

Dealing with Rabies

Answers for Ohio Veterinarians



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RABIES PATHOGENESIS AND EPIDEMIOLOGY

WHAT IS RABIES?

Rabies virus is a negative strand RNA virus in the family Rhabdoviridae, genus Lyssavirus (genotype 1, serotype 1). It causes acute encephalitis in all warm-blooded hosts; the outcome is almost always fatal.

The most common sign is a notable change in temperament or behavior. Regardless of exposure history, rabies should be considered as a differential whenever neurologic signs are evident, especially when coupled with abnormal behavior. Once signs develop, clinical disease in domestic animals progresses rapidly. Response to therapy or an illness lasting longer than 7 to 10 days is not likely to have been caused by rabies.

WHAT IS THE PRIMARY ROUTE OF RABIES TRANSMISSION IN MAMMALS?

Rabies is transmitted to humans and animals through contact with infected saliva or neural tissue. Most often this occurs via a bite. Though rare, infectious material may also be introduced through open wounds or mucous membranes. Petting a rabid animal is not an exposure risk, and neither is contact with blood, urine, feces, or skunk spray. The virus does not survive long outside the host so environmental contamination is not considered a likely exposure source.

WHAT ADDITIONAL ROUTES OF TRANSMISSION ARE A CONCERN FOR HUMANS?

Inhalation of aerosolized rabies virus is a highly unlikely route of infection even among avid spelunkers. This is mostly a concern for people working with the rabies virus in a laboratory setting. Ingestion is not believed to be a significant risk; however consumption of meat or milk from a rabid animal is strongly discouraged. Cooking and pasteurization will destroy the virus, but those who drank raw milk from a rabid animal should be assessed to determine recommendations for post exposure prophylaxis. The only reported human to human transmission of rabies has been through tissue transplants.

WHAT IS THE PATHOGENESIS OF RABIES?

Once the virus enters the body, it multiplies locally in the skin or muscle tissue while it works its way into peripheral nerves. The virus then migrates by retrograde axoplasmic flow to the central nervous system. The time span from exposure until the virus first reaches the brain is known as the incubation period. The animal is not shedding virus in the saliva during this time.

The length of incubation is highly variable and is largely based on the inoculated dose and the length of the neural path from the exposure site to brain. Most cases develop clinical signs between 3 weeks and 3 months; in rare cases disease can develop as early as 10 days or up to 6 months after exposure in animals and after more than a year in humans.

Once in the brain, the virus replicates in abundance leading to encephalitis and neural degeneration. During this time the virus migrates to the salivary glands where it is shed in the saliva. The length of time that an animal has infectious saliva before it develops clinical signs is variable. In dogs, cats, and ferrets it is just a few days, which is the biological basis for the ten day quarantine. If a dog, cat, or ferret is able to transmit rabies at the time of a bite the animal will be obviously ill and most likely deceased, within ten days following the exposure. For other species, the infectious period before the development of clinical disease is not well established; testing is therefore recommended over quarantine if rabies is a concern. Viral shedding in excess of two weeks prior to recognizable signs has been documented in some wildlife species.

WHAT ARE THE CLINICAL SIGNS OF RABIES IN ANIMALS?

Abnormal behavior is the early predominant sign. Initial symptoms in animals include fever, behavior changes, agitation and reflex excitability. Self-mutilation is sometimes evident. Signs progress within days to cranial nerve dysfunction, difficulty breathing, difficulty swallowing, excessive salivation, cerebral dysfunction, ataxia, weakness, paralysis, seizures, recumbency, and death.

Two forms of rabies have been described: the dumb form and the furious form. Many animals will display aspects of both although one tends to predominate. With the furious (excitatory) form, animals become dangerously aggressive and may bite objects, other animals and humans. In the dumb (paralytic) form, animals often appear dull or depressed, the excitatory phase is short or absent and paralysis becomes the predominant sign. For both, salivation can be profuse and there may be voice changes due to paralysis of the throat muscles.

DOES THE CLINICAL PRESENTATION OF RABIES VARY WITH SPECIES?

There are no truly typical presentations; even within the same species clinical signs can vary widely. In general, dogs show either the furious or dumb form. Cats generally show the furious type, followed by paralysis 2-4 days later. Pigs tend to display an extremely violent phase at the onset of clinical illness followed by the furious or dumb form. Livestock, including horses, primarily show ascending paralysis, muscle fasciculations, and incoordination. Cattle often develop difficulty swallowing, an abnormal bellow, and facial paralysis may cause the jaw to drop; these signs can be interpreted as choke. Horses and other equids usually appear restless, uncomfortable, agitated or distressed; all of which can be mistaken for colic.

WHAT SPECIES ARE RESERVOIRS FOR RABIES IN OHIO?

There are several variants of rabies named for their primary host species; however, all of the variants can infect other mammals and the symptoms are the same. In Ohio, bat variant and raccoon variant are the primary concerns. Historically, skunk variant has been active. Recently though, Ohio's rabid skunks have been spillover cases of raccoon variant.

The canine variant has been eradicated from the United States which means there have been no animal or human cases acquired here in two or more years. This is a great accomplishment exemplifying the success of animal control and vaccination strategies implemented by human, animal, and public health practitioners. Canine rabies is the primary cause of human rabies deaths throughout the world, and importation of this disease remains a constant threat. Despite the absence of the dog variant, canines can be infected with other wildlife variants so the need for rabies vaccination and vigilance remains.

WHAT ANIMALS ARE RABIES VECTOR SPECIES IN OHIO?

The wildlife most likely to transmit rabies to humans or their domestic animals includes bats, raccoons, skunks, fox, and coyote. Any bite or close encounter with one of these animals should be reported to the local health department and evaluated for the risk of rabies exposure. If the wild animal is unavailable for testing, then the bitten animal should be treated as if the biting animal was infected with rabies.

WHAT SPECIES HAVE BEEN INFECTED WITH RABIES IN OHIO?

