

Rabies: Public Health Surveillance and Disease Investigation

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SLIDE 1

Hi! I am Marilyn Haskell, one of the state public health veterinarians and a veterinary epidemiologist with North Carolina Division of Public Health. I'm going to talk to you today about rabies – risk assessments and post-exposure prophylaxis.

SLIDE 2

Today, you're going to learn how to recognize the public health significance of rabies, know what constitutes a rabies exposure, and know the importance of pre and post-exposure prophylaxis.

SLIDE 3

Do donkeys get rabies? This may seem like a strange question to you. If you were living in NC this spring, then you probably know the answer to this question. Yes, donkeys do get rabies. In fact, any mammal (defined as a warm blooded animal that nurses its young and has fur or hair) is susceptible to infection with rabies. Rabies is very much present in NC wildlife. And, an unfortunate donkey named Eddie, on a farm in Durham county, found this out the hard way – probably through exposure to a rabid raccoon, because a dried up raccoon carcass was found on the property a couple of weeks prior to Eddie's demise. This investigation centered around a working goat farm that produced cheese, provided agro-education to young school children, including hands-on animal activities like milking goats, and hosted farm porch suppers and other group agro-tourism activities for the public. This investigation involved assessing many animals and people for possible exposure to rabies, decisions on animal confinement periods, animal quarantines, and human post-exposure prophylaxis. Many different agencies collaborated in this investigation, including the local health department, Animal Control, the NC Department of Agriculture, and the NC Division of Public Health, State Lab of Public Health, and Public Health veterinarians. This was a complex rabies investigation – not the usual. Fortunately, most rabies investigations are not this involved, but they can be. Let's take a look at the world of rabies.

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Rabies is enzootic in North Carolina wildlife. That means it is present in the wildlife throughout the state. Raccoons are the terrestrial or land reservoir for rabies in NC. They are the species that carries, spreads, and keeps the rabies virus alive in NC. Eastern raccoon variant is the type of rabies virus that we have in our state now. In the 1940s and 50s, canine variant was the threat, but canine variant was recently eradicated from the US in 2008, according to the CDC. Domestic animals like dogs, cats, and livestock, though less likely to become infected and transmit, are still susceptible to rabies because they are mammals. When domestic animals become infected with rabies, people are more likely to be exposed.

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Close interactions with raccoons result in spread of rabies or “spillover” into other wild, domestic animals, and humans. Raccoons have adapted well to urban and suburban areas, as you might know. People live in those areas with their pets, so it is not uncommon to see raccoons around your home and in homes throughout NC. You should assume any raccoon or rabies vector species is infected with rabies. One of the most important public health messages we can deliver is for people and their pets to stay away from wildlife! Do not approach, handle, or bring wildlife home; do not feed wildlife; do not feed your pets outside, or leave pets outside unsupervised. All livestock are also susceptible to rabies. Do you see Eddie, the donkey, in this picture?

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This slide shows the wild species we expect to be infected with rabies in NC. They include the reservoir species, raccoons and bats, and other wildlife that live and feed in the same environment as raccoons – skunks, foxes, bats, beaver, and groundhogs. Other large carnivores are also considered high risk rabies vectors for transmission. Bats are the other rabies reservoir in NC, and they are the only flying mammal. Bats have their own variant of rabies; these variants are named according to the species of bat infected. If a human or an animal not currently vaccinated is exposed to a high risk rabies vector, then the wild animal should be submitted for testing to the state lab. Any human exposed to any of these animals listed on this slide, typically by a bite, will require rabies post-exposure prophylaxis unless the animal is captured by animal control, and then submitted for testing to the state lab. If the animal tests negative *within 24 hours*, then the person does not need post-exposure prophylaxis (PEP). Domestic animals that are currently vaccinated are required to be boosted within 5 days of the exposure with rabies vaccine.

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In 2009, 473 animals tested positive for rabies at the state lab. About 90% of the reported rabid animals each year are wildlife species. You can see from this pie chart that among the positive animals, raccoons represented more than 50%, followed by foxes 18%, skunks 13%, and bats 7%. Among domestic animals, rabid cats (19 cases here) consistently outnumber rabid dogs (7 cases), both in NC and nationally. Every year, several livestock species test positive as a result of an encounter with a rabid species of wildlife. Eddie was the first donkey in NC that ever tested positive for rabies at the state lab of public health. In 2009, we also had our first positive river otter and one of three opossums that have ever tested positive in NC. Low risk wild animals include small rodents (like squirrels) and rabbits. Animal control is required to call one of the state public health veterinarians to approve testing of low risk species through a risk assessment before they can be submitted to the state lab.

