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Research Article

Vaccinating rural domestic dog populations which is a source of rabies for wild carnivores- A Bio fencing strategy

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Keywords

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Abstract

A study of dog ecology, dog bites, rabies vaccination rates and the wild carnivore demography was carried out in the villages adjoining the Bandipur tiger reserve, Karnataka. Villages and tribal hamlets close to the forests were selected and the dog populations were estimated by direct counting and enumerated by using a datasheet questionnaire. The dog's were caught in nets with that provided least stress inducing strategies and proper non- invasive, less pain inducing equipments and vaccinated against rabies. Overall estimates of 127 villages carrying 1265 dogs were vaccinated. The questionnaire was designed to obtain data in order to determine the dog population and its intermediary presence adjoining forest regions and the connecting link between wild carnivores was obtained. Majority of the dogs owned were non descriptive desi mongrels 98.66% (1248) aged between 1 to 8 years old and managed under partial or no confinement. The dogs were mostly used for security and as mere companions. Dog owners reported low or no vaccination coverage, level considered not sufficient to prevent rabies transmission. Domestic dogs have been found to be tolerated but poor management in terms of feeding, confinement and vaccination thereby constituting a continuous risk to domestic animals, humans and to wild animals especially when the big cats that prey on these dogs and there is a direct transmission of the disease. An overview of the various factors that establish the spread of rabies with regard to vaccination and control strategies have been critically analyzed and discussed in this paper

Introduction

Rabies is caused by a neurotropic virus of the genus Lyssavirus of the family Rhabdoviridae, and is transmissible to all mammals. It is considered as one of the very serious diseases and is of the Risk Group III.The virus belongs to - Group V – Negative sense RNA viruses of the Order Mononegavirales Family – Rhabdoviridae Genus - Lyssa virus Species - Classical Rabies virus (CRBV). All mammals are affected by rabies [1]. Rabies virus is more commonly transmitted to a new host only through an open wound or, less likely, through the mouth, the eyes, or the mucous membranes of the nose. Since the virus is present in the saliva and brain material of infected individuals, most transmission events occur through bite wounds. The respiratory transmission has been reported in very rare circumstances. The incubation period vary from as little as a few days to many years in rare cases. However, in most cases, incubation occurs within one to three months. Once an individual is infected with the rabies virus, it replicates within the cytoplasm of muscle cells and pass from cell to cell. Finally, it reaches nerve receptors and enters the nervous system. The virus passes along the nerve network, traveling to the central nervous system, where it concentrates in the brain and upper spinal cord. As the disease

progresses, the virus continues to multiply and spreads back through the peripheral nervous system to the salivary glands. A significant finding is that not all animals or humans exposed to the virus contract the disease. However, once symptoms become evident, the disease usually is fatal. Many animals like dogs, bats, act as reservoirs. When dogs act as reservoirs for spread of rabies to other animals including dogs it is referred as canine rabies [2].

The incubation period is both prolonged and variable. Most cases in dogs occur within 21-80 days after exposure, but the incubation period may be shorter or considerably longer. Rabies is a fatal infection and once symptoms are exhibited animals will certainly die [3]. Canine Rabies can have a devastating effect on the wild population especially the wild cats when they prey on these dogs that are easy to attain as prey than other healthy dogs. Well-designed dog population studies are necessary and these studies will be useful in planning rabies control. The information obtained will be pivotal in planning and developing sustainable dog rabies control programs and evaluate other health risks associated with dogs, in addition to the epidemiology of the disease in the wild.

Materials and Methods

2.1. Study area

Bandipur National Park established in 1974 as a tiger reserve under Project Tiger, is a national park located in the south Indian state of Karnataka and the park spans an area of 874 square kilometers from 75° 12’ 17” E to 76° 51’ 32” E and 11° 35’ 34” N to 11° 57’ 02” N (Figure 1)where the Deccan Plateau meets the Western Ghats and the altitude of the park ranges from 680 meters (2,230 ft) to 1,454 meters (4,770 ft).

All villages within a two kilometer buffer of the Reserves boundaries were identified, totaling to a number of 130 were plotted. In each of these villages/hamlets the local people had been informed of the proposed vaccination project and were open to it.

