Deer diseases in North America

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Abstract

A brief review of infectious and parasitic diseases of elk in North America is presented Two published surveys of pathology laboratory data on diseases of elk in North America are discussed Data presented is mostly reported as morphologic diagnoses Outbreak reports are used to indicate the trends and emerging disease problems Except for Chronic Wasting Disease (CWD), disease from tuberculosis, MCF, Johne's disease, parasitism, copper and other trace mineral imbalance, and stress, are almost universal in significance and occurrence Foci of endemic tuberculosis in wild cervids are emerging in the USA and in Manitoba, Canada demonstrating the global nature of tuberculosis as a re-emerging disease problem

Introduction

North America encompasses most of the known biomes in the world and North American deer are farmed in climates from subarctic to subtropical Accordingly the conditions under which deer are farmed are manifold and therefore the list of diseases that occur in North American deer is a lengthy one indeed However, a study of a few pathology laboratory mortality surveys shows that the economically important diseases in North American farmed deer are remarkably similar to those found in New Zealand and other parts of the world

Searching the literature

In 1991, Smits reviewed the reported diseases of farmed and captive elk in Western Canada and Northwestern United States (Smits, 1991) The information was gathered through keyword literature searches of computerized databases and published bibliographies Smits discussed the bacterial, viral, and parasitic diseases of biological or economic significance. Nutritional and "management diseases" such as trauma and emaciation were not included, the latter group being largely unpublished and unremarkable to those looking for specific causes of disease Bacterial diseases included were Actinomyces pyogenes and Fusobacterium spp. infections, brucellosis, leptospirosis, clostridial infections such as blackleg, malignant edema and enterotoxemia, pasteurella pneumonia, and tuberculosis Reports of enteric disease included E coli enteritis (and septicemia) of neonates, yersiniosis, and Johne's disease The range of bacterial problems described is similar to that found elsewhere in the world, with regional differences in incidence depending on factors such as climate and management intensity For instance, in most of North America, it is likely that yersiniosis does not represent nearly the problem that it does in New Zealand On the other hand, due to their ubiquitous nature, Johne's disease and tuberculosis remain global issues Although their occurrence in North America is sporadic, they continue to pose the threat of emerging or re-emerging disease In addition, the probability of cervid wildlife reservoir for tuberculosis in North American now exists.

Apparently there were few reported viral causes of disease in North American farmed elk at the time of this review. Smits mentioned several potential disease agents such as bluetongue and epizootic hemorrhagic disease virus, bovine herpes virus 1 (IBR), and MCF virus (OHV 2) but was unable to say that they were of much significance in farmed elk

Importantly, Chronic Wasting Disease was mentioned as a disease of only potential importance to farmed elk The author could not have known what influence this disease would have on the future of North American elk farming and the story continues to unfold Chronic Wasting Disease has become the disease of greatest economic importance in North American cervid industry There is an article devoted to the subject of CWD elsewhere in these proceedings.

Disease-causing parasites reviewed were lungworm (Dictyolcaulus spp), meningeal worm (Parelaphostrogylus tenuis), tissue worm (Elaphostrongylus cervi), arterial worm (Elaeophora schneideri), liver flukes (Fascioloides magna), tapeworm, psoroptic mange, and winter tick (Dermacentor albipictus). Of those mentioned, only lungworm, liver fluke and winter tick represent a real economic threat to farmed populations Liver fluke infestation has been associated with rapidly fatal Clostridium hemolyticum infections, and winter tick infestations have caused clinical signs such as severe alopecia, dermatitis, and emaciation Control of these parasites is hindered by the unavailability in North America of effective flukicides against F magna and suitable topical anti-parasitic preparations against D albipictus Brainworm and tissue worm are notable for their great potential to cause problems in naive western North American populations of native mule deer, black-tailed deer, moose, and caribou Although this has not happened yet, the increasing movement of farmed cervids from east to west in North America increases the chances of moving P. tenuis from enzootic eastern regions to the west where it does not yet exist. Until recently the situation was complicated by a lack of suitable diagnostic tests to detect P tenuis infections An ELISA serum test is expected to be marketed in Canada in the next few months

