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EPIDEMIOLOGICAL PROFILE OF RABIES IN BRAZIL DURING THE YEARS 2014 TO 2016

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ABSTRACT

The rabies virus, since a long time ago, has been a constant concern for the world populations, due to being a potentially fatal zoonosis, affects both humans and animals. This study aimed to describe the presentation and the rabies virus epidemiology in Brazil during the years 2014, 2015 and 2016, in different animal species from both the urban cycle, and the rural cycle, in addition to the cases in humans. For this official data presented by the Ministry of Health were presented, and the compilation of such data, presenting them graphically, facilitating the presentation understanding of the rabies virus in Brazil. Thus a predominance of rural cycle was observed, and it was found that the occurrence of rabies cases in Brazil has been decreasing, but preventive and control measures still need to be taken to further reduce the cases of rabies, since it is a zoonosis that puts public health at risk.

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INTRODUCTION

Rabies is caused by a RNA virus, genus *Lyssavirus*, of the Family *Rhabdoviridae*, being one of the most important virus diseases for the Brazilian livestock, as well as for public health. Due to being an infectious disease, of zoonotic character responsible for causing acute encephalitis in mammals, possessing high transience, and lethality of approximately 100% (WADA; ROCHA; MAIA, 2011). It is distributed in almost all over the world, affecting both wild and domestic animals, which also serve as reservoirs for the virus for long periods (LIMA *et al.*, 2005). In South America, there are climatic conditions favorable to the virus spread, because the presence of the main transmitters, the hematophagous bats, as well as the existence of natural and artificial shelters and also by the wide distribution of the cattle population, which constitute the main factors responsible for the enzootic stability of rabies, in a given region (Barros *et al.* 2006; Pereira *et al.*, 2011; Pedroso *et al.*, 2009).

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In Brazil there are two variants of the virus detected: (1) one associated with the urban cycle, isolated from dogs, cats and humans, which causes the furious form or rabies, and occurs frequently in canines. The animals affected by this variant generally present lesions in the cerebral cortex, hippocampus and thalamus; (2) another associated with the sylvatic cycle of the disease, isolated from cattle and bats, which causes the paralytic form of rabies which is the most commonly reported for bovine species and is associated with lesions in the spinal cord, brainstem and cerebellum (ITO *et al.*, 2001; Kobayashi *et al.*, 2006; Pereira *et al.*, 2011). The main clinical signs in cattle include incoordination, paresis of the hind limbs and chest, sternal or lateral decubitus followed by death (Barros *et al.* 2006; LIMA *et al.* 2005; Pedroso *et al.*, 2009). The paralytic form, is endemic in several regions of the country in bovine species (Pereira *et al.*, 2011). The annual losses in cattle by rabies are estimated at approximately 850,000 heads, which are equivalent to approximately 17 million dollars (Lima *et al.*, 2005). The rabies lesions are generally limited to the central nervous system (CNS), with no significant macroscopic histopathologic findings.

Whereas the most important microscopic histopathological findings include meningoencephalitis and lymphoplasmacytic meningoencephalitis (Fernandes & Riet-Correa, 2007) associated with ganglioneuritis in ganglia, cranial and spinal nerves (Pedroso *et al.*, 2009). The diagnosis confirmation can be made by the observation of intracytoplasmic inclusion corpuscles (Negri Corpuscles) in the histopathological examination or by direct immunofluorescence (DIF) and intracerebral inoculation in mice. Because of its speed (hours) and accuracy (sensitivity and specificity close to 100%), IFD is the pattern used for the rabies diagnosis (TEIXEIRA *et al.* 2008; PEDROSO *et al.*, 2009). According to recent data, provided by the World Health Organization (WHO), it is estimated that 55,000 human deaths by rabies, are recorded each year in the world, being 99% of them in Asia and Africa, and to a lesser extent, in Latin America, and the dog, is still its main transmitter (KOTAIT *et al.*, 2007). According to Kotait *et al.* (2007), in 2004, the Government of Brazil spent around \$28 million, for rabies prevention and control, with vaccination campaigns in humans, dogs and cats, with immunoglobulins, laboratory diagnosis and human resources training. Based on this the National Program for the Rabies Control, coordinated by the Ministry of Health, along with state programs, needed to rethink actions and conduct a new look to the rabies issues, particularly of the canidae and non-hematophagous bats in urban areas of transition, and cattle in rural areas, without abandoning the systematic epidemiological surveillance of rabies in dogs (KOTAIT *et al.*, 2007). The objective of this study is to describe the rabies virus presentation and epidemiology in Brazil during the years 2014, 2015 and 2016, with the aim of elucidating questions about viral behavior and its incidence in these years, so that important data are compiled to assist in carrying out actions, regarding the combat of this potentially fatal zoonosis.