2.2. *Direct count estimation method*

A proforma form was designed for the study which consisted of village name, number of dogs seen, breed, sex and age of the dogs seen. The counting of dogs was carried out early in the morning between 6 A.M and 10.00 A.M. and in the evenings 4-7 P.M. This time was selected because it corresponded with the period of maximum dog activity, less human activity and good visibility. Two people were selected and trained to carry out the counting of dogs. They surveyed the villages one at a time, walking up and down each of the selected village. The number of counted dogs in the selected villages in each of the identified area was used to estimate the population of dogs in that area. An estimate of the entire dog population in the entire Bandipur tiger reserve was determined based on all the counts from these areas. The same persons were used to avoid any overlapping or biased estimations of the dog count.

2.3. *Questionnaire and household survey estimation method*

A structured questionnaire was designed for survey of dogs and in addition, information on geographic locations was tracked using a GPS module and demographic aspects of dog ownership and attitudes of dog ownership were carried out. An adult member of every village was interviewed for about 10 mins using the structured questionnaire which covered information about the household, dog population, management of dogs and vaccination program, cases of dog bites, post exposure management.

2.4. *Vaccination of the dogs*

2.4.1. Cold chain

The total numbers of vaccine doses used were 1266 of Rabies. Maintenance of cold chain is very critical in storage of vaccines as their potency, safety and efficacy are determined by the temperature gradient, a portable refrigerator that had a capacity of providing ideal storage conditions (2°C to 8°C)for approximated 400 doses of each vaccine. This refrigerator was always functional as it was supported by 12 V connection supplied by the vehicle battery. The remaining vaccines pertaining to that particular period of time were maintained at similar storage conditions at the base camp, maintaining the standard protocol of vaccinations and their storage.

2.4.2. Catching and Restraint of Dogs:

The dogs in the villages adjoining the tiger reserve were caught by professional dog catchers with vast experience. The dog’s were caught in nets with the least stress inducing strategies and proper non- invasive, less pain inducing equipments. Once caught the dogs were restrained to present in a way that the injection sites were clearly visible in order to avoid wrongful vaccine delivery. The team comprised of 4 dog catchers, 2 surveyors and one veterinarian.

2.4.3. Procedure:

The vaccines were administered properly by either S/C or I.M whichever was possible at the time of restraint and care was taken to minimize invasiveness and injected at the proper sites advised by BSAVA (British Small Animal Veterinary Association). No adverse reactions were observed throughout vaccination programme on the dogs after they have been vaccinated recording a zero percent mortality due to vaccine failure/idiosyncrasy. Our aim was to vaccinate 100% of the dog population, but practical feasibility provided a 95% cover on the previous estimated dog populations. During the course

of vaccinations pregnant dogs were carefully identified and vaccinated with the least amount of invasiveness. Therefore the maternal immunity has a sturdy effect on the new born, being born resistant. Revisits to the villages that were considered critical/sensitive zone area were made in a positive attempt to get the maximum coverage.

2.4.4. Identification:

The vaccinated dogs have either been collared or a non-irritant fabric whitener (Eco-Friendly) at the nape region that cannot be reached by the dogs was used. Strict measures to avoid revaccinating the same dog were followed by the team and this was further cross checked by the team member who is the marker.

