FRIEDRICH-LOEFFLER-INSTITUT
FLI
Bundesforschungsinstitut für Tiergesundheit
Federal Research Institute for Animal Health

FAQ

Chronic Wasting Disease (CWD) in deer species

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What is Chronic Wasting Disease?

Chronic Wasting Disease (CWD) is a highly contagious and fatal disease that affects numerous cervids, including species inhabiting Germany. It is classified as a Transmissible Spongiform Encephalopathy (TSE) and thus has a similar clinical and pathological presentation to Bovine Spongiform Encephalopathy (BSE) in cattle or Scrapie in sheep. There is a legal obligation to report cases of CWD. Clinically, this disease manifests itself mainly by neurologic signs, behavioural abnormalities, and ataxia.

The infectious prion protein induces conversion of the cellular prion protein (PrP^{C}) into the misfolded pathological prion protein (PrP^{Sc}), causing CWD. Due to the high resistance to enzymatic reduction, a massive deposition of PrP^{Sc} in the brain leads to morphological damage and thus the progressive clinical symptoms resulting in death.

In many species, susceptibility to TSE depends on the prion protein gene structure, resulting in variable susceptibility/resistance to CWD. This has also been demonstrated in North American cervids. Little is known for the German cervid population, yet.

For more information on CWD, please click here Profile CWD.

What are the symptoms of CWD-infection?

The most common and noticeable symptoms are similar to those of other TSE diseases: Loss of neurological function, changes in behaviour and ataxia.

The affected animals are usually between two and seven years old, with a higher number of infected males. Increasing weight loss finally lead to cachexia („wasting disease“), is the most outstanding symptom. However, the appetite of infected animals remain intact. Affected animals separate themselves from the herd, suffer from listlessness and lose their natural shyness towards humans. Incoordination, ataxia or abnormal posture is also frequently observed. Ruminal atony, excessive salivation, frequent drinking and increased urination are also symptoms of CWD. Stress can significantly increase the described symptoms.

The disease is slowly progressive and eventually leads to death. After about four months, the animals are wasted and die shortly thereafter.

Secondary diseases such as pneumonia often shorten the duration of disease. These are caused, for example, by swallowing food debris due to the lack of coordination of chewing and swallowing processes. Sudden deaths also occur.

Which deer species are susceptible to CWD?

The phylogenetic family of cervids can be divided into two subfamilies (*Cervinae* and *Capriolinae*), including more than 80 species whereof several are susceptible to CWD. Among the subfamily of the Capriolinae following species can suffer from natural infections: white-tailed deer *(Odocoileus virginianus),* black-tailed deer *(Odocoileus hemionus),* mule deer *(Odocoileus hemionus),* reindeer *(Ragnifer tarandus)* and moose *(Alces alces)*. All species are native to North America and some of them even inhabit Scandinavia. The subfamiliy of Cervinae include the North American native species Rocky Mountain elk *(Cervus elaphus nelsoni),* wapiti *(Cervus elaphus canadensis)* and muntjac *(Muntiacus reevesi)* as well as European red deer *(Cervus elaphus elaphus)*. Those species are also susceptible to CWD. In contrast, yet, there are no data available on the susceptibility of roe deer *(Capreolus capreolus)* and sika deer *(Cervus nippon),* which also belong to the Cervinae subfamily, assuming that these species can also suffer from CWD-infection.

Previous studies have shown that fallow deer *(Dama dama)* seems to be susceptible only under experimental conditions.

How does the disease transmit?

CWD is a highly contagious disease with the most efficient transmission of all TSEs. PrP^{Sc} is excreted through all body fluids (blood, urine, faeces, lymph, saliva, semen) already during the incubation period, which can last up to 34 months. This leads to an extreme contamination of the environment, where the prion protein can remain infectious for decades.

Contact with infected animals and ingestion of the pathogen from the environment are the major ways of infection. According to a study by Denkers *et al.* (2020), the minimum infectious dose corresponds to approximately 300 ng of brain tissue or saliva. The latter is thus almost as infectious as brain.

Vertical transmission is also possible: CWD-positive hinds can transmit the disease to their offspring through the umbilical cord and transplacentally.

Can CWD overcome the species barrier and infect other animal species?

