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Source: Journal of Wildlife Diseases, 35(4) : 735-740

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-35.4.735

Journal of Wildlife Diseases, 35(4), 1999, pp. 735–740

ANTIBIOTIC TREATMENT AND POST-HANDLING SURVIVAL OF REINDEER CALVES IN ALASKA

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ABSTRACT: Free ranging reindeer (*Rangifer tarandus tarandus*) are driven into corral systems and handled each summer on the Seward Peninsula (Alaska, USA). During June and July of 1995–96 reindeer calves were inspected for injury, handled, weighed, and randomly treated with long-acting oxytetracycline. Calves that returned to subsequent handlings within the same year, received treatment only if they had been treated during their first handling. The effects of prophylactic antibiotic treatment and other factors, including weight, handling related injury, and sex on post-handling survival in reindeer calves were evaluated. Return rates of yearlings in 1996 and 1997 were analyzed using logistic regression. Weight change of calves between handlings was examined using a general linear model. Calf weight and handling injury were the only factors that significantly affected calf survival. No factor had a significant effect on calf weight change between handlings. Apparently, long-acting oxytetracycline was not an effective prophylactic treatment for this capture operation. The benefits of prophylactic antibiotic treatment have not been quantified and further studies of the effects and efficacy of prophylactic treatments are recommended. Ineffective treatments should be avoided because they may add additional stress to the captured animal. Managers should evaluate the potential effectiveness of a prophylactic treatment before indiscriminately applying one. Preventing calf injuries was the most effective method of reducing post-handling mortality in this study and should be given a high priority in the design of capture operations.

Key words: Antibiotic treatment, body mass, injury, long-acting oxytetracycline, post-handling survival, reindeer, *Rangifer tarandus*, wildlife capture.

INTRODUCTION

Free-ranging reindeer (*Rangifer tarandus tarandus*) on the Seward Peninsula (Alaska, USA) are handled each summer for velvet antler harvest, vaccination against brucellosis (*Brucella suis* biovar 4), herd health monitoring, and calf marking. Summer handlings occur in June and July when calves are 4- to 6-wks–old. During the handling process some calves experience trauma including bruising, lacerations, broken antlers, and fractured skulls.

Trauma, as well as handling stress, may encourage the onset of post-handling infections (Griffin et al., 1991). Several bacterial diseases may develop in reindeer calves subsequent to handling including necrobacillosis, caused by *Fusobacterium necrophorum* (Morton, 1981b), bacterial keratoconjunctivitis (Rehbinder and Nilsson, 1995), bacterial pneumonia (Morton, 1981c), and bacterial enteritis (Morton, 1981a). These infections may directly induce mortality or debilitate the calf and increase it's susceptibly to predation. Calves exposed to intense handling have been shown to have lower weight gain than wild calves (Reimers, 1972), which may decrease overwinter survival (Haukioja and Salovaara, 1978).

Antibiotics are widely recommended for use as a prophylactic treatment or wound treatment during wild animal capture and restraint (Jessup and Hunter, 1989, Clark and Jessup, 1992; Jessup, 1993, 1999; Kreeger, 1996). However, a review of the literature found no studies that examined the efficacy of these treatments. We wished to examine the effect that a prophylactic antibiotic treatment would have on long-term post-handling reindeer calf survival. We hypothesized that antibiotic treatment would increase post-handling survival by preventing the onset of post-handling infections and preventing a reduction in post-handling weight gain, and we hypothesized that weight would be positively correlated with survival.

We wished to use an antibiotic that would have a broad spectrum prophylactic effect after a single dose and would be easy to use in field operations. We chose a long-acting oxytetracycline formulation (200 mg/ml) (LA-OTC) for this experiment. This antibiotic was chosen because it is broad spectrum, long lasting, and can be stored at temperatures between freezing and 40C.