Results and Discussion

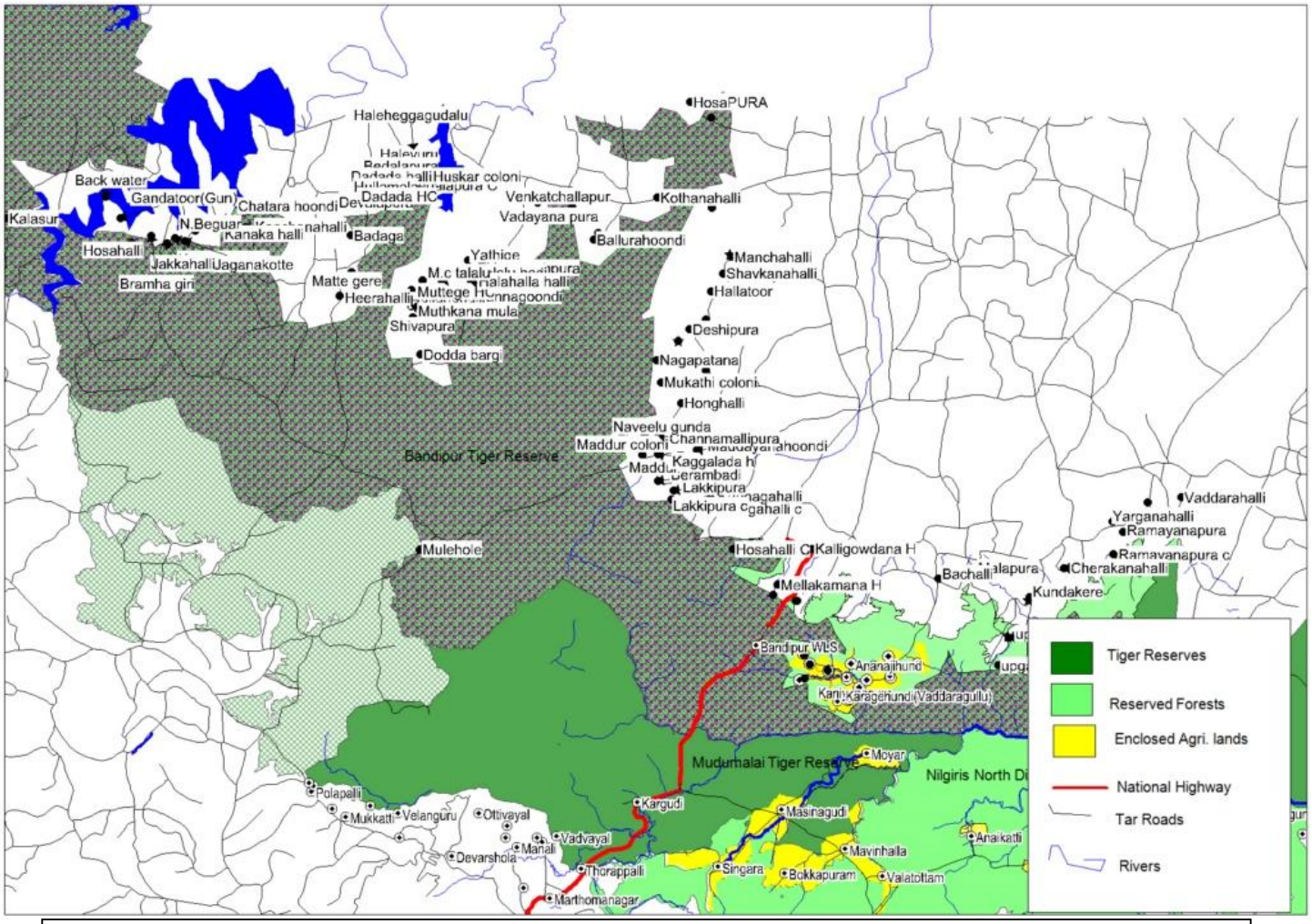
Table 1 Dog demography of the Bandipur tiger reserve

Number of villages covered and interviewed	127
Total people in the villages covered	8754
Total number of dogs in the reserve	1265
Mean number of dogs/dog owning household in the reserve	1.3
Human:dog ratio	6.92:1
Sex distribution	
Male	60.31
Female	40.68
Male to female dog ratio	1.48:1
Age distribution	
<1 yr	29.01% (367)
1–8 yrs	56.28% (712)
>8 yrs	14.70% (186)
Breed distribution	
Desi breed (mongrel)	98.65%(1248)
Identified breeds	1.35% (17)
Utility of dogs	
Security Hunting and Herding	59.76% (756)
Companionship and Pet	28.14% (356)
Breeding	4.27%(54)

Table 2 Management status of Dogs

Confinement	
Never	70.43%(891)
Partial	13.83%(175)
Unknown	15.73%(199)
Care providers	
Father	7.50 %(95)
Mother	9.88 %(125)
Children	4.82%(61)
Everybody	77.79%(891)
Feeding of dogs	
Family left over	98.26%(1243)
Cook special food	1.26%(16)
Buy commercial food	0.47%(6)
Vaccination of dogs against rabies- prior to programme	
Vaccinated	0.55% (7)
Not vaccinated	20.40(258)
Unknown	94.86(1200)

Figure 1



MAP OF THE BANDIPUR TIGER RESERVE WITH THE VILLAGES ADJOING THE FOREST REGIONS

The results obtained from the estimate of dog population in the Bandipur Tiger Reserve area of the villages adjoin forests, the community predominantly inhabited by tribals and people whose parts of daily living are connected to the forests with many people from different tribes whose cultures allow dog ownership has high population of dogs in direct counts. The entire ecology, dog demography, present status of dogs in the villages/ hamlets was recorded (Table 1, 2, 3).

