

Rabies: A Review of Disease Epidemiology, Current Public Health Standards and Recent Cases

Bonnie E. Price DVM, MPH
 Veterinary Health Science
 and Technology
 Lincoln Memorial University





Tennessee Rabies Control Manual – 2018 –



Public Veterinary Medicine: Public Health

Compendium of Animal Rabies Prevention and Control, 2016

National Association of State Public Health Veterinarians and Control Committee

Catherine M. Brown DVM, MSc, MPH (Co-Chair)
Sally Slavinski DVM, MPH (Co-Chair)
Paul Ettestad DVM, MS
Tom J. Sidwa DVM, MPH
Faye E. Sorhage VMD, MPH

From the Massachusetts Department of Public Health, 305 South St, Jamaica Plain, MA 02130 (Brown); the New York City Department of Health and Mental Hygiene, 2 Gotham Center, CN# 22A, 42-09 28th St, Queens, NY 11101 (Slavinski); the New Mexico Department of Health, 1190 St Francis Dr, Room N-1350, Santa Fe, NM 87502 (Ettestad); and the Texas Department of State Health Services, PO Box 149347, MC 1956, Austin, TX 78714 (Sidwa).

Consultants to the Committee: Jesse Blanton, PhD (CDC, 1600 Clifton Rd, Mailstop G-33, Atlanta, GA 30333); Richard B. Chipman, MS, MBA (USDA APHIS Wildlife Services, 59 Chenell Dr, Ste 2, Concord, NH 03301); Rolan D. Davis, MS (Kansas State University, Room 1016 Research Park, Manhattan, KS 66506); Cathleen A. Hanlon, VMD, PhD (Retired); Jamie McAloon Lampman (McKamey Animal Center, 4500 N Access Rd, Chattanooga, TN 37415 [representing the National Animal Care and Control Association]); Joanne L. Maki, DVM, PhD (Merial a Sanofi Co, 115 Trans Tech Dr, Athens, GA 30601 [representing the Animal Health Institute]); Michael C. Moore, DVM, MPH (Kansas State University, Room 1016 Research Park, Manhattan, KS 66506); Jim Powell, MS (Wisconsin State Laboratory of Hygiene, 465 Henry Mall, Madison, WI 53706 [representing the Association of Public Health Laboratories]); Charles E. Rupprecht, VMD, PhD (Wistar Institute of Anatomy and Biology, 3601 Spruce St, Philadelphia, PA 19104); Geetha B. Srinivas, DVM, PhD (USDA Center for Veterinary Biologics, 1920 Dayton Ave, Ames, IA 50010); Nick Striegel, DVM, MPH (Colorado Department of Agriculture, 305 Interlocken Pkwy, Broomfield, CO 80021); and Burton W. Wilcke Jr, PhD (University of Vermont, 302 Rowell Building, Burlington, VT 05405 [representing the American Public Health Association]).

Endorsed by the AVMA, American Public Health Association, Association of Public Health Laboratories, Council of State and Territorial Epidemiologists, and National Animal Care and Control Association.

This article has not undergone peer review.

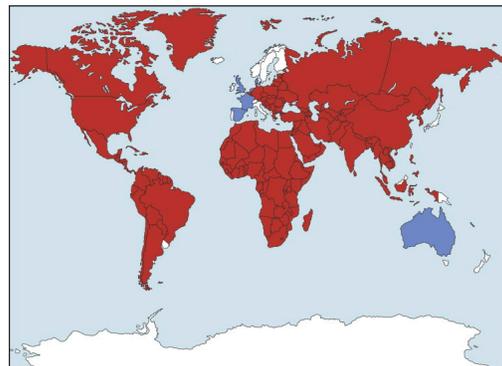
Overview

- Rabies is caused by the Rabies Virus
 - a neurotropic virus in the genus Lyssavirus
 - family Rhabdoviridae
- Zoonotic viral disease
- Can affect any mammal
 - 100% fatal in animals
 - Nearly 100% fatal in humans once clinical signs develop



Distribution

- With some exceptions (particularly islands), rabies virus is found worldwide.
 - World Health Organization (WHO) considers a country to be free of rabies if there have been no indigenously acquired cases in humans or animals during the previous 2 years