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Worldwide there are approximately 55,000 human deaths due to rabies each year, primarily in developing countries, and due to canine variant rabies. In the United States

however, the majority of the human rabies cases and deaths over the last 3 decades have been caused by bat variant rabies.

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Since 2000, there have been 31 cases of human rabies reported in the United States. Twenty- three of those cases were acquired in the US and 18 human cases were associated with bat variant. Among those, 83% reported a bite or direct contact; 17% reported having no known exposure to a bat.

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This graph displays the number of confirmed rabid animals in NC from 1952 to 2009 at the state lab. The only human case of rabies ever reported in North Carolina to date, occurred in 1953, when a woman succumbed to canine variant rabies after she was bitten by her dog. The first case of bat variant was reported in NC in 1963. Raccoon variant rabies was first reported in NC in 1991 and has grown into a major epidemic in the state since the early 1990s.

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How did raccoon variant rabies get into North Carolina? This map shows the expanding epizootic of raccoon variant rabies in the eastern United States. Two major epidemics of raccoon rabies converged on North Carolina's wildlife population in the early to mid 1990s from the north and south, as pictured by the light and dark aqua coloration on this map. In the early 1950s, there was an epizootic of raccoon rabies in Florida. Raccoon-to-raccoon transmission resulted in spread of the disease northward throughout Florida, Alabama, Georgia, South Carolina, and then into North Carolina in the early to mid 1990s. A second epizootic appeared in the mid-Atlantic states in the late 1970s – originating at the West Virginia/Virginia border, the result of hypothesized translocation of a rabid raccoon for hunting purposes. The mid-Atlantic epizootic rapidly spread north and south and into NC in the mid 1990s. From that point in time, rabies has spread from animal to animal to virtually every county throughout NC.

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This is a map of the US showing all of the rabies reservoir variants geographically. You can see that eastern raccoon variant rabies is now present in every state up and down the eastern seaboard from Florida to Canada. The Centers for Disease Control and Prevention reports that wildlife currently account for greater than 90 percent of reported cases of rabies in the United States. This is also true for North Carolina as well.

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This map of North Carolina shows the location and relative number of raccoon rabies cases by county during the period 2001 – 2005. As you can see, virtually every county in North Carolina has raccoons infected with rabies. Let's take a closer look at this disease, rabies.

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Rabies is caused by a very tiny virus of the genus *Lyssavirus*. Viruses cannot be seen with the naked eye, but can only be seen with a sophisticated microscope. Rabies is a type of virus called an RNA virus and can make you very, very sick. The disease is much more deadly than other diseases caused by RNA viruses including, the common cold, measles, flu, and HIV/AIDS.

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This person is doing something that will put them at risk for rabies transmission – handling a bat with their bare hands. Animals may appear healthy even when they are shedding rabies virus in their saliva. Most exposures start with an animal bite. After virus-infected saliva is inoculated into a wound, the virus stays at the site of the bite wound for most of the incubation period. The virus replicates or multiplies in muscle tissue and then binds to specific receptors at the junction of nerves and muscles. Virus begins to travel quickly through peripheral nerves within nerve axons and muscles toward the spinal cord.

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Once in the spinal cord, the virus moves rapidly to the brain where it infects neurons and causes swelling or inflammation, medically called encephalomyelitis. Dysfunction of neurons is what causes all of the central nervous system symptoms of the disease. Once the virus reaches the brain of an infected person or animal, it simultaneously spreads rapidly to the salivary glands and then to virtually every nerve in the body (the cornea, skin, and organs). Coma and death usually occur shortly thereafter. The incubation period in people is the time from exposure to development of clinical signs of disease and is usually around 3 weeks to 3 months.

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Bites from rabid animals are the most common way that people and animals become infected with rabies. There are other modes of possible transmission recognized as exposures called non-bite exposures. They are important, but they are not very common causes of transmission. Non-bite exposures include saliva to open wound (including a scratch or abrasion), saliva to mucous membranes, nervous tissue exposure to open wound, and nervous tissue exposure to mucous membrane. All contact with a potentially rabid animal, or the saliva or nerve tissue of a rabid animal, should be evaluated. *Any direct or suspected direct contact with a bat is considered an exposure.*

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An exposure to rabies is defined by the CDC in the 2008 ACIP guidelines as “any bite, scratch or other situation in which saliva or central nervous system (CNS) tissue from a potentially rabid or confirmed rabid animal, enters an open wound, or comes in contact with a mucous membrane by entering the eye, nose or mouth”.

