

General Information

- The classical rabies virus belongs to serotype 1 of the genus *Lyssavirus* in the family Rhabdoviridae.
- It is a bullet-shaped, enveloped, single-stranded RNA virus that survives very poorly in the environment.
- “Street viruses” are those isolated from natural infections, while “fixed viruses” are laboratory-modified strains.
- Rabies virus infections have highly variable incubation periods and clinical signs in all susceptible species.
- The virus can infect any mammal, but only carnivores and bats maintain the infection naturally. Herbivores, rodents, rabbits and other non-biting animals are not epidemiologically significant in the propagation of the disease, but they are variably susceptible to infection. Birds cannot transmit rabies virus.
- The importance of this disease is based on the near 100% mortality rate in all species once clinical signs appear, and the high cost of post-exposure prophylactic treatment for humans and control programs in animals.

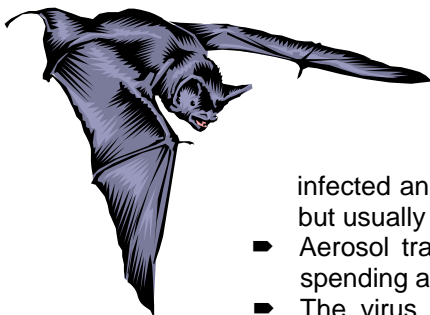
Prevalence and Risk Factors

- Rabies occurs worldwide, although there are some areas in Europe and some island nations that are rabies-free. Every year there are approximately 50 000 human deaths worldwide due to rabies, mostly in India and areas where canine rabies is still common, and mostly associated with transmission from dogs.
- In Canada, the USA and western Europe, canine rabies has been eradicated, and the disease is maintained by certain species of local wildlife. However, dogs (and cats) can still become infected by and transmit wildlife strains of rabies virus, which are infective to all mammals. Transmission from wildlife to humans is considerably less common as there is much less direct contact compared with dogs.
- From 2000 to 2006, there were 15 reported cases of human rabies in the USA, nine of which were the result of exposure to bats, and four of which were the result of exposure to rabid dogs. In the same period, only two cases of human rabies were reported in Canada, which were associated with exposure to bats.

The wildlife reservoir hosts of rabies are different in various regions of North America, but include foxes, skunks, racoons, coyotes and various species of bats. Infections in domestic species and humans are the result of spill-over from these reservoir populations. Of the nearly 7000 cases of animal rabies reported in the USA in 2004, 92% were in wildlife species, of which over 2500 cases were in racoons. Many kinds of bats, including fruitivorous and insectivorous species, are capable of transmitting rabies. Rabies has been isolated from various rodents and lagomorphs, but it is relatively uncommon in such species and the potential for transmission to humans is low, but the risk should be assessed on a case-by-case basis. In the USA, but not Canada, rabies is now more commonly reported in cats than in dogs.



Transmission



- Rabies can only be transmitted by exposure of a mucous membrane or wound (broken skin) to the saliva of an infected animal or infected tissue (such as brain, spinal cord).
 - The most common source of rabies in human cases worldwide is dogs, but in the United States and Canada it is bats.
 - Depending on the strain of virus and the host species involved, an infected animal may shed virus in its saliva for up to 14 days before clinical signs develop, but usually for less than 10 days (hence biting animals are usually isolated for 10 days).
 - Aerosol transmission has been reported in two scientists who contracted the virus after spending a few hours in a heavily populated bat cave, supposedly without being bitten.
 - The virus has never reportedly been spread to a human by ingestion, although such transmission has been shown experimentally in animals, and may occur in wildlife as well.
- Rabies can also be transmitted by solid organ and corneal transplants.

Clinical Course and Signs

The incubation period of rabies depends on the amount of virus transmitted, and the severity location of the bite wound (the more distal the bite to the brain and spine, the longer the incubation period). It can last anywhere from



7 days to six months or longer. The virus first replicates at the site of inoculation, and then travels through peripheral nerves from this site to the spinal cord and brain where it causes nonsuppurative encephalomyeloradiculitis. From there it can spread via other nerves to virtually any tissue, but particularly to the salivary glands, at which point it can also be transmitted to another host. Rabies is almost invariably fatal once clinical signs appear. There are two major forms of clinical rabies: paralytic (or dumb) rabies, and furious rabies.



- The signs of rabies in animals are hugely variable, from incoordination and loss of motor control characteristic of paralytic rabies, to violent manic behaviour characteristic of furious rabies, and the full spectrum of signs in between.
 - **Rabies must therefore be considered in any animal that develops any kind of neurological signs, especially if the animal goes outside or was bitten in the last six months by ANY animal whose rabies status is unknown.** Vaccination does not guarantee that disease will not occur.
 - Paralysis of the laryngeal and pharyngeal muscles can lead to voice change and excess drooling in some cases, which may be mistaken for signs of choke.
- Clinical disease in animals rarely lasts longer than 10 days and inevitably ends in death.
 - It is important to note that rabid animals do not necessarily become vicious. Behavioural changes in wild animals may result in nocturnal animals being seen during the day, and animals having decreased fear of humans, making them appear more friendly.

