The potential risk of rabies transmission in Madagascar- a report on the canine vaccination coverage in an urban district of Mahajanga

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The potential risk of rabies transmission in Madagascar- a report on the canine vaccination coverage in an urban district of Mahajanga

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Abstract

Background

The *Rabies lyssavirus* is one of 16 species of the Lyssavirus genus causing fatal encephalomyelitis in humans. Infection usually occurs after a bite by an infected mammal. More than 99% of human rabies deaths worldwide are caused by a canine rabies with children at highest risk of infection.

Although rabies has been endemic in the region of Mahajanga in Madagascar for a long time, research evaluating the current situation is still scarce. Here, we conducted a cross-sectional study to describe the dog demography and a survey of dog owners to evaluate rabies vaccination coverage, disease knowledge and measures taken in the districts against rabies in order to inform future interventions in the urban district of Mahajanga in the North West of Madagascar.

Results

A total of 400 dogs were recorded, of which 338 (84.5%) were owned. The vaccine coverage against rabies was at 34.4% (116/338). The reported key barriers to vaccination were lack of financial resources and the lack of geographic access to veterinary services. The transmission route of rabies being dog bites was known to 85.4% of the surveyed dog owners (105/123). Out of 19 reported dog bites, 13 were caused by the owner`s or the neighbour's dog. 6 out of 19 cases affected children between 7 and 15 years of age.

Conclusion

Most of the dogs in the urban district of Mahajanga are accessible for preventive vaccination through their owners, but less than one third of the canine population is vaccinated against rabies. Assuming that stray dogs are not vaccinated against rabies, Mahajanga is far from reaching the 70% coverage believed to minimise the spread of the disease. The prioritization

of dog owner education, school campaigns that sensitize children on the interactions with dogs and vaccination campaigns for owned dogs in collaboration with local veterinary services has shown success in other settings in Africa and will be crucial for future rabies eradication in Madagascar.

Key words

Rabies, Lyssavirus, Zoonosis, Vaccination, Madagascar

Background

Rabies is present on all continents except Antarctica (1). The dog remains the principal vector and is the source of 99% of human deaths through rabies infection (2). About 80% of people at risk reside in poor rural zones of Africa and Asia; an estimated 96% of the reported deaths occur in the population of these two continents (1). In Africa, an estimated 21, 476 human deaths occur each year due to dog-mediated rabies (36.4% of global human rabies deaths), with a loss of 1.34 million disability-adjusted life years (DALYs) (3). Effective measures such as pre-exposure prophylaxis (PrEP), namely vaccination of the population at risk and post exposure prophylaxis (PEP) could prevent the disease. Access to PrEP and PEP in rural areas is still limited. A healthy and vaccinated canine population would not only 100% prevent dog-mediated rabies, but also be more cost-effective than post-exposure treatment in humans: a treatment after a bite includes wound management and three to five rabies vaccination shots with a cost at about $40-50, constituting to be an unaffordable price in most of the regions where this disease occurs, while one canine vaccine shot that provides immunization lasting for 3 to 4 years costs less than $1 (4, 5).

Although the rabies virus (RV) has been circulating at least since the 19th century in the country, national prevention measures are still lacking. Madagascar is one of the poorest countries in the world and the fragile health system does not monitor the spread of the disease. In tandem with the lack of public education and a poorly functioning program for routine diagnosis of suspected cases (animal or human) results in a low rate of laboratory confirmation of human cases and, thus, substantially underreported human rabies (6).

Domestic dogs are Madagascar's most popular RV reservoir. Between 2006 and 2011, 470 animal specimens were collected by the National Rabies Diagnosis Laboratory (NRL), of which 231 (49.1%) tested positive for rabies antigen (6). Since there is no national sustainable rabies disease prevention and control strategy in place, the government relies on indiscriminate dog culling and strychnine poisoning, irrespective of the fact that this practice has proven to be unsuccessful in the battle against rabies and harmful to human health (7). The purpose of this study is to estimate the rabies vaccination status of dogs and to assess the awareness and actions of dog owners affecting disease transmission in Mahajanga Urban District (UDM) to inform future intervention campaigns.

Results

Through a developed questionnaire (see ANNEXES I-V) we recorded 400 dogs in the study, originating from 13 different fokontany (districts). Among these, 84.5% (338/400) had owners, the remaining dogs were strays or had unknown owners (62/400). An estimate of 4% of all households in the UDM kept dogs with an average of 3 dogs per household. Dogs were mainly kept for guarding purposes, which is reflected by the preference for male dogs (ratio of 2:1 with female dogs).