Source: Sciencedirecttopics

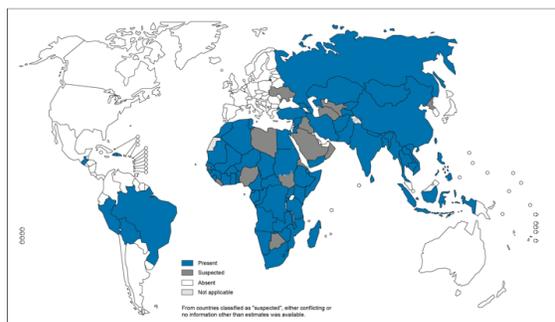
Distribution

- Worldwide, 10 million people are estimated to receive post-exposure prophylaxis each year
- 40,000-60,000 die of rabies
- Most of these cases occur in Africa and Asia, and **over 90% are caused by rabid dogs.**



Source: nytimes.com

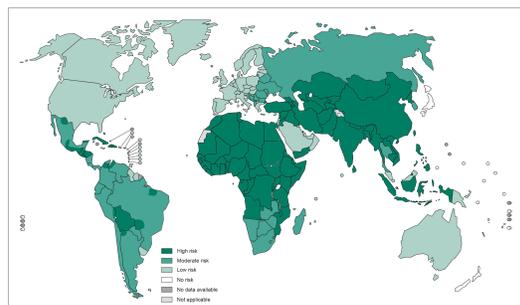
Presence of dog-transmitted human rabies based on most recent data points from different sources, 2010-2014



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its borders or the extent of its territory. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement. © WHO 2015. All rights reserved.

Data Source: World Health Organization
Map Production: Center for Integrated Tropical Diseases (CITD), World Health Organization

Distribution of risk levels for humans contacting rabies, worldwide, 2013



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its borders or the extent of its territory. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement. © WHO 2015. All rights reserved.

Data Source: World Health Organization
Map Production: Center for Integrated Tropical Diseases (CITD), World Health Organization

Global Alliance for Rabies Control

Working to eliminate deaths from canine rabies by 2030

About GARC Policy and Advocacy Capacity Building Networks World Rabies Day Resources Media

How can we help you today?
Let us take you to the right page

Choose an option

TAKE ME THERE!

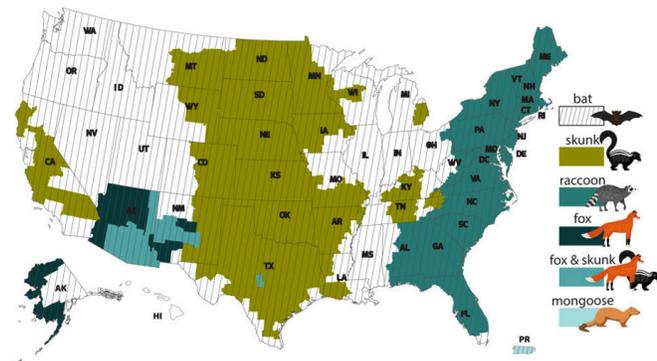
World Rabies Day
SEPTEMBER 29
Rabies: Vaccinate to Eliminate
www.globalrabiesalliance.org/world-rabies-day

Get involved in World Rabies Day

Source: who.int

Distribution

- There are many strains of this virus, each **maintained in a particular reservoir host**
- Only a few species are important as reservoirs for the disease in the US:
 - raccoons, skunks, bats, foxes, and coyotes
 - canine rabies has been largely eliminated due to widespread vaccination



Source: cdc.gov

Raccoon Rabies

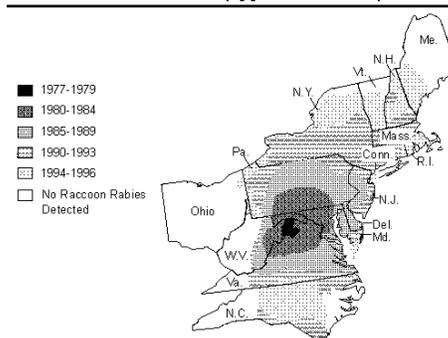
- Prior to 1977, raccoon rabies was confined to the south-eastern U.S.,
 - primarily Florida and Georgia
- From 1977 to mid-1983, a total of 1608 raccoon rabies cases was reported from Washington, D.C. and West Virginia, Virginia, Maryland and Pennsylvania
 - Raccoon rabies **never** reported before in the Mid-Atlantic



