

Epidemiology of Rabies in Sudan

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Abstract: Epidemiology of rabies in Sudan over the period 1992-2002 was studied. Data about rabies incidence in human and animals was collected and statistically analyzed. A total of 424 brain specimens were examined for rabies using Fluorescent Antibody Test (FAT). During the study period 180957 human rabies post-exposure treatments and 253 human rabies deaths had been reported. The majority of post-exposures (90727) were in Khartoum State, while most of human deaths (78) were in Central State. Peaks of human exposures were in June-July and March. A total of 2656 animal rabies suspects were reported of which 1401 were in Khartoum, highest figures were during January and February. Dogs, goats and donkeys were the main animals involved in rabies epidemiology. Out of 424 tested brain specimens, 243 were positive, most of them were dogs and goats. The rabies vaccinated and destroyed animals were 37620 and 49616, respectively.

Keywords: Rabies, epidemiology, human, animal

INTRODUCTION

Rabies is known to be endemic in Sudan since its first report in 1904^[1]. Many authors reviewed the rabies situation in Sudan. El Nasri^[2] reported that rabies has spread from Eritrea and Abyssinia to the eastern part and from West Africa to Darfur, then gradually to other parts of the country. The author reported that out of 5373 brain samples tested for rabies, 1531 were positive during the period 1935-1959, using histopathological examination. Harbi^[3] reported that 2070 cases of rabies had been confirmed in Sudan during 1904-1970, where dogs constituted 73.3% of them and game animals were only 6 (0.3%). El Hag Ali^[4] reviewed rabies situation in Sudan, a total of 18914 rabies vaccine for animals had been issued during 1952-1974. Ibrahim *et al.*,^[5] reviewed the situation of rabies in humans and animals in Sudan during 1981-1983. During 1975-1985 an increasing rabies incidence was observed in Khartoum state^[6]. Out of 2044 brain samples tested for rabies during 1977-87 117 were positive and 66.7% of them were dogs^[7]. During 1988-1991, a total of 1964 suspected rabid animals were reported while 55514 humans had received rabies post-exposure treatment during 1985-1991 in Khartoum state^[8].

Out of 1191 suspected rabid animals reported in Sudan during 1992-1998, 492 were dogs, 314 goats, 172 donkeys and few numbers of cats, monkeys, sheep, horses, cattle and camels were also found^[9]. The authors reported that 69163 humans had received rabies post-exposure treatment while 165 deaths of the disease were reported in Sudan during 1992-1998. An outbreak of rabies

in humans and animals was reported in western Sudan (Darfur state) during April-September 2000^[10]. Most of the reviewed research on rabies epidemiology in Sudan was concerned with animal rabies. This study is intended to elucidate the epidemiology of rabies in Sudan with regard to its incidence in animals and humans, seasonality, geographical distribution, laboratory diagnosis and control over the period 1992-2002. As rabies epidemiology shows some similarity in different localities, the results of this work can add to the knowledge about this disease in Africa and other tropical countries which can aid in the control of this fatal disease worldwide.

MATERIALS AND METHODS

Data sources

Human rabies: Records, annual and monthly reports of ministry of health from 1992-2002 were examined and data about human rabies deaths and post-exposure treatments in different months, years and location were obtained.

Animal rabies: Two sources of data were considered in this study to determine the magnitude of rabies burden in animals. Cases of rabies in different species of animals (establish on base of clinical diagnosis) reported from all over Sudan by veterinary field officer on a clinical base with confirmatory laboratory tests. Records of rabies control strategies adopted over the study period. These data was reviewed.