MATERIAL AND METHODS

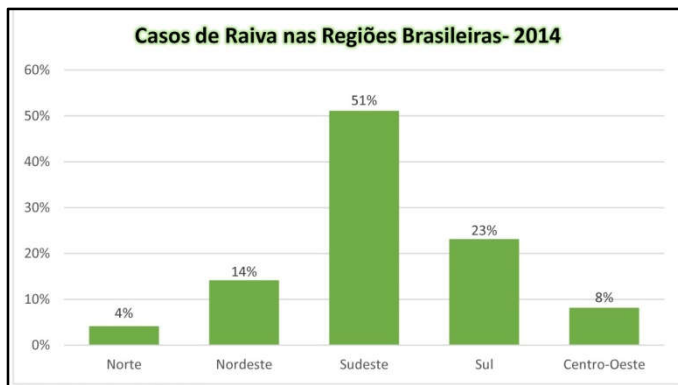
A descriptive study was carried out, from the cases of rabies reported to the Ministry of Health in Brazil, performing the comparison of rabies development rates reported by species and by region, where these data were compared during the period from 2014 to 2016. The focus of the study was also highlight epidemiological issues of disease, with the following variables: region, state, animal species and year. The rate of rabies occurrence in the regions, was calculated using the total number of cases in each region and the percentage was done in relation to other regions and to previous years, carried out by the ratio of the total number of cases in the year and the total value of affected animals in that region. The data obtained from the information supplied by the Ministry of Health, were duly analyzed following the standards mentioned above and transformed into graphs to facilitate analysis.

RESULTS AND DISCUSSION

Rabies is a viral zoonosis, which all warm-blooded animals are susceptible, therefore, can transmit it. The disease presents two main transmission cycles: urban and sylvatic, being the urban environment liable to control, due to having efficient prevention measures, both in relation to the human being, and the infection source (BRAZIL, 2016). The rabies virus belongs to the order *Mononegavirales*, family *Rhabdoviridae* and genus *Lyssavirus*. It has the aspect of a projectile and its genome is composed of negative strand RNA. It presents two main

antigens: one on the surface, responsible for the formation of neutralizing antibodies and virus-cell adsorption, and another internal, which is part of a specific group (BRAZIL, 2016). According to Brazil (2016), it is possible to divide the disease in transmission cycles according to the main reservoirs of rabies found in Brazil, such as the air cycle, which involves the hematophagous and non-hematophagous bats; rural cycle, represented by animal production. Urban cycle, related to dogs and cats and the sylvatic land cycle, which encompasses the wood dogs, foxes, raccoons, monkeys among other wild animals. The rabies transmission is given by the virus penetration contained in the saliva of an infected animal, primarily by the bite, scratch and licking of mucous membranes. The virus enters the body, multiplies in the inoculation point, reaches the peripheral nervous system and, subsequently, the central nervous system. From there, it spreads to various organs and salivary glands, where also replicates and is eliminated by the infected body saliva (BRAZIL, 2016). The incubation period is variable, with an average of 45 days, in man, and from ten days to two months in dogs. The incubation period is directly related to the location, extent, quantity, viral strain presented and depth of injuries caused by the wounds caused by the bite and scratch of infected animals (BRAZIL, 2016). In dogs and cats, the virus elimination by saliva occurs two to five days before the onset of clinical signs, persisting throughout the disease progression. Being that the animal's death occurs, on average, between five to seven days after the presentation of the clinical signs (BRAZIL, 2016). According to data of Brazil (2016), all mammals are susceptible to infection by the rabies virus, immunity is conferred by means of vaccination, accompanied or not by serum. Being that the use of the serum, occurs in humans already exposed to suspected animals, prophylactically. According to Queiroz *et al.* (2009), in São Paulo, during the period from 1993 to 2007, 10,579 samples were examined of the nervous system of dogs, cattle, cats, bats, and other mammalian species. Of the total, 518 (4.9%) were diagnosed as positive and 9,988 (94.4%) as negative. The total number of positive samples, 346 (67%) were dogs, 84 (16%) cattle, 50 (10%) bats, 22 (4%) cats and 16 (3%) other animals, being that the rest of the samples were not considered suitable for the exam.