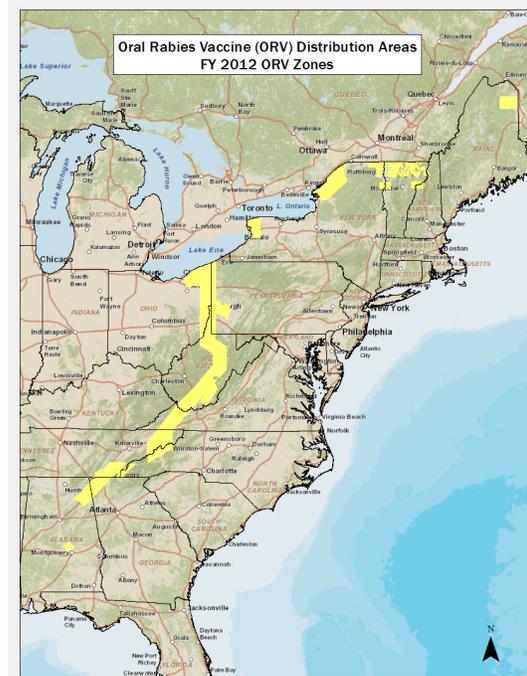
Raccoon Rabies

- The origin of this outbreak was the legal translocation of more than 3,500 raccoons from Florida to Virginia from 1977-1981
 - the raccoon variant of rabies virus had not previously been reported in VA
- Results from monoclonal antibody analysis of virus samples from the mid-Atlantic region of the U.S. were **identical to the variant of rabies virus** obtained from rabid raccoons in FL and GA

FIGURE 1. Detection of raccoon rabies, by year — United States, 1996



Raccoon Rabies

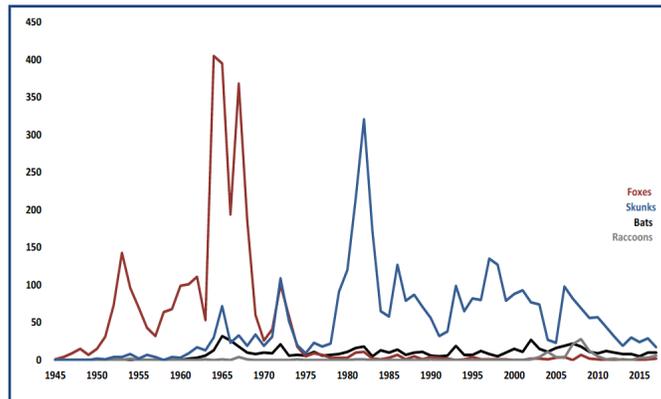


Rabies in Tennessee

- Main rabies reservoir species in Tennessee is the striped skunk
- Raccoon variant of the rabies virus was first found in east Tennessee raccoon population in 2003
- During late 2017–2018, there were multiple cases of raccoon-variant rabies in raccoons and skunks in southeastern Tennessee



Rabies in Tennessee

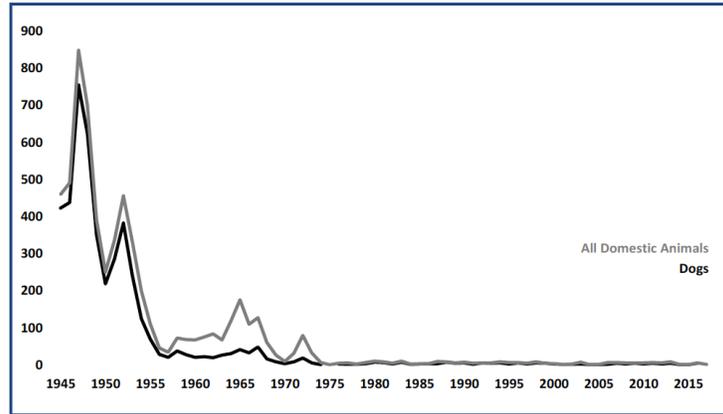


Reported Rabies in Wild Animals in Tennessee, 1945-2017

Rabies in Tennessee

- Domestic animal rabies cases have averaged 6 per year in Tennessee since the mid-1970s,
 - majority dogs
- Other domestic animals that are occasionally found to be rabid are cats, cattle, and horses
- Result of “spillover” infection with wild animal rabies viruses
 - primarily skunk variant.
- Non-reservoir wildlife species can also be affected by spillover of rabies
 - from 1975 to 2016, only 3 cases of rabies were reported in non-reservoir wild animals: a weasel, an opossum, and a bobcat.