Between 1980 and 2010, 1,311 Ohio animals have tested positive for rabies. The majority have been bats (814), followed by skunks (204), and raccoons (201). Other rabid wild and domestic animals included: fox (22), cows (22), horses (16), dogs (13), cats (10), groundhogs (3), coyote (2), opossum (2), deer (1), and chipmunks (1). This summary table found on the Ohio Department of Health's (ODH) rabies web page contains annual testing data for each of the last five years, and cumulative data by decade:

<http://www.odh.ohio.gov/ASSETS/5A2DA01CBB6D433A8D8250AF87E09529/labtest.pdf>

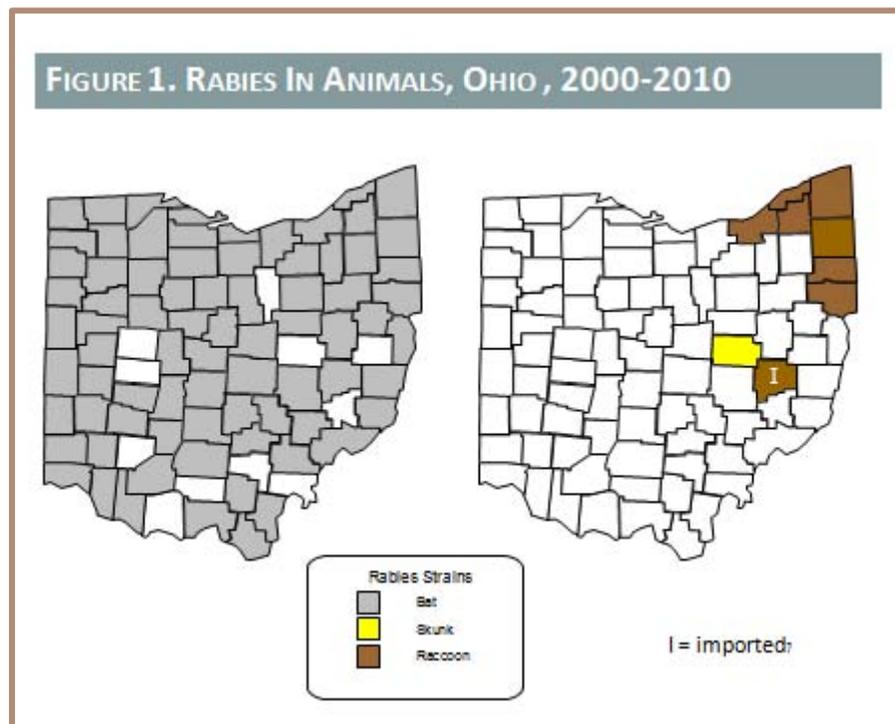
WHAT IS THE DISTRIBUTION OF RABIES?

GLOBAL Rabies is present worldwide, with only a few countries (mostly islands) being reported free of this disease. Globally, exposure to rabid dogs is responsible for more than 90 percent of human exposures to rabies and 99 percent of human cases. Over 55,000 human fatalities, mostly in children, occur in Asia and Africa each year. See World Health Organization map "World: Distribution of risk levels for humans contracting rabies, 2009." http://gamapserver.who.int/mapLibrary/Files/Maps/Global_rabies_2009.png

UNITED STATES All states except for Hawaii are considered enzootic for rabies. The principle rabies hosts are bats and wild carnivores. Effective animal control and vaccination programs have reduced, but not eliminated, the risk of rabies to humans and domestic animals. According to the Centers for Disease Control and Prevention (CDC), the number of rabies-related human deaths in the United States (U.S.) has declined from more than 100 annually at the turn of the 20th century to a current average of two or three per year. Close to 7,000 animals are confirmed to have rabies in the U.S. each year, mostly wildlife species. See the annual report published in *Journal of the American Veterinary Medical Association* on "Rabies Surveillance in the United States During 2009" <http://avmajournals.avma.org/doi/pdf/10.2460/javma.237.6.646>

OHIO Bats, raccoons, fox, skunk, and coyote are considered rabies vector species in Ohio (Figure 1), and human or animal exposure to these species should be evaluated for possible rabies exposure. Bat strain rabies occurs sporadically across the state. Raccoon strain rabies spread from Florida across the Eastern United States, and entered Northeast Ohio in 1999. A multi-agency collaboration with local, state, and federal departments of health and wildlife to distribute oral rabies vaccination in baits for raccoons has interrupted the expansion of this epizootic (<http://www.odh.ohio.gov/odhPrograms/dis/zoonoses/rabies/orv/orv1.aspx>).

Between 2006 and 2010 an average of 61 (range 47-86) animals per year were confirmed rabid in Ohio. See the ODH Summary Table for more information on statistics and species tested (<http://www.odh.ohio.gov/ASSETS/5A2DA01CBB6D433A8D8250AF87E09529/labtest.pdf>). For current information on Ohio's positive animal cases by county as well as archived data from 1980 through present, visit ODH's Animal Rabies Testing and Case Maps page.



<http://www.odh.ohio.gov/odhPrograms/dis/zoonoses/rabies/maps/animtest1.aspx>. While Ohio's animal rabies incidence remains comparatively low, our border state of Pennsylvania reports many more cases than Ohio and more cases of rabid domestic animals (409 in 2010) than any other state.