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Bat exposure assessments are a little different. Any potential exposure to a bat requires a thorough evaluation and history of exposure. If possible, the bat involved in potential human or unvaccinated animal exposures should be safely collected and submitted by Animal Control to the state lab for rabies diagnosis. When multiple bats are involved, call Veterinary Public Health for guidance. According to the 2008 CDC ACIP guidelines, “Any direct contact between a human and a bat should be evaluated for an exposure. If the person can be reasonably certain a bite, scratch, or mucous membrane exposure did not occur, or if the bat is available for testing and is negative for presence of rabies virus, post-exposure prophylaxis is not necessary.” Other situations that might qualify as exposures include finding a bat in the same room as a person who might be unaware that a bite or direct contact had occurred. Examples of this include a deeply sleeping person who awakens to find a bat in the room; an adult witnesses a bat in the room with a previously unattended child, a mentally disabled person, or an intoxicated person. These situations should not be considered exposures if rabies is ruled out by diagnostic testing of the bat, or circumstances suggest it is unlikely that an exposure took place. Consult with Veterinary Public Health always to assist with investigations if you need to.

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These pictures help to illustrate why bat bites may go unrecognized or may seem insignificant. There are several reasons that may explain this...

- the limited injury inflicted by a bat bite, compared with more obvious wounds caused by the bite of other rabid animals. (See how tiny the bite marks are in the picture? You can see how they might go unrecognized).
- evidence that some bat-related rabies viruses might be more likely to result in infection after inoculation into superficial epidermal layers;
- also, an inaccurate recall of a bat encounter that might have occurred several weeks or months earlier;
- also some people may not be aware that bats can transmit rabies and that exposure to a bat is risky business.

Education about bats and rabies is an important part of our job in public health!

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Within a 7 day period in 2010, we had 3 major bat investigations as shown on this slide! You will undoubtedly receive calls about bat exposures and bat infestations. It is important to become familiar with how to assess bat exposures and what recommendations to make. We receive calls in Veterinarian Public Health about bats in the bedroom, laundry room, kitchen, in the attic, chimney, at summer camps, universities, hospitals and churches, and so on – just about every situation. When there is a reported infestation of bats (several bats in a building) we recommend that the owner of the property call a Wildlife Damage Control Agent. These agents have been trained by the NC Wildlife Resources Commission. They know the laws pertaining to appropriate exclusion of bats. Do not hesitate to call one of the public health veterinarians to assist you with any rabies assessment or investigation.

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As a CD nurse at the local health department, you will receive calls from Animal Control, bite victims, attending physicians, hospital EDs, and veterinarians, reporting animal bites and possible rabies exposures. Risk assessments for PEP, or post-exposure prophylaxis, are based on many factors and questions posed to the bite victim. Some of these include questions about the exposure.

- Is it a true exposure according to ACIP guidelines?
- Is the animal species low risk or high risk; is it domestic or wild?

If a Low Risk animal:

- Was the behavior of the animal consistent with the species and did it show signs of illness?
- Were there bite wounds on the exposing animal?
- Was it a provoked or unprovoked attack?
- What was the severity of the attack on the victim, and location of bite wounds?

It is important to get to know your animal control officers in your local area and to maintain good communications, because they play an important role in rabies investigations, prevention and control. Animal control officers enforce the rabies laws of North Carolina. They capture the biting animals; implement 10-day confinements and 6 month quarantines; euthanize, prepare, and submit animals for rabies testing; and conduct the animal part of rabies exposure investigations.

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There are several North Carolina rabies laws that you should become familiar with, and they are located in Chapter 130A, Part 6, Rabies, of the Public Health laws. The rabies laws are regulated by the state, NC DHHS, public health veterinarians, and enforced at the local level, usually by animal control or the police department, under the direction of the local health director.

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North Carolina General Statute 130A-196, requires that attending physicians report all animal bites to the local health director within 24 hours. The person bitten, parent or guardian, and the person that owns the biting animal, are also required to report the bite by law. Then, the bite investigation begins.

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Rabies vaccination is required by NC statute for all owned cats, dogs and ferrets four months of age and older. The most important practice that pet owners and veterinarians can do to prevent rabies is keep all dogs, cats and ferrets currently up-to-date on their rabies vaccinations. Important points concerning livestock...vaccination of livestock is not required by NC state rabies laws, although Eddie, the donkey probably wished otherwise. The decision to vaccinate livestock is left to the farmer, based on economic factors and the prevalence of rabies in that geographic area. Animals in public settings, including petting zoos, horseback riding, exhibitions or sanctioned agricultural fairs, should be vaccinated against rabies according to the 2008 Rabies Compendium. This

can be enforced under Aedin's law, named after a child who was infected with E.coli 0157:H7 after petting animals at the state fair in North Carolina. There are USDA licensed rabies vaccines for horses, cattle, and sheep. There are no currently approved vaccines for goats, swine or donkeys.