A total of 123 households owning dogs in the sampled fokontany participated in the survey. In addition, the chief veterinarian of the UDM, and the regional chief veterinary officer were interviewed on current perceptions and practices.

The total evaluation showed that 48.8% (60/123) of the households with dogs had some kind of a fence to prevent dogs from leaving or entering the compound. Vaccination against rabies was done for 34.3% (116/338) of the owned dogs (Table 1), which led to an overall vaccine coverage of less than one third (29.0%, 116/400) of the overall canine population, assuming that stray dogs were never vaccinated. The vaccine status is considered valid up to 3 years after vaccine administration. The percentage of antiparasitic treatment can be seen as a surrogate for the general attitude of caretaking for dogs: a total of 24.3% of owned dogs (82/338) were treated with an antiparasitic once per year or more often (Table 1). However, this number is impacted by people admitting to self-medicating their dogs, especially with human drugs. The majority of dogs (57.7%, 195/338) had never been examined by a veterinarian and the main reasons for not adequately vaccinating or medicating dogs were reported as lack of access to veterinary care and financial limitations of the owners (Table 2).

Dog bites occurred in about 13.8% of households owning dogs (17/123). Altogether, 19 reports of individual dog bites have been registered by the veterinarians. A valid vaccination status against rabies was only confirmed in eight, whereas eleven dogs were assumed to being not vaccinated. The majority of victims were men or boys (n=13) and each third case was a child between the ages of 7 and 15 (n=6). In most cases the individual was bitten by a neighbour's dog (n=9). Bites occurred from the family dog in four cases. Of the 19 dogs that bit someone, two of the dogs have been killed, two have disappeared while the majority has remained alive.

Most dog owners (85.4%, 105/123) reported being aware of the risk of rabies being contracted by a dog bite and more than half of them (56.9%, 70/123) would seek medical attention while 28% would clean a bite wound with water and soap. An attack on one or more occasions by other known or unknown dogs were reported concerning 14.5% of all dogs with owners (49/338).

The two surveyed veterinarians indicated that owners were very hesitant to request anti-rabies vaccination and medical examination for an animal involved in a biting scenario. The local population decides whether the dog should be killed after biting a human. The killing is usually done by throwing stones or lances. The culling of stray dogs using strychnine was confirmed to be carried out once a year in all 13 fokontany. The veterinarians noted that they and their staffs are carrying out annual vaccination programs.

Discussion

This research presents demographic data on the canine population and offers initial understanding of dog owner behaviours in urban Mahajanga, Madagascar related to the risk of rabies transmission.

Compared to other cities Madagascar where vaccination rates ranged from 3.3% to 17.5% (8, 9), the UDM had a promising rabies vaccine coverage rate of 34.3%. This indicates that the veterinary department's previous public outreach efforts have helped raise awareness of the danger of rabies infections. Assuming that stray dogs are not vaccinated against rabies, Mahajanga is far from reaching the 70% coverage believed to minimise the spread of the disease (1). A recently conducted systematic review on dog rabies vaccine coverage in Africa indicated that the rabies vaccination coverage following a free of charge vaccination scheme

(68%) was closer to the recommended 70% coverage rate than the achieved coverage rate in owner-charged dog rabies vaccination schemes (18%)(10). This research confirmed the key barriers to vaccination as the lack of financial resources and the lack of geographic access to veterinary services (11) . Vaccination programs targeting dogs have proven to be effective in the efforts against rabies in other countries (4, 7). In contrast, indiscriminate dog culling and poisoning is considered to be inadequate due to impracticality (nocturnal event, low motivation, poor communication leading to disputes with the local population, restricted intervention zone). Additionally, this technique has proven to be ineffective in significant reduction of rabies infections in dogs and poses a risk to the health of the human population (12). It should be noted here that killing a potentially rabid dog imposes a high risk on the people doing so. As standardized laboratory screening of samples from the suspected rabid dog is rarely conducted after the killing, it is still very difficult to estimate the actual rate of infection in dogs.

