UF IFAS Extension UNIVERSITY of FLORIDA

WEC366

Facts about Wildlife Diseases: Hemorrhagic Fever in White-Tailed Deer[1]

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Figure 1. Relative sizes of common flying insects in Florida. On the left is a black fly, in the middle is a biting midge, and on the right is a mosquito. The biting midge (middle) is much smaller and may be very hard to see when in flight.
Credits: Katherine Sayler

Hemorrhagic Disease (HD): What It Is and How It Is Spread

Hemorrhagic disease (HD) is the most important viral disease of white-tailed deer in the United States. The viruses that cause HD do not cause illness in people.

HD is caused by two different viruses, **bluetongue virus (BTV)***, named after the swollen blue tongue found in some infected animals, and **epizootic hemorrhagic disease virus (EHDV)**. Both of these viruses are transmitted between animals by tiny, blood-feeding flies called **biting midges** (Figure 1). When the female biting midge feeds on the blood of an infected deer, the midge can become infected with the virus and then will spread the virus to a new deer when it takes another blood meal (Figure 2). Because the midge that spreads the virus emerges when the weather is warm, infections and the occurrence of sick deer have a seasonal pattern. In Florida, like much of the United States, most cases of HD occur in the late summer and early fall (August–October); however, because of Florida's subtropical climate, it is possible to see cases of disease into the winter months, especially in south Florida, where hard freezes are rare. In cooler climates, freezing temperatures typically break the cycle of transmission by killing the adult biting midges, ending the cycle of HD transmission in that year.

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*See glossary for definitions of bold, underlined phrases.

Importance of HD in Florida and Beyond

Globally, HD is a disease of ruminants. In the United States, EHDV is a naturally occurring disease of deer. Large outbreaks have occurred in the northern Midwest and western United States, yet in Florida outbreaks are fewer and less severe in wild white-tailed deer. For deer farmers in Florida, however, EHDV can be an enormous source of mortality for farm-raised deer.

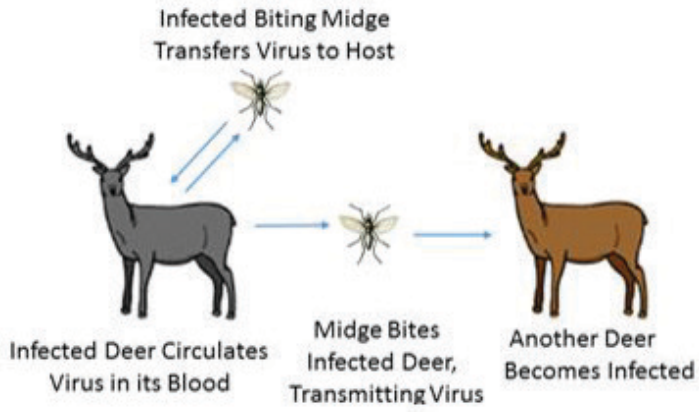

Figure 2. Transmission cycle of hemorrhagic disease viruses in the wild.
Credits: Katherine Sayler

There are more than 29 types of BTV and 7 recognized EDHVs that can be distinguished by **serological analysis**. The viruses are spreading within the United States and around the world, and new virus serotypes are being discovered every few years (Figure 3). In the United States, types BTV-2, 10, 11, 13, and 17 are the most common bluetongue viruses. In Florida, all five established BTV serotypes are reported in deer. However, other types of BTV have been found in the state, sometimes causing fatal infections in wild and farmed deer (USDA 2013a). Understanding which virus is circulating is important because the type of virus found during an outbreak may not be controlled by available vaccines (see section below "Management of HD in Farm-Raised Animals").

Before 2006, there were only two recognized EHDVs in the United States: EHDV-1 and EHDV-2. Following isolation of EHDV-6 in dead white-tailed deer from Indiana and Illinois, it was recognized that EHDV-1, 2, and 6 cause disease in white-tailed deer in the United States, including Florida (Ruder et al. 2012). Furthermore, HD case numbers are increasing in the northeastern and southeastern United States, including Florida, but the reason why is still unknown (Stallknecht et al. 2015). The reason HD deaths are increasing overall could be due to the introduction of new viruses from other parts of the world, climatic conditions (including droughts and wind patterns), and changes to biting midge populations (Mullens et al. 2004).

