Exotic Diseases

Chronic Wasting Disease - The North American Situation

Murray R. Woodbury

Abstract

Chronic wasting disease (CWD) of elk (wapiti) and deer continues its high public profile in North American animal agriculture The emergence of "mad cow disease"or BSE (bovine spongiform encephalopathy) in Europe has increased public awareness of CWD and similar neurologic diseases in other animals The cause of CWD remains unknown but the generally accepted theory is infection by abnormal prions (proteinaceous infectious particles or agents which consist largely or solely of protein) which replicate and accumulate in the brain until they cause neurologic symptoms While there is no demonstrated risk to human health, there is concern that CWD may cross species barriers to infect humans who have eaten infected animals

CWD is endemic in free-ranging Rocky Mountain elk, mule-deer, white-tailed deer and black-tailed deer in a focus involving northern Colorado, southern Wyoming, and southwestern Nebraska These states plus South Dakota, Oklahoma, Montana, and the province of Saskatchewan, have seen cases of CWD in captive cervids So far, all cases of CWD in Canadian farmed elk can be traced back to animals imported from the US. Except for a single case in a Saskatchewan mule deer CWD has not been reported in wild Canadian deer or elk As a result of the Canadian Food Inspection Agency 's investigation, trace out, and eradication efforts, all positive farmed elk will be found So far, all positive CWD animals have originated from one Canadian "source" herd that originally imported infected animals from the United States Despite the large number of animals involved in trace out slaughter activities, the number of farms with positive animals remains very low Eradication activities will continue on Saskatchewan elk farms until no further cases of CWD exist

Introduction

Chronic wasting disease (CWD) of elk and deer is a fatal, infectious, progressive, degenerative disease of the brain It was first recognised as a clinical entity in the late 1960's in captive mule deer and elk in Colorado and Wyoming. It was not until the 1980's when it was detected in wild elk, mule deer and white-tailed deer in those states. CWD belongs to a group of diseases called transmissible spongiform encephalopathies (TSE's)(1) Other TSE's in this group include scrapie in sheep, transmissible mink encephalopathy, feline spongiform encephalopathy (3), kuru in humans, and Creutzfeldt-Jakob Disease (CJD) in humans The emergence of "mad cow disease", or bovine spongiform encephalopathy (BSE), another disease in the TSE group, has raised the profile of CWD and similar neurologic diseases in other animals

Cause

The cause of CWD is currently unknown The foremost theory is infection by abnormal prions (proteinaceous infectious particles or agents which consist largely or solely of protein) (2) Normal prion protein is found in nervous tissue where it is thought to protect the synapse from oxidative damage The natural configuration of prion protein is an alpha helix form Altered or abnormal prion protein assumes a beta sheet conformation that is resistant to enzyme degradation The abnormal prion is apparently capable of acting as a template in an autocatalytic process producing more enzyme resistant prions. This is responsible for a buildup of prion protein, eventually leading to cell death and spongiform change in the affected nervous tissue

Clinical Signs

Physical signs of CWD include emaciation, excessive salivation, drooping of head and ears, weakness, bugged out eyes, increased thirst and urination (especially in deer), pneumonia and trauma-induced lesions (5) The pneumonia may be from inhaling material (aspiration) into their lungs. Behavioural signs are loss of fear of humans, ataxia, repetitive movements, inability to judge space

and distance reflected, for instance, in the inability to get out of corners. Infected animals may be more prone to trauma (e g broken necks, broken legs) due to behavioural changes Clinical signs may last for weeks to months before the animal dies, with most elk succumbing to the disease in less than 12 months (4) One study concluded that the duration of clinical disease in deer ranged from 4 -32 weeks, while clinical signs in elk ranged from 4 -24 weeks (4) In contrast to animals with scrapie, postural, proprioceptive and motor abnormalities are rarely observed in cervids, despite often having considerable cerebellar damage (13)