Considering the disease epidemiological profile in two distinct periods: from 1993 to 1997 and from 1998 to 2007, it is observed a percentage distribution of the positives that varies according to the main host (QUEIROZ *et al.*, 2009). In the first period, the urban cycle of the disease is characterized with predominance of canine rabies and in the second period the air and rural cycles, with predominance of rabies in bats and cattle. Whereas in the present study, the predominance of rural cycle was observed. Brazil (2016), explains that, in the period of 2004 and 2005, due to the occurrence of human rabies outbreaks in the states of Pará and Maranhão, the bat began to be the main responsible for cases in this species, with 86.5% of the cases in these two years, surpassing the canine transmission rates. In the year 2008, three cases of human rabies were reported, being two by bat and one per marmoset. There was no transmission by cat or dog this year. According to data from the Ministry of Health, Figure 1 shows the variation in the number of cases of rabies in dogs, cats, cattle, horses, hematophagous bats, non-hematophagous bats, monkeys, wood fox, and other animals in the period of 2014 in Brazil.



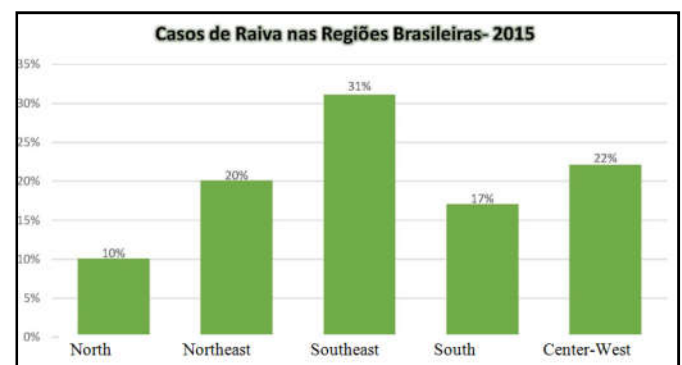
Source: Ministry of Health – 2014.

Figure 1. Rabies cases in Brazilian Regions -2014

In this year of 2014, there was a relatively high number of cases of rabies, being reported to the Ministry of Health, a total of 1,058 cases. The Northern region, proved to be the place where there were fewer cases of the disease, presenting a total of 40 cases, representing 4% in relation to the total number of cases of rabies occurring in Brazil. Of the confirmed cases in animals in this region, cattle was the most affected species, with 28 cases, representing 70% of the total number of cases occurring in this region. Whereas in equines occurred eight cases, 20% of the total number of cases. There were also two cases in non-hematophagous bats, corresponding to 5%, in the same way, also there were two cases of other animals with rabies, equivalent to 5% of the total number of cases presented in the Northern region. In the Northeast region, there were 144 cases of animals affected, accounting for 14% of the cases presented in Brazil during this period. Of the cases of rabies in the region, a large part are in cattle, with approximately 60% of the total, equating to 86 affected animals. A total of 12 canine cases were also reported, equating to 8%, other three cases occurred in cats, representing 2%. In horses there were seven cases of rabies, corresponding to 5%.

There were also other 16 cases in non-hematophagous bats, with 11%, and no case in hematophagous bats. In monkeys, there were three cases, corresponding to 2%, in wood foxes there were ten cases, i.e. 7%, and seven cases in other animal species, equivalent to 5% of which was reported to the Ministry of Health. The Southeast region, presented a total of 541 cases of animals with rabies in the same year, being considered an endemic area in this period due to representing 51% of the cases in the country, and it was the region of greater occurrence of the zoonosis. This high number, is mainly due to a high rate of cases of cattle affected by rabies, there were 392 confirmed cases in this period, representing an alarming number, of approximately 72%. Equines also showed high levels of disease occurrence, there were 64 confirmed cases, representing 12% of the total. There were two cases in dogs, and one in cats, representing respectively 0.6% and 0.4%. In hematophagous bats, there was a smaller number, approximately five cases than in relation to non-hematophagous bats with 67 cases, corresponding respectively to 1% and 12%. Whereas in other species of animals ten cases were reported of affected animals affected, that is 2%. The Southern region of the country was the second with greater occurrence of cases of rabies, with 243 notifications to the Ministry of Health, equating to 23% of cases occurring in the country in 2014. This high rate of cases is due to a high number of affected cattle, approximately 173 cases, corresponding to 71%, the majority of them occurred in Rio