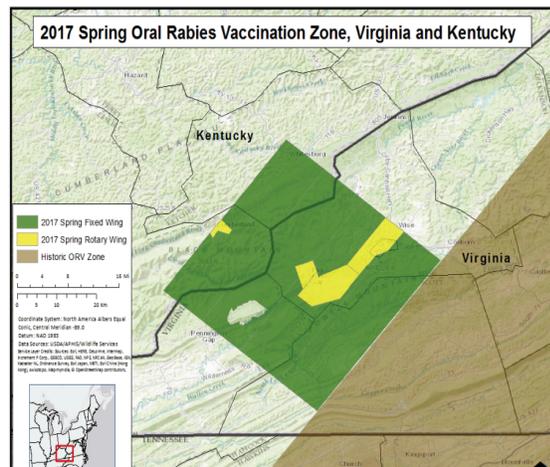
Rabies in Tennessee



Reported Rabies in Domestic Animals in Tennessee, 1945-2017

Rabies in Tennessee

- Where we have high raccoon variant rabies present, spillover to domestic animals and non-reservoir wild animal species is much more common than in Tennessee
- In raccoon rabies-endemic areas (primarily the eastern seaboard states), rabies is much more common in domestic cats
 - also occasionally found in wild species as diverse as bobcats, groundhogs, and deer



Cats	Cattle	Dogs	Horses	Pigs
4	1	24	10	1

Domestic Animals Reported Rabid in Tennessee, 2010-2017

Rabies in Humans

Variant	Indigenous	Imported	Total
Bat	6	1	7
Canine	0	5	5
Raccoon	2*	0	2
Unknown	1	0	1
All	9	5	14

Human Rabies Cases Reported in the United States, 2010-2017

*1 case was transplant-acquired



The screenshot shows the One Health Commission website. At the top, there is a navigation bar with links for 'About Us', 'Contact Us', and a search bar. Below this is a 'World Health Through Collaboration' banner with a 'DONATE NOW' button and social media icons for Facebook and Twitter. The main content area is titled 'Bat Rabies Education' and features a sidebar with links to 'Bat Rabies in the News', 'Additional Bat Rabies Resources', and 'Additional General Rabies Resources'. The main content includes a map of the United States, a photo of a woman with a dog, and the text: 'OHC BRET- Bat Rabies Education Team' and 'Our Mission is to raise awareness about bat rabies in the Americas by promoting health education in a multi-strategic One Health approach.' Below this, there is a paragraph explaining that rabies is a deadly, yet preventable, viral disease that can be transmitted to people by infected mammals, including bats.

LOCAL

Rabies case involving shelter puppy confirmed in Johnson City

Morbidity and Mortality Weekly Report

Human Rabies — Virginia, 2017

Julia Murphy, DVM¹; Costi D. Sifri, MD²; Rhonda Pruitt³; Marcia Hornberger⁴; Denise Bonds⁴; Jesse Blanton, DrPH⁵; James Ellison, PhD⁵; R. Elaine Cagnina²; Kyle B. Enfield²; Miriam Shiferaw, MD⁵; Crystal Gigante, PhD⁵; Edgar Condori⁵; Karen Gruszynski, PhD^{1,6}; Ryan M. Wallace, DVM⁵

On May 9, 2017, the Virginia Department of Health was notified regarding a patient with suspected rabies. The patient had sustained a dog bite 6 weeks before symptom onset while traveling in India. On May 11, CDC confirmed that the patient was infected with a rabies virus that circulates in dogs in India. Despite aggressive treatment, the patient died, becoming the ninth person exposed to rabies abroad who has died from rabies in the United States since 2008. A total of 250 health care workers were assessed for exposure to the patient, 72 (29%) of whom were advised to initiate postexposure prophylaxis (PEP). The total pharmaceutical cost for PEP (rabies immunoglobulin and rabies vaccine) was approximately \$235,000. International travelers should consider a pretravel consultation with travel health specialists; rabies preexposure prophylaxis is warranted for travelers who will be in rabies endemic countries for long durations, in remote areas, or who plan activities that might

cardiac enzymes, a serum troponin I level of 1.05 ng/mL (normal <0.02 ng/mL), and a serum lactate level of 8.8 mmol/L (normal, 0.7–2.1 mmol/L). Electrocardiogram results* suggested acute cardiac ischemia with atypical chest pain. The patient underwent emergency cardiac catheterization, which indicated normal coronary arteries.