The study showed that dog owning households in the villages had an average of 2.3 dogs per household, a finding which was in close conformity with that from many reports. [4]. The mean dog to human ratio obtained in this study was 1: 6.92. This was in variance with other reports [4],[5], [6], [7]. Similarly, it concurs with the findings from Nigeria [8],[9], [10].

These discrepancies in dog to human ratio in the different study areas could be attributed to differences in socio-cultural, economic and religious status and beliefs of the inhabitants of the different study areas. The inhabitants belong to the various tribal communities and have close association with dogs. These tribals keep dogs primarily for security purposes including safeguarding livestock from attacks by predators and also protecting their farm crops from destruction by wildlife. Despite this important service provided by the dogs, their care and management were mostly poor. Many were poorly fed and not confined and so forced to move around the neighborhood in search of something to eat from dumps. Such dogs are referred to as ‘‘neighborhood’’ or ‘‘community’’ dogs [1].

Table 3- Location of villages and number of dogs vaccinated

	TALUK	VILLAGE NAMES	NO. OF DOGS	GPS CORDINATES	
1.	H.d	Kanchanahalli	15	11.91098	76.32303
2.	H.d	Moorbundh	6	11.91477	76.30674
3.	H.d	Kanakahalli Thittu	4	11.91317	76.29886
4.	H.d	Kanaka halli	10	11.92177	76.29357
5.	H.d	Kalasur	8	11.91584	76.33078
6.	H.d	N. Begur	27	11.90812	76.29093
7.	H.d	Mallada Aadi	7	11.90535	76.29005
8.	H.d	Jaganakotte	1	11.90288	76.28719
9.	H.d	Kempanapura	2	11.90417	76.28147
10.	H.d	Jakkahalli	7	11.90114	76.27655
11.	H.d	Bramha giri	9	11.90567	76.26755
12.	H.d	Hosahalli	10	11.90181	76.25542
13.	H.d	Gandatoor (Gundre)	11	11.92496	76.24093
14.	H.d	Hullamala	4	11.93365	76.40047
15.	H.d	Dadada halli	21	11.93926	76.40333
16.	H.d	Dadada halli colony	6	11.92848	76.41014
17.	H.d	Bedalapura	5	11.94262	76.41362
18.	H.d	Bedalapura colony	2	11.94264	76.41362
19.	H.d	Huskar colony	8	11.93670	76.43346
20.	H.d	Haleyuru	9	11.95321	76.41446
21.	H.d	Heggagudalu	6	11.95653	76.42312
22.	H.d	Devalapura	24	11.92540	76.39299
23.	H.d	Kallahalla	12	11.90592	76.39036
24.	H.d	Badaga	7	11.89657	76.38547
25.	H.d	Gadde hoondi	2	11.88603	76.38665
26.	H.d	Matte gere	14		
27.	H.d	Kanthana Aadi	7	11.85694	76.37796
28.	H.d	Heerahalli	11	11.86890	76.37890
29.	H.d	Bankavadi Colony	6	11.87207	76.35051
30.	H.d	Bavikere Aadi	6	11.88787	76.05206
31.	H.d	Bankavadi	14	11.88007	76.35661
32.	H.d	Seegodi Aadi	2	11.87716	76.39001
33.	H.d	Naada Aade	34	11.86689	76.35337
34.	H.d	Kebbepura Aadi	21	11.85543	76.36087
35.	H.d	Moluyor	10	11.86365	76.37100
36.	H.d	Kandhaleke	4	11.88578	76.41897
37.	H.d	Kadabegur	4	11.86670	76.41179
38.	H.d	Kurnagalla	11	11.84919	76.41307
39.	H.d	Hallanahalli	5	11.83893	76.41203
40.	H.d	Muthkana mula	4	11.86470	76.42122
41.	H.d	Shivapura	4	11.85847	76.42307
42.	H.d	Kanakana halli	5	11.83660	76.42689
43.	H.d	Dodda bargi	8	11.83660	76.42689
44.	H.d	Kalanahoondi	6	11.83597	76.43295
45.	H.d	Chikkabargi	2	11.82823	76.44072
46.	H.d	Muttege hoondi circle	3		
47.	H.d	M.c talalu circle	5	11.87444	76.42611
48.	H.d	M.c talalu hadi	9	11.87949	76.40933
49.	H.d	Kadegere	3	11.84675	76.43444

