Rabies virus (RABV): cases of RABV transmission in humans registered in Brazil

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Abstract

The transmission of the rabies virus in humans is lethal, in practically 100% of the cases. It is observed that the highest transmission rate predominates in human individuals under 15 years of age, especially in males and in urban areas. The rabies virus belongs to the Rhabdoviridae family and the *Lyssavirus* genus with over 16 other circumscribed virus types. The biggest sources of transmission are in the Asian and African continents. In the Americas, the rabies virus is registered from the USA to Chile, and in Brazil so far, 207 confirmed cases of rabies transmitted between non-human mammals to humans, especially dogs and bats, have been described. Public health policies with the vaccination of domestic animals against rabies showed a significant drop in cases of transmission, although the target source is still wild bats, mainly of the *Desmodus* genus, however, several studies show that other classes of bats with non-hematophagous habits are hosts of the rabies virus. In addition to great concern about the 2019-Current Covid-19 pandemic and the emergence of cases in more than 90 countries of Monkeypox (Mamacopox) we must now be concerned about the increase in human rabies cases and its lethality. Cases in Brazil show heterogeneity between the years of confirmed cases, although we must worry about controlling and educating the population and investigating fomites carrying the virus.

Keywords: *Lyssavirus* genus, Bats, Canids, Anthropozoonosis, Rhabdoviridae

Resumo

A transmissão do vírus da raiva em humanos é letal, em praticamente 100% dos casos. Observa-se que o maior índice de transmissão predomina em indivíduos humanos menores de 15 anos em especial no sexo masculino e em áreas urbanas. O vírus da raiva pertence a família Rhabdoviridae e ao gênero *Lyssavirus* com mais 16 outros tipos de vírus circunscritos. As maiores fontes de transmissão estão nos continentes Asiático e Africano. Nas Américas, o vírus da raiva é registrado desde os EUA até o Chile, e no Brasil são descritos até o momento 207 casos confirmados de raiva transmitida entre mamíferos não humanos para humanos, em especial cães e morcegos. As políticas de saúde pública com a vacinação de animais domésticos contra raiva apresentaram uma queda importante nos casos de transmissão, embora ainda a fonte alvo seja os morcegos de hábito selvagem principalmente do gênero *Desmodus*, no entanto, diversos estudos apresentam que outras classes de morcegos com hábitos não hematófagos são hospedeiros do vírus da raiva. Além de grande preocupação com a pandemia de 2019-Atual de Covid-19 e o surgimento de casos em mais de 90 países de Monkeypox (varíola dos mamacos) devemos agora nos preocupar com o aumento dos casos de raiva humana e sua letalidade. Os casos no Brasil apresentam uma heterogeneidade entre os anos de casos confirmados, embora tenhamos que nos preocupar em controlar e educar a população e investigar os fômites portadores do vírus.

Palavras-chave: Gênero *Lyssavirus*, Morcegos, Canídeos, Antropozoonose, Rhabdoviridae

Resumen

La transmisión del virus de la rabia en humanos es letal, prácticamente en el 100% de los casos. Se observa que

la mayor tasa de transmisión predomina en los individuos humanos menores de 15 años, especialmente en el sexo masculino y en la zona urbana. El virus de la rabia pertenece a la familia Rhabdoviridae y al género *Lyssavirus* con más de 16 tipos de virus circunscritos. Las mayores fuentes de transmisión se encuentran en los continentes asiático y africano. En las Américas, el virus de la rabia está registrado desde EUA hasta Chile, y en Brasil, hasta el momento, se han descrito 207 casos confirmados de rabia transmitida entre mamíferos no humanos a humanos, especialmente perros y murciélagos. Las políticas de salud pública con la vacunación de animales domésticos contra la rabia mostraron una caída significativa en los casos de transmisión, aunque la fuente objetivo sigue siendo los murciélagos salvajes, principalmente del género *Desmodus*, sin embargo, varios estudios muestran que otras clases de murciélagos con hábitos no hematófagos son huéspedes del virus de la rabia. Además de la gran preocupación por la pandemia de Covid-19 de 2019-Actual y la aparición de casos en más de 90 países de Monkeypox (Viruela del Mono), ahora debemos estar preocupados por el aumento de casos de rabia humana y su letalidad. Los casos en Brasil muestran heterogeneidad entre los años de casos confirmados, aunque hay que preocuparse por controlar y educar a la población e investigar fómites portadores del virus.

