscerated)	7 (50)	7 (50)	14
Carcass (eviscerated), heart, liver, lung	0 (0)	1 (100)	1
Carcass (eviscerated), heart, lung	1 (33)	2 (67)	3
Carcass (eviscerated), liver	0 (0)	1 (100)	1
Carcass (eviscerated), liver, lung	3 (100)	0 (0)	3
Carcass (eviscerated), lung	2 (33)	4 (67)	6
Carcass (eviscerated, headless), intestine, liver, lung	0 (0)	1 (100)	1
Carcass (partial)	3 (100)	0 (0)	3
Diaphragm, heart, liver, lung	1 (100)	0 (0)	1
Extracranial, unknown	2 (100)	0 (0)	2
Head only	19,316 (99.8)	32 (0.2)	19,348
Head, fat, skeletal muscle	2 (100)	0 (0)	2
Head, heart, liver, lung	1 (100)	0 (0)	1
Head, heart, lung	5 (100)	0 (0)	5
Head, heart, ribcage	1 (100)	0 (0)	1
Head, intestine, liver, lung, spleen	1 (100)	0 (0)	1
Head, liver	5 (100)	0 (0)	5
Head, liver, lung, spleen	0 (0)	1 (100)	1
Head, liver, spleen	2 (100)	0 (0)	2
Head, lung	17 (100)	0 (0)	17
Head, lung, ribcage	1 (100)	0 (0)	1
Head, lymph node	2 (100)	0 (0)	2
Head, mammary gland	1 (100)	0 (0)	1
Head, ribcage	5 (71)	2 (29)	7
Head, rumen, spleen	1 (100)	0 (0)	1
Head, skeletal muscle	4 (100)	0 (0)	4
Head, trachea	1 (100)	0 (0)	1
Heart, liver, lung	1 (100)	0 (0)	1
Heart, liver, lung, rumen, spleen	0 (0)	1 (100)	1
Heart, lung	1 (100)	0 (0)	1
Liver, lung	2 (50)	2 (50)	4
Lung	11 (92)	1 (8)	12
Lung, skin	1 (100)	0 (0)	1
Lymph node	1 (100)	0 (0)	1
Ribcage	4 (100)	0 (0)	4
Ribcage, skeletal muscle	1 (100)	0 (0)	1
Skeletal muscle	3 (100)	0 (0)	3
Total	19,442 (99.7)	58 (0.3)	19,500

bore lesions of *M. bovis* in some tissue outside the head. Among the subset of 26 tuberculous animals bearing extracranial lesions, there were, collectively, 20 (costal) pleural, 14 pulmonary, five diaphragmatic, four hepatic, two omental, two pericardial, one mammary, one mesenteric, one rumenal and one splenic gross lesion(s) that cultured positive for *M. bovis.* Fifteen of 26 did not show gross evidence of cranial lesions concurrently.

In all 11 *M. bovis* positive deer where gross tuberculous lesions appeared in both cranial and extracranial tissues concurrently, the cranial lesions were in the medial retropharyngeal lymph nodes. Eight of these deer had lesions in the costal pleura, four displayed lung lesions, and one deer

each showed tuberculous lesions of the diaphragm, liver, pericardium, and spleen.

The gross and microscopic characteristics of *M. bovis* lesions observed in Michigan deer from the current outbreak have been described previously (Schmitt et al., 1997). Briefly, typical gross lesions were mild to marked lymph node enlargement, and on section, lymph nodes contained one or more foci of purulent material, surrounded by variable amounts of pale inflammatory tissue. These caseogranulomas were sometimes deeply embedded within the lymph node parenchyma, while at other times they formed multiple raised nodules on the lymph node surface resembling a cluster of grapes. Microscopically, the central purulent material was composed of partially mineralized necrotic debris. Surrounding the debris was a layer of inflammatory cells composed of lymphocytes, macrophages, and frequently Langhans' giant cells, and fibrous connective tissue. Acid fast bacilli were usually present in low numbers, most commonly within the cytoplasm of macrophages and giant cells, or occasionally free within the central debris. Lesions in tissues other than lymph node, typically caseogranulomas as well, were similar in character.