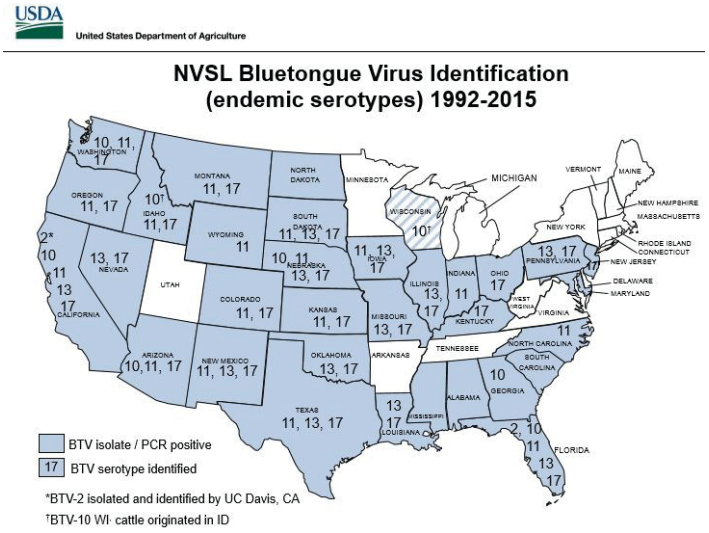

Figure 3. Map of common bluetongue serotypes identified by National Veterinary Services Laboratories (NVSL).
Credits: Map courtesy of Dr. Eileen Ostlund, Associate Director of the National Veterinary Services Laboratories, USDA, APHIS (Ostlund 2015).

Currently, the Southeastern Wildlife Disease Cooperative Study (SWDCS) in Athens, Georgia, actively monitors for new, invasive types of biting midges that might come into the United States from the Caribbean or Central or South America. Their long-standing project not only looks at introduced, "exotic" biting midges but also describes where the midges that spread BTV and EHDV are currently found in the southeastern United States.

Species Susceptible to BTV and EHDV

Both BTV and EHDV can cause hemorrhagic fevers in many different animals; globally, BT is mostly a disease of domestic livestock (sheep, goats) and deer, whereas in contrast EHD is a disease of certain species of wild, hoofed animals, especially white-tailed deer (McVey and MacLachlan 2015).

Who develops EHD? According to the World Organization for Animal Health (OIE), EHD mostly affects white-tailed deer (*Odocoileus virginianus*) and cattle (OIE 2014). Mule deer may also get sick (Center for Food Security and Public Health (CFSPH) 2015). Sheep, black-tailed deer, red deer, wapiti, fallow deer, and roe deer might also be susceptible (meaning they can pick up the virus), but usually do not

become sick. Recent outbreaks in elk have occurred in the United States.

Who develops BT? A large number of animals can be infected with BTV including goats, sheep, cattle, buffalo, white-tailed deer, mule deer, and key deer. Globally, most cases of sick animals with BTV occur in domestic sheep, but can also occur in goats, pronghorn sheep, and bighorn sheep (CFSPH 2015).

Signs of Infection

Signs of infection can vary widely between herds or even individuals; signs range from fatal disease, from which animals get very sick quickly, to a far more mild disease.

Figure 4. Characteristic swollen tongue observed in a white-tailed deer with HD infection.
Credits: Charlotte Dow

EHD: With the classical form the disease (also known as acute disease), deer can become sick soon (2–7 days) after being bitten by an infected midge. White-tailed deer exhibit high fever, anorexia or dropping of partially chewed feed, respiratory distress, and swelling (sometimes severe) of the head and neck. Swelling of the tongue and the tissue around the eyes can also occur. Soft tissue swelling is one of the more common signs typical of HD. Deer may also lose their appetite and fear of humans and grow progressively weaker. They often salivate excessively and develop a rapid pulse and respiration rate. Sick deer typically remain near a source of water. Farmers of white-tailed deer in Florida have observed that infected deer may walk as if either one or all of their feet are sore and with a rounded back. In many cases, with the acute form of the disease, the deer may not display any outward signs of infection and the farmer will find a dead animal in the pen that appeared perfectly normal the previous day. In deer that die, hemorrhages may be seen in many tissues including skin and heart, and animals may develop ulcers or erosions of the tongue, dental pad, palate, **rumen**, and **abomasum** (Savini et al. 2011). Veterinarians and farmers have often noted that the skin of affected deer appears bruised. The bruising is most easily appreciated on the inner thighs and caudal abdomen where the hair is the thinnest. Surviving deer may also develop abnormal hooves and slough their hoof walls. This is typical of the "chronic" form of the disease, where animals survive but fail to thrive in the years following infection. In animals that survive, long-lasting antibodies (parts of the immune system that help protect an animal from future illness) may protect the animal from infection with the same type of virus temporarily (either EHDV-1, 2 or 6). However, new strains of the EHD virus can occur in subsequent years, to which animals are susceptible.