Grande do Sul, approximately 119 cases, and other 28 cases in Paraná and 26 in Santa Catarina. Whereas in horses there were 19 cases, representing 8% in hematophagous bats there were six cases, and non-hematophagous bats 43, representing respectively 2% and 18% of cases. In the canine species there was only one case of the disease, or 0.5%, and in other animal species there was also one case, or 0.5%. In the Center-west region, in the same year, there were 90 cases of the disease, representing only 8%. A large part of cases occurred in cattle, with 65 animals affected by viruses, i.e. 72%. The equines were affected by 14%, i.e., 13 cases. Whereas in canines there was only one case, and non-hematophagous bats there were 11 cases of the disease, corresponding respectively to 1% and 13%. The following year, 2015 changes are observed in the numbers of cases of rabies in dogs, cats, cattle, horses, hematophagous bats, non-hematophagous bats, monkeys, dogs, and other animals, according to data from the Ministry of Health. These numbers are expressed in Figure 2.



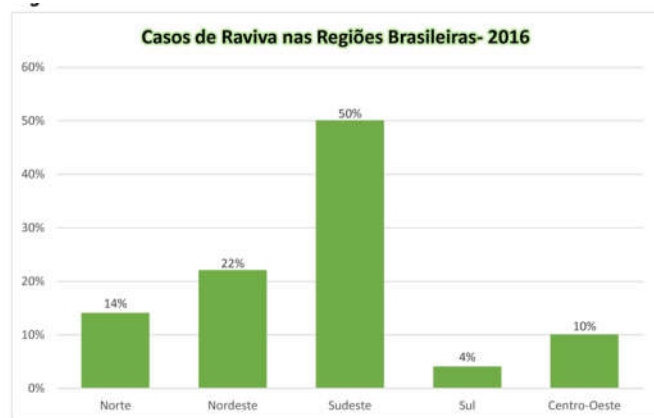
Source: Ministry of Health – 2015.

Figure 2. Rabies cases in Brazilian Regions -2015

The data presented show that in 2015 there was a significant decrease in the number of cases of animals affected by rabies if compared to the previous year, where this value decreased to half. Then the total number of reported cases in Brazil this year was 556. The Northern region, again was less affected by the rabies virus in relation to other states, but in comparison to the year 2014, there was an increase in the number of cases in this region. Therefore, there were 54 animals with the zoonosis, representing 10% of the total number of cases in 2015. Cattle was the most affected, with 43 cases, presenting a percentage of 79%. In equines, there were eight cases, or 15%. Both hematophagous bats, and non-hematophagous were affected by only one case in each species, representing 2%. In other species of animals there was also the confirmation of one case of animal affected, i.e. 2%. The Northeast region, decreased the number of cases in relation to the previous year, and showed 112 cases of the disease in 2015, equating to 20%. In this region the most affected species again was the cattle, with 53 cases, corresponding to 47%. Whereas in the canine species there was 10%, or 11 animals affected. In cats there were three cases of this zoonosis, equating to 3%. While in equines there was only one case, corresponding to 1%. In hematophagous bats there were two cases of affected animals, or 2%, and in non-hematophagous bats 18 cases, equating to 16%. The affected monkeys accounted to 3% of animals with this zoonosis, or four cases. There was a positivity of 17 wood foxes, representing 15% of the episodes of the disease. Other species of animals were also affected with 3%, three occurrences of the disease. The Southeast region, again showed high rates of disease, demonstrating that there is still a

large number of cases of rabies in 2015, with 174 cases (31%), but one should take into consideration that this number decreased by more than half. Again cattle was the most affected, with 60% (104 cases). In canines, one animal was affected (1%), in felines, the number of cases is higher, there were four cases of the disease, or 2%.