Long-acting oxytetracycline is specifically designed to produce high peak and sustained serum concentrations after a single intramuscular (IM) treatment so that it remains effective for 3 to 4 days. The long-acting formulation uses a high dose and controlled precipitation to prolong its absorption into the blood stream (Cornwell, 1980). Its half-life has been reported as 36 hours in cattle (*Bos taurus*) (Davey et al., 1985), 28 hr in goats (Escudero et al., 1996), 28 hr in sheep (Escudero et al., 1996), and 20 hr in fallow deer (*Dama dama*) (Haigh et al., 1997). Fallow deer (Haigh et al., 1997) and red deer (*Cervus elaphus*) (Wilson, 1983) are the only cervids in which the pharmacokinetics of LA-OTC have been studied. Both studies found that serum concentrations of LA-OTC, after IM administration, were not maintained above the mean inhibitor concentration (MIC = 0.5 μg/ml) as long as has been reported in cattle.

Oxytetracycline is a bacteriostatic, broad spectrum antibiotic. Its activity against gram positive organisms includes *Actinomyces* sp., *Bacillus anthracis, Clostridium perfringens* and *tetani, Listeria monocytogenes* and *Nocardia*. Its activity against gram negative organisms includes *Bordetella* spp., *Brucella* spp., *Bartonella* spp., *Fusobacterium* spp., *Haemophilus* spp., *Pasteurella multocida, Shigella* spp., and *Yersinia pestis*. It is effective against *Mycoplasma* spp., *Chlamydia* spp., and *Rickettsia* spp. as well.

Oxytetracycline's antimicrobial activity occurs when it binds to the 30S ribosomal subunit of susceptible organisms. This interferes with the binding of aminoacyl-tRNA to the mRNA/ribosome complex and prevents bacterial protein synthesis. Single dose treatment with LA-OTC has been effective in preventing pasteurellosis in lambs (Appleyard and Gilmour, 1990) and treating infectious pneumonia in cattle (Musser et al., 1996).

Oxytetracycline is well distributed to most tissues of the body. In cattle oxytetracycline concentrations have been found above the MIC at 7 hrs in lung, bone marrow, mammary gland, uterus, uterine horn, ovary, joint tissue, liver, kidney, spleen, muscle, fat, brain, urine, bile, synovia, and serum (Landani and Errecalde, 1992). Oxytetracycline is not metabolized to a significant extent and is eliminated in the urine, via glomerular filtration (60%), and the feces, via bile (40%). Bile concentration of oxytetracycline can reach twenty times plasma concentrations and eneterohepatic circulation occurs.

We felt that the single dose, broad-spectrum, long-lasting, and heat stable characteristics of LA-OTC made it a good choice for prophylactic antibiotic treatment to be given during a reindeer capture operation. We chose to examine post-handling survival to test the efficacy of these treatments. We could not find any studies which have previously examined the use of prophylactic antibiotic treatments in wildlife.

MATERIALS AND METHODS

We used reindeer owned by L. Davis (Nome, Alaska USA). Data was collected during summer handlings in 1995–97. This herd ranges over approximately 3,875 km^2 with the corral site (64°39′N, 165°17′W) located approximately 8 km north of Nome. The corral is similar to that described in Thompson et al. (1992).

Reindeer were gathered in groups of 800 to 2,500 animals and driven to the corral site by helicopter. Calves were held in the main corral with adults and were removed manually as they moved through the handling facility or removed via a "fawn separator" (Thompson and Dieterich, 1990). There were 1,243 calves in 1995 and 1,435 calves in 1996. Calves were

TABLE 1. Observed frequencies of return rates of reindeer calves on the Seward Peninsula, Alaska, as related to year, sex, antibiotic treatment, and injury level.

Sex	Injury	Treated	1995 Returned		1996 Returned	
			Yes	No	Yes	No
Female	None	Yes	126 (43.2)[a]	166 (56.9)	108 (43.9)	138 (56.1)
		No	130 (47.8)	142 (52.2)	94 (40.2)	140 (59.8)
	Mild	Yes	12 (46.2)	14 (53.9)	54 (52.4)	49 (47.6)
		No	10 (43.5)	13 (56.5)	29 (33.3)	58 (66.7)
	Severe	Yes	3 (50.0)	3 (50.0)	7 (70.0)	3 (30.0)
		No	3 (42.9)	4 (57.1)	6 (66.8)	3 (33.3)
Male	None	Yes	129 (47.3)	144 (52.8)	116 (43.9)	148 (56.1)
		No	121 (47.5)	134 (52.5)	115 (43.9)	147 (56.1)
	Mild	Yes	12 (31.6)	26 (68.4)	54 (47.8)	59 (52.2)
		No	13 (38.2)	21 (61.8)	40 (48.8)	42 (51.2)
	Severe	Yes	3 (42.9)	4 (57.1)	6 (66.7)	3 (33.3)
		No	6 (60.0)	4 (40.0)	11 (68.8)	5 (31.3)