Smits followed her literature review with a 1992 survey of elk mortalities seen by pathology laboratories in western Canada and northwestern United States (Smits,1992). The lack of information on significant diseases of farmed and captive elk at that time is reflected by the lack of recorded data The survey of 7 laboratories found only 231 necropsy reports on farmed elk spanning a 10-year period from 1981 to 1991. However, the summary data is remarkably similar to that reported elsewhere in the world in the days when management practices and animal handling techniques were being developed by trial and error, and were sometimes based on the belief that farming elk must be similar to farming domestic livestock such as cattle

Among neonates, dehydration, and emaciation accounted for 66% of deaths, with 25% dying with signs of enteritis. Corona virus or E coli was isolated from more than half of the enteritis fatalities. The leading causes of calf mortality were emaciation (26%) and enteritis (26%) associated mostly with E coli or Clostridium perfringens Pneumonia, septicemia, and trauma were each seen in 17% of all calf deaths. The major cause of death in mature elk appeared to be trauma, seen in 40% of bull deaths and 26% of cow deaths. Emaciation was seen in 23% of deaths, in conjunction with disease such as pneumonia, footrot, trauma, arthritis, and nephritis.

One can assume from these data that, in the 1980's, a mature elk on a North American farm was much more likely to die from misadventure than from disease

A similar survey was carried out in 1997 by Bruning-Fann who surveyed producers in the state of Michigan, rather than pathology laboratories, to provide some descriptive epidemiology of captive cervid herds in Michigan (Bruning-Fann, 1997) The information regarding elk was not reported separately from that of other cervids The information was producer derived, proportional data, reported on a per farm basis. This means that the number of farms experiencing one or more deaths attributed to each disease syndrome category was divided by the number of farms reporting deaths. Fifty three percent of farms experienced disease due to injury, or resulting from handling or transport stress, and 30% of them experienced mortality due to these factors

A repeat of the 1991 study done by Smits was performed in 2000 by Berezowski from the Western College of Veterinary Medicine. Early analysis provides some generalizations about disease in elk from western North America that are similar to the findings of Smits and Bruning-Fann Berezowski looked at proportional mortality data from several pathology laboratories. This means that each occurrence of disease on a farm was counted once regardless of how many animals were submitted from the occurrence or outbreak In this manner, mortality due to a specific cause or syndrome is not over represented in the total mortality for the study period The reporting is based on morphologic rather than etiologic diagnosis because etiology was not given in a large proportion of cases. Predictably, trauma was the largest cause of mortality (11% of diagnoses) Lung disease and enteritis/diarrhoea were 8 9% and 7 0% respectively No diagnosis was provided for 13% of the necropsies recorded The remainder were attributed to various morphologic pathologies but no clear trends or predominant etiologies could be demonstrated This either indicates a deficiency in the manner in which the pathologic data is being recorded in elk or a lack of definitive diagnostic testing being performed I suspect that in many cases of pneumonia or enteritis, for example, the causative organisms were not named because the significance of specific bacterial presence in most pathological conditions has not been established in elk There may have been a reluctance to attribute the cause of death to specific organisms Whatever the reasons, there was a dearth of etiologic data in the pathology records surveyed

When examining the importance of individual diseases to North American elk farming, it seems prudent to look at diseases considered to be of importance elsewhere and observe whether North America is experiencing similar problems In 1998, Mackintosh published a paper on deer health and disease in which he estimated the global importance of specific diseases Among them were malignant catarrhal fever, yersiniosis, Johne's disease, copper deficiency, tuberculosis, and parasitism by lungworm, ostertagia, Parelaphostrongylus tenuis, and babesia Chronic wasting disease was mentioned as an emerging problem of potential importance should it become translocated from the North American continent Interestingly, stress related disease and animal welfare issues were considered as important to the cervid industry as infectious disease

Malignant Catarrhal Fever (MCF)

If it were known, the prevalence of MCF in North American elk would probably be considered low by New Zealand standards This is likely due to the fact that, in North America, sheep are not a large part of livestock agriculture Elk can be considered only moderately susceptible to MCF when compared to cervids like white-tailed deer Berezowski (3) estimated the proportion of white-tailed deer submissions diagnosed with MCF in western Canada and the US at 4 4% No estimation was made for elk because of the relatively smaller proportion of necropsies resulting in that diagnosis So, although MCF in elk might be regionally important where sheep are farmed in North America, this disease has less overall significance than in other countries like New Zealand or Britain

Johne's Disease

The prevalence of Johne's disease in North American farmed elk has not been established, although its existence is certain Many elk farms are efforts at agricultural diversification and were at one time, dairy or beef cattle farms Others are mixed farms, where elk occupy paddocks sometimes used for cattle. Since the incidence of Johne's disease in North American cattle is as high as anywhere else in the world, farmed elk are also at serious risk