On the evening of May 8, the patient became progressively agitated and combative and was noted to be gasping for air when attempting to drink water. Hospital staff members questioned family about animal exposures, and the patient's husband reported that she had been bitten on the right hand by a puppy approximately 6 weeks before symptom onset while touring in India. According to the husband, the patient cleaned the wound with the help of the tour operator but did not seek further medical treatment. The patient had no record of a pretravel health screening, did not receive rabies

[A-Z Index](#)

CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives. Protecting People™

Search

Importation

CDC > Importation > Laws and Regulations

Importation

Bringing an Animal into the U.S. +

Bringing Animal Products into the United States +

Traveling with Pets

Human Remains Importation

Internet Pet Adoption Scams

Laws and Regulations

Dog Importation Policy 2019

Egypt Dog Ban

FAQs: Dogs from Egypt

Notice of Temporary Suspension of Dogs Entering the United States from Egypt

On May 10, 2019, the Centers for Disease Control and Prevention (CDC) in the Department of Health and Human Services (HHS) published a Federal Register Notice titled, "**Notice of Temporary Suspension of Dogs Entering the United States from Egypt.**" Through this notice, CDC is informing the public that, effective immediately, it is temporarily suspending the importation of:

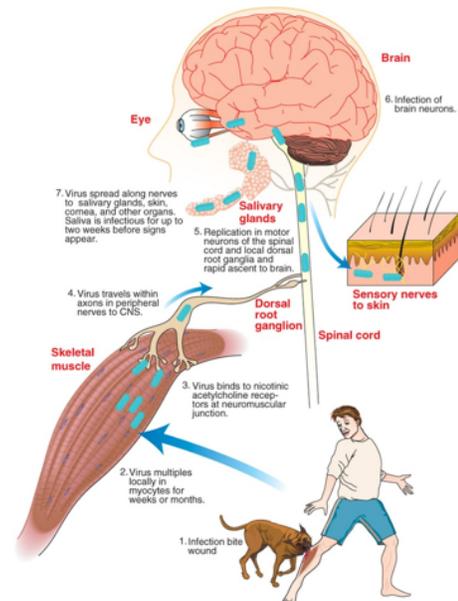
- Dogs from Egypt, or
- Dogs originating in Egypt that are imported from third-party countries, if the dogs have lived in those countries for less than six months.

Rabies is fatal in both humans and animals, and the importation of even one rabid dog could result in transmission to humans, other dogs, and wildlife. Given three recent cases of rabid dogs imported from Egypt since May of 2015, CDC is taking this action to protect public health and prevent the reintroduction of dog rabies (canine rabies virus variant), which has been eliminated from the United States since 2007.

CDC will maintain this suspension until appropriate veterinary safeguards to prevent the importation of rabid dogs from Egypt have been established. CDC has coordinated with other federal agencies and entities as necessary to implement this action. CDC will review this suspension periodically.

Transmission

- Transmission of rabies virus occurs when **infected saliva** of a host is passed to an uninfected animal.
 - Usually happens via a bite
 - transmission has been rarely documented via other routes such as contamination of mucous membranes (i.e., eyes, nose, mouth), aerosol transmission, and corneal and organ transplantations.
- Blood, vomit, feces, and urine are NOT sources for rabies transmission



Pathogenesis

The diagram illustrates the pathogenesis of rabies in a human. It shows a person being bitten by a dog. The virus enters through the wound and travels through the peripheral nervous system (PNS) to the central nervous system (CNS). The diagram is divided into seven numbered steps:

1. Infection bite wound
2. Virus multiplies locally in myocytes for weeks or months.
3. Virus binds to nicotinic acetylcholine receptors at neuromuscular junction.
4. Virus travels within axons in peripheral nerves to CNS.
5. Replication in motor neurons of the spinal cord and local dorsal root ganglia and rapid ascent to brain.
6. Infection of brain neurons.
7. Virus spread along nerves to salivary glands, skin, cornea, and other organs. Saliva is infectious for up to two weeks before signs appear.

Labels in the diagram include: Eye, Brain, Salivary glands, Sensory nerves to skin, Spinal cord, Dorsal root ganglion, Skeletal muscle, and a person being bitten by a dog.

- Immediately after infection enters eclipse phase:
 - No clinical signs
 - Virus replicates in non-nervous tissue (e.g., muscle)
 - Not easily detected
 - Does not stimulate an immune response at this time
 - but it is susceptible to neutralization if antibodies are present.
- After several days or months, the virus enters the peripheral nerves and is transported to the CNS.
- In the CNS, clinical signs develop as the neurons are infected

Pathogenesis

The diagram illustrates the pathogenesis of rabies in a human, identical to the one above. It shows a person being bitten by a dog. The virus enters through the wound and travels through the peripheral nervous system (PNS) to the central nervous system (CNS). The diagram is divided into seven numbered steps:

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Labels in the diagram include: Eye, Brain, Salivary glands, Sensory nerves to skin, Spinal cord, Dorsal root ganglion, Skeletal muscle, and a person being bitten by a dog.

