Epidemiology, Prevention and Control Methods of Rabies in Domestic Animals: Review Article

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Abstract: Rabies is a viral disease that affects the central nervous system of warm-blooded animals, including humans. The disease has a long incubation period (Six months) and symptoms may take several weeks to appear after infection. However, once symptoms appear, rabies is always fatal in animals. The rabies virus is a lyssavirus, a group of viruses responsible for causing encephalitis that also includes several recently identified bat lyssaviruses. Lyssaviruses belong to the family Rhabdoviridae. The name Rhabdo comes from the Greek and identifies the characteristic bullet or rod-shape of the viruses. There are several strains of the classic rabies virus that are each generally confined to a major species as reservoir. Domestic dogs serve as a major reservoir of rabies virus in many developing countries and are capable of maintaining virus transmission in a well-defined maintenance cycle. Cats are not known to act as maintenance reservoirs for unique rabies virus variants. They are important as incidental hosts affected by spillover and can serve as important in a chain of transmission of rabies virus to humans and other domestic animals.

Key words: Domestic animals · Epidemiology · Human rabies · Prevention and Control · Worldwide

INTRODUCTION

Rabies is caused by an RNA virus belonging to the genus Lyssavirus in the family Rhabdoviridae [1]. The antigenic structures of rabies virus biotypes are stable in nature and not easily affected by passage in laboratory hosts or cell cultures. The rabies virus is bullet shaped, measures 180 X 75 nm and consists of a nucleo capsid, size 160 X 50 nm, which is composed out of three proteins (N, NS and L) surrounded by a bilayer lipid envelop derived from host cell membranes (M), through which flattened spikes or peplomeres project; it contains a RNA genome. The outer virus envelop consists of a glycoprotein (G-antigen) which can be isolated from the lipid cover of the virus. It represents the haemagglutinating as well as immunizing component of the antigen [2].

The virus is in many ways considered a close relative of the prototype species vesicular stomatitis virus (VSV) of the genus vesiculo virus, in the same family, since it share a similar morphology, chemical structure and life cycle and it can infect mammalian (Animal and human) hosts [3,4]. However, because the rabies virus is highly neurotropic in the infected host, invariably causing a fatal encephalomyelitis, rabies virus and the rabies-related viruses belong to a separate genus [4].

The genus Lyssa virus comprises rabies virus and closely related viruses, including Mokola virus, Lagos bat virus and Duvenhage virus from Africa, European bat virus 1 and 2 and Australian bat Lyssavirus. Each of these viruses is considered capable of causing rabies like disease in animals and humans. Rabies virus and the rabies-like viruses, including European bat viruses 1 and 2, Lagos bat virus, Duvenhage virus and Australian bat lyssavirus use bats as reservoir host; several other members of the family Rhabdoviridae have been isolated from bats [4,5].

Rabies virus replicates by budding from the host cell membranes and viral nucleocapsid develops in the cytoplasm. Complete viral particles may be formed at the cell surface, but, more commonly, they bud from intracytoplasmic membranes. Free virus particles infect new or adjacent cells by fusing their viral genetic material [6]. Strains of rabies virus isolated from naturally occurring cases are referred to as “Street virus” and attenuated laboratory strains are referred to as “Fixed virus”. 
These strains may differ in their biologic properties in laboratory animals; for example, virulence, length of incubation period, histopathology and the antigenic variations between these strains can be distinguished by the utilization of monoclonal antibodies [3, 7].

As an enveloped virus, rabies is inactivated by various concentrations of formalin, phenol, alcohol, halogens, mercurials, mineral acids and other disinfectants. The virus is extremely labile when exposed to ultraviolet (UV) light and inactivated by heating at 56°C for 30 minutes. Rabies virus can remain viable in a carcass for several days at 20°C, although it may survive much longer when the body of the victim is refrigerated or at 4°C [3, 6]. This review should help in better understanding domestic animals rabies epidemiology, prevention and control methods.

Important properties of rhabdoviruses [8].

| Virion: | Bullet-shaped, 75 nm in diameter X 180 nm in length |
| Genome: | single-stranded RNA, linear, no segmented, negative-sense, MW 4.6 million, 12 kb |
| Proteins: | one envelope glycoprotein |
| Envelope: | present |
| Replication: | cytoplasm; virion bud from plasma membrane |

Outstanding characteristics: wide array of viruses with broad host range group includes the deadly rabies virus

Current classifications of Lyssa viruses [4]