There is at least one report of Johne's disease affecting young elk in outbreak form, with high, acute mortalities rather than the chronic morbidity usually associated with the disease in older animals (Manning, 1998). Other, unpublished accounts from Canadian veterinary clinicians confirm that Johne's disease does indeed affect elk herds in Canada. Still, one might speculate that the incidence of Johne's disease is low when compared to other, domestic species Assuming this, then the challenge becomes keeping the incidence low in the face of increasing trade, unreliable diagnostic tests, and the high cost of eliminating carrier animals Understandably, North American elk farmers are loathe to accept such a challenge and many prefer to insist that Johne's disease will remain a minor problem without the need for expensive surveillance and health assurance programs Several facts argue against them. Johne's disease has recently been targeted by countries such as Australia and the United States for inclusion into their heath assurance programs for production limiting diseases Since international trade is frequently based on health status equivalency, trade with these countries may demand attention to a Johne's disease control program Human health epidemiologists have made assertions that Johne's disease is associated with Crohn's disease in humans. They suggest that Johne's organisms can escape pasteurization, making the consumption of milk and other products by susceptible individuals a health risk. Should this association ever be established as causal, Johne's disease will be elevated in its importance as a zoonotic disease. It seems wiser to maintain or eliminate whatever low levels of disease exist, than to permit Johne's disease to become widespread before acting to control it's spread among North American elk farms

Parasitism

In much of North America, for example Canada, there is a natural parasite control called "winter". Winter affects host feeding behaviour, diet selection, intermediate stage survival, vector survival, and other factors critical to parasitic cycles In northern parts of the continent, the average annual temperature is simply too low to sustain many parasites outside the host That is not to say that parasites don't exist, but they certainly don't cause the economic losses that are seen in temperate countries like New Zealand.

An example of environmental parasite control can be seen with brainworm or P. tenuis. P. tenuis is found east of the 100th meridian but not west of it The exact reasons for this are unclear, but it seems likely that environmental factors of sustained low temperatures and lack of moisture play a large role in controlling the intermediate host (snails) survival or the larval stage viability in the environment. This has created practical problems in the elk industry because translocation of animals across this natural boundary through trade has the potential to also translocate the parasite to susceptible, naive cervid populations in western North America

Movement of animals through trade may lead to other parasite problems. Babesia odocoilei is a tick borne blood parasite of white-tailed deer that under normal circumstances does not cause serious disease problems in deer or elk (Holman et al, 1994). The supposition is that elk are somewhat adapted to the parasite as long as they have been exposed at low levels through living in endemic areas Translocation of non-adapted elk into endemic areas, and the creation of stressful situations such as when elk are herded and crowded for management purposes, predisposes the naive elk to infection and subsequent clinical disease. These circumstances may also facilitate clinical disease expression in subclinical or carrier animals Herd problems from babesiosis have been seen in the upper mid west of the US and most recently in Manitoba, Canada

Significant parasitic disease is not due to biological or environmental factors occurs when suitable therapeutic agents are not available for treatment of the problem Examples of this are disease from liver fluke (Fascioloides magna) and winter tick (Dermacentor albipictus) It has been demonstrated that triclabendazole (Fascinex™) is effective against F magna, including the larval stages However, because the necessary trials for drug licensing have not been carried out in North America, the drug is not licenced for use. In Canada, special permission called an emergency drug release (EDR) can be obtained to acquire and use triclabendazole but these are not a suitable solution to the larger problem. Liver fluke continues to be a problem, especially in areas on the eastern slopes of the Canadian Rocky Mountains because the fluke damage predisposes to Clostridium hemolyticum infection. Heavy losses have been observed in some herds and the multivalent clostridial cattle or sheep vaccines appear not to be protective in this case

Winter tick infestation has proven to be a nuisance with no suitable chemical solution Dermacentor albipictus is a single host tick which attaches to its host in the fall, develops through nymph stages and feeds on the host during the fall and winter, and drops off in the spring. Heavy infestations can cause loss of condition and skin irritation. The problem is made larger because currently marketed anti tick chemicals are not very effective against winter tick Flumethrin (Bayticol™) is an effective pyrethroid chemical agent, but because information like maximum residue levels (MRL) has not been generated for the North American market, it is not available to us Cyfluthrin, which is the currently distributed pyrethroid in Canada at least, appears not to be very effective against winter tick