The other source of data is brain specimens submitted to the Central Veterinary Research laboratory in

Table 1: Human rabies post-exposure treatments and deaths of the disease in Sudan 1992-2002

Year	Khartoum		Central		Northern		Eastern		Kordofan		Darfur		Total	
	P	D	P	D	P	D	P	D	P	D	P	D	P	D
1992	10500	2	678	-	91	-	25	-	121	1	2237	-	13652	3
1993	7853	2	232	10	1	1	476	21	144	2	6	-	8712	36
1994	8122	3	238	15	26	4	215	12	51	3	5	-	8657	37
1995	12861	3	264	7	12	-	47	1	634	4	16	1	13834	16
1996	6721	7	142	8	56	-	160	14	40	2	2	3	7121	34
1997	10885	2	-	1	-	-	2	3	77	4	-	-	10964	10
1998	6180	-	117	15	41	4	208	8	20	1	-	1	6566	29
1999	6567	6	400	5	1	-	300	2	157	7	390	-	7815	20
2000	6137	3	950	9	128	2	388	1	291	3	918	14	8812	32
2001	10089	6	1809	-	135	2	622	2	664	2	1121	-	14440	12
2002	4812	2	1262	8	100	1	353	1	578	6	1279	6	8384	24
Total	90727	36	6092	78	591	14	2796	65	2777	35	5974	25	108957	253

P: Post-exposure treatments D: Deaths

Khartoum. A total of 399 fresh and 25 formalin preserved brain samples were collected and tested for rabies using Fluorescent Antibody Technique (FAT). FAT was applied on all brain specimens according to Dean *et al.*,^[11]. Formalin preserved samples were treated prior to FAT application by double enzyme digestion (trypsin and pepsin) as previously described^[12,13].

Data analysis: The occurrence of rabies in species, location and years was tabulated and check for significance difference. Furthermore the time trend of rabies in different species was explored. Statistical package SPSS was used for analyzing the data.

RESULTS

Human rabies: (During 1992-2002 rabies was found to be exciting in Sudan, a total of 108957 rabies post-exposure treatments had been reported. The average number of post-exposure per year was found to be 9945.09 ± 2835 (median=8712, minimum=6566 and maximum= 14460). A higher resurgence in rabies post-exposure was observed in the year 2001 (14460) and the year 1992 (13688). The majority of post-exposure doses were used in Khartoum followed by Central Sudan. 253 human deaths of the disease had been reported from 1992-2002, average number of deaths per year was found to be 23 ± 11.6 with the minimum number of deaths reported in 1992 (only three deaths) and the maximum number of deaths were reported in 1994 (37 deaths) and 1993 (36 deaths). The highest number of deaths was reported from central Sudan (78 deaths), followed by Eastern Sudan (65) and the minimum number of deaths (14) were reported from Northern Sudan (Table1 and Fig. 1).

Demand for post-exposure treatment is high around the year with peaks in June-July and March, however different time trend of post-exposure in different regions could be observed (Fig. 2 and 3).

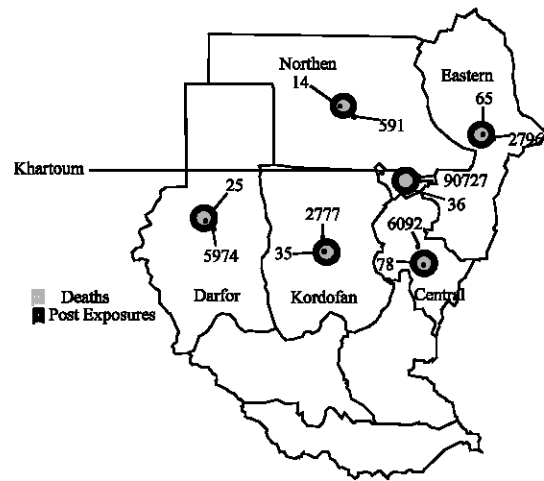


Fig. 1: Human rabies post-exposure treatment and deaths in Sudan 1992-2002

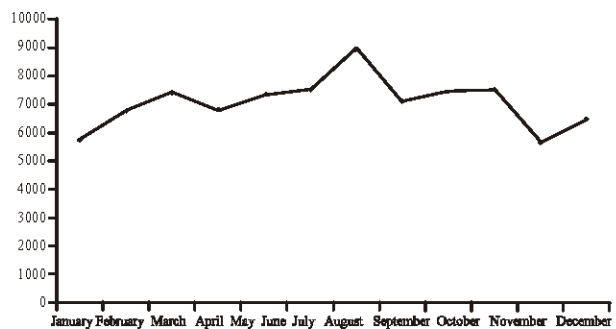


Fig. 2: Seasonal variations of human rabies post-exposure treatment 1994-2002

Animal rabies: Rabies suspected cases: A total of 2656 suspected rabid animal cases had been reported to the veterinary clinics in Sudan during 1992-2002 with highest incidence in Khartoum (1401) followed by Kordofan (535) Darfur (402), Northern (195), Eastern (80), Central States (43); this is shown in Fig. 4.