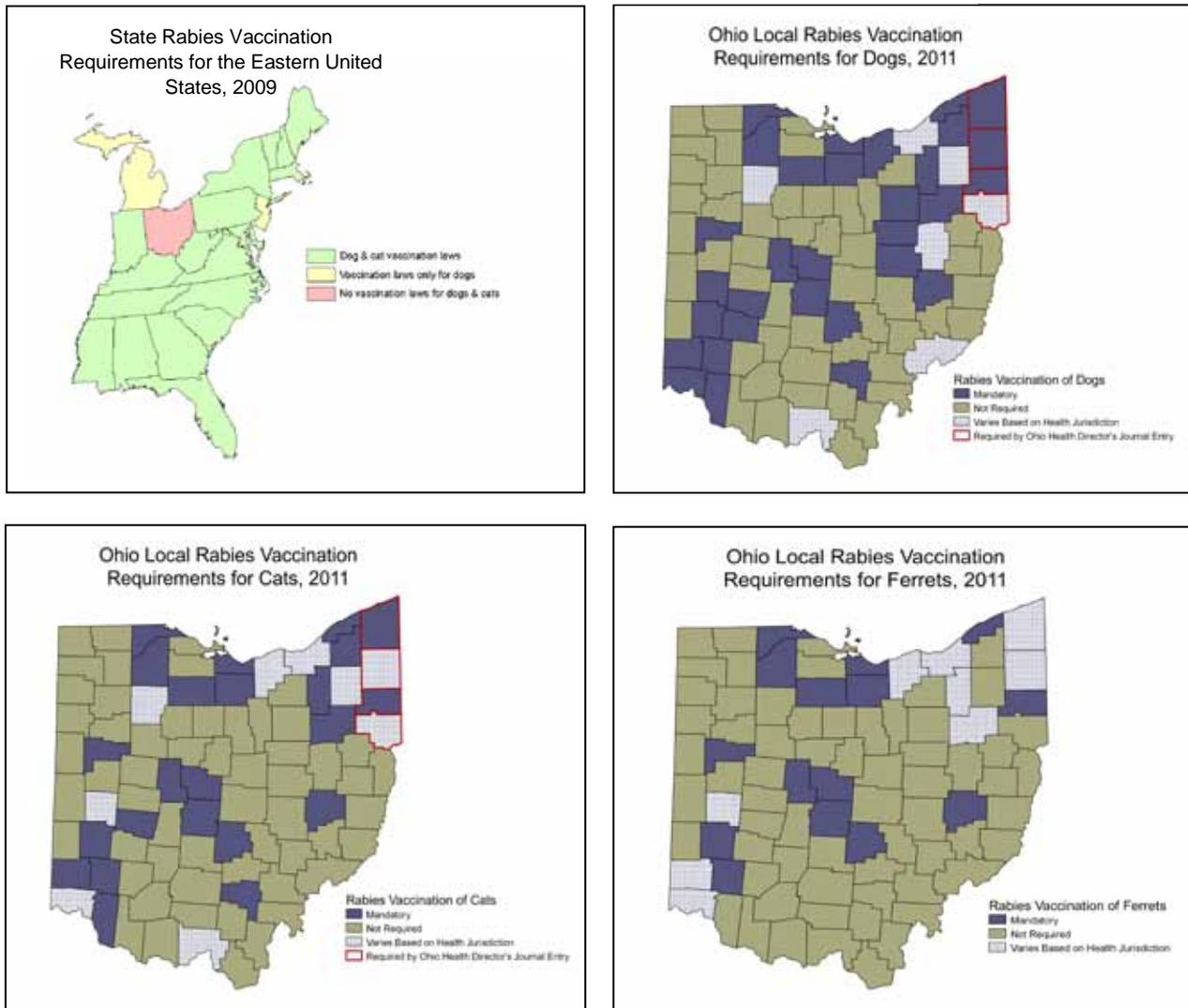
The last human case of rabies in Ohio occurred in 1970; however, local health departments annually investigate more than 20,000 rabies exposure events and report more than 400 persons receiving post exposure prophylaxis to prevent rabies.

RABIES VACCINATION OF ANIMALS

ANIMAL VACCINATION LAWS IN OHIO

Ohio does not have a state-wide law requiring the vaccination of animals against rabies, except in certain situations as described in the paragraphs below. A 2009 survey conducted by the Ohio Department of Health (ODH) Zoonotic Disease Program found that Ohio was the only state with enzootic raccoon variant rabies in the U.S. that does not have state-wide vaccination requirements for resident dogs and cats. (Figure 2) In response to the incursion of raccoon variant, the Ohio Director of Health signed a Journal Entry order in 1997 requiring rabies vaccination of all dogs and cats in Ashtabula, Trumbull, Mahoning, and Columbiana counties.

Figure 2. Rabies Vaccination Requirements for Dogs, Cats and Ferrets in Ohio



Ohio law gives local governments authority to enact rabies vaccination regulations at their discretion. A 2011 survey, conducted by the ODH Zoonotic Disease Program, found that 62 (48 percent) of 128 surveyed local health jurisdictions require vaccination of dogs, 49 (38 percent) require vaccination of cats, and 32 (25 percent) require vaccination of ferrets. The maps in Figure 2 depict counties with mandatory vaccination, those without, and those that have regulations that vary within the county based on local health jurisdiction. Counties under the Director's Journal Entry requiring the vaccination of dogs and cats are outlined in red. Note that some counties have more than

one health jurisdiction and that local regulations may have changed since January 2011 when this survey was completed. Those seeking guidance on specific jurisdictional requirements are encouraged to contact their local health department.

Ohio law requires that dogs that bite someone must be currently vaccinated against rabies before they are released from quarantine (<http://codes.ohio.gov/oac/3701-3-29>). Ohio law also requires that dogs and cats that are staying in Division of Parks and Recreation and Division of Forestry campgrounds must be currently vaccinated and display proof of rabies vaccination (<http://codes.ohio.gov/oac/1501%3A41-9-10>, <http://codes.ohio.gov/oac/1501%3A3-3-08>). Similarly, state parks with designated dog exercise areas require dogs to wear a tag as proof of current rabies vaccination. (<http://codes.ohio.gov/oac/1501%3A41-3-34>) Dogs and cats entering Ohio must be vaccinated against rabies prior to entry. (<http://codes.ohio.gov/oac/901%3A1-17-05>)

CAN OWNERS VACCINATE THEIR OWN PETS?

Persons residing in Ohio are permitted to purchase and administer rabies vaccine to their own animals. However, parenteral animal rabies vaccines should be administered by or under the supervision of a licensed veterinarian, and owner vaccination should be discouraged. For the purposes of assessing the public health risk for an animal to acquire or transmit rabies, there is no accountability to determine if lay-vaccinated animals are currently vaccinated. This may result in extended quarantine periods or possibly euthanasia depending on the circumstances. Proof of vaccination is confirmed by a valid rabies vaccination certificate that is signed by the veterinarian responsible for the proper storage and administration of the vaccine. Most communities with mandatory rabies vaccination ordinances require that vaccination be given by or under the supervision of a veterinarian.

CAN RABIES VACCINE BE ADMINISTERED TO OFF-LABEL SPECIES AND WILD HYBRIDS?

Animal rabies vaccines have been safely used in numerous domestic and wild animal species. Efficacy, however, has not been established in species other than those listed on the product label. Rabies vaccine can be administered to valuable or at-risk animals, and will likely afford them some protection. However, for the purposes of assessing the public health risk of an animal acquiring or transmitting rabies, non-approved species and wild hybrids are considered to be unvaccinated.

Regarding wolf-hybrids, the American Veterinary Medical Association (AVMA) Professional Liability Trust, which carries malpractice insurance for most veterinarians, takes the position that if there is no state or local law against keeping wolf-hybrids as pets, the Trust would consider vaccination a discretionary use of a biologic. The Trust further cautions veterinarians to inform owners that the vaccine is not licensed for use in wolf-hybrids and no studies have proven efficacy of the vaccine in the animals. Veterinarians are also reminded to enter their discussion with the client in the animal's record and have the client initial it.

CURRENT AND OVERDUE VACCINATION STATUS

An animal is not considered immunized until 28 days after its initial vaccination. Regardless of the age of the animal at its first rabies vaccine, a booster should be administered one year later. If an animal's vaccination history is unknown assume it has never been vaccinated.