Stress and Animal Welfare

In 1998, Mackintosh wrote that over the last 30 years the amount of acute, stress induced disease such as trauma has decreased as farmed cervids have become better adapted to pastoral farming conditions, and management practices have improved The broken necks resulting from mishandling have been replaced by disease resulting from more subtle stresses like underfeeding at critical times, lack of shelter, trace element deficiency, overcrowding, and social stress (Mackintosh, 1998). In 1992 Smits showed that trauma was the largest cause of elk mortality in western Canada and the northwestern US, with 11% of diagnosed mortalities attributed to trauma Similarly, in 1998 Bruning-Fann demonstrated that 30% of Michigan cervid farms experienced mortality due to injury, or resulting from handling or transport stress (Bruning-Fann, 1998). In a study presently underway, Berezowski estimates that trauma, capture myopathy, and emaciation account for 18% of elk submissions to the pathology laboratories that he surveyed

It is difficult to state whether the incidence of trauma and stress related disease is increasing, or decreasing as elk farming evolves in North America. Old management mistakes are sometimes replaced by new management mistakes The current North American trend in antler production is to produce animals that are maximizing their genetic potential to grow antler. Nutrition is designed to allow maximum antler gain per day, with highly palatable, high energy, hi protein diets being hand fed several times a day This promotes a different type of nutritional stress in the animal. Chronic, cyclic, subclinical acidosis from high concentrate diets cause changes in the rumen epithelium Liver disease, laminitis and lactic acidosis perhaps combine to "burn out" the stag. Some animal scientists are making the distinction between maximum antler production and optimum antler production The latter may actually yield more marketable antler over the animal's production lifetime. Also, as elk meat inevitably enters the food market, there will be selection for genetics giving a more feed efficient animal, needing fewer agricultural inputs The new animal may need to be more competitive with other meat species and capable of being farmed more efficiently in the face of shrinking margins.

There are other considerations in the movement to quality assurance programs which include welfare issues Based on their desire to remove antler using drug free techniques, many North American elk producers are harvesting antler using unproven analgesic techniques such as "electroanesthesia" The need for drug free product is conflicting with the need to demonstrate humane farming practices These conflicts need to be resolved by developing alternate techniques for antler removal which are drug free, but scientifically proven to be animal friendly

Tuberculosis

In 1923, the Canadian TB Eradication Plan was created for cattle The basis of the plan was the testing of all animals and slaughter of the test reactors By 1961 the national prevalence fell to 0 11% and it was said that Canada was, for statistical purposes, TB free. In 1978 the Plan was replaced by slaughter surveillance where lesions found at slaughter were cultured and the herd was slaughtered if positive. Trace-out herds were then tested and reactors sent to slaughter. In 1989, a TB eradication and accreditation program using test and slaughter methods was established for farmed cervids.

In the period from 1984 to 1994 there were a number of Canadian cervid herds depopulated due to tuberculosis In Quebec there were 5 herds, in Ontario 8 herds, and a larger outbreak in the early 1990's, took 56 herds in Alberta and Saskatchewan Since 1994 there have been small outbreaks in Ontario and Quebec which were efficiently cleaned up All TB found in Canadian deer and elk herds has so far been attributed to transmission from infected domestic cattle.

There is an emerging problem with TB having to do with sources of infection. In North America, tuberculosis is traditionally thought of as a disease of farmed animals It has been said by many of us that tuberculosis occurs "behind wire" but never in wild populations. Mathematical models showed that TB would die out in a wild population of elk or deer. The population dynamics of wild herds were such that TB infection could not be sustained over time and that the problem would die with the affected individual The current models relied on numerical inputs such as population density, and there was no need to factor in a wildlife reservoir of TB Britain has its badgers and New Zealand has its possums but there is no such wildlife reservoir in North America. To an extent this is still true, except that in the North American situation, wild cervids themselves may become the wildlife reservoir for TB infections in farmed elk and deer

There has been a paradigm shift The old notion that farmed elk are those most at risk of TB has been replaced by the knowledge that under some circumstances tuberculosis can become endemic in wild North American cervids In some areas of North America, the risk to farmed elk may now come from wild deer and elk rather than domestic cattle These circumstances where this is possible stem from management of wild herds Where there has been interference with normal feeding habits and food supply, there has been overpopulation, and increased animal to animal contact because of feeding behaviour. We have changed the inputs to our disease transmission model and the outcome has changed, now reflecting sustained tuberculosis in wild populations

