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Chronic Wasting Disease: Crossing the Species Barrier into Human Populations

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INTRODUCTION

- Prion diseases are fatal neurodegenerative disorders, for which there is no treatment. Chronic Wasting Disease (CWD) is a transmissible spongiform encephalopathy (TSE) that infects cervids.
- CWD is spread between cervids through excreted bodily fluids or from mother to fetuses in utero.[5]
- Clinical symptoms that cervids experience include weight loss, lack of muscle coordination, and excessive salivation.
- CWD was identified in captive deer in 1967 in Fort Worth, Colorado. CWD has rapidly spread through wild deer and elk in the United States and Canada during the past 50 years.[6,7]
- Export trade of cervids has brought CWD to captive deer in South Korea. Additionally, wild herds of caribou throughout Scandinavian countries have developed CWD and impose a threat to the rest of Europe's cervid populations.[8,9,10]
- Common traditional practices including tanning, handling of infected carcasses, and consumption of cervid meat and brain tissues have increased the risk of CWD transmission to humans.[11]

Figure 1. Traditional tanning of hides using deer brain[11]

METHODS

- Reviewed possible implications for the impact of CWD outbreak globally on cervids and other animals including humans. Analyzed the scientific literature on the origins of CWD and transmission among and between cervids and other species.
- Tracked the spread of CWD using maps produced by United States Geographical Survey (USGS).[12]
- Compiled data from experimental oral and intracranial inoculation of CWD central nervous system tissues from prion infected animals to draw conclusions about cross-species transmission of CWD.
- Cross-referenced CWD trends with the Bovine Spongiform Encephalopathy (BSE) outbreak in Europe in the 1990s, leading to variant Creutzfeldt Jakob disease (vCJD) transmission to humans.

RESULTS

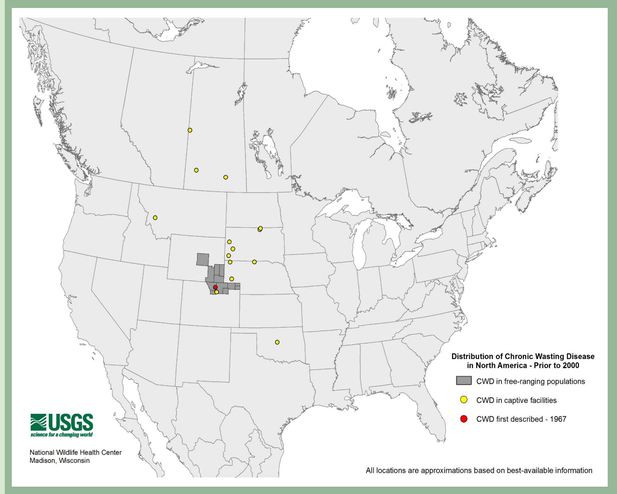

Figure 2a. Map of CWD before 2000 in the United States and Canada[12]

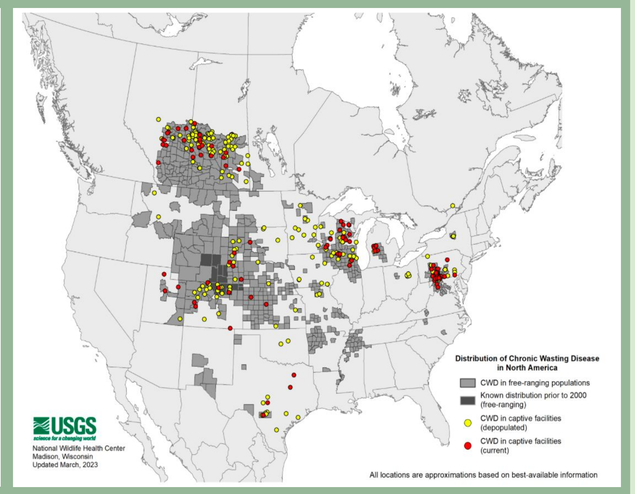

Figure 2b. Map of CWD as of 2023 in the United States and Canada[12]

Table 1. Summary of Experimental Inoculation of CWD Prions from Deer into Other Species

Animal	Route of inoculation	Incubation Period	Transmission
Wild type mice[1]	i.c	151 +/- 9 days	5/5
Wild type mice	oral	>600 days	0/3
tga20 mice[1] *	i.c	153 +/- 9 days	5/5
tga20 mice[1]*	oral	140 days +/1 days	5/5
Pigs[2]	i.c	64 months	4/20
Pigs[2]	oral	64 months	1/19
Squirrel Monkey[3]	i.c	Average 45 days	13/13
Squirrel Monkey[3]	oral	Average 68 days	11/12
Cynomolgus monkey[3]	i.c	> 10 years	0/8
Cynomolgus monkey[3]	oral	> 10 years	0/8