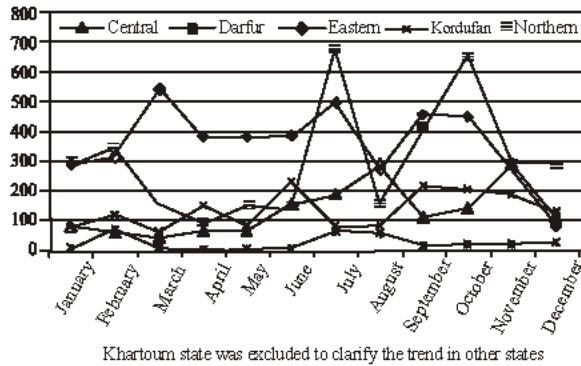


Fig. 3: Time trend of human rabies post-exposure treatments in different states of Sudan

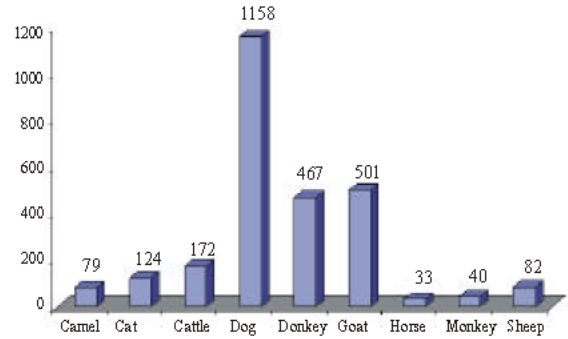


Fig. 6: Species of rabies suspected animals 1992-2002

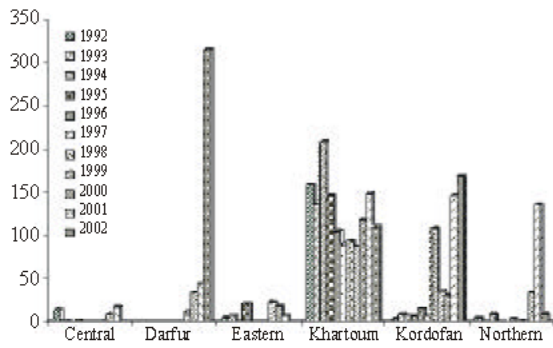


Fig. 4: Reported rabies suspected animals in different states from 1992-2002

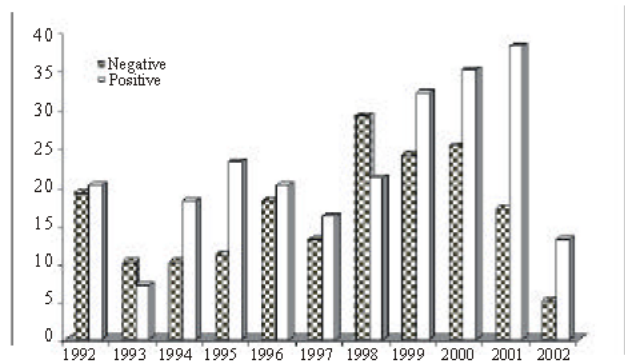


Fig. 7: Laboratory confirmed rabies specimens 1992-2002

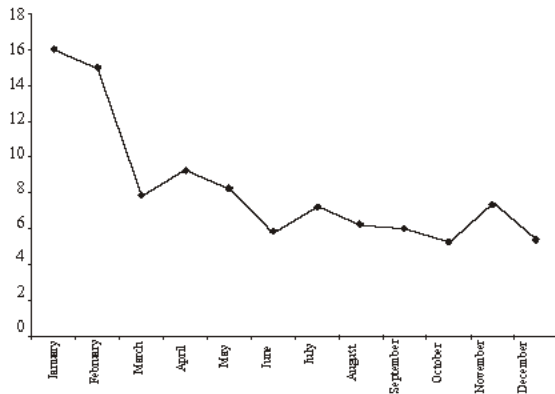


Fig. 5: Animal rabies suspected cases distribution over time 1992-2002

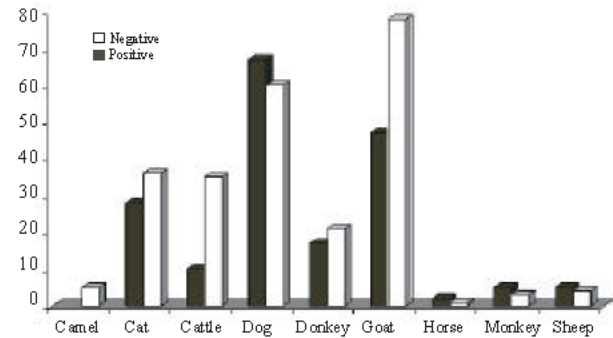


Fig. 8: Laboratory tested specimens from rabies suspected animal species

Seasonal variation of animal rabies: Evidences of seasonal variability in reported suspected rabid animal cases in Sudan are clearly shown in Fig. 5, more cases were reported in January (16%), (15%) in February.

Affected animal species: Incidence of rabies was reported in nine species from which was higher in dogs, goats then donkeys (Fig. 6).

Rabies laboratory diagnosis: Laboratory diagnosis of rabies is carried out using FAT; out of 424 brain specimens examined 243 were positive. Figure7 shows the results of rabies laboratory diagnosis in different years. With regard to the species of animal brain specimens submitted to laboratory examination, most of specimens and positive results were collected from goats and dogs (Fig. 8). Out of the tested samples 25 were formalin fixed enzyme digested brain specimens of which 18 were positive.