A previously vaccinated animal is considered currently vaccinated immediately after a booster, even if it was overdue. A 3-year vaccine can be used in animals that are overdue returning them to their regular vaccination schedule.

RABIES CERTIFICATES

"All agencies and veterinarians should use National Association of State Public Health Veterinarian's (NASPHV) Form 51 (revised 2007), Rabies Vaccination Certificate, or an equivalent. This form can be obtained from vaccine manufacturers, NASPHV (<http://www.nasphv.org/Documents/RabiesVacCert.pdf>), or CDC

(http://www.cdc.gov/rabies/pdf/nasphv_form51.pdf). The form must be completed in full and signed by the administering or supervising veterinarian. Computer generated forms containing the same information are also acceptable." (NASPHV Rabies Compendium, 2011 <http://www.nasphv.org/Documents/RabiesCompendium.pdf>)

CAN I PROVIDE PROOF OF RABIES VACCINATION TO A THIRD PARTY WITHOUT OWNER CONSENT?

Public health officials conducting an investigation for a rabies risk assessment can be provided rabies vaccination history and other relevant animal health information. In these situations, this information is considered necessary to protect the welfare or health of other individuals or animals and is not limited by any confidentiality agreements.

CAN RABIES SEROLOGY BE USED INSTEAD OF VACCINATION?

"Rabies virus antibody titers are indicative of a response to vaccine or infection. Titers do not directly correlate with protection because other immunologic factors also play a role in preventing rabies, and our abilities to measure and interpret those other factors are not well-developed. Therefore, evidence of circulating rabies virus antibodies in animals should not be used as a substitute for current vaccination in managing rabies exposures or determining the need for booster vaccinations" (NASPHV Rabies Compendium, 2011 <http://www.nasphv.org/Documents/RabiesCompendium.pdf>). Positive titers are required by some countries prior to animal import to verify vaccination.

ADVERSE EVENTS

"Although rare, adverse events including vomiting, injection site swelling, lethargy, hypersensitivity, and rabies in a previously vaccinated animal have been reported. Adverse events should be reported to the vaccine manufacturer and to United States Department of Agriculture, Animal and Plant Health Inspection Service, Center for Veterinary Biologics (Internet: http://www.aphis.usda.gov/animal_health/vet_biologics/vb_adverse_event.shtml; telephone: 800-752-6255). No contraindication to rabies vaccination exists. Animals with a previous history of anaphylaxis can be medically managed and observed after vaccination." (NASPHV Rabies Compendium, 2011 <http://www.nasphv.org/Documents/RabiesCompendium.pdf>) Some local health jurisdictions may allow waivers for their rabies vaccination requirements if a veterinarian can document a legitimate medical reason why the animal should not be vaccinated.

INADVERTENT HUMAN EXPOSURE TO VACCINE

Accidental injection, or other exposure, to parenteral rabies vaccine is not capable of causing a rabies infection. Oral rabies vaccine (used in federal wildlife vaccination efforts) contains a live vaccinia vector capable, in rare circumstances, of causing pox-like lesions in humans. Exposures should be reported to state public health authorities.

RABIES EXPOSURE EVENTS

WHAT IS A RABIES EXPOSURE?

Rabies is typically transmitted through a bite, so all mammal bites are considered potential rabies exposures. In general, rodents, lagomorphs, and pocket pets (e.g., as hamsters, gerbils, mice and guinea pigs) do not present a significant risk of rabies. Cats, dogs, ferrets, horses and domestic livestock are of more concern depending on the circumstances. Bats and carnivores such as raccoon, skunk, fox, coyote, and bobcat are considered a significant risk.

“Any dog, cat, or ferret bitten by a known rabid mammal, or that had reasonable probability to have been bitten by a wild carnivorous mammal or bat that is not available for rabies testing shall be regarded as having been exposed to the rabies virus.” (<http://codes.ohio.gov/oac/3701-3-29>)

Non-bite exposures rarely cause rabies. Inhalation of aerosolized virus is unlikely to occur or lead to infection; however, these exposures should be avoided, and those who cannot avoid them should consider pre-exposure prophylaxis (e.g. some laboratory workers, bat biologists). Ingestion is not known to cause rabies, but a risk assessment should be performed if known consumption of meat or milk from a rabid animal has occurred. Infectious saliva introduced through mucous membranes or broken skin (e.g. wet scratch) can result in rabies.

Bats in the home, per se, are not considered a rabies exposure. Due to the small chance that a bite could occur without the person’s knowledge, awakening to find a bat in the room is considered an exposure. Similarly, finding a bat in the room with unattended pets, small children, or person(s) with an impairment that could prevent them from describing what transpired are also considered exposures.

WHAT IS NOT A RABIES EXPOSURE?

Touching or petting a known rabid animal is not a rabies exposure. Blood, urine, feces, and skunk spray are not considered infectious materials. Mechanical transmission such as from saliva-contaminated objects is rarely an issue, unless it is immediate and into a fresh open wound. Desiccation quickly destroys the virus, as does exposure to sunlight, so environmental contamination is not a concern.

REPORTING OF RABIES EXPOSURES AND SUSPECT ANIMAL CASES?

In Ohio, all mammal bites (and other rabies exposures) to humans are required to be reported to the local health department within whose jurisdiction the event occurred. Bites must be reported within 24 hours by the individual bitten or any physicians or veterinarians with knowledge of the bite. (<http://codes.ohio.gov/oac/3701-3-28>). Domestic pets that have been exposed as described above must also be reported to the local health department. (<http://codes.ohio.gov/oac/3701-3-29>) A searchable listing of local health departments can be found: (<http://www.odh.ohio.gov/localhealthdistricts/localhealthdistricts.aspx>). If livestock are at risk as a result of an exposure, the Ohio Department of Agriculture (ODA) should also be contacted.

Veterinarians are required to report to the local health department any suspect animal cases of rabies (<http://codes.ohio.gov/oac/3701-3-30>) and can hold the animal until its rabies status is determined. Veterinarians do not have any statutory authority to issue quarantines or require the removal of the head for testing, other than under an order of the local health department.

PUBLIC HEALTH’S ROLE

All rabies exposures must be reported to the local health department. They have the legal authority to perform an investigation, complete a rabies risk assessment, and require quarantine or euthanasia of animals depending on the circumstances. Typical information needed by the local health department includes contact information for victims/owners, the species involved, vaccination status, and the circumstances surrounding the bite or exposure.