Clinical signs of EHD in cattle are similar to those exhibited by BTV-affected animals. Cattle infected with EHDV will show signs of sickness in 1% to 18% of cases, but death is rare. Production losses associated with the disease in cattle may be significant, especially in dairy farms (European Food Safety Authority 2009).

BT: Signs of EHD and BT are very similar in white-tailed deer, and diseases caused by the two viruses can be very difficult to tell apart. In deer, non-specific signs such as fever, severe depression, anorexia, and loss of fear of humans have been reported. The lips and tongue may become very swollen and may hang out of the mouth, often becoming blue or purple in color (Figure 3). The muzzle, mouth and tongue, and coronary band of the hoof (the soft skin that the hoof grows from) may all appear bruised. Problems with the mouth caused by the virus can result in drooling, soreness during feeding, or a complete inability to eat.

Management of HD in Farm-Raised Animals

There is no treatment for HD once an animal shows signs, only supportive care to reduce secondary bacterial infections. The best way to manage HD is to prevent it.

Supportive Care

There is no "cure" for HD, only supportive care that can help get the animal through the infection. *Early treatment is best, and giving treatment at the first sign of illness may improve chances of the animal recovering*. It is not recommended to "dart down" or anesthetize a sick deer; however,

in certain cases this is the only possible way to administer treatment. If possible, give IV fluids and concentrated dexamethasone along with B complex vitamins and an A, D, and E vitamin complex. Long-acting antibiotics like Draxxin or Excede may also be given. These antibiotics *do not* kill the virus. They are only given to help control bacterial infections in the lungs that happen because the virus is replicating in the animal and weakening its immune system. Pneumonia is the most common outcome in deer with an HD viral infection, so antibiotics are an imperative part of the treatment plan. If the animal is not dehydrated, giving Baytril and subsequent fluids is another option for reducing secondary infections. Adding electrolytes to the water trough and moving additional water troughs close to the sick animal is also useful because sick deer will often become isolated away from the rest of the herd. A probiotic should be added to the deer's feed if any of the deer in the pen are acting sick or are being treated with medications.

If darting a deer is the only available method of administering treatment, it is recommended to dart with a long-acting antibiotic and a concentrated dexamethasone injection. Note that currently there are no approved treatment protocols or medications for white-tailed deer. Any uses of the above mentioned medications for deer are considered "off-label" and must be done under direct recommendation from a veterinarian with whom you have a valid client-patient relationship.

Vaccination

Vaccination of animals against HD is difficult in the United States. Inactivated (killed) vaccines have controlled outbreaks in Europe (BTV-8), but effective vaccines are not available for most North American BTV and EHDV serotypes (McVey and MacLachlan 2015). This is because there are no USDA-licensed vaccines that will protect against all of the different types of viruses that cause HD. At this time (2016), there is only 1 USDA-licensed vaccine for HD, and it protects only against BTV-10. No cross-protection exists between EHDV and BTV, so vaccination for one will not provide protection against the other. In other words, vaccinating against BTV will not protect against EHDV, or vice versa.

It is also important to know that vaccination with the BTV-10 vaccine will not protect against the other BTVs (BTV-2, BTV-10, BTV-13 and BTV-17 are common in Florida, but other bluetongue viruses have been found on occasion). **Autogenous vaccines** (viruses grown from the tissues or blood of an infected, sick animal) have been developed for both EHD and BT, but success is undetermined because those vaccines have never been tested (USDA 2013b). Florida-specific vaccines are currently being manufactured, and researchers at the University of Florida are working to determine how well these vaccines work and how they can best be formulated to protect the largest number of animals in the state. For captive deer, scheduling and administration of autogenous vaccines must be done under direct recommendation from a veterinarian with whom you have a valid client-patient relationship.

Integrated Pest Management

HD is a vector-borne infection that relies on biting midges for transmission. There are currently no proven biting midge control options known to effectively reduce virus transmission, although techniques can be used to mitigate against virus transmission under some scenarios (Carpenter 2008). Insect control methods for the control of biting midges include chemical, biological, or physical/land management strategies (Pfannenstiel et al. 2015). Each method has advantages and disadvantages. Due to the huge number of *Culicoides* spp. that may be present during an outbreak of HD and the cost associated with controlling these insects, some approaches are more feasible than others.