Post mortem findings

Gross lesions found on post-mortem are non-specific but include. carcass emaciation, absence of fat, serous atrophy of the bone marrow, and a dry, rough hair coat (5) Animals that die from pneumonia or trauma may be in better condition Traumatic reticuloperitonitis ("hardware disease") also has been seen in several animals and is thought to occur secondary to neurological signs that cause indiscriminate eating habits Increased amounts of sand and gravel may be found inside the digestive tract for the same reasons Deer often have excessively fluid rumen contents, likely secondary to polydipsia (increased drinking) (7)

Microscopically, CWD is similar to other TSE's in that it causes degenerative changes in the brain (including vacuolation) and no inflammation or immune reaction Lesions in the supraoptic and paraventricular nuclei produce a lack of antidiuretic hormone and thus diabetes insipidus, which leads to the clinical signs of polyuria and polydipsia Lesions in deer and elk are topographically similar and often bilateral The dorsal motor nucleus of the vagus nerve, in the obex region of the brain stem, appears to be the first region affected This may be due to the infectious agent travelling up the vagus nerve from the gastrointestinal tract (13)

Diagnosis

Live animal tests are not available The tentative diagnosis is based on clinical signs The confirmed diagnosis is made by post-mortem examination of the brain tissue for microscopic changes, immunohistochemistry (IHC) (14) to look for protease-resistant prion protein (PrPres) and/or Western immunoblot Screening for surveillance programs is done using immunohistochemical staining.

Transmission

The mode of CWD transmission is not known with certainty In an outbreak in captive Rocky Mountain elk, transmission appeared to be from animal to animal within a herd, without preference for spread by mother to offspring (4). This is different than the pattern of scrapie transmission in sheep where outbreaks appear to be related to lambing and occur from mother to offspring, spread to others may also occur from environmental contamination by the placenta and birthing fluids (3) It is thought that the CWD agent is passed in saliva, feces and/or urine and is transmitted via a fecal-oral route Once ingested, the disease has a natural incubation period of 1.5 to 3 years before the onset of clinical signs (4)

It is not known whether contact with a prion-contaminated environment plays a role in perpetuating outbreaks of CWD but current research suggests it may occur. Initial re-stocking of a research facility in Colorado, approximately 1 year after depopulation to control CWD, resulted in CWD infection in the re-stocked animals (4) As the status of the re-stocked animals was unknown, it was not possible to know if the new animals became infected from living in a contaminated environment, or were infected before arrival In a more recent experiment, animals from a certified-free CWD herd were put into a contaminated paddock Deaths from CWD still occurred in these animals approximately 18 months later (10) Investigation into the role of environmental exposure is ongoing

Geographic Distribution

CWD exists in free-ranging Rocky Mountain elk, mule-deer, white-tailed deer (4) and black-tailed deer (6) in an endemic focus that involves northern Colorado, southern Wyoming, and southwestern

Nebraska (5) CWD has been reported in a single wild mule deer in Saskatchewan No other cases in wild elk or deer have been found despite surveillance Colorado Wyoming and Nebraska, plus South Dakota, Oklahoma and Montana, and the provinces of Ontario and Saskatchewan, have seen cases of CWD in captive cervids So far, all cases of CWD in Canada can be traced back to animals imported from the US (7)

Canadian History of CWD

A case of CWD in a mule deer at the Metro Toronto Zoo occurred in the 1970's. The animal had been imported from a zoological park in Colorado (7) The deer was euthanased, diagnosed and incinerated.

In 1996, a 7-year-old elk cow in Saskatchewan died after a 3 month illness with lesions in the brain and immunohistochemistry (IHC) diagnostic of CWD This cow was imported from South Dakota in 1989 into a Saskatchewan farm, now known as the "source" herd, from which all subsequent cases came The cow had been sold to a second farm in 1993 where it became ill approximately 30 months later. All elk on the second farm were destroyed and incinerated by the Canadian Food Inspection Agency (CFIA) due to intensive herd management and the number of calves the cow had raised on the farm All herd mates were negative for CWD by histology and IHC.

In 1998, a second case was found in a young bull elk. The bull was born in the "source" herd in 1996 to a cow imported in 1989 from another farm in South Dakota. The bull was sold to a second farm in 1998, where it died The dam of the bull, and her siblings, now located on 4 other farms, were destroyed and tested negative for CWD by histology and IHC. All herdmates (all bulls) of affected animal were placed under surveillance on the farm where it died, and no sales from farm were permitted All remained non-clinical until 2000.