OHIO DEPARTMENT OF AGRICULTURE'S ROLE

Although rabies exposures involving companion animals are typically handled by local health departments, ODA will become involved in cases involving livestock and exposures that put livestock at risk. Rabies is included in their list of dangerously contagious and infectious diseases (<http://codes.ohio.gov/oac/901%3A1-21>) so they also have the authority to impose quarantines or order euthanasia of suspect rabid animals or animals exposed to rabies. Both the local health department and ODA should be notified in the event of any suspected livestock rabies.

MANAGEMENT OF ANIMALS THAT EXPOSE HUMANS

DOGS, CATS, AND FERRETS

Regardless of vaccination status, the biting animal must be tested or quarantined for a minimum of 10 days. The local health department typically imposes a 10 day quarantine period that starts from the date of the bite (day 0). The time between contagiousness and clinical signs is known to be short in dogs, cats, and ferrets. If the animal was able to transmit rabies at the time of the bite it would be obviously ill, and most likely will succumb to the disease during the quarantine period.

The quarantine can be done in the home or at a pound or kennel, at the owner's expense. If the animal shows signs of illness or abnormal behavior during this time, it must be examined by a veterinarian (at the owner's expense) and the local health department must be contacted. If signs are consistent with rabies, then the animal should be euthanized and the head of the animal sent to the Ohio Department of Health Laboratory for rabies testing. If the animal dies or is euthanized during the quarantine period for any reason, it also must be tested.

(<http://codes.ohio.gov/oac/3701-3-29>)

If the animal was not already current on rabies vaccination at the time of the bite, Ohio law requires it to be vaccinated at the end of the quarantine period. Due to the small chance of a vaccine reaction leading to an unnecessary euthanasia for testing, vaccination is not recommended during the quarantine period. Inadvertent vaccination during the quarantine, however, does not otherwise interfere with the pathogenesis of disease and does not require the quarantine to be extended.

WILD-DOMESTIC HYBRIDS

Coydogs, wolf hybrids, savannah cats, safaricats, etc., are not considered to be domestic pets, and are therefore handled as wildlife if they bite a person.

LAGOMORPHS (RABBITS), SMALL RODENTS, AND POCKET PETS (HAMSTERS, GERBILS, MICE, GUINEA PIGS)

Whether domestic or wild, these small animals are rarely rabid and no documented transmission to humans has occurred. Unless there were unusual circumstances surrounding the bite, such as abnormal behavior, these exposures are not considered a significant risk; and quarantine or testing is not generally recommended. ODH Laboratory will test such animals, but there is a \$30 fee.

RABIES VECTOR SPECIES

Rabies exposures from bats, raccoons, skunks, foxes, coyote, or other or wild carnivores are considered higher risk. The animal should be captured if it can be done safely and euthanized for testing. If it is not available for testing then local health department assessments often proceed as if the animal were positive.

OTHER WILD, DOMESTIC, AND EXOTIC SPECIES

The local health department determines what follow up is needed on a case by case basis. If a significant risk of rabies is determined, then euthanasia and testing is recommended. In some cases an extended quarantine period will be imposed if it is determined that the biting animal is at low risk of having acquired rabies. The person exposed, however, must be willing to accept the risk that if the animal develops clinical signs later during its extended quarantine period, it may be too late for post-exposure rabies prophylaxis to be effective.

PRE-AND POST-EXPOSURE TREATMENT OF HUMANS

WOUND CARE

Immediately wash and flush bite wounds or skin that was in contact with potentially infectious material using water and soap or other disinfectant. The rabies virus is not very stable, and this first aid measure is very effective at reducing the risk of rabies. Regardless of the apparent severity, persons bitten by an animal should be directed to seek medical attention for routine bite wound care. Their health care provider will assess the damage to surrounding tissues and may prescribe treatments such as antibiotics or a tetanus shot.

TIMING OF TREATMENT FOR EXPOSED HUMANS

Post-exposure prophylaxis for rabies, when necessary, is a medical urgency and not an emergency. If the animal is available for rabies testing or is a dog, cat, or ferret available for quarantine, then it is recommended to wait until the rabies status of the animal has been determined.

Post-exposure prophylaxis should begin promptly for a bite or known exposure from a rabies vector species such as a bat, raccoon, skunk, fox, or coyote when the animal is not available for testing. Other exposures to animals not available for testing should be assessed by the local health department and, if recommended, should begin within a few days.

Little data is available on the length of a “safe” waiting period following a rabies exposure. In the US, appropriate treatment that was received within several days of exposure to a known rabid animal has never failed to prevent infection. Delays of 14 days or longer are associated with a decrease in treatment success. Even when delayed prophylaxis should still be administered after a rabies exposure event; this treatment may still be effective at preventing disease or increasing the chance of survival.

WHAT IS THE TYPICAL COURSE FOR HUMAN RABIES POST-EXPOSURE PROPHYLAXIS?

For persons with no prior vaccination against rabies, post-exposure prophylaxis consists of the administration of both passive antibody and vaccine. Human rabies immune globulin (RIG) is recommended for both bite and nonbite exposures, even in cases where treatment is delayed. Typically RIG is infiltrated around the bite. Four or five doses¹ of rabies vaccine are given starting on day 0, and then again on days 3, 7, and 14. In some circumstances when immune status is suspect, a 5th vaccine booster is given on day 28¹. Vaccines are given intramuscularly, usually in the arm and distant from the RIG administration site.

For persons who have previously received rabies vaccination (pre- or post-exposure), only two doses of vaccine are required on days 0 and 3. RIG is not needed.

Treatment is highly effective at preventing rabies if given as soon as possible following exposure.

PRECAUTIONS AND PRE-EXPOSURE VACCINATION FOR ANIMAL CARE WORKERS

Persons handling potentially rabid animals should take precautions, including proper training, to avoid being bitten. Pre-exposure rabies prophylaxis is recommended for those who regularly handle high-risk animals or work in occupations that have an elevated risk of rabies exposure. These groups include “veterinarians and their staff, animal handlers, rabies researchers, certain laboratory workers, and anyone whose activities bring them into frequent contact with rabies virus or potentially rabid bats, raccoons, skunks, cats, dogs, or other species at risk for having

¹ The Advisory Committee on Immunization Practices (ACIP) Recommendations published March 19, 2010 state that 4 doses of vaccine (administered on days 0, 3, 7 and 14) and one dose of RIG administered on day 0 are adequate for post exposure treatment in persons with no immunosuppression. See <http://www.cdc.gov/mmwr/pdf/rr/rr5902.pdf>.

rabies." (Human Rabies Prevention-United States, 2008
<http://www.cdc.gov/mmwr/preview/mmwrhtml/rr57e507a1.htm>)

Rabies pre-exposure prophylaxis consists of three vaccines given over a period of one month. While they do not prevent the need for additional medical evaluation after a rabies exposure, they do reduce the course of post-exposure treatment that might be needed and should provide protection against exposures that go unrecognized.