<table>
<thead>
<tr>
<th>Serotype, genotype</th>
<th>Major mammalian reservoirs</th>
<th>Distribution</th>
<th>Annual death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabies</td>
<td>Dogs, wild carnivores and bats</td>
<td>Worldwide (With exception of Australia, Antarctica and designated rabies free countries)</td>
<td>~50000</td>
</tr>
<tr>
<td>Lagos bat (Serotype 1, genotype 1)</td>
<td>Bats</td>
<td>Africa: Central Africa Republic, Ethiopia, Nigeria, Senegal, South Africa</td>
<td>Never report</td>
</tr>
<tr>
<td>Mokola (Serotype 2, genotype 2)</td>
<td>Shrews, cat, dogs</td>
<td>Africa: Cameroon, Central Africa Republic, Ethiopia, Nigeria, S. Africa, Zimbabwe</td>
<td>Occasional</td>
</tr>
<tr>
<td>Duvenhage (Serotype 3, genotype 3)</td>
<td>Bats</td>
<td>Africa: South Africa, Guinea, Zimbabwe</td>
<td>Occasional</td>
</tr>
<tr>
<td>European bat Lyssavirus 1 (Genotype 4)</td>
<td>Bats</td>
<td>Europe</td>
<td>Occasional</td>
</tr>
<tr>
<td>European bat Lyssavirus 2 (Genotype 5)</td>
<td>Bats</td>
<td>Europe</td>
<td>Occasional</td>
</tr>
<tr>
<td>Australian bat Lyssavirus (Genotype 7)</td>
<td>Bats</td>
<td>Australia</td>
<td>Occasional</td>
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</tbody>
</table>

Epidemiology of Rabies in Domestic Animals: Domesticated animals’ remains the major threat for transmitting rabies virus to humans. Domestic dogs serve as a major reservoir of rabies virus in many developing countries and are capable of maintaining virus transmission in a well-defined maintenance cycle. Other domestic animals typically are involved through secondary transmission of rabies virus variants maintained by dogs or wildlife [4].

Outbreaks in domestic animals appear to be associated with a “spillover” from epizootic spread in affected wildlife populations [9, 10].

Distribution and Origin of Rabies Virus Associated with Dogs: Worldwide, domestic dogs accounted for most of human rabies deaths and post exposure prophylaxis. In less developed nations, where dog rabies has not been controlled, the prevalence of canine and human rabies is quite high. Adequate vaccination of at least 50% to 70% of dogs in a given population may be necessary to block the occurrence of rabies epidemics [6]. In Latin America and Asia, this feature is a problem because of the existence of many strays; unvaccinated dogs and the absence of rabies-control programs. These two factors are responsible for thousands of rabies cases in dogs each year in these countries [11].

In Africa, the domestic dog is the single most important reservoir species and everywhere the most important vector of rabies to the human. In 1998, more than 50 percent of all cases of rabies diagnosed in mammals in Africa were in domestic dogs [7, 8].

Rabies in dogs is well established in Addis Ababa with no decline in the annual number of confirmed rabid cases during the last 10 years (1990-2000). From the total of 2,667 brain samples examined from dogs during the study period, 1,951 (73.2%) were positive for rabies. Dogs accounted to 96.2% of the 13,889 total animals examined and represented 89.83% of the total brain samples that were found to be laboratory confirmed positive rabies cases [12].
Epidemiology of Rabies in Cats: Feline rabies is an important public health concern because cats continue to have the highest rabies incidence of any domesticated animal. This may be because cats are more likely than other species to have non-fatal interactions with important wildlife reservoir of rabies virus such as raccoons, skunks and bats. Because of the variability of the chemical manifestation of rabies in the cat and the intimate interaction between cats and human beings, the impact of feline rabies on human health care is considerable. In one single incident, a rabid pet-store kitten exposed at least 665 people who subsequently received antirabies prophylaxis at an estimated health care cost of more than $1.1 million. In endemic areas, rabies should be considered as differential diagnosis for any cat with unexpected change in behavior / or signs of central or peripheral nervous system disease [13].

Cats are not known to act as maintenance reservoirs for unique rabies virus variants. They are important as incidental hosts affected by spillover and can serve as important in a chain of transmission of rabies virus to humans and other domestic animals [14].

Cat as a Source of Human Rabies Exposure: The relative importance of rabies in cats as a source for human exposure in a given geographic area depends on whether canine rabies is being controlled by vaccination [6]. Reports from European countries from the 1950s through the 1970s indicated that cats were found rabid more frequently than dogs and were associated more frequently with human exposures. Among 1,104 persons receiving PET in France in 1988 following exposure to an animal proved to be rabid by laboratory testing, 88 (8%) had been bitten by a rabid dog and 285 (26%) by a rabid cat; almost half (522; 47%) were treated for contact with rabid herbivores [4]. When we see these situations in Ethiopia, during the 10 year period (1990-2000) cats accounted for 5.35% of the total confirmed rabies cases and contributed to 2.62% of humans that took antirabies post exposure treatments [12].

Characteristics of Rabid Cats and Origin of Their Infection: Cats are naturally highly resistant to rabies virus infection. Feline rabies is acquired through contact with infected wild reservoirs, usually due to a bite wound. Raccoons and skunks have also been observed eating from food bowls left out doors for cats and/or feeding alongside them. If there is an open wound in the oral cavity, rabies virus could be introduced during contact with infected saliva during communal feeding. Rarely, ingestion of rabies infected tissue has been suspected as the source of exposure [4, 13].