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The NC statutes 130A-196 and 197 are important to understand because they are based on the shedding and incubation periods for rabies in dogs, cats and ferrets. NCGS 130A-196 requires a 10-day confinement period for any dog, cat or ferret that bites a person. The shedding period for dogs, cats and ferrets from development of clinical signs and death shortly thereafter, has been established through rabies challenge studies to be not longer than 3-7 days. Based on guidelines from the 2008 Rabies Compendium, published by the CDC in an MMWR, and one of your references, the 10-day confinement is sufficient time to observe an animal for clinical signs of rabies, if it had been shedding rabies at the time that it exposed the person. You can be certain that if the animal is normal and healthy 10 days after the bite, then it was not shedding rabies virus at the time of the bite. GS 130A-197 requires either a 6 month quarantine or euthanasia of all dogs, cats and ferrets that are not currently vaccinated when they are exposed to a rabid animal or animal reasonably expected to be rabid. An infected dog, cat or ferret may incubate rabies as long as 6 months, but typically develops rabies 3 weeks to 3 months after the bite. The quarantine period covers the entire potential incubation period.

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The rabies timeline begins when an animal is exposed to rabies. In this case, a dog has killed a rabid raccoon and has a mucous membrane exposure to nervous tissue as it bites and chews through the raccoon carcass. The raccoon may have also bitten the dog. This is probably how Eddie, the donkey, was exposed. The incubation period begins when the animal is exposed to the virus and lasts until the onset of viral shedding in the animal. In other words, incubation is the time between entrance of virus into the animal and the time when that animal can transmit the virus in their saliva. "Shedding" of rabies virus occurs late in the incubation period and begins when rabies virus enters the salivary glands and is excreted in the saliva, about the same time virus enters the brain. *It is important to remember that rabid animals can shed and transmit rabies virus in their saliva while they may appear normal and healthy, before they develop clinical signs of disease.* That period is maximally 10 days, and that is the basis for the 10-day confinement period. You will use this shedding information to determine the time frame of potential human exposures to a rabid animal. You will have to interview those people potentially exposed to the animal during the shedding period, and conduct human exposure assessments to determine who will or will not need post-exposure prophylaxis.

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According to NC statute 130A-197, if a currently vaccinated dog, cat or ferret is exposed to a potentially rabid animal, then all that is required is a rabies booster administered

within 5 days of the exposure. If a person or unvaccinated animal is exposed, then the wild animal should be submitted for testing.

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This is a true example of a high risk rabies exposure. This person thought that a baby raccoon that he found in his yard abandoned by its mother was so cute. When he tried to pick it up, the raccoon bit him and then ran off. Is it legal to rehabilitate rabies vectors in NC? No-- this activity is not permitted by NC Wildlife Resources Commission. Can a baby raccoon transmit rabies? Some people think baby animals can't. Yes, they can. Any rabies vector species at any age is considered infected with rabies unless captured and tested negative. This person had to complete a post-exposure prophylaxis regimen because the animal escaped and could not be captured and tested.

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This is another true story and we receive calls of this sort more often than we like or should. A pet dog fights with a raccoon or a dead raccoon is found in the yard where a pet was left unsupervised. The dog then licks a family member in the face or the family member handles and cleans the wounds inflicted by the raccoon with bare hands, and there may be cuts on their hands. If wet saliva or neurological tissue from a rabid or potentially rabid raccoon were transferred onto a mucous membrane or open wound of a person, then that is considered an exposure to rabies. Post-exposure prophylaxis would be recommended unless the raccoon was captured and tested negative for rabies. People should always be warned not to handle and to keep their children away from wild animals or animals that are domestic and recently exposed to wild animals. If necessary to handle the pet, wear thick, intact rubber gloves and don't let children near. What happens to the dog in this situation? Animal Control should always be called to assist in the assessments of dog, cat or ferret exposures to potentially rabid animals. Animal control will determine if the dog was currently vaccinated against rabies and if so, then a rabies booster is given within 5 days of date of exposure. If no humans or unvaccinated animals were exposed, the raccoon will not have to be submitted for testing. If the raccoon escapes or tests positive or unsatisfactory, and the dog is unvaccinated or not currently vaccinated against rabies, the dog will be placed in 6 month quarantine at the discretion of the local health director or euthanized. If a person or unvaccinated animal is exposed to a potential rabies vector, ALWAYS call Animal Control to capture the wild animal, if possible, and submit for testing. This is one reason why it is so important to keep dogs, cats and ferrets currently vaccinated. Livestock exposures are investigated by North Carolina Department of Agriculture (NCDA). Always call Veterinary Public Health when livestock are potentially exposed to a rabid animal. We will then report the incident to NCDA.