So far, no natural case of transmission to another animal species is known. However, CWD can be transmitted experimentally. In particular, bank voles *(Myodes glareolus)* and deer mice *(Peromyscus maniculatus)* are highly susceptible to CWD-infection when intracerebrally inoculated (i.c.). Other mice as well as hamsters are only barely susceptible via i.c. inoculation. Other laboratory animals, such as minks and ferrets, as well as cats, are susceptible when i.c. inoculated. However, the latter have a rather long incubation period of up to 42 months. So far, transmission of CWD to livestock is only possible under experimental conditions. Slightly less than half of i.c.-inoculated cattle develop signs of disease. Experimental transmission is also possible in swine, but similar to cats, it is associated with long incubation periods and low attack rates.

Is there a health risk for humans?

Various *in vitro* experiments suggest that the species barrier to humans is very high. However, the experiments are strongly influenced by the genetic background of the used isolate and the human recipient tissue. Only certain combinations of human genotypes and cervid isolates allow *in vitro* conversion. However, the conversion rate is always lower than for BSE.

Furthermore, *in vivo* experiments in which highly sensitive transgenic „humanized“ mice were infected with CWD by intracerebral inoculation confirm these results – transmission was not successful. Squirrel monkeys, on the other hand, were sensitive to i.c. infection. Susceptibility and incubation time strongly depend on the isolate/species used. In subsequent animal studies macaques, which are genetically much closer to humans, were infected with CWD intracerebrally and orally (i.e., via food). While previously published studies have found no evidence of transmission after oral and intracerebral infection, even after 13 years, another study from Canada, that is still ongoing, has found evidence of transmission in individual animals that has not yet been conclusively determined. Therefore, a final evaluation of these results will not be possible until published. Furthermore, in the epidemiological studies published between 1979 and 2011, there is no evidence for CWD transmission to humans.

In summary, based on current scientific knowledge, transmission of CWD to humans cannot be ruled out with absolute certainty, but the risk of this can at date be assumed extremely low, as the species barrier for CWD in humans appears to be very high.

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How does CWD spread?

The spread of CWD depends on several factors. The biggest influence is the massive contamination of the environment, mainly due to decaying carcasses, antler velvet, saliva, urine and faeces, as well as blood, placenta and milk.

In addition to natural migration of animals, population density also plays an important role. The more animals living in a confined space, the higher the transmission rate as the contact between individuals is closer. This also explains why CWD spreads more in domesticated herds where it can easily reach transmission rates of close to 100%, than in free-ranging animals.

Feeding stations and salt lickes in particular represent a major risk factor. Here, the animals gather and come into close contact with each other, which also results in massive contamination of the environment. Thus, the disease spreads easily.

The further spread of CWD also depends on a certain extent on the genetic predisposition of the population. If there are many animals that are genetically susceptible to CWD, more cases occur and therefore more infectious prion protein is excreted, which in turn results in a massive contamination of the environment.

Humans also play a significant role in the spread of the disease. The translocation of animals or contaminated soil by humans poses a major threat. For example, the disease reached Canada and South Korea through the importation of infected animals. Other risk factors may include contaminated clothing, footwear, or equipment (e.g. infected attractants) worn and used during hunting trips in high-risk areas and subsequently brought back – to risk-free areas.

Where does CWD occur?

CWD occurs in both free-ranging and domesticated herds and was first described in Colorado/USA in 1967 in a mule deer. However, the disease had probably been endemic in Colorado, Nebraska, and Wyoming for several decades. From these states, CWD spread over large parts of the USA and reached Canada in 1980 through the importation of infected animals to the Toronto zoo. The last known case of importation so far was an infected red deer, which was introduced from US to a red deer farm in Quebec in 2018. In this regard, it is of interest that infections in domesticated animals usually precede those in the wild. Currently (July 2021), 26 U.S. states and three Canadian provinces are affected by the CWD endemic.

The pathogen also reached South Korea in 2001 through another importation of infected wapitis from North America. There are currently about 50 positive animals there, distributed among several but epidemiologically associated farms.

In 2016, the disease first appeared in a Norwegian reindeer herd in the Nordfjella region, resulting in strict surveillance of Scandinavian deer and eradication of approximately 2000 reindeer from the affected valley, resulting in additional 19 animals tested positive. However, four years later in 2020, another positive reindeer was described in the geographically distant region of Hardangervidda.

As a result of the initial outbreak an active surveillance program was established, leading to detection of additional cases of infected moose in Norway, Sweden and Finland, as well as in a red deer in Norway. In September 2021, a second red deer was found death and tested positive for CWD. However, these cases show characteristics of sporadic age-associated disease with presumably little infectious potential.