As Greene [6] rabid cats, which usually are reclusive, often become aggressive and may attack humans and other animals when disturbed. In cats rabies can assume the furious form with signs similar to those seen in dogs. Rabid cats are extremely dangerous animals for human attendants and owners become of their viciousness and quickness of action. The very few cases of vaccine induced rabies in cats frequently have been paralytic in nature [15,16].

Epidemiology of Rabies in Cattle and in Other Domestic Animals: In terms of economic impact, rabies among cattle remains an significant concern, especially in locations of Latin America from northern Argentina in to Mexico [4] and it is also a problem in South America related with both economic and public health problem where vampire bat transmitted rabies result in cyclic out breaks [2,10].

In central Southern Africa, rabies is a problem in cattle when the jackal population is allowed to increase and over a 4- year period, of all the domestic animal rabies cases reported, cattle accounted for one-half of the rabies cases in South African domestic animals [17, 18].

Cattle of all ages that are exposed to wild life or dogs are susceptible. The signs are extremely variable. In general two forms are observed. The acute, maniacal, furious form is accompanied by hyperesthesia, bellowing, ataxia, charging of animate or inanimate objects and sexual excitement. Blindness and seizures are rare [15].

According to Jackson and Wunner [4] rabies among horses, pigs, goats and other domestic animals remains a sporadic occurrence wherever rabies virus is endemic. The susceptibility of the sheep or goat rabies increase in proportion to the quality of inoculum (Usually saliva from a bite) placed in to a wound, the number of nerves in the area around the wound (Rabies virus migrates along nerves), the vaccination history of the bitten animal and the location of the wound. The closer the wound is to the central nervous system, the more susceptible to infection the animal becomes [9].

Rabies is a rare, fatal viral disease of pigs in rabies-infected areas characterized by sudden onset, nervous signs and death. Less than 0.05% of rabies cases notified in Europe occurs in the pig. It is equally rarely diagnosed in pigs in other parts of the world in which rabies is present [18]. When we see the incidence of rabies in horse in United States it is low compared to wildlife or domestic small animals but some yearly fluctuation occurs [10].
Clinical Findings

Fig. 1: Salivation, Bellowing and loss of condition

Fig. 2: Cow salivation, bellowing and lameness

Fig. 3: In horse, muzzle tremors were the most frequently observed and most common initial signs. Unexplained aggressiveness and kicking, biting, colic, sudden onset of lameness. Pharyngeal paralysis, anorexia, depression, colic and ataxia.
Prevention and Control: Vaccination is effective at preventing rabies [16, 19]. In domestic species rabies vaccines are used primarily for pre exposure prophylaxis; treatment after exposure is not advised. Mass immunization of dogs has been employed for many years to control the spread of rabies by creating an immunological barrier between wildlife reservoirs of the disease and human populations. Several nations, including, Japan, England, Iceland and Scandinavian countries have eradicated rabies by implementing control programs and strict quarantine regulations [16, 19].

For control of rabies in dog populations, vaccinating a minimum of 50% to 70% of dogs is theoretically necessary. Eliminating unvaccinated feral dog population alone has not proved effective and is expensive. Eliminating wild life populations is nearly impossible and is expensive. Therefore the control measures centered on vaccination of dogs and cats are most appealing and effective [6, 20].

Unvaccinated dogs and cats exposed to a rabid animal should be euthanized immediately. If the owner is unwilling to have this done, the animal should be placed in strict isolation for 6 months and vaccinated 1 month before being released. Animals with expired vaccinations need to be evaluated on a case-by-case basis. Dogs and cats that are currently vaccinated should be revaccinated immediately, kept under the owner’s control and observed for 45 days [20].

For farm animals there are two useful control techniques: the prevention of exposure and vaccination. The former can be achieved to a degree by destruction of wild fauna, muzzling, restraint and vaccination of all cats and dogs and keeping farm animals indoors [21].
CONCLUSIONS

Rabies is regarded as one of the most important zoonotic diseases in the world (A disease which primarily affects animals, but can cause disease in humans). Any encounter with a domestic or wild animal where a bite is received must be investigated. Rabid wild animals lose their natural fear of humans, increasing the risk of encounter. Clinical signs in animals such as excessive salivation, choking or gagging can lead humans to unknowingly risk infection while examining inside the mouth of dogs and livestock searching for a foreign body or attempting to administer medication with bare hands.

Recommendations: It is important to immediately wash any bite wound or exposed surface with soap and water and report the incident to a doctor or hospital emergency department. The risk of rabies transmission must be evaluated based on the nature of the encounter, species of animal involved, prevalence of rabies in the area and evaluation of the vaccination and clinical status of the animal and its availability for diagnostic testing.

REFERENCES