Activities such as preparing specimens for rabies testing should be done by those who have received pre-exposure prophylaxis. Contact with neural tissue should be avoided and those performing decapitations should, at minimum, wear gloves, eyewear, and a protective apron.

HOW OFTEN SHOULD I GET MY TITERS CHECKED?

"Persons in the rabies enzootic areas are considered to be in the frequent-risk category and should have a serum sample tested for rabies antibody every 2 years. If the titer is less than complete neutralization at a 1:5 serum dilution by the Rapid Fluorescent Foci Inhibition Test (RFFIT), the person also should receive a single booster dose of vaccine. Veterinarians, veterinary students, and animal-control and wildlife officers working in areas with low rabies rates (infrequent exposure group) do not require routine pre-exposure booster doses of vaccine after completion of primary pre-exposure vaccination." (CDC Rabies Website
http://www.cdc.gov/rabies/specific_groups/veterinarians/staff.html) Ohio is enzootic for bat, skunk, and raccoon rabies variants.

MANAGEMENT OF ANIMALS THAT HAVE BEEN EXPOSED TO RABIES

DOGS, CATS, AND FERRETS

NEVER VACCINATED OR UNKNOWN VACCINATION HISTORY "Dogs, cats, or ferrets not currently vaccinated against the rabies virus or when vaccination cannot be verified shall be humanely killed; or if sufficient justification for preserving the dog, cat, or ferret exists, the exposed dog, cat, or ferret shall be quarantined by the health commissioner of the health district in which the bite was inflicted. The quarantine period shall be for not less than six months. The dog, cat, or ferret shall be vaccinated against rabies by a licensed doctor of veterinary medicine one month before the end of the quarantine period required by this paragraph" (<http://codes.ohio.gov/oac/3701-3-29>). The 2011 NASPHV Rabies Compendium states that vaccination on entry to quarantine is preferable to vaccination one month before the end of quarantine.

CURRENT VACCINATION STATUS Dogs, cats, or ferrets "with a current rabies vaccination shall be given a booster rabies vaccination immediately and quarantined under an order issued by the health commissioner of the health district in which the bite was inflicted. The quarantine period shall be for not less than 45 days." (<http://codes.ohio.gov/oac/3701-3-29>)

PREVIOUSLY VACCINATED BUT OVERDUE "Animals overdue for a booster vaccination should be evaluated on a case-by-case basis based upon severity of exposure, time elapsed since last vaccination, number of previous vaccinations, current health status, and local rabies epidemiology to determine need for euthanasia or immediate revaccination and observation/isolation" (NASPHV Rabies Compendium, 2011 <http://www.nasphv.org/Documents/RabiesCompendium.pdf>).

LIVESTOCK AND HORSES

Animals currently vaccinated with a product approved in that species should be boosted and observed for 45 days. Unvaccinated animals should be euthanized immediately or confined and observed for 6 months; as determined in consultation with public health and agriculture authorities (NASPHV Rabies Compendium, 2011 <http://www.nasphv.org/Documents/RabiesCompendium.pdf>).

OTHER DOMESTIC AND CONFINED MAMMALS

Mammals not vaccinated with an approved rabies vaccine that are known to have been exposed to rabies should be euthanized immediately. Confinement and observation for 6 months is an alternative and should be determined on a case-by-case basis. (NASPHV Rabies Compendium, 2011 <http://www.nasphv.org/Documents/RabiesCompendium.pdf>).

IS THERE AN EFFECTIVE POST-EXPOSURE TREATMENT FOR ANIMALS?

As with people, prompt cleaning and disinfection of bite wounds or areas in contact with potentially infected material is recommended. Administering a booster to a previously vaccinated animal triggers a strong anamnestic response which should provide some protection. There is no USDA approved vaccine for post-exposure treatment of previously unvaccinated animals and there is evidence to suggest that vaccination alone may not be sufficient to prevent infection.

SHOULD ANIMALS THAT ARE EUTHANIZED DUE TO RABIES EXPOSURE BE TESTED?

During the lengthy incubation period there is no detectable virus in the brain, therefore testing recently exposed animals is not of any value.

RABIES TESTING

APPROVED TESTS

Direct Fluorescent Antibody (dFA) is the most reliable test, and is therefore the only recommended diagnostic method for routine rabies determination in animals. dFA has a higher sensitivity and specificity than viral isolation. Because rabies is present in nervous tissue (and not blood like many other viruses), the ideal tissue to test for rabies antigen is brain.

Monoclonal antibody tests and RT-PCR with sequencing can be performed at the CDC rabies laboratory on dFA positive specimens in order to identify the rabies variant involved.

A direct rapid immunohistochemical test (dRIT) is performed by trained USDA field personnel for rabies surveillance when there are no human or domestic animal exposures. All positive results are tested by dFA at an approved laboratory.

INTERPRETING DFA RESULTS

Three test results can be reported from the Ohio Department of Health Laboratories: positive, negative, and unsatisfactory. Unsatisfactory results often result from missing, damaged, or decomposed samples where positive status cannot be ruled out. For rabies vector species and animals that were displaying signs consistent with rabies, indeterminant results should generate the same public health recommendations as do positive results.

IS THERE A RELIABLE ANTE MORTEM TEST?

Serology is not a reliable diagnostic test for rabies infection. The presence of antibodies indicates prior vaccination or exposure, but does not necessarily indicate a current infection.

There are no USDA approved ante mortem test kits available for rabies diagnosis; however, there are some unlicensed saliva tests being sold commercially. These tests have not been validated against current accepted methods and the sensitivity and specificity are not known. Additionally, viral shedding in the saliva may be intermittent and the amount varies over time. The infectious dose could be as low as 1 virion. According to CDC "more than 2 billion rabies virions would need to be present in a sample if a test had a sensitivity that was limited to detecting virus in the microgram (1,000,000th of a gram) range." There may be value to a positive test result; a negative test could be misleading.

WHERE SHOULD AN ANIMAL RABIES SAMPLE BE SUBMITTED?

The Ohio Department of Health Laboratories (ODHL) is the only lab in Ohio that performs dFA testing on animals for rabies. Samples can be submitted directly to ODHL or through the local health department. If shipping directly, the local health department must be notified of the circumstances surrounding any suspect rabies cases and human or animal exposures. A searchable listing of local health departments can be found at (<http://www.odh.ohio.gov/localhealthdistricts/localhealthdistricts.aspx>).