50.	H.d	Channagoondi hadi	7		
51.	H.d	Jaylaxmipura	2	11.86685	76.43140
52.	H.d	Yathige	5	11.89109	76.45538
53.	H.d	Yaswanthpura	4	11.89153	76.46433
54.	H.d	Venkatagiri Colony	3	11.87623	76.46724
55.	H.d	Harahalli Addi	4	11.87422	76.45942
56.	H.d	Channagoondi	3	11.87356	76.45021
57.	H.d	Bankahalli	9	11.88613	76.46998
58.	G.pet	Nagarathnamma colony	2	11.92224	76.60033
59.	G.pet	Kothanahalli Colony	3	11.93323	76.56599
60.	G.pet	Kothanahalli	17	11.92810	76.56740
61.	N.gud	Nagnapur	4	11.90708	76.53270
62.	N.gud	Ballurahoondi	2	11.90321	76.53030
63.	N.gud	Naganapura colony	8	11.92252	76.51718
64.	N.gud	Mahadeva nagar	5	11.92736	76.51456
65.	N.gud	Venkatchallapura	4	11.92535	76.49726
66.	N.gud	Vadayana pura	5	11.91617	76.49262
67.	N.gud	Hosapura	25	11.98466	76.58759
68.	N.gud	Srikantapura	4	11.97516	76.59953
69.	G.pet	Manchahalli	6	11.89461	76.61104
70.	G.pet	Kurubarahundi	2	11.93163	76.60847
71.	G.pet	Shavkanahalli	5	11.88362	76.60666
72.	H.d	Chikkabargi Colony	3	11.82202	76.43579
73.	G.pet	Hallatoor	15	11.87352	76.60006
74.	G.pet	Siddayanapura colony	0	11.85687	76.59733
75.	G.pet	Deshipura	31	11.85064	76.58709
76.	G.pet	Deshipura colony	6	11.84383	76.58065
77.	G.pet	Bargi	22	11.82754	76.59688
78.	G.pet	Mukathi colony	21	11.81962	76.57003
79.	G.pet	Nagapatana	4	11.83242	76.56713
80.	G.pet	Honghalli	22	11.80553	76.58031
81.	G.pet	Hullyammana guddi	9	11.79093	76.57234
82.	G.pet	Naveelu gunda	14	11.78933	76.56044
83.	G.pet	Channamallipura	13	11.78624	76.56881
84.	H.d	Vaderahalli	4		
85.	G.pet	Maddur	9	11.77721	76.55881
86.	G.pet	Maddur colony	37	11.78214	76.54868
87.	H.d	Kudege Colony	4	11.85910	76.41101
88.	H.d	Kudege	6	11.86015	76.41408
89.	G.pet	Berambadi	24	11.76109	76.56777
90.	G.pet	Lakkipura	2	11.75576	76.57756
91.	G.pet	Lakkipura colony	2	11.75089	76.57623
92.	G.pet	Kunnagahalli	13	11.75045	76.59802
93.	G.pet	Kunnagahalli colony	3	11.74758	76.59402
94.	G.pet	Haggada halla	23	11.73058	76.59830
95.	G.pet	Hosahalli Colony	10	11.73108	76.61274
96.	G.pet	Siddayanapura	9	11.72344	76.65620
97.	G.pet	Kalligowdanahalli	31	11.72137	76.65926
98.	G.pet	Muguvanahalli	13	11.69755	76.65119
99.	G.pet	Muguvanahalli colony	4	11.69350	76.65014
100.	G.pet	Mellakamanahalli	22	11.69965	76.63886
101.	G.pet	Melakamanahali colony	6	11.69493	76.63621
102.	G.pet	Karamala	9	11.65943	76.65469
103.	G.pet	Adina kanave	18	11.64513	76.65514