The distribution of tuberculosis lesions noted in this study largely agrees with previous case reports of *M. bovis* in white-tailed deer. Three of five previous reports note pleural lesions (Levine, 1934; Belli, 1962; Friend et al., 1963), while all but Belli (1962) and LeDune (1937) (who do not describe any lesions) also report lung lesions. Diaphragmatic and mediastinal or pericardial abscessation (Fig. 1) was reported in two cases, by Levine (1934) and Friend et al. (1963). Mesenteric lesions were noted only by Levine (1934). Lesions in the liver (Fig. 2), spleen, rumen and mammary gland have apparently not been previously reported in white-tailed deer.

By comparison to other cervids, three extensive reports of post mortem findings in red deer and elk (Stuart, 1988; Whiting and Tessaro, 1994; Rohonczy et al., 1996) and another in fallow deer (Towar et al., 1965), as well as case reports in spotted and hog deer (*Axis porcinus*; Basak et al., 1975), axis deer (*Axis axis*; Sawa et al., 1974), and roe deer (*Capreolus capreolus*; Gunning, 1985) also note gross lesions as occurring predominantly in the lungs, pleura, diaphragm, and lymph nodes, particularly the retropharyngeal nodes. Cranial lymph node lesions of *M. bovis* have also been documented in a mule deer (*Odocoileus hemionus*; Rhyan et al., 1995).

FIGURE 1. Pericardial sac surrounding the heart of a free-ranging Michigan white-tailed deer with bovine tuberculosis. Numerous 0.5–2.5 cm diameter raised firm granulomas were restricted to the pericardium, with no involvement of the epicardium.

Similar to our findings in white-tailed deer, Towar and colleagues recorded gross lesions on the serosal surfaces of the spleen and mesentery in fallow deer, but also on the ovaries and uterus, sites not noted thus far in the current Michigan outbreak. Splenic lesions have also been

FIGURE 2. Carcass of a tuberculous free-ranging Michigan white-tailed deer with viscera exposed. Hundreds of 0.3–1.0 cm diameter granulomas covered the lungs, pleura, liver, omentum and mesentery.

found in roe deer (Gunning, 1985). While we did not note renal lesions, miliary tuberculosis of the kidney has been documented in red deer (Stuart, 1988). Mammary lesions have been reported in a review (Clifton-Hadley and Wilesmith, 1991) as occurring rarely in cervids, and are described in captive elk in a single original report (Rhyan et al., 1992). The finding of disseminated tuberculosis in the udder in this study establishes the plausibility of doe to fawn transmission via milk, but this solitary case among the large number of animals examined also suggests that such transmission is probably uncommon.

These results also raise some practical issues that may assist future surveillance and public education efforts. First, the finding of unilateral parotid lymph node lesions emphasizes the necessity of routine and consistent bilateral examination of the cranial nodes. Except where necessitated by logistical constraints, unilateral examination is insufficient. In both cases in this study, the deer carrying unilateral parotid lesions bore no others. Moreover, one was harvested from a county where *M. bovis* had not been previously identified in deer, a county well outside of the quarantine region defined to restrict movement of livestock. Finding such "outlier" deer has proven to have formidable regulatory and management implications, since they are evidence of *M. bovis* in areas previously thought to be disease free. A unilateral examination of this deer might have missed the lesion, the presence of the disease thus going unrecognized. Second, the fact that only 5 of 33 deer for which only extracranial tissues, and 21 of 119 deer for which both cranial and extracranial tissues were submitted by hunters as being suspicious, cultured positive for *M. bovis*, suggests limited ability of hunters to definitively identify positive animals by sight alone. Some interest groups have charged that hunters harvesting deer grossly infected with TB do not submit them for TB testing, hoping to avoid identification of their region as infected, and thus leading to underestimation of the geographic distribution of the disease. These results suggest such scenarios may be improbable.

The authors gratefully acknowledge the assistance of staff from MDNR, USDA-APHIS, MSU and MDCH for their roles in surveillance efforts, with particular thanks to M. K. Raths and P. D. Friedrich.

LITERATURE CITED

BASAK, D. K., A. CHATTERJEE, M. K. NEOGI, AND D. P. SAMANTA. 1975. Tuberculosis in captive deer. Indian Journal of Animal Health 14: 135–137.

BELLI, L. B. 1962. Bovine tuberculosis in a white-tailed deer (*Odocoileus virginianus*). Canadian Veterinary Journal 3: 356–358.

BRUNING-FANN, C. S., S. M. SCHMITT, S. D. FITZGERALD, J. B. PAYEUR, D. L. WHIPPLE, T. M. COOLEY, T. CARLSON, AND P. FRIEDRICH. 1998. *Mycobacterium bovis* in coyotes from Michigan. Journal of Wildlife Diseases 34: 632–636.