WHAT SAMPLES SHOULD BE COLLECTED AND SENT TO OHIO DEPARTMENT OF HEALTH LABORATORY?

Never send a live animal. The animal should be humanely destroyed in a manner that preserves the brain. For small mammals such as bats or rodents, the whole body can be submitted. Only the head of larger animals such as cats and dogs should be submitted. Do not remove the brain, as the sections required for testing are easily damaged.

For very large animals (horses and cattle), only the brain should be submitted. The Ohio Department of Agriculture (ODA) will accept the entire head, remove the brain, and send the brain to ODHL. There is a fee associated with this

service if it is the only test requested. More information on fee structures, shipping, and submission forms to ODA can be found at <http://www.agri.ohio.gov/addl/>. The ODHL form, in addition to the ODA submission form, must accompany all specimens first going to ODA.

REMOVAL OF HEADS FOR RABIES TESTING

Decapitation of rabies suspects should be performed by those with proper training and who have already received pre-exposure prophylaxis. Although there has never been a case of human rabies associated with decapitation, the brain, spinal cord, salivary glands and the saliva may contain rabies virus that could be infectious. Precautions should be taken to avoid direct contact with skin, splashing into mucous membranes, and exercise caution with the use of sharp instruments. Hatchets and power saws may aerosolize infectious material and are not recommended for routine decapitations. If an exposure does occur during sample preparation it should be reported to the local health department.

Protective covering for clothing should include a surgical gown, plastic apron or coveralls. Hands should be protected with rubber gloves which may also be worn under heavyweight autopsy gloves. Face and eye protection should also be worn, and a full face shield is recommended. The animal should be placed in a tub or other disinfected area. Alternatively, plastic sheeting can be placed under the animal, or the animal can be decapitated after being placed inside a body bag to catch the draining fluids.

With the animal in dorsal recumbency and the head extended, a sharp knife or scalpel can be used to incise the skin immediately caudal to the larynx. The trachea should be sectioned and the muscles and associated soft tissue should be bisected to the level of the spinal cord. The head can be flexed, extended, or rotated to identify the atlanto-occipital joint, so that the ligaments can be incised. The spinal cord can be severed allowing the head to be removed by hyper-extending the head exposing the spinal cord for cutting, then severing the rest of the skin and soft tissue. Another method is to complete a circumferential incision to the level of the spinal cord followed by rotation of the head to sever the cord. If there is not adequate exposure to the spinal cord, continue locating and severing the vertebral ligaments. The head should be allowed to drain before placing it in a bag for packaging. All contact surfaces and instruments should be thoroughly cleaned and disinfected.

CARCASS DISPOSAL

Because the rabies virus is primarily concentrated in the brain and salivary glands, only the head submitted for testing is considered medical waste. The remaining carcass can be disposed of by any legal means available in that locality. The carcass should be double bagged before transport. If the animal was positive, incineration would inactivate the virus and the remains would not be infectious. If the animal is to be buried, ensure that scavengers cannot recover the body. If the ground is too frozen for excavation, the body should not be left outside; the cold temperatures can preserve the virus for extended periods of time.

WHAT IS THE COST OF RABIES DFA TESTING?

The Ohio Department of Health Laboratory does not charge for rabies testing that is recommended or required by the local health department. These include cases of human or domestic animal exposures from known rabies sources and animals displaying signs consistent with rabies. In general, rabbits and small rodents do not present a significant risk of transmitting rabies and testing is usually discouraged; however, these samples will be tested on request for \$30.00. For all samples, the submitter bears the shipping cost, whether or not the test is required by the local health department.

SPECIMEN HANDLING AND SHIPPING

Caution must be taken during sample preparation to avoid direct personal contact with specimens. Pre-exposure vaccination is recommended for persons preparing rabies specimens.

The specimen should be placed in a water-tight bag. A Ziploc-type bag is recommended in addition to double bagging to reduce the chance of fluid leakage. It should be kept at refrigerator temperatures until shipped. Do not freeze or use fixatives. If the sample is already frozen, it may be kept frozen until it is submitted. Do not attempt to thaw out a frozen carcass at room temperature as this will further degrade brain tissue.

Rabies samples are considered to be diagnostic specimens, i.e. any human or animal material, including excreta, secretions, blood and its components, tissue, and tissue fluids being transported for diagnostic or investigational purposes, but excluding live infected animals. Unless they are transported by ground-based private or contract carriers with dedicated vehicles, these specimens must meet the requirements established by the DOT Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180 http://ecfr.gpoaccess.gov/cgi/t/text/text-dx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfrv2_02.tpl). These federal regulations apply to commercial shipping companies; specific carriers such as USPS, FedEx, and UPS may have additional requirements.

It is the shipper's responsibility to ensure that packaging and labeling meets applicable federal requirements. Animal specimens for diagnostic testing are considered to be exempt human (or animal) specimens, unless the animal is known to be rabid. The basic shipping requirements for exempt diagnostic specimens include triple packaging. The primary receptacle must be leak proof (can be rigid or flexible). The secondary receptacle must be leak proof (can be rigid or flexible) and should contain absorbent material to capture any fluid spills. Rabies specimens are not overly fragile; however, newspaper, bubble wrap or other cushioning may be considered to stabilize the contents and separate the sample from direct contact with coolant. The outer packaging (rigid) must be large enough to adequately contain the inner receptacles and should be able to withstand a 4 foot drop intact. The outside of the package should contain the shipper's information, the consignee (ODHL), and the words "Exempt animal specimen." The outer packaging should be sealed closed with tape.

Several packaging configurations will meet these requirements including two individually sealed bags in a rigid outer shipping container. Again, be sure to check with your shipping company for specific instructions. Some will not accept Styrofoam containers as the outer packaging unless they are then placed in a cardboard or similar box.

Be sure to include enough gel packs, or similar refrigerants, to ensure the specimens will remain cold for at least 48 hours. Ice is not recommended. If ice must be used, double bag and seal it securely to prevent leakage. Do not use dry ice.

Do not ship on a Friday or before a holiday as transport time is increased and the viability of the brain tissue will be rapidly compromised if it warms to room temperature. It is best to hold the sample in a refrigerator until the next business day. Please call the Zoonotic Disease Program at ODH (614-752-1029) if the need for testing is urgent.

WILL THE OHIO DEPARTMENT OF HEALTH LABORATORY RETURN THE HEAD AFTER TESTING?