In 2000 the third case was diagnosed in a 4-year-old bull on the same farm having the 1998 case. The bull came from the "source" herd at the same time as the 1998 case Sixty-four elk on the premise, now exposed twice to CWD, were destroyed and extensive sampling done to determine level of infection. All animals tested negative for CWD by IHC

By this time the owner of the source herd identified several deaths over previous 10 years whose clinical histories were suggestive of CWD The "source" herd was subsequently depopulated and the discovery of several more positive but non-clinical cases was made

As a result of CFIA's further investigation, more positive elk were found on other farms To date, approximately 4000 animals from Saskatchewan farms have been destroyed. Epidemiological investigations have been extensive and trace-out animal destructions are now in the fourth round. All positive CWD animals have originated from the "source" herd so far Eradication activities will continue in Saskatchewan until no further cases of CWD exist.

Other Species Affected

Because Bovine Spongiform Encephalopathy has been linked to cases of CJD in humans, and may have arisen initially from scrapie, the possibility that CWD could behave similarly is being investigated No evidence for natural transmission of CWD to other species has been found so far. Studies include the following:

10 cattle given a single oral dose of CWD infected brain tissue, at a level that would easily cause CWD in cervids, have not had any signs of CWD 4 years later (10) The study is ongoing

20 cattle placed in a pasture with CWD infected deer and elk have no signs of CWD 4 years later (11). This study also continues

A 10-year investigation of 22 cattle herds that graze areas with a 13% incidence of CWD in wild cervids, has found no CWD in over 260 cattle tested (animals resided in the test herds for average of 7 years) (11)

Inoculation of CWD infected material directly into the brains of 13 cattle caused neurologic signs in 3 animals but the method is not a natural route of exposure (10).

- In laboratory "test tube" experiments, CWD converted prion protein from humans and cattle only at a very slow rate suggesting an interspecies barrier (11)

There has been much speculation from the hunting industry about the threat to hunter safety posed by CWD Inflammatory articles have appeared in hunting magazines claiming that hunters have died from CWD infection resulting from the consumption of wild shot venison. The three cases of CJD found in young hunters occurred in areas outside where CWD occurs in wild cervids Genetic and diagnostic testing of the CJD strains in these people, also found no evidence for transmission from CWD (11) The case rate of CJD among humans in Wyoming and Colorado, where CWD has been endemic in wild cervids for over 20 years, is less then the national average of 1/1,000,00 (11)

However, it is difficult to prove that a threat to human health does not exist Recall that at one time, the British public were being assured that BSE was not a threat to human health Although the issue remains contentious the association between BSE and variant CJD in humans has been made Experiments on the transmissibility of CWD to other species (ferrets, mink, goats, squirrel monkeys, cattle, sheep) are ongoing, as well as epidemiological investigations Until the lack of transfer can be confirmed, it is recommended offal, brain, and spinal cord, as well as all meat from clinically affected deer should be avoided for use as a protein source in animal food (12)

Treatment and Control

There is currently no treatment for CWD Chronic wasting disease is a federally reportable disease (required by law to be reported to the CFIA) and all cases of CWD are dealt with by the CFIA Their present program is based on the following principles, established from current scientific knowledge (8).

Highly contaminated premises have an environment which may contain enough of the CWD agent to cause disease

Non-contaminated or low-contaminated premises are defined by CFIA as having had only one to two clinical cases over a short period of time and where the animal(s) most likely acquired the infection at another premise

An animal exposed to infection will develop the disease in 36 months

Clinically diseased animals could be infectious to other animals up to 18 months prior to death.

In premises deemed by CFIA to be non-contaminated or low-contaminated the soil, feed and manure is scraped off to a depth of where the soil is undisturbed, or deeper if a clinical animal spent considerable time at one site New material is added to form a barrier and kept topped up Material removed is buried so animals do not have access or where there will be seepage. All facilities and equipment exposed to clinical animals are cleaned of organic material and disinfected by soaking for one hour in sodium hydroxide or sodium hypochlorite.