104.	G.pet	Channe katte	6	11.65386	76.65859
105.	G.pet	Mangala	24	11.64973	76.67129
106.	G.pet	Kaniyanpura	5	11.63853	76.66854
107.	G.pet	Kaniyanpura colony	32	11.63276	76.68199
108.	G.pet	Karagihoondi	3	11.63463	76.67654
109.	G.pet	Jakkhalli	13	11.64552	76.68083
110.	G.pet	Booradhara hoondi	10	11.64039	76.68773
111.	G.pet	Anangihundi	8	11.65414	76.68283
112.	G.pet	Chaluvarayanapura	18	11.64469	76.69235
113.	G.pet	Guddekere	11	11.65261	76.69625
114.	G.pet	Yelachatty	13	11.64631	76.70525
115.	G.pet	Lokkere	8	11.65859	76.70536
116.	G.pet	Chikkayelachatty	6	11.65490	76.72783
117.	G.pet	Bachalli	18	11.70449	76.73497
118.	G.pet	Malapura	8	11.70846	76.75471
119.	G.pet	Kundakere	44	11.69314	76.78684
120.	G.pet	upgara colony	4	11.66970	76.77729
121.	G.pet	Upgara	4	11.66574	76.77023
122.	G.pet	Cherakanahalli	11	11.71100	76.80942
123.	G.pet	Kadubur	3	11.70995	76.81992
124.	G.pet	Ramayanapura	15	1 1.73171	76.84469
125.	G.pet	Ramayanapura colony	6	11.71828	76.83914
126.	G.pet	Yarganahalli	27	11.74108	76.84861
127.	C.nagar	Vaddarahalli	9	11.75690	76.88171

In this study most of the dogs were recognizable and traceable to specific owners, but they enjoy free range. A dog from one household is permitted to wander the neighborhood and may be offered food in other households. This promotes straying, encourages the gathering of dogs in packs and facilitates easy contact between dogs and humans/domestic animals/wildlife and cycle of endemic canine rabies can be easily maintained. In addition, there are problems of environmental pollution, social nuisance of dog bites that led to extermination and increased human exposure risk to rabies.

Also, as observed during the study, some villagers keep dogs for guarding purposes and most of these people keep three or more dogs. These villages and hamlets are placed in areas adjoining forest regions, the dogs indicate a sign of danger from any wild animal and also as assured body gaurds. The dogs in villages are mostly used either for hunting and or guarding of farm crops and livestock from attacks by predators or for security reasons. The breed, age and sex distribution of dogs population obtained in this study showed that majority of the dogs kept by owners are the indigenous breed which are mostly cheap and easy to obtain and aged between 1 and 8 years of age. Other investigators have also identified this age range as most active in the lives of dogs [8], [9]. Also, as observed during the study, most people keep more male dogs as compared to female dogs. This is consistent with other reports [9, 10, 11] and this preference appears to be due to the belief that male dogs make better guards and also female dogs attract a lot of male dogs to the house during their mating periods. Dogs being seasonally polyestrus may cause a menance during the estrus period leading to an increase in the dog population.

The study showed there has been low vaccination coverage against rabies before the vaccination programme. This is insufficient to control the spread of rabies and also indicative of lack of awareness amongst the general public on the dangers of rabies posed by unvaccinated dogs in the study area. To have an effective control of rabies, vaccination coverage of 70–75% is considered necessary [11, 12] (Table 2). The opinion of respondents who had knowledge on cases of dog bites in the study area showed that dog bite cases do occur frequently among family members and the dog bite victims were mostly bitten by dog with owners (household dogs and neighbors dogs). Other investigators have reported similar findings [9, 13, 14].This suggests that circumstances of dog bite or transmission of rabies is not always due to stray dogs but even the owned dogs may be involved in transmission of rabies. This proves to be an essential point of focus that we had covered 127 villages carrying 1265 dogs providing an unwinding 95% coverage. The most important aspect of this programme was that all the villages were close to forests and were susceptible to predator attacks, the vaccination of the stray dogs/village dogs provides a “bio fencing” phenomenon that provides a barrier support to the wild animals even if the rabies positive cases are ingested by these big cats, preventing the spread of disease to the wild, curbing the sylvatic cycle.