Riding Mountain National Park is a 3000 square kilometre area in western Manitoba, Canada. It was designated as a national park in the 1930's to protect forest, parkland and grassland ecosystems. Until about 1970, commercial activity such as logging, hay cutting, and livestock grazing were permitted within the park This served to maintain excellent elk habitat, and the park population of elk was about 12,000 head Commercial cattle grazing activity in the park inevitably placed TB infected cattle and wild elk in the same pastures, consuming the same food and water. It is assumed that some of the elk in the park contracted TB in this manner

At the same time that logging and other commercial activities were halted in the park, fire suppression was instituted. Natural fires that started in the park were extinguished as rapidly as possible. Over the ensuing years the net result was a loss of habitat suitable for feeding elk. In winter, the elk at the periphery of the park soon learned that hay stored on agricultural land bordering the park was an easy meal, and before long, cattle and elk were once again sharing forage This time the forage was cattle feed, and the infected animals were elk from the park The loss of elk habitat within the park, and a good point source of nutrition outside the park, permitted the same number of elk to live in smaller areas, effectively crowding the elk while increasing contact time and frequency

The record of tuberculosis associated with deer and elk in Riding Mountain Park begins in the 1970's when a mule deer was found to have died from tuberculosis. No other information was available about this deer A 1960's study of wolf ecology in the park resulted in the incidental confirmation of M. bovis in two timber wolves, and in 1978, a sample taken from another park wolf was positive for M bovis. Infection in these cases is thought to have resulted from eating infected ruminants rather than a persistent wolf pack infection In December of 1991 a hunter killed elk was found to be infected It was shot very near a farm recently depopulated because of TB Genetic testing proved the elk and cattle TB strains to be the same. Despite further testing of cattle and elk, no more positives were seen until 1998 when a bull elk was found dead from natural causes, and a culture of suspicious lung lesions yielded M. bovis organisms Random sampling and hunter kill testing found another positive elk in 1998, and three more in 1999 The five positive elk were found in various locations in and around the park rather than in one discrete area The Riding Mountain Park "herd' is still considered "TB free" because from 1200 animals samples, the 5 positives make up less than 0 5%. Nevertheless, this is the first time wild elk have been found to be infected with TB outside of Yellowstone National Park in Wyoming, USA The Yellowstone Herd is also a managed wildlife herd with artificial winter feeding and predator control measures keeping the population density above the number which would allow the natural extinction of tuberculosis in a ruminant wildlife population

Summary

Most of the disease observed in farmed elk results from management strategies used to maximize productivity The need to handle and treat elk with preventative medications and the protocols used to harvest product has led to traumatic disease The increasing trend to intensive farming of elk to improve efficiency and decrease waste places them at risk from infectious disease. The exact nature of the disease changes from place to place on the globe depending on climate and local factors In North America, like other parts of the world, there is a trend towards emerging or re-emerging disease such as tuberculosis and Johne's. As elk farming evolves, so do disease problems. In North America the problem is not one of eliminating disease but managing this co-evolution and devising strategies to minimize the effects on elk farming

References

Berezowski, J 2001. Morbidity and mortality of farmed cervids in western Canada and northwestern USA In progress

Bruning-Fann, C S, Shank, K L, Kaneene, J B, 1997 Descriptive epidemiology of captive cervid herds in Michigan, USA Veterinary Research 20 295-302

Holman, P J Craig, T M et al, 1994 Culture and partial characterization of a *Babesia sp* From a North American elk (*Cervus elaphus*) Journal of Wildlife Diseases 30(3) 460-465

Mackintosh, C 1998 Deer health and disease Acta Veterinaria Hungarica 46(3) 381-394

Manning, E J B, Steinberg, H, Rossow K, Ruth G R, Collins M T, 1998 Epizootic of paratuberculosis in farmed elk JAVMA 213(9) 1320-1322

Smits, J E G, 1991 A brief review of infectious and parasitic diseases of wapiti, with emphasis on western Canada and the northwestern United States Canadian Veterinary Journal 32 471-479

Smits, J E G , 1992 Elk disease survey in western Canada and northwestern United States In Biology of Deer, R D. Brown, ed pp 101-106 Springer – Verlag, New York