CLIFTON-HADLEY, R. S., AND J. W. WILESMITH. 1991. Tuberculosis in deer: a review. The Veterinary Record 129: 5–12.

FANNING, A., AND S. EDWARDS. 1991. *Mycobacterium bovis* infection in human beings in contact with elk (*Cervus elaphus*) in Alberta, Canada. The Lancet 338: 1253–1255.

FERRIS, D. H., P. D. BEAMER, J. O. ALBERTS, AND D. TRAINER. 1961. Tuberculosis in transported deer: A case report. Journal of the American Veterinary Medical Association 138: 326–328.

FRIEND, M., E. T. KROLL, AND H. GRUFT. 1963. Tuberculosis in a wild white-tailed deer. New York Fish and Game Journal 10: 118–123.

GUNNING, R. F. 1985. Bovine tuberculosis in roe deer. The Veterinary Record 116: 300–301.

LEDUNE, E. K. 1937. Post mortem findings in deer. *In* State of New York, Conservation Department, Twenty-sixth Annual Report to the Legislature for the Year 1936. Legislative Document Number 38, p. 314. J. B. Lyon Company, Albany, 466 pp.

LEVINE, P. P. 1934. A report on tuberculosis in wild deer (*Odocoileus Virginianus*). Cornell Veterinarian 24: 264–266.

LUGTON, I., P. R. WILSON, R. S. MORRIS, AND G. NUGENT. 1998. Epidemiology and pathogenesis of *Mycobacterium bovis* infection in red deer (*Cervus elaphus*) in New Zealand. New Zealand Veterinary Journal 46: 147–156.

RHYAN, J., K. AUNE, B. HOOD, R. CLARKE, J. PAYEUR, J. JARNAGIN, AND L. STACKHOUSE. 1995. Bovine tuberculosis in a free-ranging mule deer (*Odocoileus hemionus*) from Montana. Journal of Wildlife Disease 31: 432–435.

RHYAN, J. C., D. A. SAARI, E. S. WILLIAMS, M. W. MILLER, A. J. DAVIS, AND A. J. WILSON. 1992. Gross and microscopic lesions of naturally occurring tuberculosis in a captive herd of wapiti (*Cervus elaphus nelsoni*) in Colorado. Journal of Veterinary Diagnostic Investigation 4: 428–433.

ROBINSON, R. C., P. H. PHILLIPS, G. STEVENS, AND P. A. STORM. 1989. An outbreak of *Mycobacterium bovis* infection in fallow deer (*Dama dama*). Australian Veterinary Journal 66: 195–197.

ROHONCZY, E. B., A. V. BALACHANDRAN, T. W. DUKES, J. B. PAYEUR, J. C. RHYAN, D. A. SAARI, T. L. WHITING, S. H. WILSON, AND J. L. JARNAGIN. 1996. A comparison of gross pathology, histopathology, and mycobacterial culture for the diagnosis of tuberculosis in elk (*Cervus elaphus*). Canadian Journal of Veterinary Research 60: 108–114.

SAWA, T. R., C. O. THOEN, AND W. T. NAGAO. 1974. *Mycobacterium bovis* infection in wild axis deer in Hawaii. Journal of the American Veterinary Medical Association 165: 998–999.

SCHMITT, S. M., S. D. FITZGERALD, T. M. COOLEY, C. S. BRUNING-FANN, L. SULLIVAN, D. BERRY, T. CARLSON, R. B. MINNIS, J. B. PAYEUR, AND J. SIKARSKIE. 1997. Bovine tuberculosis in free-ranging white-tailed deer from Michigan. Journal of Wildlife Diseases 33: 749–758.

STUART, F. A. 1988. Tuberculosis in farmed red deer (*Cervus elaphus*). *In* The management and health of farmed deer: A seminar in the CEC programme of coordination of research in animal husbandry, H. W. Reid (ed.). Kluwer Academic Publishers, Dordrecht, Germany, pp. 101–111.

TOWAR, D. R., R. M. SCOTT, AND L. S. GOYINGS. 1965. Tuberculosis in a captive deer herd. American Journal of Veterinary Research 26: 339–346.

WHITING, T. L., AND S. V. TESSARO. 1994. An abattoir study of tuberculosis in a herd of farmed elk. Canadian Veterinary Journal 35: 497–501.

Received for publication 23 May 2000.