Table 2: Rabies control measures in Sudan (1992-2002)

Year	Khartoum		Central		Northern		Eastern		Kordofan		Darfur		Total	
	V	D	V	D	V	D	V	D	V	D	V	D	V	D
1992	3850	2368	0	0	10	0	11	0	0	0	0	0	3871	2368
1993	469	0	0	0	500	0	398	0	208	0	0	0	1575	0
1994	313	0	0	0	0	0	15	0	100	0	0	0	428	0
1995	1030	110	0	0	0	0	7	0	0	0	0	0	1037	110
1996	2324	98	0	0	0	0	200	0	0	0	0	0	2524	98
1997	705	10263	0	0	0	0	969	0	0	0	0	0	1674	10263
1998	2302	9500	0	0	0	0	0	0	1383	0	0	0	3685	9500
1999	326	100	0	0	0	0	0	0	527	44	0	0	853	144
2000	2946	1053	0	82	0	2671	0	76	394	40	0	441	3340	4363
2001	3025	4000	2216	1742	3067	11663	600	1000	1794	118	691	905	11393	19428
2002	825	249	77	0	2025	0	1000	1750	1452	200	1661	1143	7240	3342
Total	18115	27741	2293	1824	5602	14334	3200	2826	5858	402	2525	2489	37620	49616

V: Vaccination D: Destruction

Rabies control: Rabies control strategy routinely applied in Sudan is vaccination of susceptible animals and destruction of stray and non vaccinated ones, from 1992-2002 a total of 37620 animals had been vaccinated meanwhile 49616 had been destructed (Table 2).

DISCUSSION

Rabies is endemic in Sudan, continuous outbreaks of the disease since 1904 where its first incidence had been reported^[1]. Human rabies post-exposure treatments as well as deaths of the disease in Sudan is routinely occurred, during 1981-1987 a total of 12029 human exposures and 13 deaths of rabies in Khartoum State had been reported^[7]. The reported human rabies post-exposure treatments in Sudan during 1988-1991 were 36473, while deaths were 29^[8].