- The virus is **concentrated in nervous tissue, salivary glands, saliva and cerebrospinal fluid (CSF)**
- The virus targets the limbic system, causing increased aggression and likelihood of biting
- When a rabid animal bites another animal, the virus concentrated in the saliva is inoculated in its new host
- **The virus is not present in the salivary glands, and thus cannot be transmitted via a bite, until after it has reached the brain.**

Pathogenesis

- The incubation period varies with:
 - the amount of virus transmitted
 - virus strain
 - site of inoculation
- In humans, the incubation period can be a few days to several years.
 - Most cases become apparent after 3w-3m
- In dogs, cats and ferrets, the incubation period is usually less than 6 months
 - Most cases in dogs and cats become apparent between 2 weeks and 3 months

Clinical Signs

Three 'forms'

- Prodromal
- Furious
- Dumb



[Bayside Animal Hospital](#), Cambridge, MD 2013

Prevention and Control: Domestic Animals

- Vaccination!
- **NOTE: Tennessee law requires that dogs and cats over 6 months of age be currently vaccinated against rabies.**
- Frequency of booster vaccinations depends upon the labeled duration of the vaccine used.
 - State law does not specify whether 1- or 3-year vaccines must be used however
 - Local jurisdictions may have more stringent rules regarding rabies vaccination.
- Dogs and cats considered currently vaccinated only if they meet 3 criteria:
 1. Initial vaccination was administered at least 28 days previously
 2. A valid certificate exists
 3. Revaccination date on the certificate has not been reached

Risk Category	Nature of Risk	Typical Populations	Pre-Exposure Recommendations
Continuous	Virus present continuously, often in high concentrations, with specific exposures likely to go unrecognized; bite, nonbite, or aerosol exposure possible	Rabies research laboratory workers; rabies biologics production workers	Primary course with serologic testing every 6 months; booster vaccination if antibody titer is below acceptable level*
Frequent	Exposure usually episodic, with source recognized, but also might be unrecognized; bite, nonbite, or aerosol exposure possible	Rabies diagnostic laboratory workers; cavers; veterinarians and staff; animal control and wildlife workers in rabies-enzootic areas; all persons who frequently handle bats	Primary course with serologic testing every 2 years; booster vaccination if antibody titer is below acceptable level*
Infrequent	Exposure nearly always episodic with source recognized; bite or nonbite exposure possible	Veterinarians and animal control staff in areas where rabies is uncommon; veterinary students; travelers to rabies-enzootic areas where access to medical care is limited	Primary course with no serologic testing or booster vaccination

*Minimum acceptable antibody level is complete viral neutralization at a 1:5 serum dilution (CDC recommendation) or 0.5 IU per ml (WHO recommendation) by the rapid fluorescent focus inhibition test.

Exposures in People

Risk Categories For Pre-Exposure Prophylaxis in Tennessee Counties



Pre-Exposure Prophylaxis



Veterinary professionals are considered high risk group



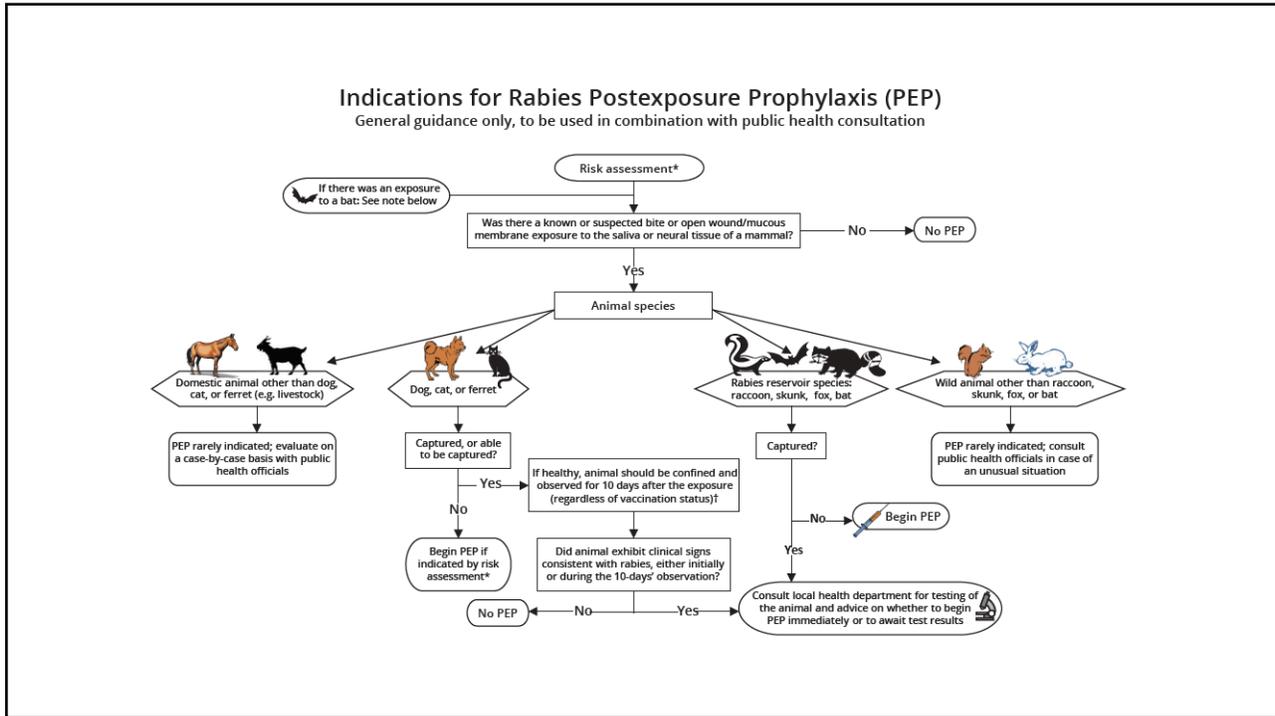
State public health recommends rabies pre-exposure for veterinary technicians