At date, an introduction of CWD into other European countries cannot be completely ruled out. All European CWD cases show differences to the North American CWD, therefore a connection with the North American outbreaks does not seem likely according to current scientific opinion.

How can we prevent an introduction of CWD to Germany?

As there are no known therapies for TSE diseases and the control of the pathogens in the environment is challenging, it is important to prevent the introduction of CWD into Germany in the first place. To ensure this, some prevention methods should be considered.

The import of animal products of cervids from the USA and Canada is only allowed if these products have been tested negatively beforehand with methods specified in Regulation (EC) No 999/2001 (Annex IX, Chapter F).

In addition, it is strongly advised not to import trophies (i.e. antlers) and game of animals hunted in Norway to Germany or to ensure that the animal products are tested free of CWD in the country of origin. The import of live cervids from Norway is prohibited under the Implementing Decision (EU) 2020/2167.

Especially for hunting trips to Scandinavia or North America and Canada, please consider hygiene measures. For more information, check out “What should be observed during hunting trips?“.

What can hunters do?

It is important that all hunters and people who come into contact with game species have basic knowledge about CWD. Remain vigilant and report suspicious animals to the veterinarian agencies responsible for your region. The State Veterinary Investigation Offices (Landesuntersuchungsämter) are able to perform tests for CWD and are regularly certified by the FLI within the context of ring trials. Samples of brain (*medulla oblongata*) and deep neck lymph nodes (*Lymphonodus retropharyngeus*) are used for a CWD test.

If you participate in hunting trips especially to Scandinavia, but also to other risk areas (e.g. North America), please note the following link “What to consider during hunting trips?“.

Avoid the use of natural urine lure as far as possible. If the use of these is necessary, always make sure they are synthetic or certified CWD-free (e.g. the National CWD Herd Certification Program of the USA).

Furthermore, remember that infectious prion protein cannot be eliminated with conventional disinfectants. For further advice on inactivation of the pathogen, check out “What is known about the resistance of the pathogen and under what conditions can it be inactivated?“.

What to consider during hunting trips?

After hunting, thoroughly clean your clothing (e.g. with bleach) and especially footwear (e.g. by removing loose soil with a toothbrush). If clothing as well as footwear are heavily contaminated (e.g. with blood), it is advisable to dispose them while still in the risk area. For more information on the inactivation of the pathological prion protein, check out “What is known about the resistance of the pathogen and under what conditions can it be inactivated?“.

In addition, please pay attention to the current legal decisions on the import of animals and animal products into the European Union.

What can be done against CWD?

Due to the high tenacity and resistance of the pathogen against environmental influences and disinfection measures, the control of CWD is a major challenge.

As consequence of the first CWD positive reindeer in Norway in 2016, the whole herd was eradicated in the affected valley of the Nordfjella region. During subsequent testing for CWD, additional animals tested positive. This measure initially contained the spread of the disease. Nevertheless, in 2020, another case of CWD was reported in the geographically distant region Hardangervidda, indicating the further spread of the disease.

This highlights the importance of minimizing risk factors. Especially the reduction of population density is a major factor. The proportional amount of males should be reduced, as they are three times more likely to be affected by CWD infection than females. Lower population density decreases environmental contamination and the risk of infection. In addition, it can be helpful to reduce human activity in regions affected by CWD, resulting in animals having access to larger areas that otherwise are occupied by humans, additionally reducing population density. This measure also prevents pathogen spread by humans. To avoid natural migration of individuals between populations, regions affected by CWD should be fenced. It is also important to avoid licking and feeding areas. This will prevent animals from gathering and coming into close contact.

Informing interest groups (e.g. hunters, veterinary agencies and other people, staying in close contact with game species), reduces the risk of an unintentional introduction drastically and ensures an early detection of the disease.

What is the benefit of shooting susceptible deer species as a preventive measure?

The shooting of susceptible deer reduces the population density in the hunted area. A lower population density reduces a contamination of the environment through CWD-positive animals. It also allows a smaller number of animals to spread over a relatively larger area, meaning less gathering of animals.

However, in a CWD-affected area, carcasses should be tested free before consumption. Additionally, it is strongly advised that the viscera of the animals is not buried in the forest after breaking open, but disposed properly through rendering facilities to ensure decontamination of the pathogen.

Is there a therapy against CWD?