ODHL does not typically return the heads to the submitter. They are severely disfigured during testing, and for owners this is often more traumatic than the knowledge of decapitation. Though strongly discouraged, special arrangements can be made in advance for return provided the submitter pays for shipping and handling. If the animal tests positive, the head will not be returned.

ANIMAL QUARANTINE AND ISOLATION

RECOMMENDATIONS FOR QUARANTINE

Quarantine is defined as the separation and restriction of the activities of healthy animals that are known or believed to have been exposed to a case of rabies. This is done to facilitate recognition of disease and reduce the exposures that would result during the pre-clinical contagious period.

Local health departments and the Ohio Department of Agriculture have the authority to impose quarantines on animals that have exposed a person or have potentially been exposed to rabies. The regulatory agency determines the specific restrictions, location, and length of quarantine. In general, animals should be confined to a home (or barn in the case of livestock), animal control agency, or veterinary clinic for the duration of the quarantine period. Most often quarantines can be done at home, any expenses incurred are the responsibility of the owner. Routine care and handling should continue as normal. Unnecessary contact with humans and any contact with non-quarantined animals should be avoided.

Dogs and cats should not be permitted outside unless supervised and confined to a fenced area or leashed and under the control of a responsible adult. Petting and grooming an animal present no significant risk of rabies transmission, but licking and rough play should be discouraged. Owners or caretakers should be educated about specific signs of rabies. If the animal should develop any illness or display any unusual behavior during the quarantine period, the owners or caretakers should contact a local veterinarian for examination and notify the regulatory agency.

RECOMMENDATIONS FOR ISOLATION

Isolation is defined as the separation and restriction of movement or activities of ill animals that are diagnosed with or suspected of having a contagious disease such as rabies. If veterinarians suspect rabies in an animal they should immediately confine the animal, restrict human and animal contact, and contact the local health department. Those handling an animal in isolation for rabies should take precautions to avoid bites and contact with saliva. Water repellent gloves and gowns should be worn to protect the skin. Eye protection and a mask or a visor face shield is also encouraged when there is a risk of salivary droplet contact. Routine disinfection neutralizes rabies virus.

IMPORT/ EXPORT REQUIREMENTS FOR DOGS AND CATS

IMPORT INTO OHIO

Although Ohio does not require rabies vaccination of resident dogs and cats, Ohio does require vaccination of these animals prior to arrival in Ohio. They must also have a valid certificate of veterinary inspection. The relevant sections of the Ohio Administrative Code can be found here: <http://codes.ohio.gov/oac/901%3A1-17>. Contact the Ohio Department of Agriculture, Division of Animal Industry with any questions (614)728-6220.

EXPORT TO OTHER STATES

All states in the US require vaccination of dogs prior to entry. The majority also require vaccination of cats. Most but not all states require a valid certificate of veterinary inspection signed by an accredited veterinarian. Hawaii, as a rabies free state, has additional import requirements. Contact the receiving state's Department of Agriculture for details on requirements specific to their state. To prevent unexpected problems, it is recommended that current vaccination and health records should accompany animals when they are traveling or moving to other states. Note that airlines also have specific requirements that must be met before they will transport an animal; travelers should contact the airline directly for more information.

IMPORT INTO US

The CDC regulates importation of animals with respect to protecting human health in the U.S. It is a federal requirement that dogs be vaccinated against rabies at least 30 days prior to entry. Cats have no vaccine requirements. Neither is required to have a health certificate; however, animals are subject to inspection at ports of entry and any sign of illness upon arrival can result in further evaluation and possible quarantine. The CDC regulations can be found at <http://www.cdc.gov/animalimportation/BringingAnimalToUs.html>. Individual state requirements must also be met for at least the state of entry into the U.S. and the final destination state. Unvaccinated animals and those that are too young for vaccination may be permitted to enter provided the owner completes a Confinement Agreement, (<http://www.cdc.gov/animalimportation/pdf/dog-import.pdf>). Confinement Agreements are completed at the port of entry. The CDC Division of Global Migration and Quarantine forwards it to state and local public health officials to ensure the conditions are met.

Note that airlines also have specific requirements that must be met before they will transport an animal; travelers should contact the airline directly for more information.

USDA Animal and Plant Health Inspection Service (USDA) regulates the importation of animals with respect to protecting US animal populations. Requirements for dogs and cats coming from countries endemic for Foot and Mouth Disease, screwworm, etc. can be found at http://www.aphis.usda.gov/import_export/animals/animal_import/animal_imports_pets.shtml. Import/export questions should be directed to USDA APHIS Veterinary Service's Pickerington Ohio office at (614) 856-4735.

EXPORT TO OTHER COUNTRIES

Each country has its own set of regulations regarding entry of animals. It is recommended that the country of destination be consulted directly as regulations may change and other broker or third party sources may be outdated. A list of requirements by country and a list of approved embarkation ports can be found on the USDA APHIS site <http://www.aphis.usda.gov/regulations/vs/iregs/animals/>

International health certificates can be completed by an accredited veterinarian that has examined the animal and performed the requested tests. Once completed, the owner must send the certificate to the USDA Area Veterinarian in Charge to be reviewed and endorsed. Import/export questions should be directed to USDA APHIS Veterinary Service's Pickerington Ohio office at (614) 856-4735.

Some requirements are very specific and the process can take weeks to months depending on the country. For example, the European Union requires that a specific microchip be implanted prior to rabies vaccination. If the animal had no microchip or a non-approved microchip at the time of vaccination then they are not considered to be vaccinated. A chip must be implanted, the animal vaccinated for rabies, and 21 days must elapse before the animal is eligible to enter the European Union.

Note that airlines also have specific requirements that must be met before they will transport an animal; travelers should contact the airline directly for more information.

REFERENCES

- [NASPHV Rabies Compendium, 2011](#)
- [Human Rabies Prevention---United States, 2008](#) Advisory Committee on Immunization Practices (ACIP)
- [CDC Rabies Information for Health Care Professionals](#)
- [ODH Zoonotic Disease Program Rabies Web Page](#)
- [ODH Infectious Disease Control Manual](#)
- [Searchable Listing of Ohio Local Health Departments](#)
- [Animal Bites and Rabies First Aid, University of MD Medical Center](#)
- [Iowa State University Center for Food Security and Public Health Animal Disease Factsheets](#)
- [ODA ADDL Submission Information](#)
- [ODH Laboratories Rabies Submission Form](#)
- [Ohio Revised and Administrative Codes](#)
- [World Rabies Day Education Bank](#) (educational resources, posters, brochures, videos, press releases, etc.)
- [Global Alliance for Rabies Control](#)