Often available in travel clinics

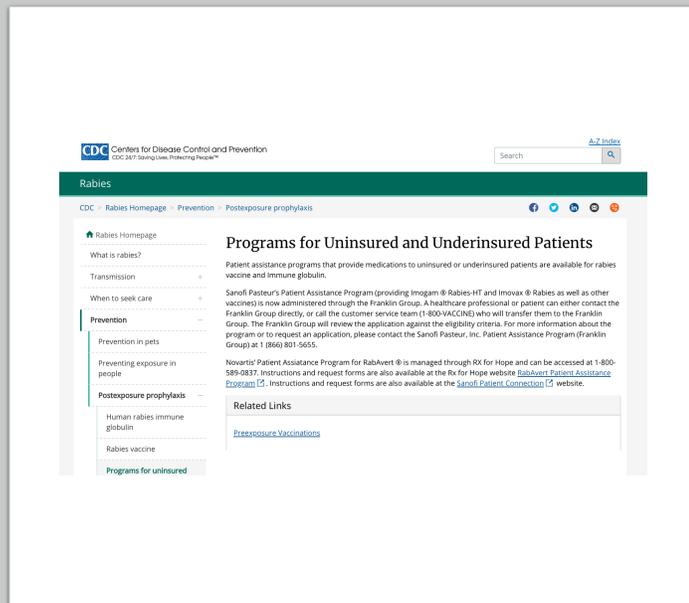
Exposures in People

- Any potential exposure to rabies requires a prompt risk assessment.
- First consideration is whether the exposure was bite or non-bite.
 - Very few documented cases of rabies in humans have involved non-bit exposures, and these resulted from highly unusual situations.
- **Rabies virus is only present in saliva and nervous tissue of a rabid animal.**
 - Touching a rabid animal or contact with blood, urine, or feces does not constitute an exposure.
 - The virus is fragile and does not persist in the environment
- Other considerations when assessing an exposure include the type of animal involved and the situation leading to the bite.
- The risk of rabies transmission from normal, healthy domestic and non-reservoir wild animals is very low, whereas the risk from rabies reservoir species (skunks, bats, and possibly raccoons in Tennessee) is high.



Post-Exposure

- If concerned about potential exposure, contact the health department:
615-741-7247
ask for the rabies program
- Can provide consultation on potential exposures
- ERs often only place for post-exposure immunoglobulin



Exposure in Animals

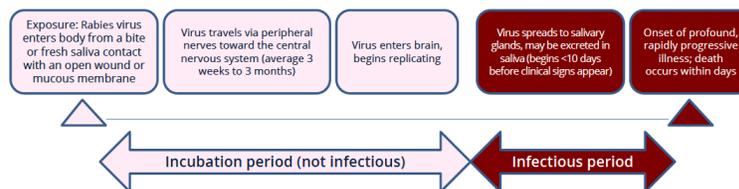
Management of a Domestic Animal Potentially Exposed to a Rabid Animal

- **Vaccinated:** If a domestic animal that is currently vaccinated or overdue for vaccination is exposed to a confirmed or suspected rabid animal, it should receive a booster vaccine immediately and be observed by the owner for 45 days. Any sign of illness during this time should be promptly evaluated by a veterinarian.
- **Unvaccinated:** If an unvaccinated domestic animal is exposed to a confirmed or suspected rabid animal, it should be euthanized immediately. Alternatively a dog or cat may be strictly isolated for 4 months such that it has no direct contact with humans or other animals
- Rabies vaccine should be administered as soon as possible after the exposure. Any illness during the confinement period should be evaluated by a veterinarian and reported to public health.