Diagnosis

- In animals, there is no antemortem test by which to diagnose rabies that is sensitive enough to reliably rule out the disease. Antemortem testing is therefore not performed in animals. Nonetheless, virus can be detected in saliva and skin biopsies from live animals.
- The diagnosis is usually made by direct immunofluorescence of neural tissue post-mortem, which has very high sensitivity and specificity.
- Histological examination of cerebral tissue for Negri bodies can be reasonably specific, but is not used in Canada because the fluorescent antibody test is superior.
- Strains can be typed to help determine the source of rabies virus, if needed.
- Serology is primarily used to determine host response to pre- or post-exposure vaccination in humans. It cannot be used reliably for diagnosis of infection, particularly in previously immunized patients (human or animal).



One cannot rule out rabies based solely on a lack of definitive exposure. The fur or hair of animals can make it very difficult to detect small bite wounds. There are no characteristic serum biochemical or hematological abnormalities, and cerebrospinal fluid analysis has been rarely reported in natural infections. However, if clinical signs fail to progress or if clinical signs improve at all over 7-10 days, then rabies is extremely unlikely.

In Canada, by law, any animal suspected of having rabies must be reported to the Canadian Food Inspection Agency (CFIA), through the local district office. A federal veterinarian will then determine the likelihood of rabies infection and the need for testing. If testing is required, a federal veterinarian will collect the appropriate sample (typically the animal's entire head) and arrange to have it sent to a federal laboratory. Refrigerate but ideally do not freeze or chemically fix the tissues, as this can interfere with sample collection and testing. The need for a complete necropsy is usually left to the discretion of the attending veterinarian. It is important to remember that the rabies virus can be found in many body tissues, so necropsy must be performed with great caution, and protective equipment including a full face mask should be worn. For more information, consult the website of the Canadian Food Inspection Agency (CFIA) at <http://www.inspection.gc.ca/>, or contact your district veterinarian.

Biting Animals and Suspected Rabid Animals

All human animal bites should be reported to the local public health department. Any dog, cat or ferret that has bitten a human should be isolated for at least ten days and monitored for development of clinical signs of rabies. If an animal under such isolation, or any animal with known exposure to another rabid animal, develops clinical signs compatible with rabies, it must be reported to the Canadian Food Inspection Agency. Stray/feral animals or wild animals that bite a human may be euthanized and tested for rabies without undergoing the period of isolation. All animal exposures to rabies must be reported. Exposed, unvaccinated animals will be euthanized, or else isolated for at least six months, and vaccinated one month prior to release if they remain free of clinical signs.



Vaccinated animals very rarely develop clinical rabies. Nonetheless, an exposed, vaccinated animal should be revaccinated as soon as possible (within five days) and then quarantined under the owner's care for 45 days.

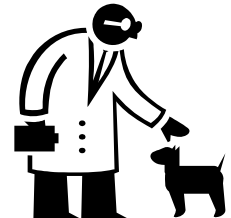
Animals with clinical signs compatible with rabies, but unknown exposure, and particularly if their immunization status is unknown, must be handled with extreme caution, as little as possible, and only by experienced personnel vaccinated against rabies. Any broken skin and all mucous membranes, including those of the eyes, must be protected to prevent contamination with saliva. Because these animals can have very unpredictable behaviour, extra precautions to prevent bites and scratches (such as wearing very heavy gloves and using catchpoles and cages) must also be taken. All suspected clinical cases of rabies must be brought to the attention of a federal veterinary inspector (or state authorities in the USA), who can also provide further instructions and assistance.

Requirements for companion animals entering a rabies-free area vary by region, but may include permanent identification (e.g. microchip), a health certificate, proof of vaccination, measurement of a current rabies titre, and quarantine for a period of up to six months.

Treatment

There is NO effective treatment for rabies. Once clinical signs appear, the mortality rate is virtually 100%. Initial bite wound care is very important if rabies transmission is at all possible. The bite should be cleaned vigorously with soap and water for at least 15 minutes and then disinfected with alcohol, povidone iodine or a quaternary ammonium compound. Primary closure of the wound should be avoided. There is recent experimental evidence that post-exposure prophylaxis of dogs with vaccine and monoclonal rabies antibodies may be effective. The World Health Organization currently discourages the use of such antibodies in animals, and there are no products of any kind licensed for post-exposure rabies prophylaxis in animals. However, a currently vaccinated animal that is exposed to rabies should be revaccinated as soon as possible. An unvaccinated animal should not be, as any vaccine reaction may interfere with detection of developing clinical signs of rabies.

Humans who have been exposed to the virus can be given prophylactic immunization in order to help the body eliminate the virus before it invades local peripheral nerves and travels to the central nervous system. It is important to bear in mind that such treatment can be quite expensive and is not without its own risks, but also that any delay in obtaining treatment can significantly decrease its efficacy. If the biting animal remains healthy for 10-14 days, or if it is euthanized and tests negative for rabies, further post-exposure treatments should be stopped.