Palabras clave: Género *Lyssavirus*, Murciélagos, Cánidos, Antropozoonosis, Rhabdoviridae

1. Short Communication

Human rabies is considered an anthropozoonosis transmitted to humans through the inoculation of the rabies virus (RABV) contained in the saliva and secretion of infected mammals, transmission occurs through the bite of dogs and hematophagous bats. The virus is of negative-sense single-stranded RNA genetic material, approximately 11 Kb in size, belonging to the order Mononegavirales and Rhabdoviridae f.. RABV is circumscribed in the genus *Lyssavirus* with 16 more species included. It is an enveloped-type virus, 180 nm long and 75 nm wide, with five genes distributed in the 3' N-P-M-G-L 5' order, which encode five proteins: nucleoprotein (N), phosphoproteins (P), matrix protein (M), glycoprotein (G) and the RNA polymerase, viral-dependent RNA (L) (Batista et al., 2007; Quevedo et al., 2020; Aldrich et al., 2021).

RABV has been described in more than 150 countries, and according to Duarte et al. (2021) around 60 thousand cases of death from human rabies are recorded per year. It is invariably fatal, caused by acute infection of the central nervous system (CNS) in mammals including humans (Schreiber; Fachinetto, 2021; Shipley et al., 2021). The highest rates of positive serological diagnosis are described in children under 15 years of age, with greater foci recorded in the African and Asian continents. In the American continent, specifically in Latin America between the period 2013-2016, a reduction in human rabies cases has been described with domestic canids as an intermediate host, although cases are still higher due to transmission by bats (Wada et al., 2011; WHO, 2013, 2018; Devleesschauwer et al., 2016; Ministry of Health, 2018; Vargas et al., 2019).

In Brazil, cases of rabies in animals recorded between 1990 and 2017 total 594 cases with the highest transmission rate in urban environments, this is due to seven antigenic variants (AgV), two canine types 1 and 2 (AgV1 - *Canis familiaris* and AgV2 – *Canis familiaris*), three in bats (AgV3 – *Desmodus rotundus*; AgV4 – *Tadarida brasiliensis* and AgV6 – *Lasiurus* spp.) and two in wild reservoirs (AgV2* - *Cerdocyoin* thous and (AgVCN – *Callithrix jacchus*) as presented by Vargas et al. (2019) and Quevedo et al. (2020). In our environment, cases of human rabies present a characteristic that demonstrates a distance between the forms of transmission observed in other regions, our cases are a priori transmitted by animals in the wild cycle such as bats, crabs, foxes and primates. Type 1, the only genotype circulating in Brazil, *D. rotundus* is commonly associated with antigenic variant 3 (Dias et al., 2011; Yang et al., 2013).

Several vaccination programs against animal rabies are carried out in the countries of South America and the Caribbean, and with that the contamination rates have reduced drastically. Between 2013 and 2016, the cases registered in health regulatory bodies in Bolivia, Brazil, Dominican Republic, Guatemala, Haiti, Honduras, Peru and Venezuela still have an important role in the attention to the movement of this virus in America (Meske et al., 2021). With the development of the Action Plan on the elimination of RABV in urban and peri-urban environments, eyes were turned to the main transmitter, the bat (*Desmodus rotundus*) in the American continent with a rate of 68% of animal-human transmission. In addition to this species, there are reports of two more species of hematophagous bats where RABV was isolated and another 33 species of bats there are also reports of positive diagnosis infected with this virus (Kotait et al., 2007; Hayes; Piaggio, 2018; Kotait et al., 2019; Caraballo et al., 2021).

Haupt & Rehaag (1925) identified the presence of Negri bodies in the CNS of a hematophagous bat of the *Desmodus* genus (Scheffer et al., 2007). Although RABV is not only found in vampire bats, in the USA in 1953, a male child was attacked by the insectivorous bat *Lasiurus intermedius* infected with this virus. In a short period

after this discovery, several groups of bats with different feeding characteristics were diagnosed as carriers of RABV (insectivores, frugivores, omnivores, polynivores and pscivores) (Baer, 1975).

A study carried out in the São Paulo State, Brazil found that the following genera of bats were positive for RABV: *Artibeus*, *Myotis*, *Eptesicus*, *Lasiurus*, *Nyctinomops*, *Tadarida* (*T. brasiliensis*), *Histiotus*, *Molossus*, *Eumops* and *Desmodus* (*D. rotundus*) (Scheffer et al., 2007).

RABV cases in humans in Brazil have been growing non-homogeneously, until 2017 there were 188 confirmed cases, mostly men 66.5%, rural residents 67.0%, children under 15 years of age 49.6%, with most frequent exposure by biting 81.9% (Vargas et al., 2019). In 2018, 11 cases were registered, 2019 only 1 case in the Santa Catarina State, 2020 with 2 cases in the Rio de Janeiro and Paraiba States, 2021 only 1 case was registered in the Maranhão State, and so far, 4 cases, 3 in the Minas Gerais State and 1 in the Federal District, Brazil. It is observed that Brazilian cases are predominantly sporadic and accidental, according to data from the Brazilian Ministry of Health (Brasil, 2022).

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