[a] *n* (%).

weighed, sexed, and identified with a unique ear tag. A random number table was used to assign ear tags to treatment or control (no treatment) groups prior to handling (Zar, 1984). Treatment tags were notched and calves were assigned to groups on the basis of the ear tag they received.

Calves in the treatment group were administered Liquamycin® LA-200® (Pfizer, Animal Health Division, New York, New York USA) according to label dosages (20 mg oxytetracycline/kg), IM in the left tricep brachii. All calves were inspected for handling related injuries. Injuries were classified as (1) no injury; (2) mild injury (antler broken above the pedicel, lacerations <1.3 cm with no undermining, and minor puncture wounds), or (3) severe injury (fracture through the antler pedicel, infectious keratoconjunctivitis, lacerations >1.3 cm or lacerations with undermining, and noticeable limping). Injuries were treated according to Dieterich and Morton (1990) and recorded. Calves that returned in subsequent handlings were processed according to their ear tag and subsequent treatments were given in the right tricep brachii muscle.

Calf body mass (kg) was transformed to a Z-score ($(x - \bar{x})/SD_{mass}$) using the mean and standard deviation of body mass for all calves captured on a given day (Zar, 1984). This allowed us to calculate relative weight adjusted for different ages.

Yearling return rates were determined in 1996 and 1997 (Haukioja and Salovaara, 1978) and were considered an index of survival (Lancia et al., 1996). We assumed that yearlings present at handlings in 1996 and 1997 represented a random sample of the yearling population.

Data was analyzed using Systat 7.0® (SPSS Inc., Chicago, Illinois, USA). A chi-squared (χ^2) test (Zar, 1984) was used to test for association between survival and treatment. The probability of returning as a yearling was modeled using logistic regression (Zar, 1984). Independent variables used were Z-score, sex, injury (three level categorical variable), year (1995 or 1996), and LA-OTC treatment (yes or no). All two and three way interactions were included in the model. Higher order interaction terms were removed one at a time when determined to be not significant at $\alpha = 0.05$ by the t-ratio.

Calves handled more than once in the same year were used to examine summer weight gain. We used a general linear model with the change in Z-score between handlings as a dependent variable and treatment, sex, date of first handling, days between handlings and injury level as independent variables.

RESULTS

The number of calves handled was tabulated for each combination of variables (Table 1). No significant difference in overall return rate ($\chi^2 = 0.11$, $P = 0.74$) was observed for untreated calves (51.8%), and treated calves (48.2%).

Z-score and injury level were the only independent variables to be found significant ($P < 0.05$) in the logistic regression model (Table 2). The overall model was significant ($\chi^2 = 13.39$, 3 df, $P = 0.004$). Return rates increased with increasing Z-

TABLE 2. Results of logistic regression with Z-score and injury level as the independent variables of return rate, the dependent variable.

Parameter	Odds Ratio	Estimate	S.E.	T-ratio	p-value
Constant		−0.004	0.086	−0.052	0.96
Z-score	1.10	0.094	0.039	2.40	0.016
No Injury	1.24	0.22	0.090	2.43	0.015
Mild Injury	1.26	0.23	0.10	2.30	0.022

$2*\{LL(N) - LL(0)\} = 13.389$ with 3 df χ^2 *P*-value = 0.004
Mcfadden's Rho Squared = 0.004

scores and return rates decreased with increasing levels of injury (Table 2).

The general linear model examining weight change between handlings found no significant effects. The mean number of days between handlings was 7.55 ± 6.24 days.