Infection Control

Control of rabies in people depends on control of rabies in animals. Companion animals have the highest degree of human contact and therefore pose the most significant risk to people if they become infected. Immunization of pets, particularly those that venture outside, and control of feral, non-immunized populations is of primary importance. In wild carnivores, control efforts are now being focused on immunization in combination with reduction of population density. A key component of rabies control programs is public education, which should be promoted by health care, public health and veterinary professionals alike.

- ▶ People should avoid all contact with bats, particularly if bats are seen during the day or found on the ground.
- ▶ It is important to prevent bats from gaining access to dwellings, and to try to prevent pets and other domestic animals from being bitten by bats. However extermination of insectivorous bat populations is not recommended as they are beneficial to agriculture.

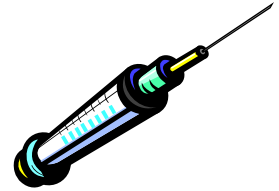
Vaccines

- ▶ Inactivated rabies vaccines are both very safe and efficacious. Modified live virus vaccines were previously used in oral baits for mass vaccination of feral animals and wildlife, but this type of vaccine has on a few occasions been associated with cases of clinical rabies. Numerous recombinant vaccines have since been developed which are safer but still effective.
- ▶ Rabies vaccines for dogs, cats, ferrets, some livestock and humans are commercially available. It is important to follow label directions for rabies vaccines in terms of dose and species, as vaccines developed for one species may not necessarily be safe in other species.



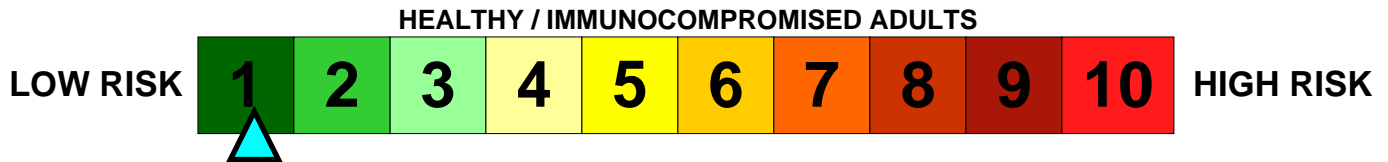
- Companion animals should be vaccinated at 3 months of age, boosted one year later, and then annually or every three years, depending on the product used. Both one-year and three-year vaccines are considered acceptable in Canada.
- Even indoor animals should be vaccinated in case they escape outdoors, or a rabid bat is found in the dwelling.
- Rabies antibody titres can be measured in animals, but currently this cannot be used to determine whether or not an animal is protected. Therefore animals should always be vaccinated according to the product label.

Human vaccination is limited to those at increased risk of exposure, including veterinarians, animal handlers and animal control personnel. All people in a veterinary practice that may have contact with animals should be vaccinated (this may also include front-office staff in some practices). Such individuals should have their antibody titre checked every two years, and booster vaccination should be considered if the titre is less than 0.5 IU/mL.



Zoonotic Disease Risk

In adults, the risk of rabies *exposure* from pets is:



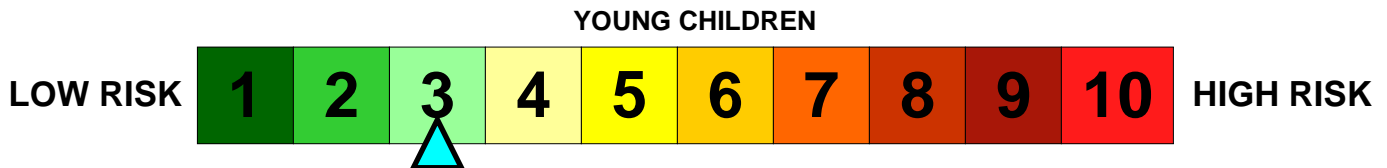
Individuals with Compromised Immune Systems:

- Because both pre-exposure and post-exposure rabies prophylaxis may be significantly less effective in individuals who are immunocompromised, these individuals are at slightly *increased risk of becoming ill* and succumbing to the disease if they are exposed to rabies. They should therefore avoid situations and occupations which entail any increased risk of exposure to rabies. If it cannot be avoided, their antibody titres must be monitored very carefully to ensure that their response to immunization is adequate and protective.

Young Children:

- When it comes to animals, young children are more likely than adults to try to touch or pick up an unfamiliar animal, and they are also more likely to, either intentionally or unintentionally, provoke or frighten an animal and thus be bitten.
- Young children should always be supervised when playing with animals, and they should be taught never to approach or touch any unfamiliar animal, even if it seems very friendly or if it looks sick or unconscious.

Overall, for children the risk of rabies *exposure* from pets is likely:



Additional Information

<http://www.nasphv.org/Documents/RabiesCompendium.pdf> provides the most up-to-date information on prevention and control of rabies and vaccination in animals

Greene CE. Infectious Diseases of the Dog and Cat. 3rd ed. Edinburgh: Elsevier Saunders, 2006.

Centers for Disease Control and Prevention (CDC). Public health response to a rabid kitten – four states, 2007. MMWR Morb Mortal Wkly Rep. 2008;56:1337-1340.

CFIA Rabies website: <http://www.inspection.gc.ca/english/anima/heasan/disemala/rabrag/rabrage.shtml>