Equines represent 27 cases of diagnoses (15%). In non-hematophagous bats, the number of cases of the disease is higher than in hematophagous bats, which were respectively 33 and three cases, representing that there were 19%, and 2%. In other species of animals there were two cases of the disease, or 1%. In the South region, there were 94 cases of the disease, more than 60% less comparing to the previous year. Turning out to be the second region least affected by the zoonosis in 2015, where there 94 cases of the disease, or 17%, with only one episode of the disease in Paraná, 17 in Santa Catarina and in the largest number of occurrences was in Rio Grande do Sul, with 76 cases of rabies. The most affected species of animals was the cattle, with 74 cases, representing a large percentage in relation to other animals 79%. In felines there was one case of the disease, or 1%. Other three cases occurred in equines, representing 3%. In hematophagous bats there were no reports of cases, but in non-hematophagous bats there were 16 cases, equating 17%. In the Midwest region there was a relative increase of cases of the disease in comparison to 2014, presenting a total of 122 cases, being the region with the 2nd greatest number of occurrence of rabies, representing 22% of the total. Of this value, a large part occurred in canines, with 71 episodes of the disease, and all of them occurred in Mato Grosso do Sul, equating to 58%. Thus, the second most affected species was, the bovines with 32%, 39 occurrences of the disease. Equines were also affected by rabies, with nine cases, or 7%. In non-hematophagous bats there were few cases three, which represent 3%. Figure 3 shows the variation of the rate of cases of rabies in different species of mammals by regions, in 2016, according to data from the Ministry of Health.



North Northeast Southeast South Center-West

Figure 3. Rabies cases in Brazilian Regions -2016

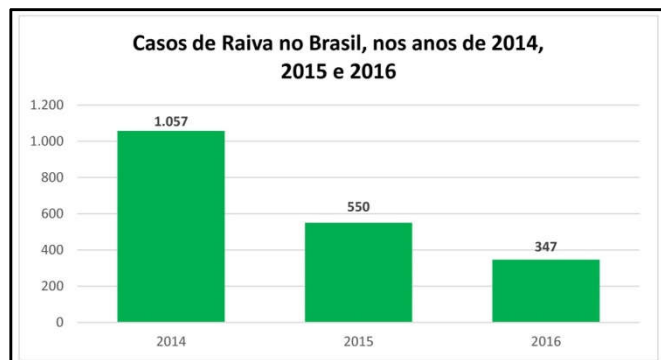
From the data analysis, the rabies development in the previous two years, regarding the year 2016, demonstrates that in this year there was a significant decrease in the number of cases of animals affected by rabies. This value fell by around 25% compared to 2014 and for a little less than half, if compared to 2015. Thus, the total value of cases reported in Brazil this year, passed to 356 cases of this disease, being two of them in humans, and 354 episodes in animal species. In the Northern region, the number of cases in the disease development

reduced a little, and this region was the 3rd less affected with the rabies virus in relation to other states, presenting 49 cases of animals with the zoonosis, equating to 14% of the total. A particular concern was the occurrence of one case of rabies in humans this year in the North, due to being a zoonosis of high transmissibility for different species of mammals, thus causing great concern, raising the need for greater attention to this important disease. In animals, the species that showed more cases of the disease, was bovine, with 72%, that is 35 cases of rabies. Equines were the 2nd species with more cases of the disease, totaling 10% of the cases, five episodes. In canines, there was one case of the disease, and in felines and also one episode, representing each species 2% of the occurrence of cases of rabies in that year. Whereas in hematophagous bats and non-hematophagous bats, there were respectively three and two cases of rabies, representing 6% and 4%. In other species of herbivores there was the presentation of one case of the disease, accounting for 2%.

In the Northeastern region of the country, there was the development of 79 cases of rabies, there is a relative decline in the percentage of the number of animals affected by rabies, where in 2016, passed to represent 22% of the total number of occurrences of this zoonosis. A large part of these cases, occurred involving bovines, with 32%, i.e., 25 cases of rabies in this species. Non-hematophagous bats, were the second most affected species, with 15 diagnosed cases of the disease, or 19%, whereas in hematophagous bats, there were eight cases of the disease, representing 10%. In this region, it was also reported the occurrence of one case of rabies in humans, in the state of Ceará, equating to 1%, worrying information due to this zoonosis being fatal and representing the second case of rabies in humans in the country. The canine and feline species, were also affected by the virus, where there was the development respectively of five and one cases of the disease, accounting for 6% and 1%. Equines were also affected, with seven cases of rabies, or 9%. In wild canids it was also observed a high incidence of the disease, being diagnosed 13 cases in this species, equating to 17%. In other analyzed species, it was also evidenced the viral presence, with the occurrence of four episodes, representing 5% of the total number of cases of rabies. The most affected region by the rabies virus, for the third consecutive year, was the Southeastern region, which remained with values similar to the rate of cases of rabies, presented in previous years. Thus, there were a total of 179 cases of rabies in the region in animal species, representing 50% of the cases of rabies in the country in 2016.