Quarantine Periods

10 days*: If the animal has bitten a person or other domestic animal. Strict confinement is not necessary. If the animal remains healthy for 10 days after a bite, rabies cannot have been transmitted at the time of the bite, regardless of the animal's vaccination status.

4 months: If a dog or cat is unvaccinated and has been bitten by a confirmed or suspected rabid animal, and the owner refuses euthanasia. Strict confinement is necessary. Public health officials should be consulted. Other species may be confined for 6 months.



*Applies ONLY to dogs, cats, and ferrets. Viral shedding periods are not established for any other species.

Testing Diagnosis

- If you suspect rabies contact the health department
- State health department:

615-741-7247
ask for the rabies program

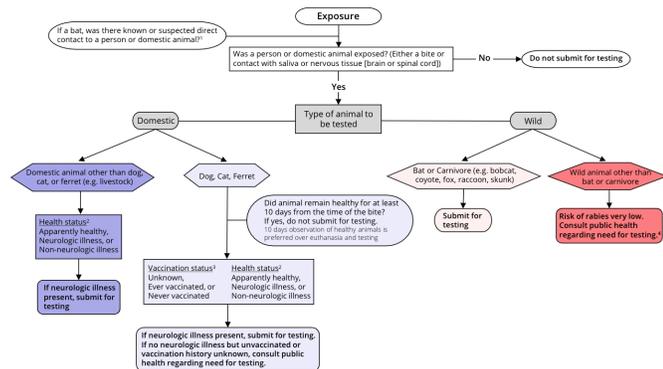
Testing Diagnosis



Tennessee Rabies Control Manual
– 2018 –
Specimen Submission Guide



Guidelines for animal submission for rabies testing



¹ If a bat was in the room with a sleeping person or an unattended young child or pet, unrecognized direct contact may be suspected.
² If animal was healthy at the time of bite/exposure, it is very unlikely to be rabid. Neurologic illness greatly increases the likelihood of rabies.
 * If animal has ever received at least 2 rabies vaccines, it is very unlikely to be rabid.
 * Small rodents (e.g. squirrels, chipmunks, mice, hamsters, rats) are not considered a risk for rabies transmission and generally will not be tested.

Tennessee Department of Health: 615-741-7247

Testing Diagnosis

- Collection, Packaging, and Identification
- Euthanized in a manner that will not damage the brain
 - The state public health laboratories do not have facilities to dispose of whole carcasses; therefore, only the head should be submitted for rabies testing.
 - Exception: when submitting bats, ship the entire animal.
 - For large animals such as cattle and horses, submit only the brain.
 - If it is not possible to recover the brain from a large animal, send the head only to either the CE Kord Animal Health Diagnostic Laboratory or the University of Tennessee College of Veterinary Medicine, Veterinary Medical Center, Diagnostic Laboratory



Testing/Diagnosis

Laboratory Locations and Contact Information

Public Health Laboratories (for rabies testing)

TDH Laboratory Services

630 Hart Lane
Nashville, TN 37243
Phone: (615) 262-6300
Fax: (615) 262-6393

Knoxville Regional Laboratory

2101 Medical Center Way
Knoxville, TN 37920
Phone: (865) 549-5201
Fax: (865) 549-5199

Animal Diagnostic Laboratories (for removal of brains from large animals—rabies testing not performed)

CE Kord Diagnostic Laboratory

436 Hogan Road
Nashville, TN 37220
Phone: (615) 837-5125

UT CVM Diagnostic Laboratory

2407 River Drive
Knoxville, TN 37996
Phone: (865) 974-5673



If you forget everything
else...

- When submitting samples- refrigerate, do not freeze
 - If you've already frozen it, leave it frozen
- If you have ANY questions, call the state health department:
- 615-741-7247
 - ask for the rabies program

Acknowledgements:

Mary-Margaret A. Fill, M.D. | Medical Epidemiologist

Karen Gruszynski DVM, PhD, DAVCPM | Veterinary Epidemiologist

One Health Commission Bat Rabies Education Team



Thank you!!

Contact information

bonnie.price@lmunet.edu

423-869-7118