Chemical control methods involve pesticide application where the biting midges develop as larvae or directly onto animals on which they feed as adults, such as deer. This can be very expensive and time consuming because adult midges can occur in huge numbers and applications have a limited lifespan so may need to be used every day in some cases. Treatment of breeding sites, or where the midges reproduce, would lessen the amount of application needed, but that treatment would require a better understanding of the biology of midges because the specific breeding sites would have to be found and treated with pesticides. It is challenging to treat breeding sites directly because biting midge breeding sites may cover huge areas, like entire stream margins. Physical means of biting midge control involves physically modifying the environment, including changing the location and depth of watering holes and holding captive deer as far away from midge breeding sites as possible (if the breeding sites are even known). Building waterholes that are steep and have rocky edges (rather than sandy or muddy banks) may decrease breeding sites for midges. In combination with removing sick animals from the herd and keeping penned animals within an insecticide-treated barrier, management of the environment can be a practical approach for controlling *Culicoides,* but it tends to be highly specific to particular situations. Much more research needs to be done on management of these insects,

and therefore HD, in Florida and beyond. Researchers at the University of Florida Cervidae Research Health Initiative (CHeRI) are working on this problem here in Florida to aid in developing best practices for the captive cervid industry.

Best Management Practices for Farmed Deer in Florida

Diagnostics

Diagnostic tools for HD are currently expensive and may involve a significant lag time between sample submission and results. The lack of a comprehensive, affordable toolkit for determining which virus strain an animal has been exposed to or is infected with prevents the understanding necessary to develop prophylactic tools like vaccines.

To improve sensitivity and turnaround time, UF/IFAS is working to streamline virus identification in infected animals. Using improved techniques, the virus can be detected using real-time polymerase chain reaction (PCR) that can be used to quickly determine (usually in under 2 hours) whether or not an animal is infected. Using a simple follow up test, the type of EHDV or BTV can be determined. It is also possible to isolate the virus using fresh samples. From these samples we can determine the genetic code of the entire virus and tell how different it is from or similar it is to viruses circulated throughout Florida. This can give researchers clues as to when and from where new, "exotic" strains of the viruses have been introduced into the state.

Whole-blood collected in EDTA-coated tubes (available from your veterinarian) or spleen samples from dead deer collected as soon as possible after death are the ideal diagnostic specimens. Samples should be refrigerated *but not frozen* because the virus degrades on direct contact with ice.

The Work of UF/IFAS CheRi (Cervidae Health Research Initiative)

In response to Florida stakeholders, UF/IFAS Cervidae Health Research Initiative (CHeRI) seeks to promote interdisciplinary science, education, and outreach that increase the health and production of captive cervids in a sustainable manner and promotes the health of native wildlife and the ecosystems in which they live. In response to the needs of farmers in Florida for controlling HD, we have developed a multi-pronged approach to reduce mortality and increase production in deer and cattle. We have begun collecting data to support the development of an integrated pest management plan and a best farm management plan; we are increasing diagnostic capabilities for detection and management of disease; and we are developing relationships with captive deer farmers and cattle ranchers throughout Florida.

Glossary

Bluetongue virus (BTV) is a vector-borne viral disease that affects wild and domestic ruminants. Infection with BTV is inapparent in most animals, but can cause fatal disease in some infected sheep, deer and wild ruminants.

Epizootic hemorrhagic disease virus is a vector-borne viral disease that affects wild and domestic ruminants, especially white-tailed deer. The acute form of the disease can result in a very high mortality rate in white-tailed deer.

Biting midges are very small flies that can transmit the epizootic hemorrhagic disease and bluetongue viruses. Officially, these tiny insects are members of the genus *Culicoides*.

Serological analysis is a laboratory test that uses a sample of blood serum, the clear liquid that separates from the blood when it is allowed to clot. The purpose of such a test is to detect serum antibodies that the body puts out to help fight infections.

Rumen and abomasum are two of the four chambers of the stomach of a ruminant animal, such as cattle, goats, sheep, deer, and antelope.

Autogenous vaccines are vaccines made from freshly isolated viruses taken from a dead deer that has died from EHDV or BTV, which is then grown up in a laboratory. Typically, these types of vaccines are made for use only within the herd from which the animal that died came.

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