The most affected species by the virus, was again the bovine, with a value close to that of the previous year, demonstrating hence that the Southeastern region, lacks attention and intensification of control measures. Thus, it should be considered that the bovine species requires greater care in relation to the other species so that there is reduction in the rates of rabies occurrence, as this is the most affected species in the third consecutive year. Presenting in this year 96 cases of rabies, equating to 54% of the total number of cases in the Southeast. The non-hematophagous bats were the second most affected species by rabies, offering a total of 48 episodes in this region, accounting for 27% of the total number of cases. Whereas in hematophagous bats seven cases of the disease were reported, or 4%. Canines and wild canids, each of which were affected with one case of the disease, accounting for 1%. In felines, there was the report of four cases of rabies (2%), in

other animal species three episodes were identified of the zoonosis, representing 2%. In turn, the Southern region was the one that showed the lowest rates of development of rabies cases in Brazil in 2016, exhibiting only 13 cases of the disease. Representing approximately 4% of the total number, of occurrences of rage this year. Of the 13 cases, eight occurred in bovines, being seven of them in the state of Rio Grande do Sul and one in Santa Catarina. Evidencing that this number of cases in this species fell in almost 80%, compared to the previous year, although it is noted that these eight cases, represent 61% of the cases of rabies in the south of the country this year.



Source: Ministry of Health.

Figure 4. Rabies cases in Brazilian, in the years 2014, 2015 and 2016

Other four episodes occurred in non-hematophagous bats, representing 31% and one case in the canine species, equivalent to 8% of the total number of cases of zoonosis in this region. In the Central-west region, there was also a significant reduction in the rates of rabies occurrence, in comparison to the previous two years, becoming the second least affected region by the virus in 2016. Responsible for developing approximately 10% of the total number of cases, i.e. there were 36 episodes of this disease in this region during that year. Thus, due to developing 19 episodes of rabies, the bovine species was again the most affected by the virus, representing 53% of cases in relation to the occurrence of the zoonosis in other species. There was also the development of 11 cases of rabies in equines, which is equivalent to 30%. In canines one case of the disease was identified, as well as in other species, each of which presented one case of the disease, representing 3%. Hematophagous bats were also affected with one (3%) case of rabies, whereas the non-hematophagous bats developed three cases of the disease, accounting for 8% of the total number of cases of zoonosis, in the Midwest of Brazil, in 2016. Considering the number of cases of rabies in the years 2014, 2015 and 2016, the most affected species by the rabies virus, were the bovines, presenting 744 cases in 2014, 313 in 2015 and 183 in 2016.

Even though there is a significant reduction in the rates of rabies in this species, the bovines still require attention regarding the control of this zoonosis. According to the data presented, in this year of 2016, there was the appearance of two cases of human rabies in Brazil, demonstrating that the country still requires a great deal of attention concerning this zoonosis. Due to needing a greater control, risk areas were determined for rabies, being developed a more intense monitoring and research in these areas, with the aim to reduce and prevent the occurrence of cases of animals and humans affected by rabies virus. The presentation of the incidence of

rabies cases, in the years 2014, 2015 and 2016 has been decreasing from year to year, as shown in Figure 4.

Conclusion

The occurrence of mammals affected by rabies in Brazil, decreased significantly in the period between 2014 to 2016, but this country is still an area considered endemic for this zoonosis. The presented data show that the country has been evolving on the issue of rabies virus control, but this, in turn, still requires special attention, until it reaches increasingly low and safe rates of this occurrence. Due to being a zoonosis present in the country, and due to causing risks to public health, requires the monitoring of cases, as well as the development of strict sanitary control campaigns for prevention of new infections. Among the species affected by rabies, the bovines were those that developed the largest number of episodes of the disease. Emphasizing the importance of greater monitoring of flocks of this species, as it is a transmissible disease, with rapid diffusion capacity, taking large proportions in a short period of time, causing major economic losses for the Brazilian livestock. Therefore, there are many interfaces between the human and animal rabies. In the rabies surveillance, epidemiological data are essential for prophylactic decision-making, as well as for the adoption of emergency measures of blocking of outbreaks and animal control. Finally, it should be noted that the integration between the medical and epidemiological surveillance are essential for the control of this zoonosis, in our country, through the notification of cases in order to have knowledge of the areas of greater need for intervention.

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