DISCUSSION

Our results suggest that reducing the number of injuries is an effective method of improving post-handling survival. This supports recommendations that capture methods and handling practices should be designed to reduce the number of injuries and amount of stress associated with capture and handling (Koch et al., 1987 a, b, c; Dieterich, 1991; Clark and Jessup, 1992; Jessup, 1993, 1999; Spraker, 1993; Kreeger, 1996). We feel that reducing handling stress and injuries should be a high priority for all wildlife capture operations.

Return rate analysis showed that LA-OTC treatment did not significantly increase survival. We were unable to monitor reindeer calves after they were released from the handling corral. Therefore, it was not possible to document whether the oxytetracycline treatment failed to effectively prevent post-handling infections or if the effect was too short to produce a significant change in long-term survival. Oxytetracycline treatment did not have a significant effect on calf weight which suggests that the treatment did not prevent post-handling infections or that these infections were insignificant in number.

We observed mild post-handling lameness for several days in captive reindeer calves that received LA-OTC treatment in 1997. Similar lameness in calves treated in this study may have reduced post-handling survival. Lameness may have caused calves to be more susceptible to predation or reduced weight gain. Such effects could mask the antibacterial effect of antibiotic treatment.

Antibiotics are widely recommended for use as a prophylactic or treatment of injury during wildlife capture operations. However, there has been no research that shows that these treatments have a positive effect on post-handling health or survival. The results of our study suggest that LA-OTC does not provide significant prophylaxis for the capture and handling process we studied.

We tested a broad spectrum antibiotic because little is known about the post-handling diseases of reindeer on the Seward Peninsula and we wanted to provide blanket protection. An antibiotic treatment targeting a specific disease that has been shown to be responsible for a significant amount of post-handling mortality may produce better results. Antiparasitic treatment of calves (Oksanen et al., 1996) might increase survival by increasing the summer weight gain of calves or corticosteroid treatment may improve short-term survival of severely injured calves. However, the efficacy of these treatments has been poorly studied.

When planning a capture operation a wildlife biologist or veterinarian must consider whether prophylactic treatments will be beneficial to post-handling health or survival. The pharmacokinetics of many drugs have not been studied in wildlife which makes it difficult to predict how effective a drug will be in a wildlife species. Wildlife managers and veterinarians often have to guess at the efficacy of their treatments because the drug has not been studies in the treated species. In our study, therapeutic concentrations may not be maintained long enough in reindeer to make LA-OTC an effective prophylactic agent. Adequate knowledge of the pharmacokinetics of a drug in the treated species is essential to predicting the clinical usefulness of a treatment.

Our study examined the long-term results of handling and prophylactic treatment. Studies examining the short-term and long-term effects of prophylactic treatments on post-handling health and survival are needed. Further study of the pharmacokinetics of prophylactic agents is also needed to evaluate the efficacy of commonly used drugs. Knowledge of the efficacy of prophylactic antibiotic treatments is important when planning wildlife capture operations. Ineffective treatments or procedures should be avoided during wildlife capture operations to minimize the amount of time the animal is restrained and stressed.

The administration of prophylactic antibiotics is a commonly recommended procedure for wildlife capture operations. To the best of our knowledge we are the first group to attempt to assess the efficacy of prophylactic treatment with LA-OTC. The efficacy of prophylactic antibiotic treatments in wildlife remains unknown and our results suggest that this treatment was not effective during our capture operation. The efficacy of prophylactic treatments will vary with species, method of capture, and drugs used. When planning capture operations managers should attempt to evaluate these factors and determine whether prophylactic treatments are necessary. Further study of the efficacy of these treatments in different species and settings is needed to help managers make educated decisions when designing capture operations. Minimizing stress and injury during wildlife capture operations should always be a high priority with or without the use of prophylactic antibiotic treatments.

ACKNOWLEDGEMENTS

We thank L. Davis and the Davis Family, J. Blake, P. Quang, and D. Shain. This study was funded by the Agricultural and Forestry Experiment Station at the University of Alaska Fairbanks. This paper is Alaska Agricultural and Forestry Experiment Station paper number J-98-1.

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Received for publication 13 July 1998.