A method of removing the agent from a heavily contaminated premise has not been resolved but probably will involve removal as described before, and sentinel animals to monitor if still present.

Wild cervids are not allowed on any infected premises If found they are destroyed and tested for CWD

Based on these principles, when a positive CWD animal is found these actions are taken (8)

Incineration and/or deep burial of the carcass of the affected elk in an approved site

Quarantine and inventory of all elk on the farm

Depopulation of all cervids in the herd, which had direct contact with the positive animal, and proper disposal in an approved site

Clean-up and disinfection of contaminated areas

Evaluation and compensation to owner

Removing and testing trace-out animals which have left the herd in the last 3 years - depending on results of testing, further depopulation may occur in the trace-out herds

Monitoring of trace-out animals that left the herd in the last 36-60 months, to be cautious

Most provincial and state departments of agriculture, and the farmed cervid industry have created surveillance programs for CWD. For example, the Saskatchewan Cervid Health Surveillance Program is based on an accurate herd inventory, individual identification of herd members, and reporting of all deaths in animals over 12 months of age to Saskatchewan Agriculture and Food (SAF) Reporting is followed by submission of the head to a laboratory and examination for CWD by immunohistochemistry. A physical inventory is done at program entry, including the reading and recording of unique (provincial, and one other) identification tags of all animals, including calves. The physical inventory is repeated every three years, or less, to coincide with CFIA's tuberculosis testing Annual head counts (audits) will be done in the years between. Producers enrolled in the program are supplied with seals (tags) for identifying and tracking antler velvet Herds that are found in non-compliance with the program will have their enrolment revoked The program is intended to help eradicate CWD and to restore public and trading partner confidence in the cervid industry

References

1 George, LW Diseases of the Nervous System In Smith BP, ed Large Animal Internal Medicine 2nd edition St Louis Mosby - Year Book, 1996 pp 1011-1015

2 Schreuder BEC General aspects of transmissible spongiform encephalopathies and hypotheses about the agents Vet Quart 1993, 15 167-174

3 Schreuder BEC Animal spongiform encephalopathies -An update Part I Scrapie and lesser known animal spongiform encephalopathies Vet Quart 1994, 16(3) 174-181

4 Miller MW, Wild MA, and Williams ES Epidemiology of chronic wasting disease in captive Rocky Mountain elk J of Wildl Dis 1998, 34(3) 532-538

5 Spraker TR, Miller MW, Williams ES, Getzy DM, Adrian WJ, Schoonveld GG, Spowart RA, O'Rourke KI, Miller JM, and Merz PA Spongiform encephalopathy in free-ranging mule deer (Odocoileus hemionus), white-tailed deer (Odocoileus virginianus) and Rocky Mountain elk (Cervus elaphus nelsoni) in northcentral Colorado J of Wildl Dis 1997; 33(1) 1-6

6. http.//www aphis usda gov/oa/pubs/fscwd html

7. http //www cfia-acia agr ca/english/animal/hofa/cwd html

8 Luterbach G, Operations Directorate, CFIA, Winnipeg, Personal communication

9 O'Rourke KI, Besser TE et al. PrP genotypes of captive and free ranging Rocky Mountain elk with chronic wasting disease J Gen Virol 1999, 80 2765-2679

10 Williams ES, University of Wyoming, Personal Communication

11. Kreeger TJ, Wyoming Game and Fish Department, Personal Communication

12. http //www uwyo edu/AG/CES/PUBS/Chronic htm

13 Williams ES and Young S Neuropathology of Chronic Wasting Disease of Mule Deer (Odocoileus hemionus) and Elk (Cervus elaphus nelsoni) Vet Pathol 1993, 30 36-45

14 Guiroy DC, Williams ES, Yanagihara RY, and Gajdusek DC Immunolocalization of scrapie amyloid (PrP27-30) in chronic wasting disease of Rocky Mountain elk and hybrids of captive mule deer and white-tailed deer Neurosc Let 1991, 126 195-198