The incidence of dog bites happened regularly in the UDM; the most frequently reported incidents involved either a neighbour's dog or the owner’s dog. Approximately one third of dog bites reported affected children aged 7 to 15 years. This is in line with similar findings in other countries that showed 30-50% of those receiving post-exposure treatment were < 16 years of age, suggesting a particular higher risk of exposure to rabid dogs and tendency to riskier behaviour among children (13). In fact, children are more likely to underestimate the danger of confrontation with dogs. Hence, they are at higher risk of bites on their heads and faces and may not report bites because of fear punishment or lack of knowledge. Although most of the surveyed dog owners knew that dogs were a potential RV vector, less than one-third of all owned dogs were vaccinated and only every fourth person interviewed

acknowledged that treating the wound with water and soap or a disinfectant was a first-line therapy. With more than half (70/123) of the population at risk intending to seek healthcare, hence receiving PEP if available, a positive trend of disease education in the population was observed. This shows that many people are aware of the threat, but further measures are needed to improve geographically as well as financially capacity and facilities for care after a dog bite incident. Basic knowledge about disease prevention and immediate action should be included among the entire population in education and awareness campaigns.

In sum, the prioritization of dog owner education, school campaigns that sensitize children on the interactions with dogs and vaccination campaigns for owned dogs in collaboration with local veterinary services has shown success in other settings in Africa and will be crucial for future rabies eradication in Madagascar.

This study has some limitations. The surveyed individuals included either dog owners or veterinarians. It is therefore likely that results of knowledge presented here do not fully reflect the knowledge of the general public. Generalizations of the results should be made with care since dissimilar socio-economic conditions, varying education levels, fear of consequences to responses (i.e. fear of tax collectors) among dog owners might have influenced their statements. Extensive information about the background of the research and the study team was given to reduce this bias. Inaccuracies in the detection of stray dogs cannot be excluded, thus, careful consideration is recommended in interpreting the results of this study.

Conclusion

This study shows a relatively unmanaged, high-density canine population and lack of disease awareness and health care accessibility (pre-and post-exposure) in the communities of Mahajanga district. Country wide surveillance data is not available, but the few estimates from

other cities showed even lower rabies vaccine coverage rates in dogs and indicate the urgent need to act.

Following this research, intervention actions are recommended at various levels. Most importantly, citizens, especially children and dog owners need to be aware and taught about the high risk of rabies and how to take care of themselves after a dog bite incident. Passing on knowledge of rabies and its mechanisms of infection should be done through the involvement of public agencies and veterinary officials in the region. This will be highly beneficial to, and involve agencies of public health to raise the awareness and prepare for collaborative measures such as mass vaccination campaigns. Additionally, improved access to vet healthcare could encourage dog owners or caretakers to seek vaccination and then reach a vaccination rate of 70 percent.

Education campaigns need to inform the public regarding the value of the vaccine price versus the treatment price in the event of a biting incident and veterinary service.

Methods

Study area and time period

The study was conducted in Mahajanga, situated on Madagascar's north western coast. Data collection took place from July 4 to September 13, 2016.

Mahajanga is the Boeny region's capital and a popular resort for local and foreign tourists and one of the country's most populated cities with around 245,000 inhabitants. It is 57 km^2 (12) and is divided into 26 fokontany (smallest administrative unit), with one chief in each fokontany (12).

Study design and data collection

The estimation of the sample size was performed using the online tool Open Source Epidemiologic Public Health Statistics (version 3.01) (12). The confidence level is 0.05 (α=0.05, two-sided) with a margin of error of 5% (as recommended by the Institute Pasteur of Madagascar). The sample proportion was calculated assuming 50% of the canine population was not vaccinated for the demographic evaluation of the canine population. For the household survey the sample proportion was set at 5% of dog owning households in this district. The sample sizes were 385 dogs for the demographic analysis (95% confidence level) and 73 households for the survey (95% confidence level) or 127 households (99% confidence level). Data collection was conducted using adapted, structured questionnaires targeting private households with dogs, and two veterinarians. In addition, observations of stray dogs were conducted in the surveyed areas.

A simple random sample of 13 fokontany was selected from a list of all fokontany by blind draw to be included in the analysis. One sector was then randomly selected in a similar fashion in each of the 13 fokontany. Dog owning households in these sectors were identified and invited to participate in the survey with the aid of a local guide. Because residents and the guide were typically familiar with individual dogs, the stray dog population was counted by observation in the streets of the selected areas during the time period of data collection.

Declarations

Ethics approval and consent to participate

This study was carried out in accordance with relevant guidelines and regulations in Madagascar. As this study was an integral part of obtaining the degree of Doctor of Veterinary Medicine, it was submitted and approved by the faculty of Medicine of University of Antananarivo. The chiefs of each fokontany were consulted to discuss the research and to obtain their approval prior to the study conduct. All interviewees were informed about the study goals

and consent was obtained. Every person retained the right to stop participating in the survey at any given time. A local guide was employed for public advocacy in each fokontany. At completion of the study, all questionnaires and study documents were to be securely stored for five years with access only to authorized staff to ensure confidentiality.