[1]Thackray et al., 2003, [2] Moore et al., 2017, [3] Race et al 2014
*tga20 mice are a commercially bred strain of mice that exhibit 10-fold more PrP protein

Table 2. Interspecies and Intraspecies inoculation of CWD prions showing reduced incubation time on second and third passage

Animal	Route of Inoculation	Incubation Period	Transmission
Hamster[4]	i.c Mule deer CWD prion (1st passage)	1 year	0/20
Hamster[4]	i.c Ferret CWD prion (1st passage)	152 +/- 44 days	16/20
Hamster[4]	i.c Hamster CWD prion (2nd passage)	53 +/- 2 days	14/14
Hamster[4]	i.c Hamster CWD prion (3rd passage)	50 +/- 2 days	10/10
Ferret[4]	i.c Mule deer CWD prion (1st passage)	17-21 months	6/6
Ferret[4]	i.c Ferret CWD prion (2nd passage)	8-9 months	11/12
Ferret[4]	i.c Ferret CWD prion (3rd passage)	5 months	5/5

[4]Bartz et al., 1998

- In Table 1, CWD was experimentally inoculated (intracranially or orally) into laboratory mice, pigs, squirrel and cynomolgus monkeys. Since squirrel monkeys (*Saimiri sciureus*) and cynomolgus monkeys (*Macaca fascicularis*) are non-human primates these findings (especially oral transmissions) are important for understanding the potential of CWD transmission to humans.[1,2,3,7,13]
- In Table 2, intracranial (i.c) within species inoculation (second and third passage) of both ferrets and hamsters resulted in significantly decreased incubation time.[4]

REFERENCES

DISCUSSION

- Bovine spongiform encephalopathy (BSE or Mad Cow Disease) is a prion disease that is transmitted from sheep infected with scrapie to cows. BSE can then cross the species barrier a second time to humans. BSE prions were transmitted through contaminated meat products eaten by humans, which manifests as variant Creutzfeldt Jakob's Disease (vCJD) which is a new fatal neurodegenerative disease.[14]
- Studies have demonstrated that CWD prions in soil and vegetation are a plausible long-term environmental reservoir for scrapie and CWD prions that resist environmental degradation and maintain their persistence, transmissibility and potential to cross the species barrier into other animals.[15,16]
- Kuru, the first recognized human prion disease that arose among the Fore people of New Guinea as a result of ritualistic cannibalistic practices by women resulted in an average incubation period of 2-12 years. Men, who only participated in these practices occasionally as children at their mothers' side exhibited incubation periods longer than 50 years.[17]

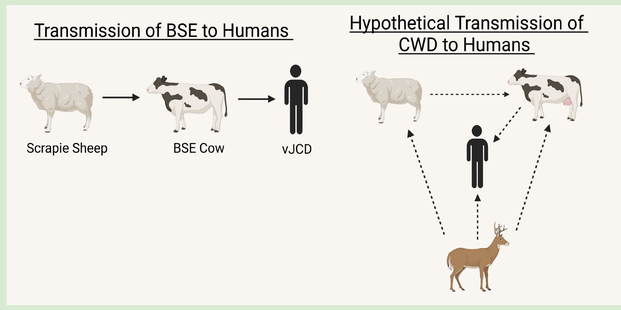

Figure 3. Depiction of BSE transmission from Scrapie sheep to humans in comparison with potential transmission of CWD across species barrier. Adapted from Young et al., 2013;*Created in BioRender.com.*[20]

CONCLUSION

- Recommendations and precautions should be taken to minimize the exposure to CWD prions including, but not limited to:
  - Following CWD state regulations regarding testing and disposal of cervid carcasses
  - Testing cervids before consuming them and if positive for CWD follow CWD guidelines not to consume the affected animal[18]
  - Utilizing protective gear when in direct contact with carcasses, especially brains and spinal cord tissue
  - Monitor Creutzfeldt-Jakob Disease like illnesses and deaths in CWD endemic areas
- Although there is currently no epidemiological evidence that CWD has crossed the species barrier naturally to humans or other animals, repeated exposure suggests that with time a species barrier breach may occur.[19]