So far, there is no known therapy against CWD or other TSE diseases. The disease always leads to death. Therefore, it is even more important to take preventive measures and to prevent or contain an outbreak. For more information on disease prevention as well as disease control, check out “What can be done against CWD?“ and “How can we prevent an introduction of CWD to Germany?“.

Can we speak of a genetic susceptibility?

Susceptibility to TSE disease has a strong genetic component in many species, depending on the structure of the prion protein gene, which can lead to varying degrees of susceptibility/resistance to TSE infection. Studies from North America demonstrate this for cervids, too. Unfortunately, to date little is known about the genetic susceptibility for native deer species in Europe, in particular for roe deer (Capreolus *capreolus*). North American studies suggest that fallow deer (*Dama dama*) may not be affected by CWD, as no natural infections have yet been reported in this

species, whereas experimental infections via intracerebral inoculation are possible.

The primary structure of the prion protein depends on the differences in the genotype. We already know from other prion diseases that the compatibility of the primary structure of the donor and recipient prion protein determines whether and how easily conversion to PrP^{Sc} is possible. Even the exchange of a single amino acid can influence transmission rates positively or negatively. The knowledge of these so-called polymorphisms is already used for Scrapie disease control, breeding sheep and goat with resistant prion protein genotypes.

To find out more about the genetic diversity of German cervids and their genetic susceptibility to CWD, the FLI performs a comprehensive study on the occurrence and distribution of the prion genotypes present in the German cervid population. In particular, tissue samples of red deer, roe deer and sika deer are of great interest. For more information about this project, check out "Is there a current research project on CWD ongoing at the Friedrich-Loeffler-Institut?".

What is known about the resistance of the pathogen and under what conditions can it be inactivated?

The increased resistance of the pathological prion protein is the major challenge of disease control and prevention. Only destroying the tertiary structure of the prion protein reduces its infectivity. However, this cannot be achieved with conventional decontamination measures. Dry heat, steam sterilization procedures as well as most bactericidal, virucidal and fungicidal disinfectants do not show sufficient effects. Aldehydes and alcohols even stabilize the protein. Only a few very complex decontamination measures are suitable for inactivating PrP^{Sc}, these include treatment with highly concentrated sodium hydroxide solution, sodium hypochlorite or sufficiently high temperatures. Details on decontamination are listed on the FLI website Empfehlungen des Friedrich-Loeffler-Instituts über Mittel und Verfahren für die Durchführung einer tierseuchenrechtlich vorgeschriebenen Desinfektion (openagrar.de).

How long can the pathogen be detected in the environment?

If prion proteins enter the environment, they can remain infectious there for years by binding to soil particles. Different mineral compositions of different soils can additionally preserve the protein. Contaminated soils could thus represent a reservoir for the infectious prion protein that should not be underestimated and have therefore been classified by the European Food Safety Authority (EFSA) as a risk factor for the spread of CWD. In addition, Pritzkow *et al.* (2015) demonstrated that plants inoculate prions from contaminated soil and transfer them to their leaves. By grazing in contaminated regions, cervids infect themselves with PrP^{Sc}. The widespread sale of - potentially infectious - lichens as feed for free ranging deer in northern Europe could also be a source of infection.

It has been shown that infected carcasses heavily contaminate the environment (Miller *et al.*, 2004). Therefore, it should be considered that improperly disposed killed animals, parts of animals and carcasses could be relevant as a source of contamination.

Is there a current research project on CWD ongoing at the Friedrich-Loeffler-Institut?

The FLI is one of six partners in the EU project „Tackling Chronic Wasting Disease in Europe“. This project is within the Cofound ERA-NETs International Collaboration of Research of Infectious Animal Diseases (ICRAD), Horizon 2020 research framework program, and is funded in Germany by the Federal Ministry of Food and Agriculture.

The aims of this project are to investigate the diversity of the prion protein genotype in European deer and thus their susceptibility to CWD. The Scandinavian partners perform epidemiological investigations of European CWD and evaluate the surveillance strategies applied so far. In addition, *in vitro* and *in vivo* studies will investigate the potential of European CWD isolates for interspecies transmission - especially to livestock and humans.

Hunters of all over Germany can significantly support the study on the genetic diversity of native deer species, by sending us samples of roe deer, red deer and sika from their hunting grounds. The most suitable samples are spleen, heart, kidney or brain (extended medulla). For a guideline for sample collection and more information about our project click here FLI-Animal Disease Situation - CWD.

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Photo/Source: Red deer cow (© S. Ernst)