Consent for Publication

Not applicable.

Availability of data and material

The datasets used and/or analysed during the study are available from the first author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable.

Authors' contributions

The field research was designed by BR and PRF. Conceptualization of the article was done by AH, SR, BR, RR, and CTR. BR, SR, and AH curated the data. The data were analyzed and interpreted by BR, SR, GN, FM, RR, AH, PRF. Original draft preparation was supported by BR, SR and AH. All authors critically reviewed and edited the manuscript. All authors read and approved the final manuscript.

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Table 1: Rabies vaccination status and antiparasitic administration in Mahajanga, Madagascar

			n (%)
Total of owned dogs			**338**
Rabies	Vaccinated		116 (34.3)
	Non-Vaccinated		222 (65.7)
Antiparasitic treatment	No		220 (65.1)
	Yes		118 (34.9)
		Irregularly	36 (10.7)
		Annually	12 (3.6)
		Every 6 months or more often	70 (20.7)
Reported cases of dog bites			**19**
Vaccination status	Vaccinated dogs		8 (42.1)
	Unvaccinated dogs		11 (57.9)

Note. Vaccination was documented per self-reporting of the owner or veterinarian and considered valid if the vaccine was administered in the time period up to 3 years before the interview conduct.

Table 2: Reported reasons from dog owners for non-vaccination against rabies in Mahajanga, Madagascar

	n (%)
Total of non-vaccinated dogs	**222**
Lack of financial means	73 (32.9)
Lack of veterinary service	54 (24.3)
Accessibility of veterinary service	47 (21.2)
Lack of knowledge (owner)	34 (15.3)
Other	14 (6.3)

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ANNEXES

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ANNEXE I

SURVEY FORM - FOKONTANY

• Name of fokontany: ……
• Person questioned: ……
• Contact:

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1) Is there a rabies control plan in your fokontany?
/__/yes
/__/no
If yes which one:

Activities	Frequency	Date of last activity	Result	Problems	Products used
Culling of stray dogs					
Vaccination campaign					
Other (please specify)					

2) Why did you choose this strategy?
/__/it is mandatory
/__/at the request of the fokontany
/__/other: ….

ANNEXE II

SERVY FORM - HOUSEHOLDS (General Population)

o Fokontany: …… Sector: …
o House Number:
o Contact:

---

a) No. of people living in the household: /__/__/
b) Fence around the house:
/__/ no fence nor wall
/__/fence or wall but dogs can exit
/__/fence or wall constituting an obstacle for dogs
Distance between house and next-door neighbour:
/__/__/__/ m
c) No. of dogs in the household: /__/__/
d) No. of dogs present during our visit: /__/__/
e) Are dogs fed in your home?
/__/yes
/__/no
f) Your own dogs?
/__/yes
/__/no
/__/not concerned
g) Other dogs?
/__/yes
/__/no
h) Do dogs feed on your garbage?
/__/yes
/__/no
i) Do you sometimes find dogs strolling around your property?
/__/yes
/__/no
j) Have members of your family been bitten?
/__/yes
/__/no
If yes: FILL OUT SURVEY FORM BITES

k) What would you do in case of a dog bite?
/__/nothing
/__/clean the wound
/__/go to the doctors
/__/go to the veterinarian
/__/go to Pasteur Institute
/__/don't know
l) Can a bite from an animal transmit diseases?
/__/yes
/__/no
/__/don't know
m) If yes, which one do you think of first:
…….
n) Have you recently seen any dead dogs around your property?
/__/yes
/__/no
o) If yes, what do you think it died of?
/__/poisoning
/__/long sickness
/__/road accident
/__/other: …
p) Do you know where the next veterinarian is located?
/__/yes
/__/no
q) If yes how far is it from your home?
/__/very far (>2km)
/__/far (1 à 2km)
/__/near (<1km)
/__/don't know

ANNEXE III

SERVY FORM – DOGS WITH OWNER

o Fokontany: …….. Sector: …
o House Number: No. of dog
o Contact: Name of dog:

General Information about dog
Sex: M / F
Age:
Race:
a) Provenance:
/__/bought
/__/it was a gift
/__/born on the property
/__/found and adopted
b) Motif for having a dog:
/__/watch dog
/__/hunt
/__/companion
/__/other: …
c) Does the dog have a collar?
/__/Yes
/__/Non
d) Is the dog marked?
/__/Yes
/__/No
e) How is the dog being kept?
/__/attached:
/__/during the day
/__/during the night
/__/ free:
/__/in the courtyard (does not leave)
/__/total freedom (leaves property)
f) Type of shelter:
/__/house
/__/garage
/__/nothing specific
/__/nothing
/__/other: ….
g) Feeding:
/__/special dog food
/__/left overs
/__/prepared by neighbours
/__/dog finds food by itself
h) Character:
/__/aggressive to all
/__/aggressive to strangers
/__/docile
i) Veterinary care:
/__/regularly (at least once a year); Frequency?
/__/irregularly
j) Has the dog ever bit someone:
/__/yes
/__/No
k) If yes who?
/__/owner or member of household
/__/_/another person. Where?
/__/in the house
/__/outside (hostile terrain)
l) did a veterinarian examine the dog?
/__/yes
/__/no
m) Has/Have your dog(s) ever been bitten by other dogs?
/__/yes – which ones
/__/no
/__/don't know
n) If yes:
/__/by dogs on the property
/__/by the dog(s) of the neighbour
/__/by unknown stray dogs
o) Has/Have your dog(s) ever been bitten by another animal?
/__/yes; which ones?
:……..
/__/no
/__/don't know
p) In case of a dog bite, do you go to a veterinarian?
/__/yes
/__/no
q) Is/ Are your dog(s) vaccinated against rabies?
/__/yes
/__/no
r) If yes:
/__/regularly;
• date of last vaccination:
(as in vaccination record) :/__/__/__/__/__/__/
• type of vaccine: ….
/__/irregularly
s) If no vaccination or irregular vaccination – Why?
/__/ignorance
/__/not accessible
/__/financial issues
/__/no veterinarian
/__/other: …
t) cost of vaccine (visit to vet + vaccine):
/__/__/__/__/__/__/__/ Ariary
u) deworming:
/__/yes:
/__/systematically frequency?
/__/not systematically
/__/no
v) spaying
/__/yes
/__/no
w) If the dog is female:
- number of puppies in the las litter: …
- what happened to them?

……
……
……

ANNEXE IV

SERVY FORM – STRAY DOG

o Fokontany: …….. Sector: …
o No. of dog Breed:
o Sex M / F

---

1) Age:
/__/young (<12 months)
/__/adult
2) physical appearance:
/__/fat
/__/skinny
3) Way of life:
/__/solitary
/__/in a group
4) behaviour:
/__/aggressive
/__/docile
5) known in the neighbourhood:
/__/yes
/__/no
6) No. of people asked in the street about this specific animal: /__/__/

ANNEXE V

SURVEY FORM – DOG BITE

o Fokontany: …….. Sector: ……
o House Number: Contact:
o Date of the biting:

---

1. General information
Place where biting took place:
Time the biting took place:
2. Was the dog provoked:
/__/yes
/__/no
3. Information about the dog:
/__/owned dog
/__/dog from the household
breed: ….
sex: ….
age: ……
/__/dog of the neighbour
breed: ….
sex: ….
age: ……
/__/stray dog
/__/non-identified dog
4. Sex of person bitten: M / F
5. Age of person bitten: /__/__/__/
6. location of bite:
……
7. Post exposure care:
……..
……..
……..
8. Vaccination post exposure (ait IPM)
/__/yes
/__/no
9. What happened to the dog: …….

ANNEXE VI

SURVEY FORM - VETERINARIAN

o Fokontany: …….. Sector: …
o Name of veterinarian:
o Contact:
o Name of veterinary clinic: …

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1. Is the veterinary staff vaccinated against rabies?
/__/yes
/__/no
2. Do you have a health mandate?
/__/yes
/__/no
3. Activities in the fight against rabies
……..
4. Are biting dogs being monitored?
/__/yes
/__/no
How?
……
……

5. Have you ever taken samples for rabies control from an animal that bit?
/__/yes
/__/no
6. Have you ever taken samples for rabies control from a deceased animal?
/__/yes
/__/no
7. Attitude of dog owner most encountered?
/__/motivated
/__/negligent
8. Do people with a dog bite come for advice?
/__/yes
/__/no
9. Which rabies vaccine do you use?
……
10. Number of rabies vaccines sold per year: ……...
11. Number of tattoos (or other identification methods) performed on dogs per year:
/__/__/__/__/

Contribution statement

The field research was designed by BR and PRF. Conceptualization of the article was done by AH, SR, WW, and CTR. AH, SR, and BT curated the data. The data were analyzed and interpreted by AH, SR, BT, KK, EMKD, FM, WW, CTR. Original draft preparation was supported by SR and AH. All authors critically reviewed and edited the manuscript. All authors read and approved the final manuscript.