In this study reported human rabies post-exposure treatments and deaths of the disease were 108957 and 253 respectively. It was noticed that the majority of post-exposure cases (87.6%) were reported in Khartoum State, the same was noticed previously^[7-9]. This is mainly due to the lack of rabies vaccine and the weak reporting system in different States specially Kordofan and Darfur where more animal cases while less human exposures were reported. Occurrence of rabies in humans is reported allover the year, however slight seasonal variation was observed, many reports describing the correlation between human rabies exposures and mating seasons of dogs were reviewed^[8,14]. In the present study as noticed in the previous reports, slight increase in human rabies post-exposure treatments during December to March and July was observed although it was statistically insignificant ($p > 0.05$).

Incidence of rabies in animals in Sudan is known to occur annually with different rates, it was noticed that Khartoum State usually reports the highest Figure (52.7%) which is mainly due to the increased public awareness of the disease and the weak reporting system in different States.

Although rabies suspected animal cases are reported in different months it was noticed in this study that highest figures were reported in January (16%) and February (15%) this is slightly similar to the reported human rabies exposures which may indicate some sort of seasonality of rabies incidence which is related to the mating season of dogs.

Dogs are known to be the main animal involved in rabies epidemiology in Ethiopia^[15] and in Sudan, while the second main animals reported to be rabid are goats and donkeys as they are usually kept outdoors being in close contact with dogs^[5-8]. During the study period 43.6% of reported rabies suspected animals were dogs, 18.9% goats and 17.6% donkeys, this was in agreement with the previous reports.

Rabies laboratory diagnosis in Sudan is currently applied using FAT, until the last two decades it was based on histopathological examination. Out of 737 rabies laboratory confirmed cases in Sudan during 1950-1959, 537 were dogs, 75 donkeys, 38 goats^[2], during 1960-1970, out of 449 rabies positives, 284 dogs, 99 goats and 33 donkeys were reported in Sudan^[3]. It was noticed in the present study that the highest Figure of rabies positive cases were reported during 1999, 2000 and 2001 and that most of rabies positives were dogs, goats, donkeys and cats as previously described. The application of FAT on formalin preserved brain specimens was not possible, after the use of enzyme digestion FAT could be successfully applied on those specimens^[12,13,16]. In this report FAT was applied on 25 formalin fixed brain specimens with 18 positive results.

Rabies control measures are crucial for facing and minimizing its incidence. The routinely applied strategy in Sudan is vaccination of susceptible animals and destruction of non vaccinated ones. In Sudan dog vaccination against rabies was established in 1953^[17], since then annual vaccination was applied, the decrease in number of vaccinated animals was usually associated with increase in rabies incidence. During 1947-1957, a total of 24853 dogs and 8423 cats had been destroyed in

Sudan, while from 1953-1957, 1251 dogs and 6 cats were vaccinated against rabies^[2]. From 1981-1983 vaccinated animals were 680 dogs, 97 monkeys and 2 cats, while 11886 stray dogs were destroyed in Khartoum province^[5]. The number of vaccinated dogs, monkeys, horses and cats in Khartoum during 1977-1987 were 8363, 732,45 and 19, respectively, meanwhile during 1978-1982 a total of 24960 stray dogs were destroyed (Hameid, 1989). From 1990-1992 in Khartoum State, 15745 dogs were vaccinated and 2463 were destroyed^[6]. It was clear that vaccination coverage is usually very low compared to the estimated number of dogs in Sudan which explains the existence of rabies and its continuous outbreaks.

During the period of this study, 37620 animals had been vaccinated and 49616 had been destroyed, it was noticed that the highest figures of vaccination and destruction were reported in Khartoum State; generally it is considered very low coverage as the number of owned dogs in Khartoum State during animal census in 1992 was 71540. Direct correlation was observed between control programmes and the spread of rabies, the high the number of vaccinated and destroyed animals the lower is the reported rabies suspects in the year after.

Great discrepancy was noticed in reporting of rabies incidence between veterinary and health authorities, it was clear that the majority of human exposures were not reported to the veterinary authorities. Strengthen of rabies reporting system as well as the link between veterinary and health authorities is highly recommended. A strict rabies control activities should be applied annually, availability of human rabies vaccine and the improvement of rabies laboratory diagnosis in different States is highly recommended.

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