In this paper, by combining official disease reports, published demographic studies on domestic dogs and prevalence data of rabies in domestic and wild carnivores, we hypothesize that rural/village dog populations are the most likely source of infection for wild carnivores. In the Bandipur wildlife region, the transmission events probably occurred in the rural interface near villages close to forests, where a high density and an elevated number of dogs allowed to roam freely exist. Although the question whether a point source from domestic dogs to wild carnivores really occurred is not easily answered with this retrospective data, the rabies incidence data in rural dogs have shown critical variants in the sylvatic transmission of the disease [15]. High-density domestic dog populations have been proposed as the likely maintenance population for rabies virus in the ecosystem in Bandipur. Also, domestic dogs were identified as probable source of rabies, as the wild carnivores prey on the rural dogs especially the ones less active or isolated as in this case rabies; there is a direct contact of the agent and the host. Although in this study, the maintenance of rabies population infection was not addressed directly, it is probable that the rural dog population and our target population, the population of wild wild carnivores, are both maintenance populations as this mimics a propagating epidemic establishing the "Reed Frost model. A remarkable finding during the study was that the Human-animal conflicts (Tigers and Leopards) were recorded the areas where there was a superfluous dog population, unlike in areas were the dog population was less the humans were falling as prey for these big cats. On the epidemiological aspect if on such happening, the dog that was preyed upon by the tiger or leopard was positive for rabies then there is a direct contact of the disease spread in the Sylvatic cycle. Thus, there is a clear transmission of disease from domestic to wild populations and this infected carnivore serves to be a propagating epidemic. A common source epidemic is one in which all cases are infected from a source that is common to all individuals. If the period of exposure is brief, then a common source epidemic is a point-source (or, more briefly, just a point) epidemic. A propagating epidemic is an epidemic caused by an infectious agent in which initial (i.e., primary) cases excrete the agent, and thus infect susceptible individuals, which constitute secondary cases. The shape of a propagating epidemic is defined by a model. One of the basic models is the Reed-Frost model [15]. In this model's classical simple form, the population is divided into three groups, comprising:

1 . infected animals (cases);
2. susceptible animals;
3. immune animals.

This modeling will help us to forecast the disease dynamics in the wild populations, but intense study and experimenting is necessary to fill up the equation that has been derived in the model validating the study on the dog ecology.

The model is constructed using the formula:

$$C_{t+1} = S_t (1-q^{Ct}),$$

where:

t = the time period: usually defined as the incubation period or latent period of the infectious agent
C_{t+1} = the number of infectious cases in time period, t+ 1;
St = the number of susceptible animals in the time period, t;
q = the probability of an individual not making effective contact. The value, q, is given by (1 - p), where p = the probability of a specific individual making effective contact with another individual which would result in infection if one were susceptible and the other were infectious. The term (1 -q^{Ct}) arises because it represents the probability that at least one of the Ct [15].

The study showed that 2.6 % of dog bite victims died after manifesting some abnormal nervous signs and none of them received anti rabies post exposure prophylaxis following the bite. This is a possible reflection of lack of knowledge on the dangers of rabies among the public as only 4.89 % of the respondents indicated that the dog bite victims received anti rabies post-exposure treatment whereas majority of other victims prefer non-specific management approaches like the traditional medication which involves roasting the liver and brain of the biting dog to be taken by the victim, the application of the offending dog's hair on the bite wounds and the use of herbs. These have failed in saving the lives of such victims. Also, cases of health care workers prescribing canine vaccine have to human victims of dog bites as post exposure prophylaxis were observed during the study a serious concern on the lack of knowledge on rabies among some primary health care workers [16]. The holistic nature of traditional medication has prompted victims of dog bite to psychologically and culturally accept this mode of treatment and this is of serious public health concern.

Conclusion

The wild carnivores studied in this paper are classified as endangered, this study should be viewed as a model that could be applied to other areas of conservation where rabies can be foreseen as an epidemic. Comprehensive guidelines for control in dogs have been prepared by the World Health Organization and include the following: [16].

- Notification of suspected cases, and destruction of dogs with clinical signs and dogs bitten by a suspected rabid animal;
- Reduction of contact rates between susceptible dogs by leash laws, dog movement control, and quarantine;
- Mass immunization of dogs by campaigns and by continuing vaccination of young dogs;

- Stray dog control and destruction of unvaccinated dogs with low levels of dependency on, or restriction by, man
- Dog registration

These methods serve as connecting aids in control, but intense study on the dog ecology, distribution and predation style of the wild carnivores may be helpful in framing protocols for curbing out rabies in wild animals as well as humans. We have succeeded in mass vaccination of dogs and the efficacy of these vaccines will be checked in the subsequent visits to these villages checking the antibody titres of these dogs. The wild carnivores studied in this wild life region are classified as endangered; this study should be viewed as a model that could be applied to conservation. Although domestic dogs have been identified as a maintenance population for rabies [17], the exact extent of the domestic dog reservoir population is difficult to determine as village populations are connected to nearby forests, which may act as the ultimate source of infection. A major consideration for large-scale disease control programmes like this aimed to control rabies outbreak in wildlife is therefore whether control measures such as mass vaccination of dogs should be targeted primarily to high density rural areas especially the villages and hamlets adjoining forests where there is a liable biological interface for transmission to occur.

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