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If a domestic dog, cat or ferret bites a person and is not captured by animal control and placed in a 10-day confinement within 48 hours, then post-exposure prophylaxis should begin.

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Primary prevention of rabies requires education of the public about rabies and vaccinating their pets; changing human behavior to avoid animal exposures; and education about pre-exposure vaccinations for people who are exposed to animals in their line of work or hobby. Education is also critical for secondary prevention. Unfortunately, rabid animal attacks are often unpredictable. The public should know what to do if they are bitten by an animal –how to report to animal control, and when and where to seek help and treatment. It is our job in public health to educate healthcare providers, veterinarians, and animal control about prevention of rabies.

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There are currently 2 cellular-derived rabies vaccines available for vaccination of humans. The two manufacturers are Novartis and Sanofi Pasteur. There are also 2 companies that manufacture human rabies immune globulin – Sanofi Pasteur and Talecris. We have an affidavit to qualify indigent patients for free rabies vaccine and human rabies immune globulin (HRIG) through our state lab for public health. You may contact Veterinary Public Health to find out more information about this program.

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Pre-exposure immunization is recommended for people who have risks for rabies exposures in their line of work or hobby. These include veterinarians and their staff who work with animals, laboratory workers, Animal Control officers, animal shelter workers, wildlife workers, and travelers to rabies-endemic countries that may be at high risk.

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The regimen for pre-exposure immunization consists of 3 vaccines administered on days 0, 7, and 21 or 28. Vaccinations can be given at the local health department or by a health care provider.

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Post-exposure rabies vaccination for previously vaccinated people* –The current regimen here involves wound cleansing (always clean the wound), and 2 vaccines, given on days 0 and 3. No HRIG is required! Previously vaccinated people are considered those that have received either a pre or post-exposure regimen, complete cellular-derived, or have evidence of an adequate neutralizing RFFIT titer.

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On June 24, 2009, the Advisory Committee on Immunization Practices (ACIP) voted in favor of accepting a recommendation from the ACIP rabies work group to reduce the number of vaccines for post-exposure prophylaxis (PEP), from 5 doses, as recommended in the 2008 ACIP document, to 4 doses for most individuals that are healthy and not immune compromised. These recommendations became official on March 19, 2010, when they were accepted by the CDC Director and published in the MMWR.

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Post-exposure rabies vaccination for previously unvaccinated people, and non-immunocompromised people, is listed below. The current regimen is wound cleansing, 4 vaccines, and vaccination on days 0, 3, 7, 14, along with Human Rabies Immune Globulin (HRIG) on day 0.

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Let's look at one last example to try to put the whole rabies exposure assessment picture together. Mr. Smith calls you and says his dog got into a fight with the neighbor's dog. He immediately tried to break up the fight and got bitten on the finger by one of the dogs. What should you advise him? The first thing always is to wash the wound with lots of soap and running water for 10 minutes and apply a disinfectant. Tell him to visit his physician as soon as possible for wound assessment and to determine the need for tetanus booster, antibiotics, and wound care. He and his neighbor should confine their dogs. And then, call Animal Control to come out and begin a bite investigation. Animal Control comes out and when they do, they may

not be certain which dog bit you. Your dog is currently vaccinated and your neighbor's dog is not. What does Animal Control do? Animal Control confines both dogs, regardless of vaccination status in this situation, for 10 days to observe for clinical signs of rabies according to NCGS 130A-196. No PEP is necessary if the dogs are captured and remain normal and healthy throughout the entire 10-day confinement period. I would like to emphasize a couple of points about delays in post-exposure prophylaxis and anatomical location of exposure. Severe wounds to the face, head, neck and upper body provide ready access of the rabies virus to the central nervous system. In this situation, PEP should be provided immediately. Substantial delays between exposure and initiation of prophylaxis are of concern with any exposure. It is so important for Animal Control to be engaged to capture any biting wild animals and have them tested promptly. If the patient has sustained an aggressive attack to the face and upper body by any animal, or if we don't have the rabies test results for a wild, feral, or abnormal domestic animal within 24 hours, then PEP should begin immediately.

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I want to thank you for your attention. Please don't hesitate to call Veterinary Public Health for our assistance anytime, 24/7.

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Contact information and references.